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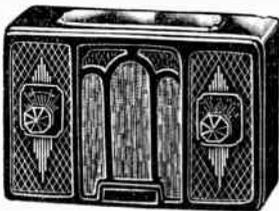
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LOW FILAMENT VOLTAGE As An Adjunct of Frequency Stability

By J. E. Anderson

IN a preceding issue we showed that a tuned plate oscillator could be stabilized as to frequency by means of an inductance in the plate circuit between the plate and the resonator equal in value to the inductance in the tuned circuit, and the stabilization would obtain for all values of the tuning condenser. The stabilization, however, was contingent on the possibility of making the grid resistance zero; that is, prevent the flow of grid current. This has been somewhat of a problem, yet it can be solved by an extremely simple expedient. The method seems to be self-evident, yet as far as is known it has never before been suggested.

If there is no grid leak and stopping condenser in the circuit the amplitude of the oscillation is determined mainly by the emission of the tube and by the plate current cut-off voltage. The solution, therefore, is to proportion the voltages on the elements of the tube so that saturation occurs in the negative bias region. There are two ways of doing this. For a given cathode temperature it can be done by increasing the plate voltage, and for a given plate voltage it can be done by decreasing the filament temperature. Which method to choose depends on the power that must be obtained from the tube. For a test oscillator that is merely to give a pure wave of constant frequency, and that is to be operated at lowest cost, the reduction of the temperature to the lowest practical value and the plate voltage in proportion seems to be logical.

Experimental Curves

As a test of the theory a set of grid voltage, plate current curves were taken on an 85 tube with only two volts on the heater. The current obtained with this voltage on the heater never exceeded 0.1 milliamperes for plate voltages up to 180 volts. The resulting curves are plotted in Fig. 1. The individual current values are not very accurate because a 0-1 milliammeter was used in the test and all the readings were confined to the first two divisions on a 20-division scale. But they are accurate enough for the purpose, which was to see what the lowest practical plate voltage was and what bias to use on the grid to give best operation.

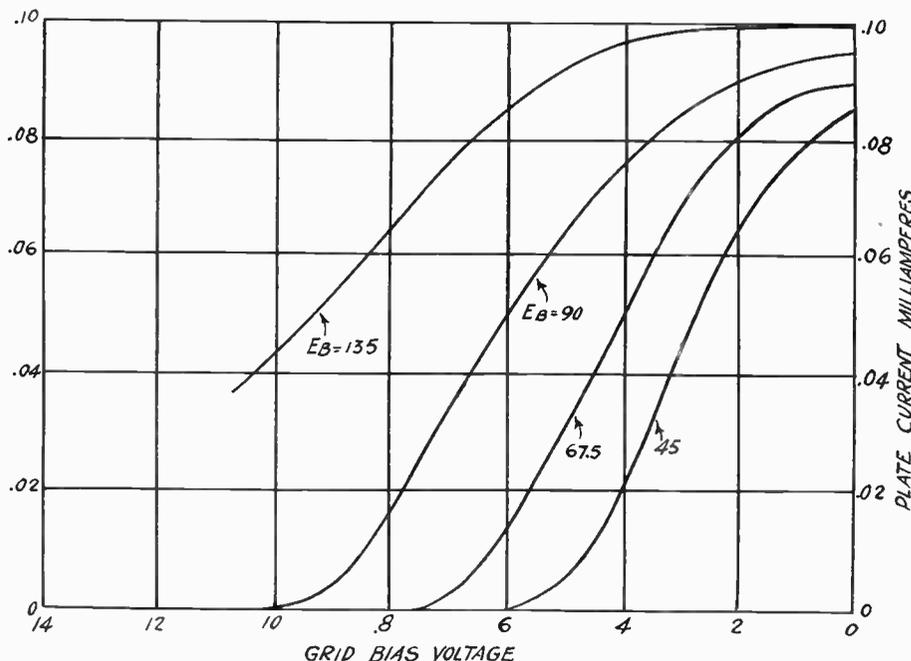


FIG. 1

Grid voltage, plate current curves of an 85 tube with only 2 volts on the heater. Saturation current is reached for negative values of bias

The curves shown are for 135, 90, 67.5, and 45 volts on the plate. The highest bias voltage available at the time of the test was 10.5 volts and for that reason the 135-volt curve carried no further.

It will be noted that even for the lowest voltage, namely, 45 volts, the effects of saturation begin to show at a bias of 2 volts.

Having these curves the next step was to set up an oscillator. For convenience this was made a Hartley, using for the inductance the primary of an audio output transformer designed for two 245 power tubes. Across this winding was connected a condenser of 0.004 mfd. The resulting frequency was judged to be around 250 cycles per second. A high resistance headset was connected in series

with the battery without any condenser across it.

When the plate voltage was 67.5 volts there was no oscillation when the bias was zero. Neither was there oscillation when the bias was 1.5 volts. At 3 volts there was a strong oscillation, with a pitch apparently much higher than the 250 cycles. At 4.5 volts there was a steady oscillation of the 250-cycle frequency, and it was sensibly a pure tone. The reason for the apparent high pitch at 3 volts was the high harmonic content in the output, due to oscillation far off the linear portion of the characteristic. No test was made at a higher bias than 4.5 volts, but the presumption is that had the circuit oscillated there the pitch would have been

(Continued on next page)

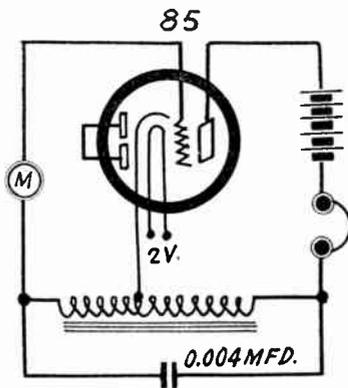


FIG. 2

The circuit diagram of a Hartley oscillator, working at an audio frequency, which oscillated with 2 volts on heater and which drew no grid current when properly adjusted

(Continued from preceding page)
high due to high harmonic content. This presumption is based on what occurred at the lower plate voltages.

When the voltage on the plate was 45 volts there was no oscillation on zero bias. At 1.5 volts there was a strong oscillation of apparently high pitch. At 3 volts bias the circuit oscillated with a pure tone of the above assumed pitch. At 4.5 volts the circuit would oscillate sometimes and sometimes not. However, when it did oscillate it was with an apparently high pitch, of exactly the same quality as in the other cases when oscillation took place off the straight portion of the curve.

No Grid Current

During all these tests there was no grid current as far as a 0-1 milliammeter would show, and it would indicate a current as low as 5 microamperes by carefully watching the needle.

Although no curve was taken for 22.5 volts on the plate, the circuit was tried for oscillation with that voltage. At zero bias there was oscillation rich in harmonics, but there was considerable grid current, amounting to approximately 25 microamperes. At 1.5 volts there was also oscillation, and at this bias the wave was pure. But there was grid current at this value also, amounting to approximately 10 microamperes. At 3 volts bias there was no oscillation, and, of course, no grid current.

In some of the cases when no sustained oscillation occurred there was a highly damped oscillation on closing the grid bias lead, that is, the grid circuit. It sounded like a drop of water falling from some height into a glass of water in which there is a considerable resonance cavity above the water surface. The sound is often referred to as "metallic." This sound, of course, occurred when the circuit was on the verge of sustained oscillation, but when the damping was too high.

Advantages of Low Temperature

There are obvious advantages of a low cathode temperature other than the possibility of securing practically infinite grid resistance. One is the constancy of the temperature. When the cathode is so "cool" that a glow cannot be detected in a dark room there is not likely to be much change in the temperature due to radiation of a variable nature. The economy of an oscillator drawing such a low heater current is an obvious advantage where the heating current is derived from a small dry cell. In this particular case the heater current was only 0.1 ampere, assuming that the filament resistance remains reasonably constant with changes in heat. The normal heater current for the 85-tube is 0.3 ampere when the term-

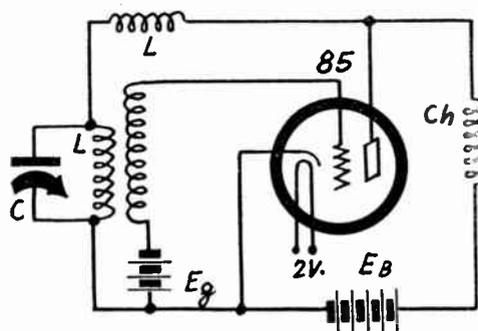


FIG. 3

A tuned plate oscillator, frequency stabilized, that may be operated at radio frequencies with subnormal heater voltage

inal voltage is 6 volts. In this case only one cell of the storage battery was used.

If other tubes are equally ready to oscillate, for example, a 230, then an oscillator could be built that required a heater current of only 20 milliamperes, for the normal current for that tube is 60 milliamperes. This current could be supplied by a very small dry cell for long periods.

There is also an obvious advantage in the economy of plate current. Suppose that the plate voltage is 45 volts and the bias is that which gives the purest tone, namely, 3 volts, the plate current is only 43 microamperes. Such a current could be supplied almost indefinitely by the tiniest B battery. The life of the battery would be almost the same as shelf life. The current of 43 microamperes, of course, refers to the 85 tube.

It will be noticed that as long as the emission is the same the current when the bias is adjusted to the purest tone, is about the same regardless of plate voltage used. There is a slight increase with plate voltage. But even if the plate voltage is 135 volts and the bias is adjusted to 9 volts, the plate current is only 53 microamperes. The higher the plate voltage the greater the assurance that the grid current shall be zero. But for a portable test oscillator, it is not convenient to use high plate voltages, both because of the additional plate voltage cells but also because of the additional grid bias cells.

The Operating Essentials

The essential conditions for no grid current is not that the heater voltage be low, but rather that the plate voltage be so high, for a given filament voltage that the saturation current is reached before zero bias is reached. If the temperature of the cathode is normal for the tube it is only necessary to increase the plate voltage sufficiently to insure that the saturation current shall be reached before the bias is zero. If the plate voltage is thus increased, and the bias is properly selected, no grid current will flow and the oscillation will be sensibly of pure wave form.

The theory has not yet been tried on a radio frequency oscillator. Possibly it will be more difficult to get oscillation at radio frequency because of the unfavorable L/C ratio. In the audio oscillator tried the inductance was very high and the capacity relatively low. In a practical radio oscillator the L/C ratio would be considerably lower, especially for the lower frequencies in a broadcast frequency oscillator.

The conditions for oscillation in this oscillator, that is, the one with the subnormal cathode temperature, are much more rigid than an oscillator where the mutual conductance is high. The plate re-

sistance in this case is extremely high, and therefore the mutual conductance is very low, since the amplification constant of the tube remains fixed. The slope of the 45-volt curve at 3 volts bias is approximately 22.5 micromhos. Since the amplification constant of the tube is 8.3 for the 85 tube, the plate resistance is about 370,000 ohms.

Tuned Plate Oscillator

The tuned plate oscillator in which the grid resistance is infinite and which has been frequency stabilized by the inductance in the plate circuit as explained above requires for sustained oscillation that $(mM-L)/C = Rr$, in which m is the amplification constant of the tube, M is the mutual inductance between the plate and the grid windings, L is the inductance in the tuned circuit, C the capacity in that circuit, and r is the a-c resistance in the plate circuit. Suppose that the two windings on the coil are equal and that the coefficient of coupling is k . Then the condition for oscillation reduces to $(mk-L)L = RrC$. Reasonable values to L and R are 250 microhenries and 10 ohms, respectively.

The value of r we just found for the special oscillator to be 370,000 ohms. Putting these values in the formula and expressing C in micromicrofarads, we obtain $mk-L = 0.0148C$ as the condition that must be satisfied. Since m is known to be 8.3, we have a relation between the value of C and the coefficient of coupling between the two coils. If the oscillator is to cover the broadcast band the largest value of C will be 334 mmfd. and the smallest will be 45 mmfd. Therefore at low frequency end of dial the coupling coefficient must be 0.716 and at the other end it must be very nearly 0.2. If the circuit is to oscillate all over the band the coupling must be selected so that the condition for oscillation is satisfied at the low frequency end. That is, it must be at least 0.716. If that is chosen the circuit will simply oscillate a little more vigorously at the high frequency end. With the values chosen oscillation is possible all over the band because a coefficient of coupling of 0.716 is not impossible. Moreover, it is always possible to make the grid winding larger than the tuned winding and thus get a larger value for the mutual inductance.

Case of Colpitts Oscillator

Another oscillator that may be stabilized with an inductance and that will remain stabilized for all settings of the tuning condenser is the Colpitts. Although this is a very simple oscillator it does not lend itself to the zero grid current condition because a grid leak must be used with it, and the leak has the same effect on the frequency of oscillation as grid conductance. However, if the tube is operated so that no grid current would flow anyway, the grid leak can be made extremely high in resistance. And if the leak resistance is made high enough the effect on the frequency will be extremely small. It may be that the circuit will operate without any blocking without any intentional resistor, for there is some leakage across insulators and through them.

