JUNE 10 1933 15¢ Per Copy

RADIO WORLD

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The First and Only National Radio Weekly

Twelfth Year *585th Consecutive Issue*

PORTABLE UNIVERSAL FOR SHORT WAVES

See Article on Page 6

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The First and Only National Radio Weekly
TWELFTH YEAR

Vol. XXIII | JUNE 10th, 1933 | No. 13. Whole No. 585

Published Weekly by **Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y.**

Editorial and Executive Offices: 145 West 45th Street, New York
Telephone: *BR-yant* 9-0558

OFFICERS: Roland Burke Hennessy, *President* and *Treasurer*; M. B. Hennessy, *Vice-President*: Herman Bernard, *Secretary*.

Entered as second-class matter March, 1922, at the Post Office at New York, N. Y., under Act of March 3, 1879. Title registered in U. S. Patent Office. Printed in the United States of America. We do not assume any responsibility for unsolicited manuscripts, photographs, drawings, etc., although we are careful with them.

Price, 15c per Copy; $6.00 per Year by mail. $1.00 extra per year in foreign countries. Subscribers' change of address becomes effective two weeks after receipt of notice.

FREQUENCY MEASURED with Television Scanner

Range is From About 20 to 12,000 Cycles

By J. E. Anderson

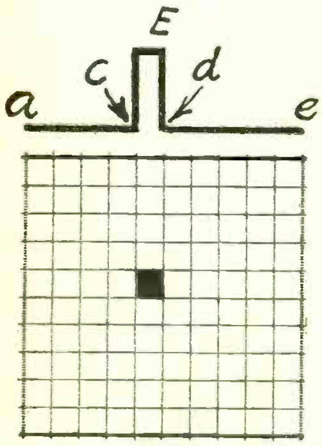


FIG. 1
A television screen and the kind of image that results when a dot appears once every frame.

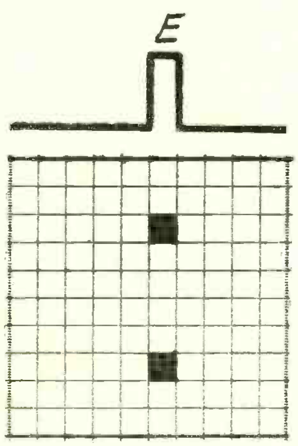


FIG. 2
When dot signal frequency is twice the frame frequency two dots appear, one above the other.

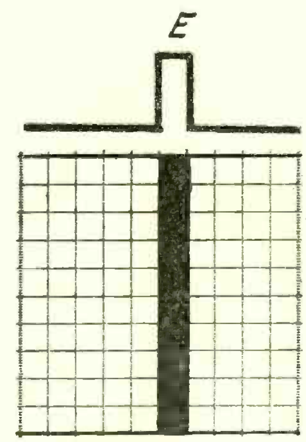


FIG. 3
When the dot signal frequency is equal to the line frequency of scanning a vertical line is stationary.

AN INTERESTING application of the television scanner is to the measurement of frequencies. How this is done will be understood when the mechanism of scanning is understood. Let Fig. 1 represent the field of the television screen, and assume it to be square. In most scanning systems at present the field is covered by 60 lines, running from left to right and from top to bottom. That is, a spot of light moves over the screen in exactly the same way as one reads a printed page. The 60 lines are completed in 1/20 of a second, or the "frame frequency" is 20 per second. Of course, it could have some other value, but that is the principal rate of scanning at the present time.

At the top of the frame in Fig. 1 is a curve representing the signal. It is a dot of very short duration. From *a* to *c* the signal is zero, from *c* to *d* it has a constant value E, and from *d* to e it is again zero.

Let us first suppose that the time between *a* and *e* is 1/20 second and that *cd* occupies a very small part of this, say 1/3,600 part. As the scanning proceeds this spot will appear on the screen either as a black dot on a white background or as a white dot on a black background, depending on whether the image is positive or negative. It will only occur on one line and at one spot in this line. Since this signal is repeated once every 1/20 of a second, or once for each frame, it will always appear at the same spot, at which it will remain stationary, provided that the frequency of the dot is the same as the frame frequency.

Frequencies Not Coincident

Suppose now that the signal frequency is a little greater than the frame frequency. The spot will no longer occur at the same place. It will always occur a little sooner than it did the previous time. Hence the spot will move in the direction opposite to the scanning direction. For example, if the spot first appears at the right edge of a line, it will slowly move toward the left edge. There it disappears, but immediately reappears at the right edge in the line above. The spot will scan the entire field but in the opposite direction to the true scanning. If, on the other hand, the frequency of the signal is a little slower than the frame frequency, the spot will move in the same direction as the scanning beam, because each time it will appear a little later than it did before.

If it were possible to follow the spot as it moves, which it may not be, it would be possible to measure frequencies both higher and lower than the frame frequency, as well as the frame frequency, in terms of that frame frequency. It would be necessary only to measure the time the spot covers the field. It is possible to measure a frequency exactly equal to the frame frequency because then the spot will stand still and it will be visible. It is also possible

(*Continued on next page*)

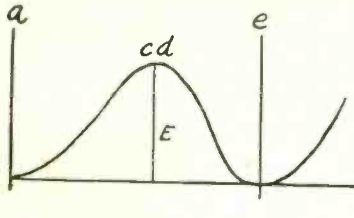


FIG. 4
When the signal is a sine wave dots are drawn out into bands, with sine wave distribution of intensity.

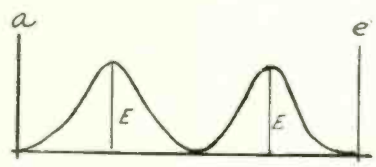


FIG. 5
When the signal in Fig. 2 consists of sine waves like this the two dots are drawn out into bands.

(*Continued from preceding page*)
to measure frequencies differing slightly in either direction from the frame frequency because the spot will move slowly and will be visible.