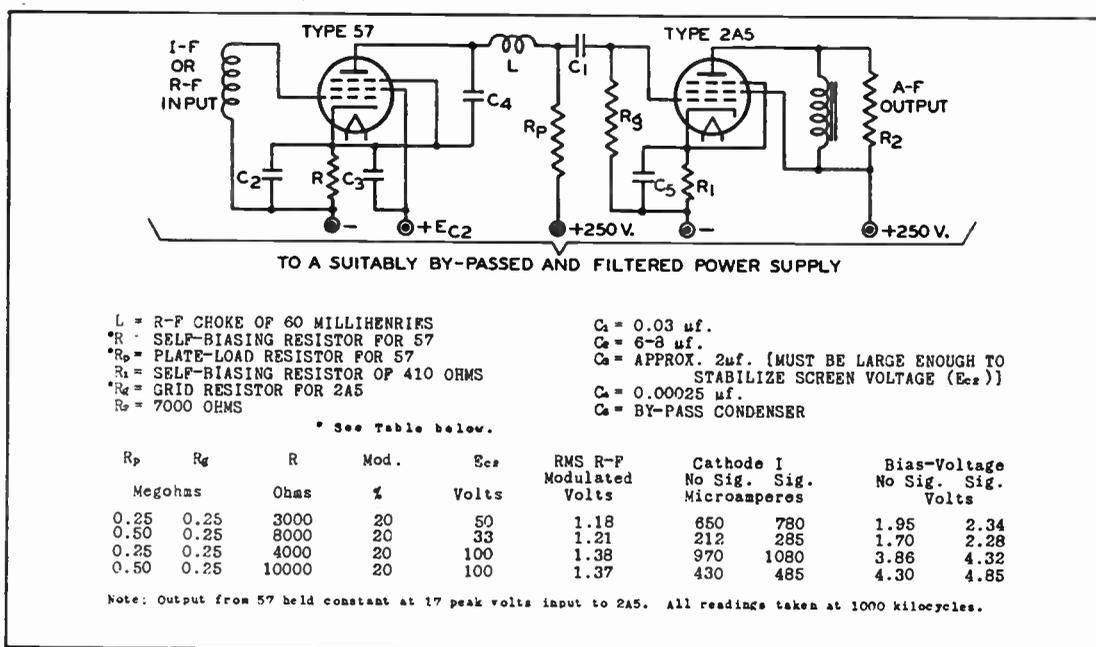
The symmetrical Colpitts stabilized oscillator has an inductance in the grid circuit and another in the plate circuit, and each is equal to half the inductance in the tuned circuit.

The Colpitts has one defect in so far as stability is concerned, and that is that the L/C ratio is high, for the two condensers are connected in series. Of course, it is always possible to make each of the condensers large, but that makes a clumsy arrangement. Yet when the oscillator is to be used for a wide range of frequencies and many coils must be used for covering the range, this oscillator is convenient.

57 FEEDING THE 2A5

Resistance and Condenser Values for Proper Loading

By Ames Osgood



Constants for properly loading up the 2A5 with a 57 detector are given in the diagram and specifications. The average signal input was 1.28 volts r-f to the 57 to produce 17 volts output, a gain of more than 13.

THE detector as driver for the output tube has been popular for nearly two years, and since receivers using few tubes are numerous, because of high sensitivity that is developed by special-purpose tubes, closer attention is being paid to the proper relationship of the detector to the output tube.

RCA Radiotron Company, Inc., and E. T. Cunningham, Inc., have issued their second "Application Note," and it covers this subject. The first "Application Note," published in last week's issue, dealt with the 77 as a detector for use in a-c and d-c sets, where the supply was 100 volts. The 77 is the 6.3-volt heater type tube equivalent to the 57 of the 2.5-volt series.

One-Volt Safety Margin

The circuit illustrating the use of the 57 as a biased detector resistance-coupled to the 2A5 is printed herewith, as are the data released on the subject. The 2A5 is a pentode like the 247 except that the mu is higher (220 instead of 150), there is an independent cathode, and the bias required is 18 volts, compared to 16.5 for the 247 under similar conditions of plate and screen voltages. The information on the 2A5 will be found in the chart of tube characteristics, pages 12 and 13 of the present issue.

The circuit diagram is a familiar one, of course, and the value of the "note" is due to the tests made for output of pure wave form sufficient to deliver 17 volts to the pentode grid, which voltage is 1 volt on the safe side of the bias voltage. As in modulators to be protected against overload by oscillators, the differential allowed is 1 volt, by a sort of uniform agreement.

The readings taken by the two tube

manufacturers were for a radio frequency input of 1,000 kc, and while the percentage of modulation is given (20%), the frequency or frequencies of modulation are not, as beyond the immediate scope of the "note."

Capacity Across Screen Circuit

However, while a capacity of 2 mfd. is prescribed for bypassing the screen, the source of the screen voltage may be a resistor of high value connected in series with maximum B plus, and therefore a serious frequency relationship exists, requiring higher capacities for higher resistors, to reduce the negative feedback, which would dampen the low notes particularly, if the bypassing were not adequate. For a high series resistor of this type, therefore, it is well to consider capacities of the order of 8 mfd., easily obtainable in electrolytic form.

Normally the biasing resistor would be lower in value than the series screen resistor, hence the bypass capacity may be less. The two companies recommend 6 to 8 mfd. for biasing by-pass, and this is of course in the right direction, but since the voltage drop is small, much higher capacities are obtainable electrolytically, and 20 mfd. may well be used.

Rp, the plate load resistor in the 57 circuit, has an r-f choke L and a bypass condenser C. L is defined as 60 millihenries, C4 as 0.00025 mfd. In a circuit using the pentode, concerning which tube there is a belief that the high audio frequencies are rather too much accentuated, the capacity of 0.00025 mfd. is doubly adequate, first as to its effect on bypassing the radio frequencies to improve the detecting efficiency of the tube, and second as to attenuating particularly some of the

higher frequencies of modulation, due to connection across the choke-resistor series circuit.

2A5 Connections

It will be found that the 2A5 is a highly suitable tube, good in tone quality, and containing little hum because of the independent cathode. The tube has a six-pin base, although there are six elements and one of them has two terminals, that is, a seven-pin base might be expected, but the suppressor is tied to the cathode inside the tube. The base connections follow the expected rotation, with plate next to one heater and cathode next to another heater, screen adjoining plate, the remaining connection being for control grid. The tube is called a pentode because the heater is not counted as an element, otherwise the tube would be called a hexode.

The values of resistances used for biasing the 57 differ, depending on the screen voltage and the plate load. Of course the value also would depend on the plate voltage applied, but this is assumed fixed at 250 volts.

The modulated radio-frequency input at 1,000 kc was varied from 1.18 to 1.38 volts, as circumstances required, to produce the 17-volt pure-wave output from the 57. This expression of biasing resistor is helpful, since previous details usually had to do with limiting the plate current to a small certain value, 0.1 ma, for doing which not every experimenter had the necessary meter.

Bias Around 4 Volts

Two values of plate load resistor were used, 0.25 meg. and 0.5 meg., and when the

(Continued on next page)

(Continued from preceding page)

doubled value was used the biasing resistor had to be about 2.5 times that used with the lower resistance plate load.

In connection with the t-r-f models of the Diamond of the Air featured in these columns the fact was brought out that the detecting efficiency was best around 4 volts, compared to 6 volts normally recommended, and authenticating curves were given. It is therefore interesting to note that the 57 is biased approximately around 4 volts, especially if one selects the values consistent with 100 volts on the screen. But if the screen voltage is 100 volts, and the source is 250 volts, then 150 volts are dropped at from around 300 to around 160 microamperes, so the series resistor would be from 330,000 to 630,000 ohms, and C3, the screen bypassing condenser, should be as large as possible, 8 mfd. being not a bit too large.

7,000 Ohms Output

R1 is a self-biasing resistor for the 2A5, being given as 410 ohms, but of course a 400-ohm unit of commercial make may be used, although it should be of the 5-watt rating. It is not usual to have the resistors so close in commercial practice as to account for a difference of 10 ohms, but 410 ohms represents the value used, which is consistent with the highest standards of requirements for testing. But just 410 ohms are not essential for commercial receiver use or home construction of receivers.

C5 is stated as being a "by-pass condenser." It bypasses the 410 ohms. For the reasons previously stated, it can not be too large, and since the voltage is low, 18 volts, 20 mfd. would constitute an excellent choice of an electrolytic.

The speaker should have an output

transformer that presents a load of 7,000 ohms to the plate circuit (same as for 247). The resistor R2 therefore should not be read in the diagram as one in parallel with a choke coil, but rather the impedance of the total load should be regarded as a pure resistance of 7,000 ohms.

Loss of Bias

The assumption of pure resistance does not quite hold, of course, due to the different audio frequencies and current changes, and moreover the 17-volt input would not hold in broadcast reception, where the input value is quickly and constantly changing. When the input is less than 18 volts there is no grid current, but when the signal voltage exceeds the bias voltage there would be grid current, due to positive grid, hence Rg, the grid resistor, is limited to 250,000 ohms, to make the effect of the grid current flowing through it as small as practical consistent with a good load on the grid circuit.

Normally grid current would cause the grid to become less positive as the grid current increased, for the rectification is on the same basis as always, that the cathode is positive, hence grid negative, from the viewpoint of bias. But the signal voltage itself is bucking the bias, and therefore the signal voltage increase may be at a greater rate than the control of bias due to grid current, hence the effect would be that the power tube would lose bias. With Rg at 250,000 ohms the loss of bias is not serious. A check for the value of grid resistor may be made by putting a milliammeter, say, 0-100, in the plate circuit of the 2A5, to determine whether at high signal inputs (loudest response from strongest local) the plate current does not exceed 50 ma.

From another viewpoint, that of low-note protection, the grid resistor should be as high as practical, and biasing systems that permit a higher value grid resistor without causing loss of bias may be used.

The data as furnished by the two tube companies follow in full:

"Application Note on the Use of the 57 as a Biased Detector Resistance-Coupled to a 2A5.

"The utilization of the 2A5 in audio-output stage of a-c receivers presents many desirable features due to the power handling ability of this tube and the low hum levels obtainable because of its heater-cathode construction. The detector circuit must be carefully designed to obtain the full 3.0 watts output from the 2A5, since the resistance in the grid circuit of the 2A5 should not exceed 250,000 ohms.

"Tests have been conducted to determine the optimum operating conditions for a 57 as a biased detector resistance-coupled to a 2A5 with a 250,000 ohm resistor in the grid circuit. Even with signals of low percentage modulation it has been found possible to secure full audio output from the 2A5 driven by a biased-detector 57.

Column Headings Explained

"In the tabulation of conditions obtaining for optimum operation, the column headings have the following meanings:

"R_p is the plate-load resistance of the 57.

"R_g is the grid resistor for the 2A5.

"R is the self-biasing resistor for the 57.

"Mod. % refers to the percent modulation of the r-f signal supplied to the 57.

"E_{sg} is the screen grid supply voltage for the 57.

"RMS r-f mod. volts is the root-mean-square, radio-frequency modulated voltage which must be supplied to the 57 in order to obtain full output from the 2A5.

"Cathode I is the cathode current of the 57, first, with no signal on the grid, and second, with the specified rms r-f mod. signal on the grid.

"Bias voltage is the bias on the grid of the 57, first, with no signal on the grid, and second, when the specified signal is applied.

"The tabulated conditions for optimum operation were determined by varying first one and then another of all possible variables and noting the results. Oscillograms of the resulting wave forms were taken to guide the selection of optimum conditions.

"Conditions for maximum power output with minimum distortion for a required r-f input and various combinations of plate resistors, bias resistors and screen voltages were determined in this way."

Boom in Short Waves; Parts and Sets Moving

A remarkable increase in interest in short waves has taken place in the last few weeks, and both stores and mail order houses are doing a brisk business in parts and sets, mostly of the less expensive types. However, interest in a-c operated devices, of the more expensive types, is growing, and the most costly short-wave superheterodynes are moving well, too, in fact two manufacturers report that they can not make as many sets as the orders would quickly require.

Some background for this spurt in short-wave interest is due to better equipment and greater power used by foreign stations, especially in South and Central America, England, Spain, Germany and Holland. Besides, these stations are on the air more often, and stay on long enough to be heard in the early evening hours.

TRADIOGRAMS

By J. Murray Barron

A new 6-tube model Postal radio receiver is now in production. It is the newest number in the a-c d-c types and is in the de luxe class. It can be furnished either in kit form or wired, in cabinet, complete with tubes, with special socket for battery operation. A descriptive circular may be had from the Postal Radio Corp., 135 Liberty Street, New York.

* * *

Harry Goldman announces the Preview Show of 1933 models in the radio industry will be held at the Hotel Edison, 228 West 47th Street, N. Y. City. The report indicates a large number of manufacturers will be represented. The dates are April 3d, 4th, 5th and 6th.

* * *

Fordson Radio Mfg. Corp., 11702 Livernois Avenue, Detroit, Mich., announces it will confine itself to the low-price field and will concentrate on one model. This is a six-tube superheterodyne. Additional information may be had by writing to the above address.

* * *

The fine weather in New York City the past few days has evidently brought to mind the joys of the auto and the tour to country districts nearby, e.g., Westchester County, Long Island and the Jersey hills. All this has created a big interest in car radios. This idea likewise will apply to other districts of the country and should stimulate small set, auto receivers and B eliminators, as it has in the East.

* * *

There are in preparation several short-wave kits for the experimenter by some of the local manufacturers and dealers in kits. They comprise one, two and three-tube kits and should prove very popular this spring and summer. Two types of a-c and battery models will be marketed.

With the general opening of the greater number of banks through the country the reaction is now being felt by the increase of mail orders and the added transactions. Ordinarily nothing short of a complete shut-down of the banking system can stop a fan or experimenter from buying his radio parts, but of course the temporary closing had to affect him too, but not completely, for the Post Office still did business.

* * *

The Beginner's Twin, a very unusual short-wave kit, is now being marketed by the Try-Mo Radio Corporation from 85 Cortlandt Street, N. Y. City. This kit has received a great reception in various sections of the country and the large numbers who have operated the set speak highly of it. As a small, and very efficient receiver, it has opened up in a short time to many hundreds the thrill there is in short-wave reception for beginners.

STURDY TUBES

WHAT is the object of the mica collar at the top of all the new tubes and the peculiar shape of the dome? As far as I can see there is no difference between two tubes that are similar in all respects except that one has the new construction and the other the old.—G. W. C., Des Moines, Iowa.

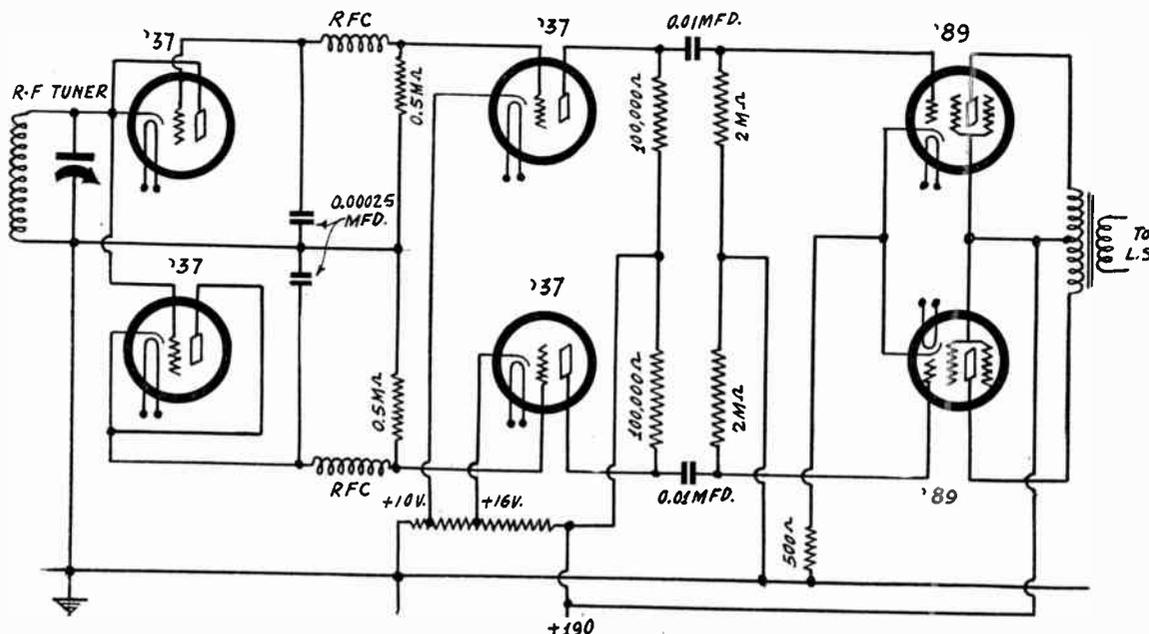
The object of new construction is to give strength of the tube structure. In the old construction the only support of the elements was the glass stem. This frequently broke. Even when it did not break it made the tube subject to vibration which would often cause a sustained singing sound if the loudspeaker was too close to the tubes so that the vibrations could be transmitted either through the table or through the air.

A NEW DETECTOR

Circuit Affording Voltage-Doubling

By J. E. Anderson

FIG. 1
The circuit diagram of a full-wave detector and push-pull amplifier built and suggested by Mr. Orval C. La France



It has been asserted many times that it is impossible to use direct coupling between a detector and a push-pull amplifier. As far as is known to the writer the assertion is true. Nevertheless, interesting circuits are evolved occasionally during attempts to perform the supposedly impossible. It may be that even the circuit which we are about to describe is a confutation of the assertion of impossibility. We owe this circuit to Orval C. La France, of San Francisco and other Pacific ports where United States ships go.

The circuit submitted by Mr. La France is shown in Fig. 1. It consists of two 37 type tubes used as diodes, two tubes of the same type used as voltage amplifiers in a symmetrical circuit and finally two 89 type tubes also in a push-pull hook-up. A single tuner feeds the diodes. The circuit is more or less self-explanatory, but just by way of emphasis let us dissect it to see how it works. We are assured by Mr. La France that it does work, and very well at that. There is no apparent reason why it should not.

A Simplified Drawing

It will help to draw the circuit in a simplified form, and this is shown in Fig. 2. In this the two diodes are represented by two rectifier symbols at the extreme left. The signal voltage is impressed on the circuit by means of the resonator Z, which is connected between the junction of the two rectifiers and ground. Note that the rectifiers are so connected that the anode of one goes to the cathode of the other.

Consider the half-cycle of the signal when the signal voltage is in the direction from ground to the rectifiers, as indicated by the full arrows. No current can flow through the upper rectifier, for it can conduct only in the opposite direction. However, current can and does flow through the lower rectifier. The current circulates in the counter-clockwise direction through the choke Ch₂ and resistor R₂ and back through the resonator Z. A voltage will

be established across R₂ and the condenser C₂ will also be charged to an equal voltage with the positive electrode toward the choke. Now R₂ is in the grid circuit of the lower amplifier tube and a voltage will be impressed on that grid. So far nothing has occurred in the upper side of the circuit.

Reversal of Signal Voltage

During the next half-cycle the signal voltage in Z is in the direction of the dotted arrows, from the rectifiers to ground. No current can now flow in the lower circuit but current can and does flow in the upper circuit. It circulates counter-clockwise through the upper rectifier, the resonator, R₁, and the choke Ch₁. A voltage is now established across R₁ and condenser C₁ is charged to this voltage. Since R₁ is in the grid circuit of the upper tube, that tube gets a voltage.

While the upper tube is active, condenser C₂ discharges slowly through the choke Ch₂ and R₂ and the voltage across R₂ persists. Likewise, while the lower tube is active and voltage across R₁ persists because C₁ discharges through R₁ and the choke Ch₁. That is, after the signal has been active a full cycle there will be voltage across both R₁ and R₂. The two half-wave rectifiers combine to form a single full-wave rectifier and the total rectified output voltage is divided equally between the two amplifier tubes. The phase is correct for push-pull input.

The same effect could have been obtained with a single rectifier but in that case the voltage across the total load resistance would have been only about half what it is with two rectifiers connected as in Fig. 2. The arrangement illustrated, therefore, acts as a voltage doubler.

Bias Precautions

As will be noticed, the rectifier current always flows in the same direction through the two load resistances. If the cathodes of the two amplifier tubes are joined to-

gether and connected to ground, or to the junction of the two load resistances R₁ and R₂, the rectified current would cause a negative bias on the upper tube and an equal positive bias on the lower tube. Of course, this is not right for push-pull action, for the two tubes would not be operated under similar conditions. Indeed, the lower tube would be practically inoperative because of its positive bias.

To avoid this difficulty the cathodes of the two tubes are returned to different points on the voltage divider. The cathode of the upper tube is returned to P₁, thus causing an additional bias to be impressed on the upper tube, the additional voltage being the drop between B minus and P₁. The cathode of the lower tube is returned to a point P₂ higher up the voltage divider. P₂ should be chosen so that the effective negative bias on the lower tube is the same as that of the upper tube. If the cathode of the upper tube were returned to ground, the proper position of P₂ would be such that the voltage drop between P₂ and B minus was equal to twice the drop in R₂ due to the rectified signal current. If the upper cathode is connected to P₁, then P₂ would have to be placed higher up by an amount equal to the drop between P₁ and B minus.

A Difficulty

If the cathodes were connected as indicated above the circuit would be adjusted properly for one particular signal level only. This is so because the drops in R₁ and R₂ are directly proportional to the amplitude of the carrier voltage whereas the drops in the voltage divider sections are independent of the signal voltage.

The only way to adjust the circuit so that the bias voltages on the two tubes will be equal for all signal levels is to make the drops in the voltage divider sections directly proportional to the signal. This could be done by making the voltage divider the load resistance of an-

(Continued on next page)

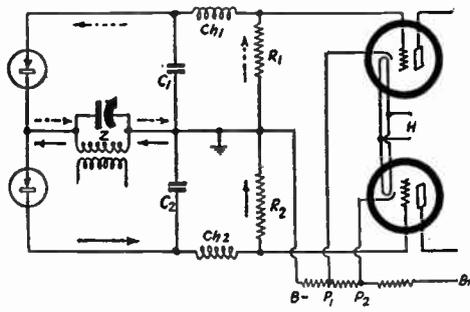


FIG. 2

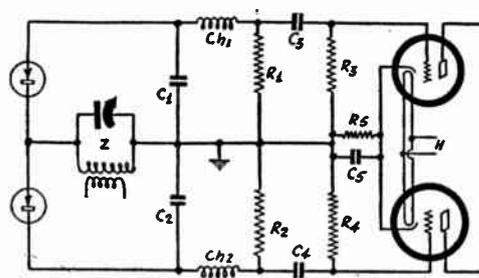


FIG. 3

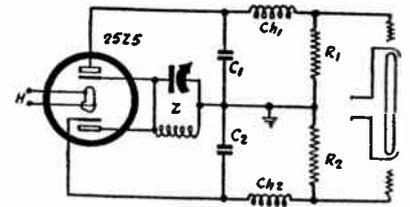


FIG. 4

(Continued from preceding page)
 other signal-driven rectifier. One method of doing this was described in the January 21st issue of RADIO WORLD, a method that could easily be adapted to the present circuit. The cathodes could not well be connected to the voltage because the cathode current would still be effective in upsetting the relations. But the cathodes could be returned to the ground and the load resistance in the additional rectifier could be put in the grid lead of the tube that is positively biased. The drop in the load resistance of this rectifier would have to be adjusted to twice the value of the drop in R_s .

If the coupling between the first push-pull stage and the second is to be of the type illustrated in Fig. 1, there is no good reason why the same type of coupling should not be used between the rectifier and the first stage, and such a coupler would avoid all the complications due to bias unsymmetry. If the stopping condensers be made of large capacity and the grid leaks of high resistance there will be no appreciable attenuation on the low frequencies. The double rectifier will still be advantageous in that the output voltage would be double for a given carrier input. The appearance of the circuit when stopping condensers and grid leaks are used is shown in Fig. 3. Here R_s biases the two tubes equally. R_3 and R_4 should be equal and should not be smaller than one megohm each. C_3 and C_4 should also be equal and should not be smaller than .02 mfd. for broadcast reception. Of course, C_1 , Ch_1 , and R_1 should be equal to the corresponding impedances in the lower circuit.

Using Single Tube

In connection with full-wave detection of the type illustrated in Fig. 1 attention may be called to the 25Z5 rectifier which

appeared recently. This tube has two independent cathodes and two anodes. It can be used as a voltage doubler, a full-wave rectifier, or as two half-wave rectifiers. It is quite suitable for use in a circuit of the type under discussion. The connections for this tube are shown in Fig. 4. The anode of one rectifier is connected to the cathode of the other and the resonator Z is connected between the junction of these two and ground. The remaining anode is connected to one side of the output circuit and the remaining cathode to the other side. The rest of the circuit is just the same as when two separate tubes are used. Of course, there is no difference between the circuits except that when the 25Z5 is used the two separate rectifiers are in one envelope while when other tubes are used they are in separate envelopes.

The 25Z5 requires a heater voltage of 25 volts and for that reason is not so convenient for use in circuits where the supply voltage is only 2.5 or 6.3 volts. But there are many cases where the tube might be particularly useful. For example, it will handle high voltages and considerable power and it might be made to deliver power directly to a loudspeaker or to a power amplifier requiring high input voltage. The amplification in that case would be provided in the intermediate or radio frequency levels.

A THOUGHT FOR THE WEEK

"TERRIBLE!" said Octavus Roy Cohen, the noted author, when discussing in public his Townsend Murder Mystery programs over N. B. C. Others seem to like it very much. Anyway, the author cannot be accused of suffering from elephantiasis. How different from a few others whose names could be mentioned!

**Padding Author
 Beclouds Readers,
 Makes Amends**

By EINAR ANDREWS

The subject of padding has been written up many times. It has been written up mathematically, graphically, technically, simply, and in several other ways. Yet it is a subject on which questions have to be answered more frequently than on any other subject.

Most of the questioners assure that they have read, nay, studied, perused, assimilated, the articles in question, but each one has a slightly different problem, one that was not covered in any of the articles. For example, one expert says that he can adjust the superheterodyne so that it will track nicely from 1,500 kc to about 800 kc but from there to 550 kc nothing that he can do or that he can find written will help him in the least.

Roundabout Information

Such questions, and such exceptions to the general rule, make the writers feel that they have entirely failed to convey to the reader the essential steps to be followed. A writer feels that as an expounder of radio technique he is "not so hot." Indeed, that is putting it mildly.

We suspect at times, perhaps in defense of our ability to express simple thoughts in writing, that the questioner had not read any of the articles at all, but had only read a heading, or that he had spoken to some one who had been told by a distant relative that we had written something on the subject and the perplexed one was recommended to go to us for possible assistance on the subject. That would save him the trouble of reading. After all, to a fellow in trouble there is nothing more consoling than to confide in some who is supposed to abound in ready-made solace for that kind of trouble.

Let us set forth the rules for padding once more. It may come to the attention of some one in superheterodyne trouble just at the moment when he is most troubled.

Rules in Snappy Words

First. Tune the intermediate amplifier circuits to the proper frequency. Use an intermediate frequency oscillator. Leave the intermediate frequency amplifier alone after that.

Second. Provide a signal of about 1,450 kc and set the main tuning condenser to that frequency approximately. Adjust all the trimmers on condensers until that signal is loudest. Especially adjust the trimmer on the oscillator. Leave the trimmers alone after that. It is especially important to leave them alone.