Twice Frame Frequency

Now suppose that the signal frequency is twice as great as the frame frequency. that is, 40 per second, and that it otherwise is the same as before. The spot will now appear in two lines, one spot appearing directly over the other. If the frequency is exactly twice the frame frequency the two spots will stand still and they will be visible. This case is illustrated in Fig. 2. Wherever the spots appear, the sum of the blank lines between the dots and the edges will be the same as the number of blank lines between the two dots.

If the frequency of the signal is slightly greater than twice the frame frequency, the two dots will move to the left as in the case of a single dot, but the lower dot, that is, the one that occurs later, will be shifted more to the left. Hence the effect is that the line joining the two dots will have a positive slope. And if the frequency is slower than twice the frame frequency the dots will move toward the right, and the later dot will move farther. Hence the line joining the two dots will have a negative slope.

Higher Frequencies

As the frequency becomes three times the frame frequency three dots will appear in a vertical line, and they will be visible because they will stand still. This may be continued until the frequency of the signal is 60 times the frame frequency, when a dot will appear in every scanning line. These dots will be so close together in the vertical direction that they will appear as a vertical line, which will be clearly visible. When the line stands still the frequency of the signal is exactly equal to 60 times the frame frequency, which in the case considered is 1,200 cycles per second. See Fig. 3.

If the frequency differs from 1,200 cycles the individual dots making up the line will not remain in one position but will move to the left or to the right depending on whether the frequency is less or greater than 1,200 cycles. The line, however, will not be vertical slant with positive or negative slope. If the frequency of the signal is less than 1,200 cycles, any dot will appear a little later, relatively, than its immediate predecessor, and the line will lean backward. Conversely, if the frequency is a little greater than 1,200 cycles, the line will lean forward.

The more the signal frequency differs from 1,200 cycles the greater will the slant be. By observing the slope of the line, it is possible to compute the amount by which the signal frequency differs from 1,200 cycles.

Harmonics of 1,200

When the signal frequency has risen to twice 1,200 cycles, two vertical lines will appear, and they will stand still. Hence it is possible to tell exactly when the frequency is 2,400 cycles. These lines will have definite spacings, for there will be as much blank space between the two lines as the sum of the blank spaces at the sides.

When the frequency of the signal differs slightly from 2,400 cycles, the lines will slant in the same manner as in the case of a single line, and it is possible to estimate the frequency from its slope and the fact there are two lines.

As the frequency increases still further, more vertical lines will appear. Thus when the frequency is 3,600 cycles there will be three lines, when it is 4,800 cycles there will be four. In general, the number of stationary vertical lines multiplied by 1,200 cycles will give the frequency of the signal. Theoretically, this could be extended indefinitely, but it would be very difficult to count the number of lines when the frequency is very high.

In estimating the frequency requirements of a television circuit it is customary to assume that the lines will not be more than 60. This limit is purely arbitrary. When the scanner is used for measuring frequencies perhaps 10 lines would be the most that could be counted without much effort. That would place the frequency at 12,000 cycles.

Deviations of the signal frequency from the exact harmonics will be indicated in every case by rotation of the lines.

Sine Wave Signal

We have assumed that the signal was a dot of very short duration. In most instances a signal to be measured is not of that type at all, but rather a sine wave. It may take the form of the curve in Fig. 4, in which the signal intensity varies from zero at *a* to a maximum E at *cd* and again to zero at *e*. Fig. 4 really corresponds to the case in Fig. 1, where the "dot" now has spread out over the entire field. The maximum intensity, either the darkest or the lightest area, now falls where the dot fell before.

If the sine wave signal has twice the frame frequency, the signal may be represented as in Fig. 5. This corresponds to the case in Fig. 2. The two dots now will spread out into two dark bands running horizontally across the field. Near the edges and half way between the bands there will be a minimum of "darkness." That is, the field will be practically white. That is for the case of a positive image. There will be hardly any change in intensity along the bands. Therefore the bands will be clearly visible.

When the sine wave signal has a value of 60 cycles per second, there will be three bands across the field, which are produced by stretching out the three dots. For higher harmonics of the frame frequency, there will be more bands across the field, running horizontally, one dark band and one light band for each harmonic.

Three dark and three light bands appear on the television screen when there is an appreciable 60-cycle hum in the television amplifier. These seriously interfere with the clarity of the image, and for that reason it is very important that the output of the amplifier be as free as possible from hum. If there is a 120-cycle hum in the output, there will be twice as many light and dark bands across the field, that is six of each.

Fractional Ratios

What will happen when the impressed frequency bears some other simple ratio to the line frequency, for example, when it is 1,800? It is not easy to see directly just what will happen, but we can analyze the case practically. Refer to Fig. 6. If we let t represent the time it takes the scanning beam to complete a line, then the time between two dots will b $2t/3$. If a dot occurs at zero time in the upper left hand corner, the next dot will occur when a time $2t/3$ has elapsed. This will fall 2/3 of the way over on the first line. The second dot will occur after another $2t/3$ has elapsed. This therefore will fall 1/3 of the way over on the second line. If this process is continued throughout the field, three vertical lines of dots will appear in the field, but these will not be continuous for there will be a dot in only every other horizontal line. These lines, therefore, will differ from the case when the frequency is 3,600 in that the rows of dots will be only half as intense.

It is easy to extend this case to the sine wave signal by imagining the dots to be spread out horizontally.

The case for any other simple frequency ratio can be obtained by analogy. Suppose the frequency is nF, in which F is the line frequency. When $n=1$, there is one solid line; when $n=3/2$, there are three half-solid lines; when $n=2$, there are two solid lines; when $n=5/2$, there are five half-solid lines; when $n=3$, there are three solid lines; when $n=7/2$, there are seven half-solid lines; when $n=4/3$, there are four 1/3-solid lines, and so on. These various patterns that appear on the screen correspond to the beats between harmonics in a circuit in which there are two beating oscillators.

It is no more difficult to identify the ratios on the screen than in a beat generator. It is a matter of experience to judge the value of the light, or shade, in a line, and thus tell whether it is solid, one-half, one-third, and so on. As in the case of beating oscillators it is possible to identify them by observing the order in which they appear as the frequency is varied. It will be noticed that in the television scanner one frequency is always known, and it is the frequency of line repetition.