Third. Provide a signal of about 600 kc. Find out where this comes in on the r-f condensers and set the condensers there. If the dial is calibrated in kilocycles, as some commercial sets are, this step is very easy.

Fourth. Tune in the 600 kc signal with the series padding condenser alone

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Electron Coupling in a Super Using 2B7 AND 2A5 TUBES

By Capt. Peter V. O'Rourke

THE term "electron coupling" is rather new, having been introduced for the first time by J. B. Dow, of the Naval Observatory, fifteen months ago, but the idea is not new, for in substance it was used by Robert E. Lacault in his Ultradyne some seven years ago.

Moreover, there is some confusion as to what constitutes "electron coupling," and even Dow admitted that he used the term only for the want of a better one. But he expressed the idea behind it quite plainly. Electron coupling is such coupling as results not from the external impedance, such as conventional inductance, capacity or resistance or combinations thereof, but by the impinging of electrons from another circuit, upon the element of a tube. Thus he used a tube of the characteristics of the 224, with grid leak oscillation, the screen used as anode, and the normal anode or plate used instead as a high d-c voltage fed element for taking off the oscillation to introduce it into an amplifier tube.

Excellent Method

So in the tube that carries the common stream to which another tube contributes electrons, even by the Lacault method, there is a direct current path from the affected element, for the a-c component of the input is in the space stream, and so is the reduced d-c component. The stricter interpretation would be that the a-c is absent, except as a pulsation of the d-c values, for the operation of vacuum tubes is that their d-c plate current is modulated by the a-c, but the space current is d-c though of a pulsating character. Resistance coupling carries on this pulsating effect from stage to stage, inductive coupling reincarnates the a-c, due to the d-c current through the winding varying at the rate of the a-c frequency, and reproducing the a-c proper by electromagnetism.

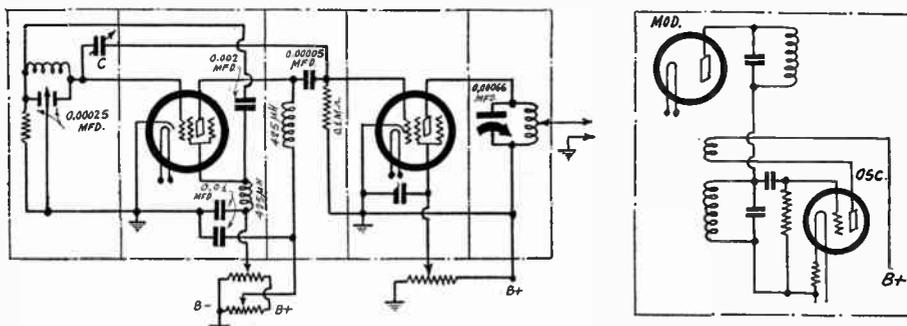
The electron method coupling is excellent, and on the following page will be found the circuit diagram of a receiver using it by the connection of grid of oscillator to screen of modulator. This is a low-harmonic method of coupling, because the high potential of the oscillator grid is relatively free from harmonics, which is not true of the oscillator plate circuit.

2B7 Detector

The detector is the diode of a 2B7 and the output tube is a 2A5. The circuit was carefully built and tested, and works splendidly, although some departures from recommended practice will be found, particularly the voltaging or loading of the pentode unit of the 2B7, for clearly the standard requirements did not permit of anything approaching amplification or reception.

All told, the new tubes proved their worth, the 2B7 because the sensitivity was much greater than with similar previous model tube, and the 2A5 for the two reasons that sensitivity was somewhat greater than with the 247 and that the hum level was extremely low. In fact, the hum was less than that contributed by any other output tube that the author has ever tried.

The circuit is presented theoretically, although it has been built and tested. The practical side relates only to the values associated with the 2B7. However, an eight tube circuit is being worked out that



Dow's oscillator, with electron-coupled amplifier, is shown at left. The modulation method used by Lacault in his Ultradyne is shown at right

will be presented constructionally, and it will include a four-gang tuning condenser. Details will be published soon, possibly in next week's issue.

What is true of the present circuit, and will be true of the other, is that the oscillator's wave form is purer than usually encountered, and the coupling to modulator effectuated in such a manner as to capitalize on this purity. Freedom from squeals due to non-uniform wave characteristics, and due to similar causes, is one factor, and there may be only one inevitable squeal point in the receiver. With an extra gang all squeals might be prevented.

The oscillator shown herewith is a good one, but the one to be shown subsequently will be a better one, because frequency-stabilized by the constant plate impedance method. Such an oscillator requires that there be no grid current, or if there be any that it be so tiny as to maintain the grid impedance still enormously high.

Plate Current Cutoff

While it might be assumed that the 2B7 gives the same results as the 55, except that the gain in the audio amplifier is greater, due to pentode supplanting the triode, this does not quite hold. There was a marked difference in the operating results and therefore of the circuit treatment required.

When the 55 is used the plate current does not cut off, if at all, until the voltage is more than 50 volts across the total of the 250,000-ohm potentiometer, for this is a low-mu tube, and takes a high bias (normally 20 volts). When the 2B7 is used the amplifier is a high-mu type, and the plate current cuts off sooner, for the normal bias is 3 volts, and the input is no different than to the triode of the 55, since the input depends on what is developed ahead of the detector.

The Plate Load Resistor

For this reason one precaution necessary with the 55 is not necessary with the 2B7, and that is, the aerial does not have to be of a certain minimum length to attain a voltage at the detector sufficient to provide a bias to prevent grid current, which current causes a steady noise. While it is easy to provide this minimum aerial when the 55 is used, since only 10 or 12 feet of wire indoors will do it, with the 2B7 the grid current does not flow, or at least the noise is not present, indicating that the grid current isn't flowing.

Another thing is that the resistor in the plate circuit of the 2B7 does not seem to permit such a high value as the tube manufacturers specify, at least such was the experience with the laboratory-model tube used in the experiments with the present circuit. It is recognized that with resistance-coupled audio the screen voltage on the 2B7 should be around 50 volts, and this was provided, and the 10,000-ohm resistor between screen and ground was for that very purpose. However, with 200,000 ohms led to 250 volts the response was feeble indeed, and it was necessary to use a much lower value before the signals would come through properly. The value in the diagram is to be read as 0.025 meg., or 25,000 ohms, although higher values up to 50,000 ohms or so may be used. But with 200,000 ohms the results were so inferior that it became apparent that curves will have to be run to ascertain the reason for this unexpected situation.

Of course it has some bearing on the screen voltage, because that is low, and the effective screen voltage should not be greater than the effective plate voltage probably, but still the proportion held satisfactorily although the results did not come up to expectations when following orthodox recommendations.

Fine Results This Way

When the change was made as diagrammed (50 volts on screen is assumed, with plate load of 25,000 ohms) the results were exceptionally fine.

What we are interested in primarily, as set constructors, are results, and these are all one would desire, although the departure from custom must be made as recommended. Also we are interested in the reason, and it is possible that this lies in the effect of a lower resistance on the plate voltage. When the plate current goes up, as when a smaller resistor is used than the 200,000 ohms recommended, the point where plate current is cut off is removed much farther, and the operating range of the tube is increased, that is, greater signal voltage handled. The actual gain may be less than the theoretical value, due to the lowered resistance load on the plate circuit, as the per-stage mu is reduced proportionate to the reduction in the resistance, yet the practical working range and net result are improved.

Various values of screen voltages were tried, from 30 to 150 volts, and it was

(Continued on next page)

LIST OF PARTS

Coils

Three high-grain r-f transformers for 350 mmfd. tuning condensers.
One filter choke.

Condensers

One gang of three 350 mmfd. tuning condensers.
One 0.00025 mfd. condenser.
Four 0.05 mfd. condensers.
Two 0.01 mfd. condensers.
One 0.006 mfd. condenser.
One 0.1 mfd. condenser.
Three 0.25 mfd. condensers.
One 10 mfd. electrolytic condenser.
Three 8 mfd. electrolytic condensers.

Resistors

One 10,000-ohm potentiometer with line switch attached.
One 30,000-ohm resistor.
One 500,000-ohm resistor.
Two 100,000-ohm resistors.
One 25,000-ohm resistor.
Two 250,000-ohm resistors.
One 150,000-ohm resistor.
One 100,000-ohm variable resistor.
One 500-ohm bias resistor.
One 130-ohm ballast resistor.
One 10-ohm resistor.

Other Requirements

One six-tube chassis.
Five five-contact sockets.
One six-contact socket.
One seven-contact socket.
Three grid clips.
One pilot light.
One vernier dial.
One loudspeaker.
One cabinet.
One cable and plug.
One auto plug (for use with batteries).

0.006 mfd., between ground and the pilot light for the same purpose.

Pilot Light Protection

Across the pilot light is a 10-ohm resistor which serves as a protection of the light, for the light does not carry as much current as the amplifier and rectifier tubes. The pilot light, incidentally, is a feature not found in the smaller universal receivers. Clearly, it is advantageous in that it is used to illuminate the dial.

In all receivers a certain amount of heat is generated and it is important that the temperature be not allowed to become excessive. There should be good ventilation of the chassis. In this case there is ample provision for ventilation of the set as the cabinet is partly open at the rear. Another feature which aids in keeping the set cool is the special design of the supply cable. There is distributed resistance in it and this resistance is part of the ballast. This advantageous feature is not shown on the diagram. However, it is arranged so that the drop in this resistance is confined to the heater circuit and it in no way reduces the voltage available for the plates and the field. Even when this cable is not used and when all the excess heater voltage is dropped in the ballast in the set, there is no danger whatsoever of excessive heat, due to the thorough ventilation for one thing and due to the low heater wattage in the second.

Use on Batteries

A special feature of the receiver is that it can be used on batteries. At the rear of the chassis is a socket, wired as shown on the diagram. There is also a specially wired plug available, wired as shown on the "Auto Plug" shown on the diagram. When the circuit is to be used on a storage battery and on B batteries, these batteries are connected to the appropriately

marked cable terminals and the plug is inserted in the socket at the rear of the chassis. This insertion automatically connects the heaters in parallel and throws out the rectifier, which is not longer needed. One other change is needed in the receiver. A 41 tube must be substituted for the 43, for the 43 is a high voltage heater tube suitable only for series connection, whereas the 41 is a 6.3 volt tube. In all respects other than the heater voltage these tubes are the same.

The receiver may be obtained either for batteries or for a-c and d-c. If the set is equipped with a-c and d-c the extra equipment that will adapt it for use on batteries is the auto plug and the 41 tube.

Importance of Dual Feature

This dual feature of the receiver is of much importance to those who travel. If they move into a place where the supply is d-c the set can be used as it is. If they move into a section where the supply is a-c, no change is necessary. But if they wish to use the receiver in an automobile, in a boat, or in any other place where high voltage is not available, the set can be changed to battery operation by merely inserting the auto plug and changing a tube.

There is a five-tube set of the same type available, which is exactly the same as the six-tube de luxe, except that it has only one 239 radio frequency amplifier and only a two gang condenser. The five-tube set, of course, is neither as sensitive nor as selective as the six-tube set. The extra tube and the extra tuner in the six-tube make this set greatly superior.

The de luxe six-tube receiver comes in a handsome burl walnut cabinet 13x7x8.5 inches of an entirely new design. The panel is attractively laid out in symmetrical fashion. There is a knob at the right for the tuning control with an illuminated window above for the dial. At the left is a similar knob for the volume control and the line switch, and

above that to match the window is a special ornament. In the center at the bottom is a similar knob for the tone control. The larger part of the front panel is devoted to the loudspeaker, which is fully six inches in diameter. The front panel acts as a baffle board.

The combination of full size 6-inch speaker and the front panel insures good low note response as well as good response on the higher audio frequencies.

A lead provided with a spring clip is brought out at the rear for the antenna connection. No ground is needed when the set is operated on a d-c or a-c line. When operated on batteries the ground should be connected to the storage battery.

Thor's Demonstrates Much Foreign Reception

A demonstration is taking place daily at Thor's Radio Store, 167 Greenwich Street, New York City, of the Audiola Short-Wave Table. This converter is installed in a beautiful table that will hold a standard midget set on top for use with the converter. The combination will give a reception range of long and short waves.

The converter tunes from 20 to 200 meters. Thrill after thrill is in store for anyone who makes his set an all-wave receiver.

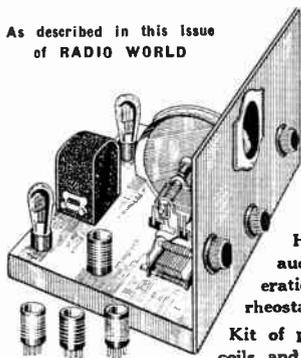
Can you imagine tuning in Paris, Berlin, London, or South America? Also police calls, airplanes, ships at sea and perhaps many unusual or unlisted programs or calls. An amateur got out one of the first bits of news of the recent California earthquake. Many listeners have often picked up items hours ahead of the newspaper reports, but without these unusual thrills there are always plenty of regular broadcasts to give great pleasure and entertainment. This converter is very efficient and well constructed.

"BEGINNER'S TWIN"

2 Tube Battery Operated Short Wave Receivers

Designed by a Famous Short Wave Engineer

As described in this issue of RADIO WORLD



Every part in this kit is guaranteed perfect quality. By carefully following instructions and blueprints you will have built a receiver that will not only bring in U. S. and foreign broadcasts but also Police Calls, Airplane Signals, Ship-To-Shore Calls and Amateurs. But this is not surprising—for this latest 1933 sensation incorporates all the worthwhile features—two 230 2-volt tubes to reduce filament drain to a minimum . . . POWERTEST plug-in coils covering 15 to 200 meters . . . HAMMARLUND tuning condenser . . . beautiful HAMMARLUND drum dial for vernier tuning . . . high quality audio transformer for tone and volume . . . smooth control regeneration with HAMMARLUND variable condenser . . . filament rheostat to control tube sensitivity.