Skew Patterns

We found that when the frequency of the signal differed somewhat from a harmonic of the frame frequency that the line joining the dots slanted one way or the other. This will also occur when the frequency differs somewhat from the line frequency or from one of its harmonics. Refer to Fig. 7. Here it is assumed that the signal frequency is to the line frequency as 60 is to 59. In the figure are sixty small squares in each line. If the first dot occurs at square (1) in the first line, the next dot will occur in the 60th square in the same line. This dot is equivalent in point of time to the zeroth square in the second line. The next dot will appear at the 59th square from this. Hence it will appear one square to the left of the last dot in the first line and one line below it. Following this out by placing a dot in each 59th square we obtain a diagonal of dots. Dots are placed at the two corners not including the diagonal for reference. Two of these dots will appear in the pattern if the field is square and if the diagonal divides the field. Of course, the diagonal might appear in another position, and then there would be two of them, the sum of the two being equal in length of the principal diagonal as shown.

Had the frequency ratio been the reciprocal of the ratio assumed, that is, 59 to 60. the diagonal would have had the opposite slope.

Sine Wave Pattern

If the signal frequency is higher than that assumed in Fig. 7 there will be more diagonals. A case of this is illustrated in Fig. 8. Here the signal frequency is assumed to be such that a dot occurs in every 31st square. There are no less than five diagonal lines. In this case the slope of the lines is negative, the opposite of the slope in Fig. 7. Had the dots been placed so that one occurred every 29th square the slope would have been positive.

It is understood that the pattern will not

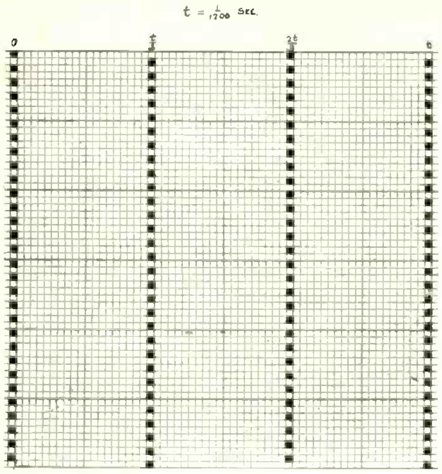


FIG. 6
If the signal frequency is 3/2 times the line frequency, the pattern appears like this, three vertical half-solid lines.

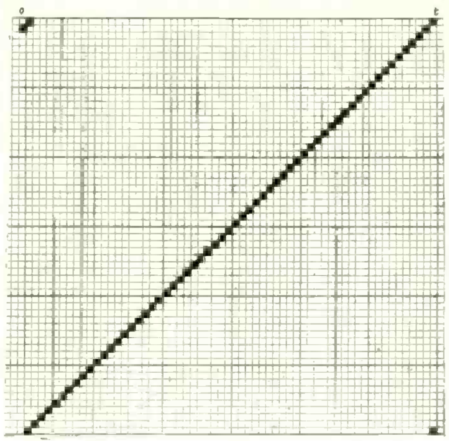


FIG. 7
In this case the signal frequency is 60/59 times the line frequency. One solid diagonal line appears, or two broken diagonals.

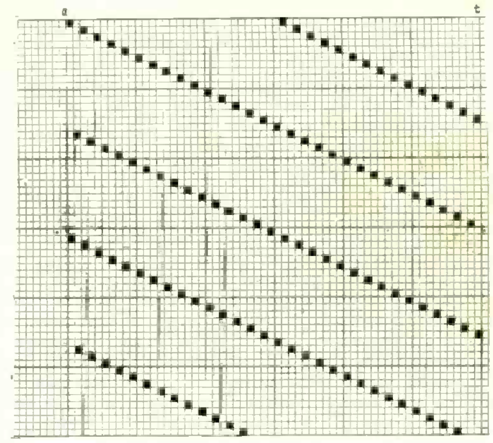


FIG. 8
In this case the signal frequency is 60/31 times the line frequency. Five half-solid diagonals appear, the negative slope being ½.

be diagonal rows of squares when the signal consists of sine waves but rather that they will be bands in which the diagonals are maxima. The field will appear as alternate light and dark bands in which the values are so distributed that if a line is drawn at right angles to them the intensity will be a sine function.

In connection with the half-solid lines in Fig. 6 it should be pointed out that the maximum intensity in one line will be opposite to a minimum in the next. This fact may make the apparent distribution over the field uniform due to the fact that the eye does have sufficient resolving power.

When the relative values of the signal and line frequencies vary continuously, the lines, whether they be vertical, horizontal, or diagonal, will rotate either in the clockwise or counter clockwise direction. This occurs when the motor driving the scanner varies in speed, the signal frequency remaining constant, and it will also occur when the signal frequency varies, the scanning motor remaining at constant speed. When the motor is hunting, as it usually does just before it falls into synchronism, the rotation of the pattern is first in one direction and then in the other. A similar effect is often observed in the movies when a moving vehicle is shown. It frequently happens that the wheels of an automobile will appear to turn backward. As the car is retarded the wheels appear to stand still for a moment, and then to turn in the proper direction. This effect is due to the fact that wheels are seen 24 times a second. The appearance is, of course, an optical illusion and is stroboscopic in nature.

When the scanner is used for measuring frequencies, the standard is the frequency driving the motor. For example, if the motor is synchronous and is driven by a 60-cycle line, the standard frequency is really 60 cycles per second. It is possible to arrange the motor so that it revolves at different rates, all of which bear a simple ratio to the driving frequency. The rate can be determined very easily by examining the motor, that is, the lowest rate. The scanning line frequency is determined by the number of elements in the scanner, such as holes or mirrors or lenses. The scanning line frequency is also known and can be used as a reference or standard frequency.

If a variable speed motor were used it would be possible to get simple patterns for almost any signal frequency. This would be a decided advantage in measuring frequencies as it would only be necessary to adjust the speed of the motor until a simple pattern appears, from which the frequency could be determined quickly in terms of the rate of the motor. However, this method vitiates the standard frequency and it would be necessary to measure the speed of the motor. This might be done with a tachometer if no great accuracy were required. A sensitive and reliable tachometer might possibly be constructed on the generator principle, in which the speed would be measured with a voltmeter calibrated to read revolutions per second. This is possible because the voltage generated is directly proportional to the speed.