Kit of parts (including coils and tubes) . . . \$7.95
Wired (with tubes and coils) . . . \$9.95
Set of tested batteries (includes 2-45 volt "B" and 2 dry cell) . . . \$2.50

"ROCKET"

"SHORT WAVE RECEIVERS"

2 Tube Short Wave "Thriller" as described in the March 11th issue of RADIO WORLD. A battery operated short wave receiver built to the demands of the short wave enthusiast for a lower priced and better grade receiver. Kit complete with drilled base and panel and 4 plug-in coils (15-200 meters). Complete kit . . . \$4.50
Set of Sylvania tubes (2-230) . . . 2.25

Wired \$5.50

ONE of our OUTSTANDING VALUES

Stromberg-Carlson

For the first time at this new low price. Outfit includes input transformer. plug 20' extension cord.



"There Is Nothing Finer Than A Stromberg-Carlson"

\$5.50 complete

TRY-MO RADIO CO., Inc.

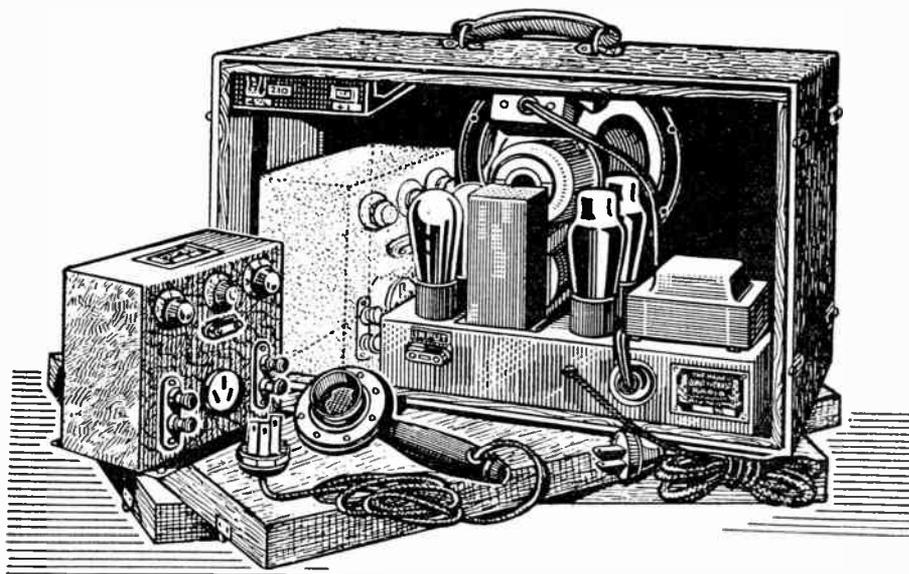
Mail Order Dept. RW
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Four-Tube, All-Purpose, 7½-Watt PORTABLE PUBLIC ADDRESS SYSTEM

Uses 59 Push-Pull and High-Gain Circuit

*Valuable Feature of Separately Removable Units Permits Wide Usage—
The Speaker in Its Baffle Chamber Can Be Remotely Placed Apart from
the Remaining Equipment*

By Louis Gancher President, Coast-to-Coast Radio Corp.



Interior Rear View of the 7½ Watt High-Gain Portable Public Address System, with Both Carrying Case Covers Removed. Note the Ease of Accessibility to Any One of the Vital Units. The Control Box and "Mixer" Are Shown at the Extreme Left. (The Phantom View Illustrates the Position Assumed by the "Mixer" Housed in the Carrying Case, While the Entire System Is Being Carried.)

(Drawing Loaned Through the Courtesy of the Coast-to-Coast Radio Corp.)

NEVER before has such a light-weight (27½ lbs.) completely self-contained Amplifier System been placed on the American market, which permits instantaneous separation of each of its vital units so as to provide adequate coverage and convenient operation under any condition. Although this Amplifier was primarily designed to meet the stringent modern purse, it utilizes every conceivable constructional feature which enhances its adaptability to innumerable public address requirements and actually produces greater volume output per dollar cost than heretofore offered.

In the good old days of "prosperity," manufacturers made it a point to develop ONE amplifier for ONE need. For versatile systems, modern economy insists that amplifiers meet varied conditions. Due to the flexibility offered by this herein described system, it is being widely accepted by travelers, schools, hotels, merchants, etc., and by virtue of its low cost and lucrative rental possibilities, the cost becomes an investment—for, after only a few such rentals, the system has been completely paid for!

While the amplifier may be used for the general run of public address work, it has found wide application in the sales pro-

motional fields, ranging from the modern "street-hawker" to department store demonstrations. Storekeepers are grasping the opportunity to conduct window demonstrations, by placing the microphone and control box behind the store window-front, alongside the demonstrator—the amplifier is placed in the rear of the store (or right in the window if desired) and the speaker chamber is conveniently located outside the window, above the heads of the audience, in such a manner as to even provide sufficient audibility on the other side of the street (if desired), causing such hearers to cross the street, their curiosity having been aroused.

A unique application was recently demonstrated by a local clever salesman who used this P. A. System in conjunction with the "Coast-to-Coast" 6-Volt Auto A-C Unit, for sales promotion work directly from his automobile. The same amplifier was then taken into a department store where a remarkable conversation was carried on between the salesman and a "canned customer." In this case, a record was previously prepared, having been made by using the amplifier as a recording unit, and then playing it back, super-imposed upon his local talk,

by correct timing. Unusual conversations can be carried on in this manner between the demonstrator in a store and his "recorded customer" so as to present in a realistic manner the advantages of any product or service.

By locating the control box and mixer at a remote point, radio programs or phono. records may be interrupted and local sales announcements injected or super-imposed in varying degrees of audible intensity. An additional carrying case, housing one or two extra speakers of the electro-dynamic or permanent magnetic types may be employed with this amplifier for providing sound coverage at remote points. These additional permanent magnet dynamic type speakers provide for simple and instantaneous installation, inasmuch as only two conductors are necessary in coupling them to the amplifier. Many servicemen, dealers and experimenters are making handsome profits by renting these systems—in fact, several such parties have as many as six to ten of these installations at all times rented out!

Economy of Operation

Although more than 7½ watts of undistorted power is produced by this amplifier, it consumes approximately only 55 watts. This low current drain permits its use with 6 volt d-c storage battery operated converters, and accordingly makes complete and flexible operation possible from either and both an automobile, or from a light socket.

You can, therefore, use this amplifier system in an automobile, and then carry it out and plug into any 110 volt a-c light socket receptacle—all within a few minutes. By using the new heater type 59 Class "A" Pentode tubes (noted for their low current consumption, and hum-free performance) superior results are obtained, and by using carefully engineered light-weight components, its results are on a par with that of considerably more costly and far bulkier as well as heavier equipment of an equivalent output nature.

Input Mixer Control

The versatile "mixer" (shown in both phantom and solid views to the left of the amplifier proper) provides for suitable matching and individual volume-tone and attenuation control of any one or more of the following audio input impulses: Radio tuner output, microphone, phono pickup and sound head. A 4½-volt battery (B) is fastened within the case and furnishes the required microphone current, requiring replenishing in six months. A three-way polarized plug and receptacle (M) is provided for ready connection of the "mike" to the control box—the female re-

For Earphone Reception of Short Waves BEGINNER'S TWIN

By S. Grimes
Try-Mo Radio Corp

THEIR interest aroused by numerous published reports of direct foreign reception on the short waves, many former radio experimenters and constructors, and new "fans" as well, are window shopping along Radio Row, studying the radio catalogues and asking many questions about suitable receiving sets. While there are several very fine short wave receivers of advanced design on the market, they are for the most part a little too complicated and expensive for the casually interested persons who want to investigate the mysteries and delights of the short wave channels but do not care to make an initial investment of any considerable size.

Full Range Covered

To meet the requirements of these people, whose number is evidently very large, the "Beginner's Twin," illustrated in these columns, was designed. This is a two-tube, dry-battery operated receiver of exceedingly simple and reliable construction, using the minimum number of parts consistent with satisfactory results. It is available in kit or "knockdown" form, and can be assembled and wired in a couple of evenings by any one capable of using a screwdriver, pliers and soldering iron. It may also be obtained in ready-to-work form.

The entire active short wave tuning range, from 15 to 200 meters, taking in broadcasting, commercial radiophone, air-

craft, ship, amateur and police stations, is covered by a set of four plug-in coils, only one of which is used at a time. Plug-in coils are not nearly as much of a nuisance as most people think; in fact, experienced short wave fans prefer them to any other method of wave changing, and the best sets, whose prices run well into three figures, still use them.

The two tubes are of the 30 type. Their very low current requirements (only an eighth of an ampere total) make ordinary No. 4 or 6 dry cells entirely satisfactory as the source of filament current. Two small 45-volt "B" batteries are adequate for plate voltage, and will last many months. The set will even work very nicely, with slightly reduced volume, on a single 45-volt block.

No apology is offered to more knowing radio men for the use of type 30 tubes instead of type 32 or 34 grid tubes. The latter are unquestionably more sensitive, but they also cost more and require higher plate voltages, which means more "B" batteries. The Beginner's Twin as it stands is probably the best kind of introductory set for the beginner, who can readily make changes and improvements in it as he becomes more familiar with short wave technic.

Series Tickler Type

The circuit, as shown in the accompanying diagram, is of the series-tickler type, with one stage of audio frequency

amplification. This is a "sure fire" arrangement, absolutely devoid of trickiness as far as regeneration and oscillation are concerned. Two midget variable condensers are employed. One, controlled by the vernier drum dial, is the tuning condenser; the other, mounted directly on the front panel, is the regeneration control. The third knob on the front panel represents a combined on-off switch and filament rheostat. Since the tubes work on two volts, and a pair of dry cells in series develops three volts, the rheostat is turned up only part of the way. As the batteries wear out the rheostat must be advanced further and further until the batteries are entirely exhausted.

The last adjustable unit is a tiny two-leaf trimmer condenser of the screw type, mounted on insulating studs next to the variable condensers. This is connected to the aerial circuit and must be adjusted for each plug-in coil to eliminate "dead spots" in the regenerative action. Different aerials will make the set behave differently in this regard, although dead spots under any conditions can always be overcome by opening the plates wide enough.

Strong Assembly

The simple mechanical arrangement of the set is made clear in the illustrations. Both front panel and sub-panel are stamped of strong steel, the latter being formed into a shallow box to accommodate the wiring and to form a solid four-

Case Serves as Speaker Baffle

(Continued from preceding page)

triode amplifier possessing HIGH-GAIN characteristics, having its grid circuit directly connected to the input jack (J) terminals located directly on the amplifier. These terminals are normally connected to the output of the Mixer Control.

A 10 mfd. electrolytic condenser (C1) is used to provide more than ample by-passing of the low audio frequencies impressed upon the 56 tube. The type 82 full-wave mercury-vapor rectifier supplies sufficient well regulated current to not only the amplifier, but it also fully energizes a dynamic speaker field of 1000 ohms. A total of 90 miles is passed through the speaker field, which also acts as a highly efficient conventional filtering choke. An additional filter choke (Ch) of 500 ohms is inserted into the filter system preceding the speaker field so as to permit the efficient use of three 8 mfd. electrolytic condensers (C3, C4 and C5). The high impedance ratio (25 to 1) between the first 8 mfd. electrolytic (C3) and the choke (CH) causes an initial elimination of more than 90% of the a-c ripple. The remaining two 8 mfd. electrolytic condensers (C4 and C5), together with the speaker field, remove all trace of audible a-c ripple currents—in plain words, there IS NO HUM!

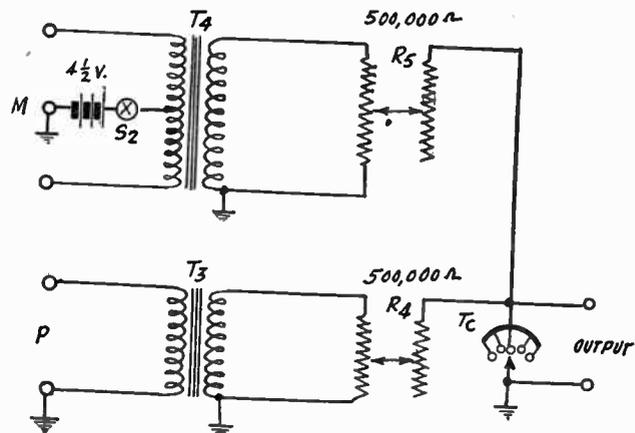
Although only 90 mils are required for the proper operation of the amplifier, and dynamic speaker, the hot cathode rectifier is capable of delivering 125 mils. This safety factor of 30% assures top notch efficiency under abnormal operating conditions with low or varying power line

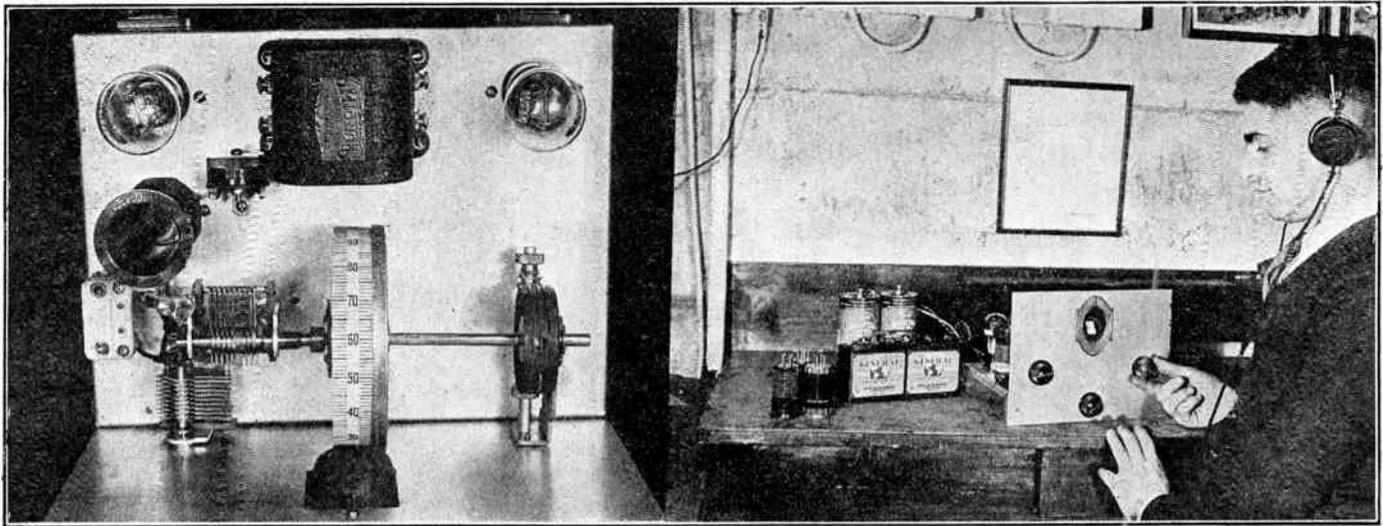
voltages. The unusual stability of the amplifier, and its subsequent lack of feedback, make it a desirable unit for use under conditions requiring the close placement of the microphone in the vicinity of the speaker. The amplifier's high gain characteristics permit the use of a low-priced microphone with satisfactory results. The complete system represents a marked improvement over what was considered an acceptable standard in the general public address market of the past season.

The amplifier and all accessories are neatly housed in a durable and handsome leatherette covered portable case, the front and sides of which act as a very

effective and acoustically correct speaker baffle. The complete unit measures 18½ inches long, 11 inches high and 10 inches deep. Its total weight is less than 28 lbs. By removing the hinged back, any one of the components can also be separately removed and accordingly may be rapidly and easily placed in advantageous positions, to meet the innumerable and varying conditions arising in public address work. Every possible provision has been made in the mechanical and electrical design of the amplifier to insure permanent operation under the most exacting conditions. The parts listed on page 17 are those actually employed in the construction of the amplifier described:

Constant impedance loads are provided in the circuit for transposing from microphone to phonograph input.





The top view of the short-wave earphone receiver is shown at left, while at right the set is shown being operated. Note the accessories in the photograph.

dition for the entire receiver. The variable condensers, plug-in coil socket and radio frequency choke form a little cluster at the left, while the tubes and the audio transformer are balanced neatly along the back. The wiring is short and follows the logical circuit positions.

Double binding post strips are mounted on the back side of the chassis for aerial, ground and earphone connections. The battery connections are made by wires in a heavy braided cable, which is equipped with a special fuse block for the protection of both the filament and plate circuits. The panel and subpanel, which are available separately, are already drilled with all necessary holes, so no tedious preparation work is involved.

Interesting Results

The photo showing Robert Hertzberg testing the Beginner's Twin also shows all the required accessories. These include a pair of high resistance earphones, two type 30 tubes, two No. 6 dry cells and two 45-volt "B" batteries. For an aerial an extra wire may simply be run to the same aerial already used with the family broadcast receiver. This seems to work quite well in most cases. An independent aerial totaling 100 to 150 feet in length is, of course, more desirable. The usual cold water pipe "ground" is employed. A natural question to ask about this simple receiver is: "What results can be expected?"

LIST OF PARTS

- One Try-Mo foundation kit, consisting of 10 3/4 x 8 inch panel and subpanel of same dimensions.
- Two Hammarlund 150 mmf. midjet variable condensers.
- One Hammarlund vernier drum dial.
- One trimmer condenser for antenna circuit.
- One 10-ohm rheostat with built-in switch.
- One 100 mmf. grid condenser, with 3-meg. leak.
- One audio transformer (any ratio between 3:1 and 6:1).
- One set of Powertest plug-in coils.
- Three four-prong sockets (two for tubes, one for coil).
- One fused battery cable.
- Two twin binding post strips.
- One short wave R. F. choke.
- Assorted hardware.
- Required accessories:
- Two type 30 tubes.
- Two No. 4 or No. 6 dry cells (preferably the latter).
- Two small 45-volt "B" batteries.
- One pair earphones.

Provided the builder has patience, the set will provide many hours of interesting reception, not from foreign stations alone, but from hundreds of other stations of the classifications previously mentioned. Too many people have the idea that foreign stations will drop right in the first time a short wave set is turned on, and their enthusiasm suffers an undeserved setback when they fail to log London or Madrid immediately. Extravagant advertising to the contrary, the short waves are still tricky, and therein lies their greatest charm. Stations that are thunderously loud one week may be completely absent the next.

Don't Expect Too Much at Once

At any event, the builder must not expect to master the fine points of short wave tuning in a few hours. First he will probably log the police stations around 122 meters, as these are easy to catch. Then there are the hundreds of amateurs on 160 and 80 meters, the airplane stations on approximately 53 and 95 meters, and finally the relay broadcasters on 49, 31 and 25 meters. Short wave broadcasting schedules are irregular and subject to quick changes, but there is always something doing below 200 meters, and the careful listener is never without signals.

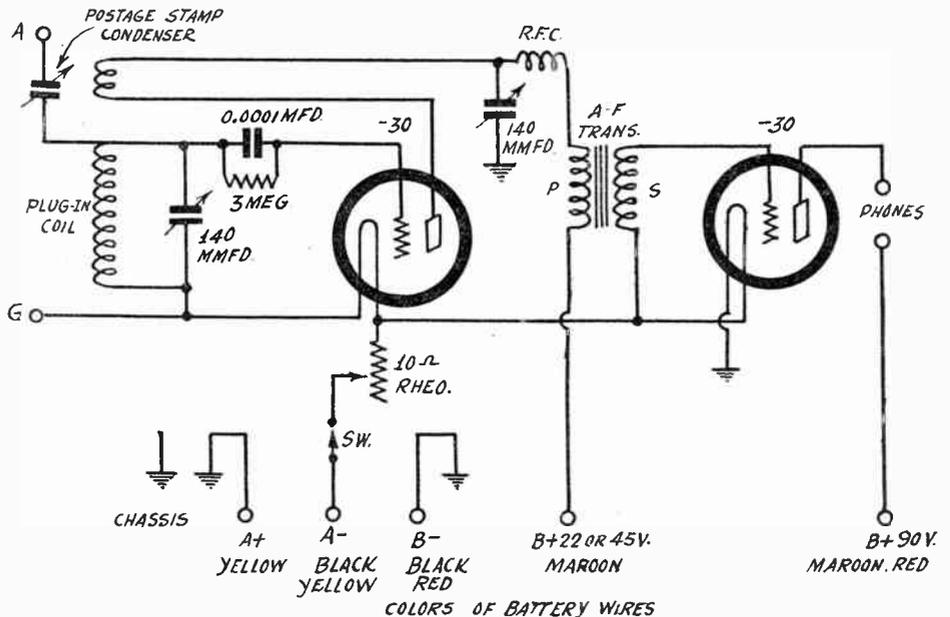
Standard Resistor Code

| For First or Second Significant Figure | Number of Ciphers After the Significant Figures |
|--|---|
| Black | 0 |
| Brown | 1 |
| Red | 2 |
| Orange | 3 |
| Yellow | 4 |
| Green | 5 |
| Blue | 6 |
| Violet | 7 |
| Gray | 8 |
| White | 9 |

The color for the first or second significant figure follows this code: body color denotes first significant figure; end color denotes second significant figure; dot denotes number of ciphers after the first two significant figures.

MORE SHORT-WAVE R-F

Short-wave receivers using a stage or two of t-r-f are becoming popular, although only a year ago this was "ducked" as being too dubious and critical. New and better tubes aid stability, and the results are excellent.



Circuit Diagram of the Beginner's Twin

Radio University

A QUESTION and Answer Department. Only questions from Radio University members are answered. Such membership is obtained by sending subscription order direct to RADIO WORLD for one year (52 issues) at \$6, without any other premium.

RADIO WORLD, 145 WEST 45th STREET, NEW YORK, N. Y.

Grid Leak Detection

IN WHAT way does grid leak detection differ from diode detection? It seems practically the same to me. If I am wrong will you kindly point out where the differences are?—R. Y., Cincinnati, Ohio.

There can be no difference as far as detection is concerned for grid leak detections is diode detection. The difference enters in the amplifier. The plain diode detector is just a rectifier and a filter, while a grid leak detector is that and amplifier in addition. Due to the position of the load resistance (grid leak) and the filter condenser (grid condenser) in the grid anode lead, which is also the amplifier control grid, the radio frequency voltage across the tuned circuit is also applied to the amplifier, and the ripple appears amplified in the plate circuit. That is why it is necessary to use a plate by-pass condenser when grid leak detection is used. Also because the signal voltage gets into the plate circuit, amplified, is it possible to regenerate with the grid leak detector. Diode detection as practiced with the 55 and the similar tubes is superior for straight detection because the tuned circuit is so placed with respect to the amplifier control grid that the carrier voltage is not impressed on the grid.

* * *

Oscillator Heats Up

RECENTLY I hooked up a vacuum tube oscillator for the purpose of driving a rectifier to obtain a high steady voltage without any ripple. I applied 250 volts on the plate of the tube, which was a 56, and used a regular oscillating circuit with grid leak and stopping condenser. The plate of the tube quickly got red hot. Why should this be when the tube will stand this voltage in an amplifier circuit?—R. W. F., Covington, Ky.

The plate got hot because the plate current was excessive and it was excessive because there was not enough bias on the grid. Perhaps the grid leak was not of the right value. It may also be that the transfer of energy from the tuned circuit to the load was not efficient. If the load on an oscillator is removed or greatly reduced there is no other escape for the energy than in heat. Most of the energy involved should have gone to the load resistance on the rectifier.

* * *

Transmitter Feeders

WHAT is a feeder as applied to a radio transmitter? Could it be used advantageously in a receiving installation?—W. H. C., New York, N. Y.

A feeder is a high frequency transmission line consisting of two parallel conductors the same distance apart all the way. Sometimes the two conductors are open when they are only two heavy wires held at a definite distance apart, and sometimes they are concentric conductors with a grounded sheath outside an inner conductor. This concentric form seems to be gaining in favor because there is no radiation from it along the

line. The characteristics of the feeder are such that no appreciable loss occurs along the line, provided that the line is properly terminated. The feeder has also been used in receiving installations for the purpose of leading the signal from the antenna on the roof down to the receiver in the building. Just as the concentric line does not radiate so does it not pick up any stray signals. It is for that reason it has been used for reception for the line may go through places where electrical noises abound without picking any of them up. Moreover, it is a means for taking advantage of the high signal pick-up of an antenna on the roof above all obstructions.

* * *

Performance of Oscillators

DOES an oscillator employing a grid leak and stopping condenser generate a pure wave or is it considerably distorted? If the wave is not pure what can be done to make it better? What would be the effect on the signal of an impure wave when the oscillator is used in a superheterodyne?—W. R. M., Tulsa, Okla.

The wave generated by such an oscillator is very impure indeed. The reason is that the oscillator works about a curved portion of the characteristics. The plate current amounts to pulses of current. When such an oscillator is used in a superheterodyne there will be many strong harmonics in the output and these harmonics will cause squealing at certain definite frequencies. If the pick-up is taken off the oscillator inductively very little of the harmonics will get to the mixer tube because the current in the resonant circuit is relatively pure and those harmonics that get into it flow through the condenser for the coil acts as a choke to them. If the grid of the oscillator is given a suitable negative bias and if the plate voltage is high the generated wave can be greatly improved. Just how this happens is explained in an article in this issue.

* * *

Mutual Conductance of Tube

JUST what is the mutual conductance of a tube and how can it be obtained experimentally? I know that it is always given in tube characteristics but it is merely a number of so many micromhos.—W. T. B., Albany, N. Y.

The mutual conductance of a tube is the slope of the plate current, grid voltage characteristic at the operating point. It is not a constant for no characteristic curve is straight. There are many methods for measuring the mutual conductance and there are instruments which read it directly. An approximate value of the mutual conductance can be obtained from a curve giving the relation of the grid voltage and the plate current. Such a curve can be taken in a few minutes. The method is to select the operating point, that is, the bias at which the mutual conductance is to be obtained, and then to read the plate current at two other voltages equally removed from the operating bias and in opposite directions.

For example, if the mutual conductance is to be measured at 3 volts, the plate currents at 2.5 and at 3.5 may be obtained. The curve should be reasonably straight over this range. The plate current at 2.5 volts may be 5 milliamperes and that at 3.5 may be 2 milliamperes. The change in plate current is 3 milliamperes, and this change was produced by a change of one volt. Hence 3 is the mutual conductance expressed in milliamperes per volt, or in millimhos. The number would usually be expressed in micromhos, which in this sample is 3,000.

* * *

Calibrated Oscillator

WOULD it be practical to make a calibrated oscillator with a 150 mmfd. tuning condenser? What would the inductance have to be? If a constant frequency oscillator is to be constructed, is it better to have a high capacity condenser and a low inductance than the other way about?—P. C., New York, N. Y.