SET BUILT INTO ARMCHAIR

(Acme)

Though there's nothing sinister about a radio set, various methods are constantly devised for secreting it. Here you have the armchair as the cache. The contraption was exhibited at the Los Angeles show.

PORTABLE UNIVERSAL
for the Reception of Short Waves

By Frank Grimes and Herman Cosman
Try-Mo Radio Corporation

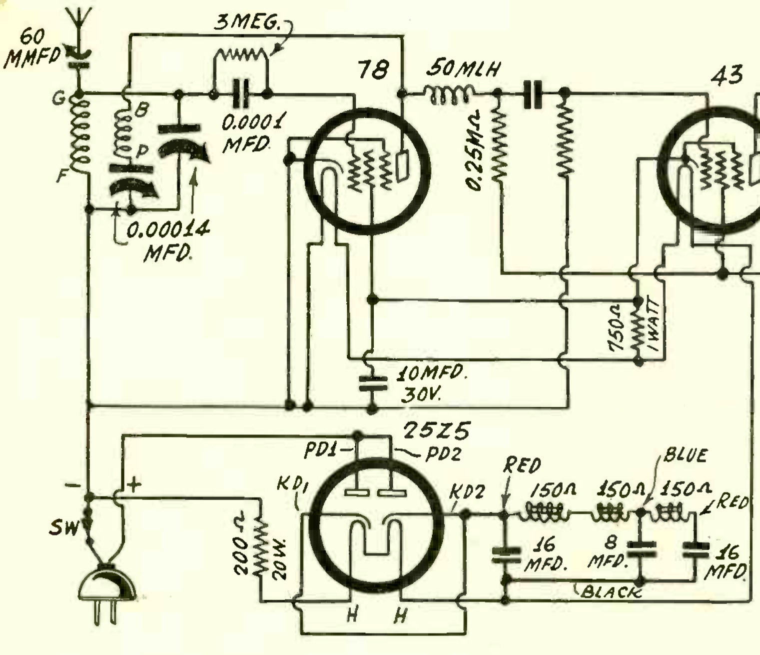


Diagram of a universal short-wave receiver, using plug-in coils. This set works on a. c. or d. c. and gives good performance in either instance. The choke coils in the B leg should be of low resistance, to hold up the voltage at the output, and in line with this voltage consideration the condenser next to the rectifier is 16 mfd.

LIST OF PARTS

Coils

One set of four two-winding short-wave plug-in coils
One 50-millihenry radio frequency choke coil
Three high-inductance filter chokes (about 30 henries each)

Condensers

Two 140 mmfd. variable condensers (Hammarlund)
One 60 mmfd. variable condenser (Hammarlund)
One 0.0001 mfd. grid condenser
One 0.01 mfd. stopping condenser
One 10 mfd. by-pass condenser
Three electrolyttic condensers, two 16 mfd. and one 8 mfd., in one unit

Resistors

One 3-megohm grid leak
One 250,000-ohm coupling resistor
One 0.5-megohm grid leak
One 750-ohm bias resistor (one watt)
One 200-ohm, 20-watt ballast resistor

Other Requirements

Three six-contact sockets
One four-contact socket
One grid clip
Two pairs of binding posts
One line switch
One slow motion dial
Three knobs
One Powertone metal chassis
One six-foot chord with plug
Two tube shields, large for 43 and one small for 78.
One metal panel
One wooden carrying case.

AN earphone portable for short-wave reception, on a.c. or line d.c., requiring few parts, being simple to construct, and assuring good performance, is especially attractive at this time of the year, when week-end travelling is popular. Then as vacation time comes along, the short-wave enthusiast will like to take his set with him under the assurance that no matter if the places where he stays have a.c. or d.c. he still can tune in with delight. So the little receiver has several attractions.

The universality is of course due to the use of the 25Z5 as rectifier when a.c. is the supply, the tube being floated otherwise on the d.c. line. For d.c. the only use of the tube is for the d.c. resistance of its heater, as it can be seen that the line voltage in any case is reduced due to the drop in the 200-ohm, 20-watt series resistor, the resistance of the rectifier heater, and the resistances of the heaters of the two other tubes.

The 78 as Detector

Of these two others, one, the 78, is the detector. In general this tube is classed as a remote cutoff radio-frequency amplifier, but it lends itself well to the grid leak type of detection, with cathode connected, as is suppressor, to ground. The plate load remains the same as in the instances of more formal uses, 250,000 ohms, and the voltage applied to the plate is the maximum obtainable, around 110 volts.

Since the total B current is only around 16 milliamperes, the three separate chokes in the positive B leg drop only 7.2 volts, and if 115 volts exist under a-c conditions, the d-c voltage may be even higher than that, despite the small drop in the chokes, because of the voltage-lifting effect of the filter condensers. However, on line d-c the output voltage would be the difference, or 112.8 volts.

The 43 is the output tube, as it is one that possesses quite a kick. Remembering that the circuit is for earphone operation, the theoretical power output will be greater than that any normal earphones would stand. That is, the output tube can deliver 1 watt, or much more than what is at hand, a more acceptable condition.

Foreign Reception

An output of 1 watt will give satisfactory speaker volume for a small room, and as some local short-wave stations will come in strong enough to be heard on a speaker, those who desire to hook up a magnetic speaker may do so for special reception purposes, although for the general run of reception, including foreign stations, earphone use is imperative.

The circuits is an improvement on one discussed recently, in that portability has been encompassed, and that the sensitivity has been increased by making the antenna series condenser variable from the front panel, instead of merely adjustable to one particular capacity setting at the rear.

The variation thus introduced is such that the effective capacity of the aerial is reduced as the series condenser is set to smaller capacity positions, and this often affords unconscious selection of half-wave and quarter-wave antenna conditions. Whatever may be the merits of the respective "measured" aerials, at least it is true that the regenerative effect is heightened by decreasing the antenna coupling (using less series capacity), and thus regeneration is as assured even on the smallest coils for the highest frequencies.

So that there shall be regeneration it is necessary to hook up most standard coils so that the so-called B plus connection goes to plate and the P connection to the stator of the feedback condenser. The feedback winding is the one connected from plate to the stator of the left-hand 0.00014 mfd. condenser.

Phase Reversal

The reason for this polarity is due to the phase reversal in the tube, and the normal construction of coils for interstage coupling rather than for regeneration. At all hazards, whatever coil you use, if oscillation can not be introduced one way it can the other, so reverse the connections either to the grid or the plate coil, but not to both. "Reversal" here means transposition of P and B or transposition of G and F.

Experiments were performed with various values of grid condenser and leak, and the final selection was for a combination of 0.0001 mfd. and 3 meg. The condenser is lower in capacity than ordinarily used for broadcast reception, because of the higher frequencies, and the consequent improved assistance to regeneration. Failure of regeneration always is accompanied by almost total collapse of performance, and therefore every precaution has been taken to insure regeneration no matter which coil is plugged in, and also no matter what the frequency. So even if regeneration would tend to fail because of the trapping effect due to the natural period of the aerial in relationship to the frequency being received, again an adjustment of the series condenser (60 mmfd.) will correct for this.

The radio frequency choke coil should have a high inductance, and a value of 50 millihenries is specified, although higher inductance values may be used, particularly if the coil is of the honeycomb type of construction, or for any other reason has a low distributed capacity. If that distributed capacity is high, the choke will act as a condenser at the higher frequencies.

Inductance Becomes Capacity

That gives rise to the point, raised occasionally before, that one has to regard a part as a condenser, inductor or resistor depending on its action at the frequency under consideration. Thus a coil may be a choke at a broadcast frequency, because of the relatively low frequency, yet the distributed capacity of the coil may be so high that as soon as one dips a bit into the short-wave band the capacity is large enough to bypass the otherwise inductance of the coil. And again, if d.c. were considered alone, the coil could be treated as a resistance only.

The 43 tube, used in the output, has an apparent bias of 12 volts negative, actually more. Since the cathode is elevated from ground by the sum of the voltages in this resistor and in the heater of the 78 tube, the total negative bias is 18.3 volts, approximately. Since the cathode of the 78 is grounded, and the screen voltage is tied to the cathode of the output tube, the screen actually gets 12 volts, which is sufficient, particularly so with detection.

Although only 750 ohms are placed between the 78 screen and ground, or cathode of the 43 and ground, so far as audio frequencies are concerned, this constitutes an imposing obstructive impedance to low frequencies, hence a large condenser bypasses this resistance. A capacity of 10 mfd. is obtainable in dry electrolytic form.

The filter condensers in the B supply also are electrolytics, in fact, are three condensers in one block, of which the two 16 mfd. elements have red outleads and the 8 mfd. unit has a blue outlead. The common black lead goes to negative. These condensers are dry.

In any use of the 25Z5 and its universal circuits, due regard must be paid to the polarity of the d.c. line voltage, though no precaution is necessary for a.c. In the diagram the positive and the negative are clearly marked. The connection of the plug to the line should be in strict accordance with this designation, because the electrolytic condensers are endangered, and may be permanently ruined, if the line is connected the wrong way.

Perhaps the best method is to take a voltmeter or other indicator and determine the polarity at the convenience or wall outlet. Then mark the positive connection, either with a plus sign, or with a red dot. Then the plug should be similarly marked, and therefore when the plug is connected into the line, and the markings respected, there can not be that costly mistake. So, if the set is taken on outings, it is well to bring a voltmeter or other polarity indicator along, so that the wall outlets can be gauged.

It is noted that the negative is shown as the grounded side, and this normally obtains, but if positive is grounded, no change in the circuit need be made, so far as radio frequency returns are concerned, for the points along the filament circuits are at ground potential, to radio frequencies.

The coils used are those manufactured by the concern for which the designers work, and these coils follow the general pattern, except that the tickler windings are a little larger than ordinarily met, as proved necessary for the retention of regeneration at all frequencies.

Regenerative System

The regeneration system consists of the parallel or shunt feed. The d. c. is fed to the plate through the resistor, while the choke differentiates the potentials, or enables the plate to be at a high r-f potential. Thus the high side may be fed back, as it is, through the throttle condenser. The operation depends in general on oscillation progressively damped by the throttle condenser to the degree of feedback just below oscillation, which is the most sensitive point of operation, the one meant by "regeneration."

Of course there should be no hum in a set like this, and that is the reason for including three separate chokes. The midsection has no bypass capacity across it, as when one was placed there it was found to constitute no advantage whatever.

The front cover illustration shows the appearance of the receiver, the diagram herewith shows the connections, and the list of parts sets forth the material necessary for construction.

In the diagram the designations in the rectifier tube have the following significance: PD1 is the plate of diode 1: PD2 is the plate of diode 2; KD1 is the cathode of diode 1, and KD2 is the cathode of diode 2.

Since not all readers will be familiar with the tubes used, particularly as all three of them are rather new, the following note on the characteristics is given:

Seventy eight—This is a super-control radio frequency amplifier, also useful as a detector with grid leak. The base is the small six-pin. Heater, 6.3 volts, at 0.3 ampere. The socket connections, bottom view, are right to left: heater, heater, plate, screen, suppressor, cathode. Grid is overhead cap.

Forty three.—This is a power amplifier, medium six-pin base, heater volts 25 at 0.3 ampere. The plate current is only around 20 ma, the negative bias not vertical, 12 to 20 volts. The mutual conductance is 2,300 micromhos, which is extremely high. The voltage amplification is 90, the ohms load 4,500 and the power output at voltages used is 1 watt. The socket connections, bottom view, beginning with right-hand heater, are right to left: heater, heater, plate, screen, grid, cathode.

Twenty-five Z five—This is a rectifier, used here in half-wave fashion, two plates paralleled. The socket connections are, bottom view, right to left: heater, heater, plate of diode 1, cathode of diode 1, cathode of diode 2, plate of diode 2.