It will probably not be possible to make a 150 mmfd. condenser cover the broadcast band because of the relatively high capacity. The inductance needed is 560 microhenries. If the 1,500 kc frequency is to be reached the minimum capacity would have to be as low as 20 mmfd. It is difficult, if not impossible, to get such a low minimum. A calibrated oscillator with such low capacity would not be very accurate nor frequency stable. It is better to use a large condenser and a small coil for an oscillator because then the frequency stability will be greater and the calibration will mean something. By making the minimum capacity high enough the oscillator need not cover more than the band desired and the calibration will be better at the higher frequencies.

* * *

Scanning Device as Oscillograph

PICTURES of facsimile transmissions clearly show the effect of echoes and are aids to learning what is going on in the space through which the signals travel. The same facts are shown on television images. It occurred to me that the principle, that is, scanning, could be used for studying wave forms and transients instead of the oscillographs. What do you think of the idea?—W. G. S., Chicago, Ill.

To some extent the scanner has already been applied to this use, and it may be that the technique developed in the search for television will find a more useful application in this by-product. The device may be applied to accurate measurement of frequency and phase shift, and it can be used to show wave forms. Another possibility is the measurement of the velocity of light. In this connection the only doubtful factor now is the distance over which a given light impulse has traveled. Time can be measured to an accuracy of better than one part in a million. Could the distance be measured with the same accuracy the velocity of light could be measured with the same accuracy, which is much better than has ever been done.

* * *

Tube Bases

HOW many different sizes of tube bases are now used? Will all tubes with the same number of base pins fit into any socket having the same number of contacts? For example, will any seven-prong tube fit any seven-contact socket?—G. H. A., Bronx, New York.

There are three different bases as to size, namely, small, medium, and large. In general they are not interchangeable. Receiving tubes are either of the medium or small size. In selecting a socket for a given tube it is always best to consult a tube characteristic chart.

STATION SPARKS

By Alice Remsen

Spring

For Swift's "Garden Party" (WEAF, Sundays, 5:30 p.m.)

The goose girl stands in the April rain,
A willow wand in her hand;
Her eyes are bright with a sapphire stain,
Her hair as gold as the sand.
Her feet are bare
To the April air
That ripples across the land.

The goose girl sits by the water's edge
And watches the geese float by;
She hears the rustle of waving sedge,
And a homing pigeon's cry.
Her eyes are cool
As the lily pool
In the fragrant woods near-by.

The goose girl lifts her face to the rain,
It spatters upon her brow;
She doesn't ask me to explain
The whither, the why, the how!
A goose girl she—
Content to be—
And what else matters now?

—A. R.

* * *
The lovely music of a symphony orchestra and the blended harmony of voices will remind you of spring if you listen in to Swift's Garden Party. Music and song, flowers and birds, rain and the beauty of the goose girl, will all be blended into one for you. Listen! You'll like it!

The Radio Rialto

Well, the sun is shining again along the old rialto. After the storm of bank closings, earthquakes and attempted assassination—the old earth bearing its countless millions lifts her head again with a sigh of relief. A new regime has begun and let us hope that safe and sane living will be the rule. . . . Business is picking up, and while a great many of the bigger accounts are going off the air for the summer, new ones are emerging and the air will still resound to the merits of this and that. It seems the old reliables will always be with us. A. & P. Gypsies, Cities Service, Barbasol, Maxwell House Coffee, to mention only a few, have tested the value of conservative radio advertising and found that it produces results. Radio stations in the east and elsewhere permitted themselves to become panicky, cut salaries to the bone and fired artists by the wholesale. This is all right, too, under the circumstances. You'll find, however, that this will also adjust itself, for even good sustaining programs cannot be bought for nothing. It's all very well to talk of putting amateurs on the air, giving auditions by the wholesale and throwing mediocre stuff out into the air, but this is a case of cutting off the nose to spite the face, and radio will find that this policy will lose what it took so long to gain—the good will of listeners. . . .

By the time this reaches print I shall be back on dear old Broadway, visiting all the old haunts, after being away a little over three months; must say that I enjoyed myself and met many fine folk in Cincinnati, although lots of things should have happened that didn't and many promises were made that were not kept. . . . Still, your girl friend has an open heart and mind in these matters and I remember what my dear old mother used to say to me: "Everything hap-

pens for the best, lass"—and I believe that is true. . . .

Niles Trammell, of the National Broadcasting Company's Chicago studios, is presenting a new kind of radio broadcast, an original musical comedy with Phil Baker as the star, supported by such well-known artists as Harry McNaughton, the Neil Sisters, the Ambassador Quartet, and Roy Shield's Orchestra—not forgetting Phil's accordion; and, oh, yes, the writer and author, J. P. Murray; it is sponsored by Armour and Company, another advertiser who believes in radio. This program may be heard each Friday at 9:30 p. m. over an NBC-WJZ coast-to-coast network. . . .

Another new program to emanate from the NBC Chicago studios is the Northwestern Chronicle, under the sponsorship of the Northwestern Yeast Company, also over an NBC-WJZ network each Sunday at 2:30 p. m. E.S.T. Every member of the cast is a radio veteran; Editor Dudley will be played by Eugene McGillen, Loretta Poynton plays the part of Little Ruth, Aunt Hessie will be played by Bernadine Flynn (Miss Flynn, as you no doubt know, plays the part of Sade in "Vic and Sade"); Bill Barth will play the role of Buck Harkins, the bashful, lovesick cub reporter, and Dolores Gillen will be Alice Dudley, daughter of the editor and sweetheart of Buck; and lest I forget—Merrill Fugit will also make himself useful in the production. . . .

The girl heard with Paul Wing, the Story Man, is Adele Harrison, and, in case you'd like to know, the roles of Janet, Peter and Pan, in the "Wheatena-ville" sketches are played by Alice Davenport, Bobby Jordan and Florence Hallop. . . .

Did you know that Fanny Brice got George Olsen his first chance with Ziegfeld? Well, she did, and here's how it happened: Fanny was playing in Portland, Oregon, which is George's home town; George, practically unknown, was leading his orchestra there; Fanny was so impressed with the personality of George and the personnel of his orchestra that she sent Ziegfeld a long telegram; "Ziggy" promptly hired George on her recommendation; sounds like a story out of a book—but it's true. . . . and here's the sequel that all good stories must have; Fanny Brice is now appearing in a series of dramatic musical sketches, with George Olsen and his music, each Wednesday evening over an NBC-WEAF network; 8:00 p.m. is the time; Royal Vagabonds is the program. . . . Those three X-ponents of harmony, the Three X Sisters, are now warbling over the National Broadcasting Company's ether waves; these gals are plenty good; an established vaudeville act under another name, they entered radio via the BBC in England, then came back to their native land and knocked 'em cold over CBS; then, like so many before them, they went over to the rival network—stars have a habit of flitting that way; you may hear them each Monday, Wednesday and Friday, over NBC-WJZ and network at 6:30 p.m. . . .

Columbia's studios are busy these days; another big-time revue and vaudeville comedian made his bow on the Five Star Theater, with a new type of variety show; he's Solly Ward, the German dialect comic; he may be heard each Tuesday at 10:00 p.m. WABC and network. . . . For feminine listeners there's a new style feature, "Fashion Forecasts" sponsored by "Vogue," offering Jean Wana-

maker in pre-publication chats; WABC only, Thursdays at 11:00 a.m. . . . Helen Nugent and Ben Alley, who have been featured together and separately on WABC for so long, were let out with many more artists just recently; they will probably bob up in Cincinnati, from whence they started, at WLW for the summer. . . . Harriet Hilliard, the blonde beauty who sings with Ozzie Nelson, wears a tuxedo suit for her New Yorker Grill appearances these evenings, and she offers the strongest argument yet for lassies in lad's clothing; go and take a look for yourself. . . . Somebody's stole Myrt's flivver "Lovable." . . . Charlie Carlile no longer wears that dinky little eyebrow over his upper lip; the banking holidays, causing lack of cash, made him decide take it off, after three years of trimming and waxing—how could you, Charlie! . . . Of course, David Ross, the jokester, had something to say about "hair today and gone tomorrow." . . .

One of the finest dance orchestras on the air is that of Henry Theis, playing at the Hotel Sinton's Club Mayfair in Cincinnati; Henry is a veteran radio man and shows it in the wonderful set-up and radioic combination of his orchestra; he is noted for his very clever dance arrangements of popular tunes; with him is the cosmopolitan tenor, Carl Grayson; Carl is handsome, tall and slender, with a most pleasing personality and a voice that causes the feminine hearts to flutter all along the route; band is heard over WLW twice daily; and don't forget this combination would be a good commercial bet with a female voice added for good measure. . . .

Biographical Brevities ABOUT WAYNE KING

Wayne King was born in Savannah, Ill., and spent his school years in Texas, Arizona and New Mexico. He attended Valparaiso University in Indiana, where he studied to be a certified public accountant. This business training led him to try his hand at banking with his brother in Iowa. Banking was slow, so he next got a job in an automobile repair show—a little more exciting but still too quiet. He went to Chicago, tried his vocal skill as an insurance salesman and found he wasn't so good.

During all this time the future waltz king was preparing for his real vocation without knowing it. He had played a clarinet all his life and decided to try a musical career for a change. His first job was with a three-piece orchestra and he collected five dollars for the job. Thought he'd try saxophone, did so and held several band jobs around Chicago, finally landing as first saxophonist at the Trianon ballroom. He organized his own orchestra in 1926 and his style of music became instantly popular. His sax solos, pleasant personality and physical appearance endeared him to dancing Chicagoans.

Originality is the keynote of Wayne King's success. When the waltz seemed relegated to oblivion by all the band masters of America, Wayne clung to it; he specialized in the arrangement of dance numbers in the slower tempo, and his popularity grew and still keeps growing. Wayne King looks like a six-footer, but in reality he is only five feet nine and a half inches tall; weighs only a hundred and sixty pounds, but looks a lot huskier. Is still in his early thirties. He married Dorothy Janis of the silver screen.

He is a great sportsman—hunter, fisherman, golfer and flies his own plane. His wife is his chief companion. His hobbies—a dog, his music, his books and his pipes. He finds relaxation in works on philosophy, and his hobby for pipes has grown until he now has a collection of over two hundred of all shapes, sizes and histories. You may hear him each Sunday and Tuesday over WEAF and each Thursday over WJZ.

DIAMOND PARTS

Tuned Radio Frequency Sets FIVE-TUBE MODEL

A-C operated circuit, 50-60 cycles, 105-120 volts, using two 58 t-r-f stages, 57 power detector and 47 output, with '80 rectifier. Three gang shielded condenser and shielded coils in a sensitive, selective and pure-tone circuit. Dynamic speaker field coil used as B supply choke. Complete kit of parts, including 8" Rola speaker and all else (except tubes and cabinet). Cat. D5CK @.....\$15.00
Wired model, Cat. D5CW (less cabinet) @.... 17.19

Kit of five Eveready-Raytheon tubes for this circuit. Cat. D5T 4.97

FOUNDATION UNIT, consisting of drilled metal subpanel, 1 3/4 x 8 1/2 x 2 1/4"; three-gang Scovill 0.00035 mfd., brass plates, trimmers, full shield; shields for the 58 and 57 tubes; six sockets (one for speaker plug); two 8 mfd. electrolytic condensers; set of three coils. Cat. D5FU..... 8.19

Super Diamond parts in stock.

FOUR-TUBE MODEL

The four-tube model is similar, except that there is one stage of t-r-f, and a two-gang condenser is used. Tubes required, one 58, one 57, one 47 and one '80. Complete kit, including 8" Rola dynamic speaker (less tubes, less cabinet). Cat. D4CK\$13.50

Kit of four Eveready-Raytheon tubes for this circuit. Cat. 4D.TK 3.88

FOUNDATION UNIT, consisting of drilled metal plated subpanel 1 3/4 x 2 1/2 x 7"; two-gang 0.00035 mfd. SFL condenser; full shield; two shields for 58-57; center-tapped 200-turn honeycomb coil; five sockets (one for speaker plug); two 8 mfd. electrolytics; set of two shielded coils; 20-100 mmfd. Hammarlund equalizer for antenna series condenser. Cat. D4FU\$5.48

INDIVIDUAL PARTS



Travelling light vernier dial, full-vision, 6-to-1 vernier, projected indication prevents parallax; takes 1/4" or 3/8" shaft; dial, bracket, lamp, escutcheon.

0-100 for 5-tube Diamond, Cat. CRD-0, @ \$9.91.

100-0 for 4-tube Diamond, Cat. CRD-100, @ \$9.91.

If dial is desired for other circuits state whether condenser

closes to the left or to the right.]
8 mfd. Polymert electrolytic, insulating washers, extra lug. Cat. POLY-8\$0.49
Three 0.1 mfd. in one shield case, 250 volt d-c rating. Cat. S-31 @..... 29
Rola 8" dynamic for 47 with 1800 ohm field coil tapped @ 300 ohms. Cat. FP @..... 3.85
2 coils for 4-tube. Cat. DP @..... .90
3 coils for 5-tube. Cat. DT @.....1.35

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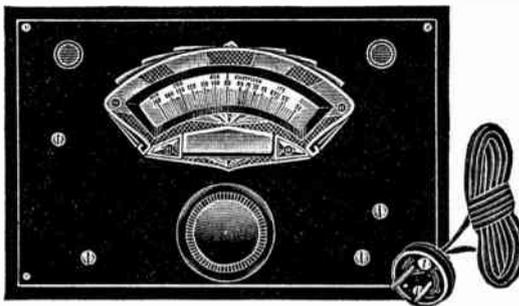
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PUSH-PULL SUPER DIAMOND: Construction and trouble-shooting article and double-page picture diagram. In Radio World of March 18, 1933. 15c a copy. Radio World, 145 W. 45th St., New York City.