OUTPUT METER

In attempting to make some measurements of a set a man tried an a-c meter across the voice coil of a dynamic speaker, but did not get any deflection, although a strong signal had been coming through. However, he got some deflection across the primary of the output transformer (the voice coil is across the secondary of this transformer).

This is not unusual. The voltage is low at the voice coil, because of the large step-down ratio, primary to secondary. Besides, if you just put an a-c meter across the voice coil it is more than likely that it was one of those meters that draw immense current, a usual condition of the run of a-c meters, and therefore the voice coil was practically shorted when the attempted test was made. If you desire to make an output measurement it is essential that the d.c. be filtered out, leaving only a.c., to be measured by a sensitive a.c. meter, say, of the rectifier type. A paper condenser or paralleled paper condensers of a total of 10 mfd. may be connected, one side to plate, other side to meter, remaining meter terminal to cathode of the output tube. This method is best used when a non-inductive resistor is in the plate circuit, of a value equal to the recommended ohms load for the tube, as derived from tube characteristics charts. When these conditions are imposed, the circumstances are favorable to an expert measurement, as there would be negligible shunt admittance and negligible series impedance.

Short Waves to Originate in Stratosphere

Plans for the first American flight into the stratosphere, which will carry National Broadcasting Company microphones into new territory, are progressing rapidly following a meeting in Chicago of the principals in the venture.

Some of the most noted figures in science and aviation conferred on the proposed ascent, which is scheduled to be made from the Century of Progress on or about July 1st, under the supervision of the Piccard brothers, Auguste and Jean, one of whom will be official observer in the balloon. Auguste now holds the altitude record of more than ten miles, made in Switzerland last year.

Conferes Listed

Among the men who attended the meeting in Chicago, the first in which all the chief figures in the undertaking were gathered together, were the following:

Lieutenant Commander T. G. W. Settle, U. S. N., who will pilot the balloon; Dr. Arthur Compton, professor of physics at the University of Chicago; Jean Piccard; Dr. Irving Muskat, representing the Century of Progress; W. C. Young, manager of the aeronautics department of the Goodyear Tire and Rubber Company, builders of the balloon; E. H. Perkins of the Dow Chemical Company, makers of the Gondola; R. M. Morris, research engineer of the National Broadcasting Company; J. I. Banish, president of the National Safety Council and consulting engineer of the Union Carbide and Carbon Company which will furnish the gas, and Major Ray Cooper, of the National Aeronautical Association, who will represent the N. A. A. in the matter of official altitude records.

S-W Set in Gondola

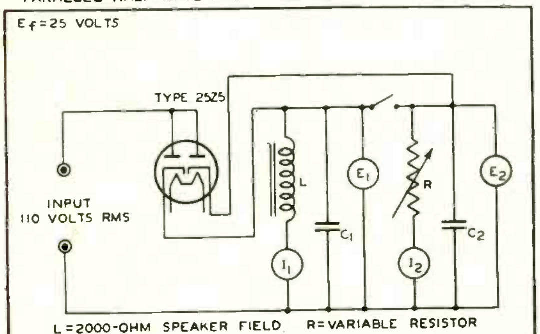
When Piccard made his record ascent in Switzerland he carried no radio transmitter, confining himself to speaking over networks in international broadcasts just before taking off and just after landing. This time however, special short-wave equipment will be carried in the gondola, so that its occupants can speak to millions of listeners over NBC networks as they ride high in the stratosphere.

Short-wave enthusiasts are awaiting the event with interest, because of the data on the effectiveness of transmission from enormous altitudes.

25Z5 VOLTAGE GAIN

Separate Load Circuits Improve Output

OPERATION COMPARISON
PARALLEL HALF-WAVE AND SEPARATE HALF-WAVE SYSTEM

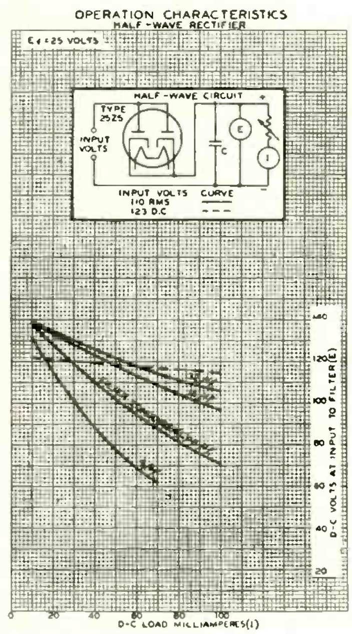


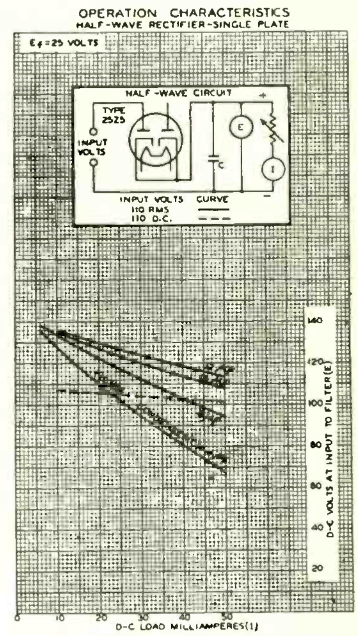
PARALLEL HALF-WAVE SYSTEM
(Switch Closed)

C (C_1+C_2) uf.	I_1 ma.	I_2 ma.	I (I_1+I_2) ma.	E ($E_1=E_2$) volts
8	46.2	15.0	61.2	98.5
8	45.0	20.0	65.0	95.0
8	43.0	25.0	68.0	92.2
16	52.0	15.0	67.0	112.5
16	51.0	20.0	71.0	111.2
16	50.0	25.0	75.0	109.0
32	52.5	15.0	67.5	119.0
32	52.0	20.0	72.0	118.0
32	51.5	25.0	76.5	117.0

SEPARATE HALF-WAVE SYSTEM
(Switch Open)

C_1 uf.	I_1 ma.	E_1 volts	C_2 uf.	I_2 ma.	E_2 volts	Increase in voltage available for plate supply volts	%
4	42.0	85.5	4	15.0	119.5	21.0	21.4
4	42.0	85.5	4	20.0	110.0	15.0	15.7
4	42.0	85.5	4	25.0	103.0	11.0	11.9
8	48.0	104.0	8	15.0	128.0	15.5	13.7
8	47.0	104.5	8	20.0	124.0	12.8	11.5
8	47.0	104.0	8	25.0	113.0	9.0	8.2
16	50.0	112.0	16	15.0	120.5	9.5	8.0
16	50.0	112.0	16	20.0	124.0	8.0	6.8
16	50.0	112.0	16	25.0	122.5	5.0	4.7





Circuit for testing 25Z5 for parallel and separate half-wave rectification. At right are the identified performance curves.

SMALL receivers, particularly those of the transformerless universal type, are limited to a great extent in their performance capabilities by the low plate-supply voltages available. For example, an increase of only a few volts in the applied plate voltage will appreciably raise the power output of a 43 with a corresponding improvement in tone quality. Consequently, a satisfactory means of increasing the available plate-supply voltage can be translated by the engineer designing such equipment into improved performance.

When the plate-current drain of all the tubes in a set is less than the speaker field current, a means of increasing the available d-c voltage in small receivers employing an electro-dynamic speaker is utilization of each rectifying unit of the 25Z5 to supply a separate load circuit.

Increased D-C Voltage

Each unit of the 25Z5 can be operated independently of the other, provided the regulation of the supply voltage is good. Since the rating of the 25Z5 is 100 ma., each half of the tube can handle 50 ma. Thus, it is possible to energize the dynamic speaker from one plate and its cathode of the 25Z5, and to supply plate voltage to the tubes in the receiver from the other unit The current drain on each unit, with such an arrangement in most small receiver designs will not exceed the allowable 50 ma. Furthermore, with this arrangement. a reduction in ripple voltage is obtainable with the same total filter-condenser capacity.

Tests have been conducted to determine the increase in d-c voltage available for plate supply with this arrangement over the voltage available when the plates of the 25Z5 are operated in parallel. The results, as tabulated, together with the attached curves showing the operating characteristics of the 25Z5 with the plates and cathodes paralleled, and with each plate and its cathode operated individually, reveal that a material increase in available voltage may be obtained with the two units of the rectifier operated individually.

Taking the case of a five-tube superheterodyne (employing two 36's, one 39, one 43 and one 25Z5), as an example, the plate and screen current drain for these tubes will be approximately 32 ma. The speaker field will draw approximately 45 ma. With two units of the 25Z5 operated in parallel, the total current to be supplied is 77 ma. With the units operated separately, one plate must supply 32 ma, for the plates of the tubes, and the other 45 ma. for the speaker field.

Gain of 8 Volts

Assume that with the plates operated in parallel a 16 mfd. condenser is used in the filter and with the separate operation two 8 mfd. condensers, one for each plate, are used. Then, referring to the operation characteristic curves for each condition, it will be seen that the voltage input to the filter will be 102 volts with the plates operated in parallel, and 110 volts with the plates operated individually. This is a gain of 8 volts in available plate-supply voltage.

While this increase in available plate voltage gives noticeable improvement in the operation of the 36's and the 39, the 43 derives the greatest benefit. An 8-volt increase on the plate of the 43 will raise the power output approximately 20 per cent. Increased output from small receivers is desirable in that more pleasing tone quality usually accompanies the higher output capability.

The circuit arrangement used in making these tests is shown in diagram at left. In this case, a 2,000-ohm speaker field was used as the load on one unit of the 25Z5; a variable resistance provided an adjustable load for the other unit.

This circuit arrangement of the 25Z5 necessitates the use of an additional filter condenser, or a two-section unit-condenser. However, the advantages which can be derived from the increased voltage available for plate supply should more than offset the cost of the additional filter condenser, or of the two-section unit-condenser.

Reduced Hum

Another consideration of interest is the hum introduced in the speaker by the ripple present in the field-supply voltage. Tests have been shown that this hum can be reduced to a very low level by the use of a loud speaker employing a suitable hum-eliminating device. The extra cost of such a speaker is about 5 cents or less. If a condenser is used to remove the hum, a capacity of at least 24 mfd. is necessary to reduce the hum level to a satisfactory value. The cost of such a condenser may be prohibitive. It has been found that a suitable device on the speaker will reduce the hum to a level comparable with that obtained using a 32 mfd. condenser in the filter.

—From E. T. Cunningham, Inc., and RCA Radiotron Co.

APPLICATION NOTE ON RECOMMENDED OPERATING CONDITIONS FOR THE 38, 41, 42, 43, AND 89

BECAUSE of the relatively low signal-voltage input required for high power-outputs, the power-amplifier pentode is particularly suited for use in the output stage of small receivers. In making a selection of the type of power-amplifier pentode to be used in any given application, the signal voltage delivered to the output tube, the plate-supply voltage, and power-output requirements must be considered.

(Continued on next page)

A 6-TUBE BATTERY SET

T-R-F Receiver Using the 2-Volt Tubes

By Einar Andrews

THOSE living in the country or other places where there is no electric service have been neglected when it comes to radio receivers. The reason is that there are relatively few of them. Yet numerically there are many who cannot use a-c sets or even line d-c sets. Indeed, there are more who have no electric power available than those who have only d-c, but they have not been so insistent about getting circuits to build.

Here is a six-tube t-r-f receiver with which these fellows can try their skill. It is sensitive, selective enough for places where it is likely to be used, and is quite economical in operation. Besides, it has output enough to operate a good magnetic loudspeaker or a permanent field dynamic.

The Filament Circuit

Five of the tubes in the circuit require 0.06 ampere each at two volts and the sixth tube requires 0.26 ampere at the same voltage. Therefore the total current will be 0.56 ampere. A No. 6 dry cell will deliver about 0.25 ampere. Therefore at least three of them should be connected in parallel. Since each cell has a voltage of 1.5 volts, and the tubes require two volts, there should be two cells in series. Hence the filament battery should be made up of six No. 6 dry cells, three in parallel and two such groups in series. For occasional service four cells would be all right.