NEW RADIO AMATEUR'S HANDBOOK, 180,000 words, 207 illustrations, 218 pages (10th edition, issued 1933). Price, \$1.00 per copy. Radio World, 145 West 45th Street, New York, N. Y.

BARGAINS IN FINEST PARTS! — Highest grade, new parts, few of each on hand. National dial, flat type, modernistic escutcheon, type G, clockwise, \$2.19; Pilot drum dial No. 1285 @ \$1.89; a-c toggle switch, 19c; triple pole, four-throw Beat switch, insulated shaft, \$1.62; double pole, four throw, \$1.08. Direct Radio Co., 145 West 45th St., N. Y. City.

All-Frequency Service from a Test Oscillator



The test oscillator has a frequency-calibrated dial, registering 50 to 150 kc, while above this tier of frequencies are registered all the popular commercial intermediate frequencies. So just consult the dial scale.

A COMPLETELY self-operated a-c test oscillator, fundamental frequencies from 50 to 150 kc, with the line frequency, 60-cycle hum, used as modulation but not heard except at resonance, affords all-frequency service, from 50 kc up. This is true because the fundamental may be used as registered on the exclusively frequency-calibrated dial, and harmonics may be used for any higher frequencies, almost without limit. All oscillators are tested up to the 28th harmonic, but response of sufficient intensity may be obtained even beyond the 50th harmonic, and there are proven cases of good results up to the 150th harmonic.

Therefore when fundamental frequencies are low, as here, you may set down the lowest, 50 kc, as one extreme, while the harmonic orders give almost unlimited service to line up short-wave receivers, converters and broadcast receivers that respond to police frequencies.

Average Accuracy 1% or Better

The a-c test oscillator, 105-120 v., 50-60 c., uses a 56 tube, a frequency-stabilized grid circuit, Hartley oscillator and a-c on the plate. Special pains have been taken to assure accuracy, and the test oscillator is guaranteed to be accurate to within 2 per cent. However, at some settings the accuracy is almost perfect, while the average accuracy is 1 per cent. or better. The 2 per cent. rating is the extreme deviation, present in only a few instances.

Therefore in possessing one of these oscillators one knows that he has an instrument of a degree of accuracy more than sufficient for the purposes to which the oscillator will be put, i.e., lining up intermediate amplifiers and padding, in superheterodynes, or lining up condenser gangs in t-r-f systems.

The oscillator will yield sharp zero beats with carriers, and the accuracy may thus be checked at any time against broadcast carriers, using the tenth harmonic (500 to 1,500 kc). This harmonic is used for all broadcast frequencies.

If any particular frequency setting that is a multiple of 50 is ascertained for a receiver or other tested device, frequencies separated therefrom in steps of 50 kc may be registered by setting the test oscillator at 50 kc and tuning the tested device. This is particularly handy in frequency calibration, and for finding frequency extremes in receivers that cover some of the police frequencies.

Get One of These Test Oscillators Free!

The oscillator is self-powered as an a-c device, but may be obtained also in battery model. The circuits used are simplifications of the Hartley oscillator and the construction of all oscillators is under the supervision of graduates of the Massachusetts Institute of Technology, who test each oscillator to verify its accuracy.

The a-c model is constantly modulated and yields zero beats at all times. The battery model has a switch at left for modulated-unmodulated service, and yields zero beats on unmodulated but not on modulated service.

The a-c test oscillator parts may be obtained free with a one-year subscription for RADIO WORLD, 52 issues, one each week, at \$6.00, the regular subscription price, while the cost is \$1.50 extra for wiring and calibrating. The \$1.50 is turned over by us to an outside laboratory. Order Cat. PRE-ACOW and remit \$7.50 with order. The 56 tube is 72c extra.

The battery model requires a 230 tube, a 22.5-volt small B battery, and a 1.5-volt dry cell. Order Cat. PRE-BATOW and remit \$7.50 with order. The 230 tube is 78c extra. Batteries not supplied.

The main scale of the frequency-calibrated dial reads from 50 to 150. The bars are 1 kc apart from 50 to 80 kc and 2 kc apart from 80 to 150 kc. Thus for broadcast work, using the 10th harmonic, the separation as registered by the bars is 10 kc from 500 to 800 kc and 20 kc from 800 to 1,500 kc. On an upper tier the intermediate frequencies are printed: 175, 360, 400 and 450 kc, with a bar to the left of 175, representing 177.5, and a bar to the right of 175, representing 172.5. These, with 150 on the fundamental, represent all the popular commercial intermediate frequencies. Any other intermediate frequency may be obtained either directly from the fundamental, or by dividing a higher desired frequency by the nearest whole number to yield a frequency represented on the fundamental.

DIRECTIONS FOR USE

Remove the four corner screws and the cover, insert the 56 tube in its socket, restore the cover and screws, connect the a-c attachment plug to the wall socket, and the a-c test oscillator is ready for service at broadcast frequencies. No other coupling is necessary, as radiation is strong enough. Mentally affix a cipher to the registered frequencies on the lower tier (so 50 is read as 500, and 150 as 1,500), and set the dial for any desired frequency. At resonance the hum will be heard. Off resonance it will not be heard. For testing intermediate frequencies, connect the bare end of a wire to the output post of the test oscillator, other bare end of this wire to plate of the first detector socket. The first detector tube may be removed and bare wire pushed into the plate spring. The intermediates then are tuned for strongest hum response. If an output meter is used, tune for greatest needle deflection.

The battery model is connected to voltage sources as marked on oscillator outleads and is used the same way, except that output lead may have to be wrapped around the aerial near set for a few turns to effectuate coupling at broadcast frequencies. The modulation is a high-pitched note, instead of hum.

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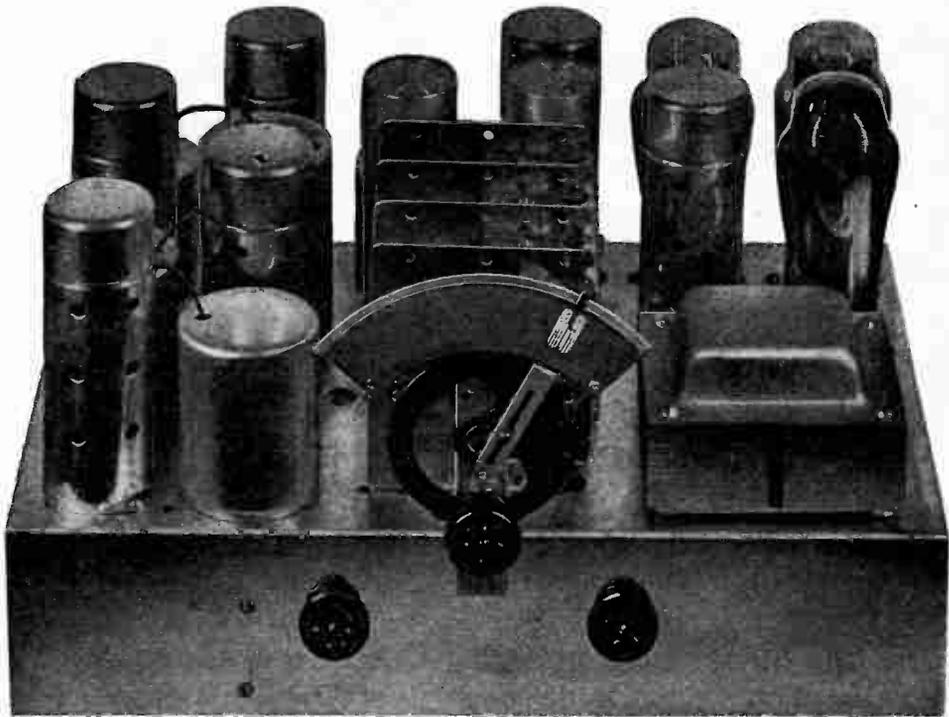
6/32 mounting holes, 1-11/16 inches apart; central socket hole recommended, 1 1/8 inches, although 1 1/4 inches may be used.
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UY, with insulator.....10c
Six-pin, with insulator.....11c
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The Greatest DIAMOND of them All!

Designed by Herman Bernard and Indorsed by Us as the Greatest Circuit We've Ever Offered

1. Push-Pull 15-watts undistorted output, the great power serving as a reserve that avoids distortion on strong low notes of orchestras.
2. New tubes. The heavy-duty 5Z3 rectifier and the 2A3 output tubes are used. The power stage is a cross between Class A and Class B, but of the no-grid-current type.
3. Full wave duplex diode linear second detector. Stands up to 60 volts signal on second detector.
4. Noise suppression control without an extra tube. This means no inter-channel hiss or "hash" without elimination of which a.v.c. is a nuisance.
5. Two stages of intermediate frequency amplification, both subject to full automatic volume control.
6. Selectivity affording non-interfered reception from a distant station through a local 10 kc away delivers 100 times as much antenna voltage.
7. Sensitivity of better than 0.5 micro-volt per meter.
8. Volume control can completely eliminate signal, and has sound volume range from bare audibility to 400,000 times bare audibility.
9. Dual range. Broadest and police bands by throwing a front-panel switch. Some amateurs, short-wave music and television can be received.



The knob at left is for throwing a switch, so 1,500-530 kc or 4,300 to 1,500 kc can be tuned in. At right is the combination a-c switch and volume control.

The Push-Pull Super Diamond

ON a chassis only 13.5 x 3 x 8.75 inches is built one of the finest a-c dual-range receivers any one could desire—the Push-Pull Super Diamond, using nine tubes, with eleven-tube performance. The reason for the extra performance is the use of a single tube as oscillator and modulator, and two tubes in one envelope as second detector and first audio amplifier (55).

The push-pull output stage uses two of the new 2A3 tubes, affording 15 watts output (5 per cent. total harmonic distortion), and the output stage is driven by a 56, which will load up the 2A3's. The gain is built up tremendously at the intermediate frequency level, where it may be done without distortion. Then follows a distortionless full-wave detector, the full-wave feature being protection of quality. The audio stages are worked well within their power-handling capacity, to a total gain at audio frequencies of less than 1,000.

The performance of the receiver is such that you never need worry about interference due to a strong local spoiling reception of a distant station on an adjacent channel, or interference due to cross-modulation, for there is no cross-modulation.

The controls are limited to the tuning dial, which is frequency-calibrated, the combination a-c switch and volume control, and the wave-band switch. Total, three controls. Result, utter simplicity. Any one in the family can tune the set without any trouble. No tuning indicator, be it meter or neon lamp, is necessary, due to noise suppression control.

You may use as long an aerial as you desire on this receiver, yet you will get an abundance of results from even remotely-distant stations on only ten feet of wire. The only precaution necessary is that the aerial be long enough to cause some voltage to exist in the second detector at all times, as on this voltage alone depends the bias on the first audio amplifier, (triode of 55). Without any bias there would be grid current, and consequent hiss at all settings, but 10 feet of wire as aerial, wherever placed, is usually sufficient to overcome this, and besides every one uses an aerial longer than that. Any type of outdoor aerial will meet the requirement of 55 triode grid current elimination.

The circuit was designed by Herman Bernard, has been carefully tested out by us in all particulars, and is unhesitatingly recommended as an outstanding circuit that will satisfy those who want "something better." The Push-Pull Super Diamond is distinctly "better."

Wired Model of Push-Pull Super Diamond, including speaker, tubes and everything else, except cabinet. Lined up and padded by experts. Licensed. Cat. WM-PPSD

\$36.27

Complete parts, speaker, tubes, everything except cabinet. Cat. K-PPSD.

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FOUNDATION UNIT

The Foundation Unit for the Push-Pull Super Diamond consists of a shielded antenna coil, a shielded interstage r-f coil, a combination oscillator and 175 kc assembly in one high shield, a shielded regular 175 kc transformer, and a shielded 175 kc transformer with center-tapped secondary; also a 0.00041 mfd. tuning condenser, three-gang, with compensators; an 850 to 1,350 mmfd. padding condenser, a frequency-calibrated dial and a drilled chassis. **\$6.55**
Cat. FU-PPSD @

[The coils for r-f and oscillator are wound exactly according to specifications of Herman Bernard and are of a higher order of accuracy than in commercial practice, and moreover provide for matching the tuning to the scale of the frequency-calibrated dial that bears Mr. Bernard's name.]

ADDITIONAL PARTS

- The nine 0.1 mfd. and two 0.25 mfd. bypass condensers for the Push-Pull Super Diamond are specially made up in one shield, with three mounting lugs for which the chassis is drilled. Cat. CU-PPSD @ **\$1.20**
- Three-gang 0.00041 mfd. tuning condenser, compensators. Cat. TC-PPSD @ **\$1.80**
- Cadmium-plated drilled steel chassis for the Push-Pull Super Diamond. Cat. CH-SD7 @ **.98**
- The tube kit consists of four 58, one 55, one 56, two 2A3 and one 5Z3, total 9 tubes. The radiotron tube kit is Cat. TK-PPD @ **\$10.62**
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- 70-meter switch **\$1.50**
- Heavy-duty power transformer, 150 ma rating, correct voltages and windings. **\$2.95**
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- Complete kit of the 17 one-watt resistors. **\$1.87**
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- Complete set of ten sockets (one for speaker) **.92**
- 0.00005 mfd. mica condensers, 50 mmfd. **36¢ each**
- Push-pull input transformer, unshielded. **\$1.87**
- 775-ohm, 5-watt resistor. **.42¢**