A 15-ohm resistance is connected in the negative leg of each of the tubes drawing 0.06 ampere. For the power tube, which draws 0.26 ampere, the filament ballast is 4 ohms. As a means of adjusting the filament voltage more closely and to save current when the full current is not needed, a 6-ohm rheostat is put in the common positive lead. This filament switch should be attached to this rheostat as a means of simplifying the assembly and to result in a symmetrical panel layout.

Grid Bias

The three r-f amplifiers are biased by the drop in the 15-ohm ballast resistors. This bias is approximately one volt. If it is desired to increase this bias, and thus to reduce the drain from the B battery and make the circuit more stable, the grids should be returned to a suitable point on the grid voltage battery. In order to make this possible and at the same time leave the rotors of the tuning condensers grounded, each of the r-f grid returns should be treated in the same manner as the grid return of the detector. That is, a condenser of 0.1 mfd. is connected between ground and the coil, and the coil is then connected to the grid bias. Three more condensers of 0.1 mfd. would be required if. While only one such condenser is required absolutely, it is well to use one for each circuit in order to minimize feedback. Using three condensers permits placing them so that the leads are short.

The suggested bias for the 230 detector is 9 volts. This, however, is subject to variation. If the grid bias battery has a tap at every cell different bias values should be tried and that retained which gives the greatest detecting efficiency. The bias on the 230 audio amplifier is 4.5 volts, which is the recommended value for a plate voltage of 90 volts. The bias on the 233 power tube is 13.5 volts, which is the recommended value when the plate and screen voltage is 135 volts.

Plate Voltages

The voltage on the plates of all the tubes with the exception of the 230s is 135 volts. The plate voltage on the detector is 67½ volts, which is the same as the screen voltage on all the radio frequency amplifier tubes. The voltage on the plate of the 230 audio amplifier is only 90 volts, which is sufficient when the tube precedes a high gain tube like the 233.

The total plate and screen current drawn by the set is 31.5 milliamperes. That is the current when the filament, grid, and plate voltages are normal. Normal grid bias for the 34 tubes is 3 volts. This current is not very large for a six-tube set, and it can be supplied by a dry cell B battery of medium size. Of course, if the set is to be used much, it is better to use large size B batteries because they are more economical.

When the set is used as a portable, and it is quite suitable for that, small B batteries should be used as a matter of convenience, for even when light batteries are

(*Continued on next page*)

How to Voltage the 38, 41, 42, 43 and 89

(*Continued from preceding page*)

The maximum allowable peak signal-voltage input to a power-amplifier pentode is equal to the applied bias voltage. Consequently, the bias voltage is an indication of the signal required to give full output.

Typical recommended operating conditions for the 38, 41, 42, and 89 at 100, 135, 180, and 250 plate volts are shown in the tabulation. Recommended operating conditions for the 43 at 100 and 135 plate volts are also included.

The 41 has only recently been approved for operation at 250 plate volts. This increased voltage rating, with the resulting increase in power output, makes this tube particularly attractive for automobile receiver applications.

The 41 and 42, in comparison with the 38, 43, and 89, require the smallest input-signal voltage to give full output. The power output is approximately the same as that of the 89 operated as a pentode, according to RCA Radiotron Co., Inc., and E. T. Cunningham, Inc.

The 38 requires a relatively low value of input signal, but gives a low value of power output compared to the other types. However, the plate-current requirements of the 38 are very moderate.

The 43 gives much greater power output than any of the other types shown, but it requires a relatively large input signal. Naturally, the plate current requirements of the 43 are large compared to those of the other types.

The importance of utilizing the maximum plate supply voltages available is indicated by the tabulation. It will be noted that the power output for all types shown at 135 plate volts is approximately double the power output at 100 plate volts. Thus, an increase of only 35 plate volts allows twice the power output from a set. Even small increases in plate voltages, particularly in small universal receivers, produce noticeable improvements in power output.

In the same way, the increase in plate voltage from 135 to 180 volts approximately doubles the power output, and the increase from 180 to 250 plate volts again doubles the power output. Consequently, approximately eight times the power output is available with 250 plate volts as with 100 volts. Of course, the plate-current requirements rise with the plate voltages. The distortion, for a given type, remains approximately constant. The input signal required for full output rises in proportion with the higher plate and higher bias voltage.

Tube Type	*Grid Volts*	*Screen Milliamp.*	*Plate Milliamp.*	*Load Resistance Ohms*	*Max. Allowable Grid Resistor Megohms*		*Harmonic Distortion Percent*	*Power Output Watts*
PLATE AND SCREEN VOLTS=100								
					Self Bias	*Fixed Bias*		
38	—9.0	1.2	6.8	15,000	1.00	.50	8.0	0.27
41	—7.0	1.6	9.0	12,000	.25	.10	10.0	0.33
42	—6.5	1.8	10.0	11,000	.25	.10	7.0	0.34
43	—15.0	4.0	20.0	4,500	.25	.10	11.0	0.90
89*	—10.0	1.6	9.5	10,700	.25	.10	10.0	0.38
PLATE AND SCREEN VOLTS=135								
38	—13.5	1.5	9.0	13.500	1.00	.50	10.0	0.55
41	—9.0	2.2	12.5	10,400	.25	.10	10.0	0.75
42	—9.0	2.6	14.5	9,600	.25	.10	7.0	0.75
43	—20.0	7.0	34.0	4,000	.25	.10	9.0	2.00
89*	—13.5	2.2	14.0	9,200	.25	.10	10.0	0.75
PLATE AND SCREEN VOLTS=180								
38	—18.0	2.4	14.0	11,600	.25	.10	8.0	1.00
41	—13.5	3.0	18.5	9,000	.25	.10	10.0	1.50
42	—12.0	4.0	21.0	8.250	.25	.10	7.0	1.50
89*	—18.0	3.0	20.0	8,000	.25	.10	10.0	1.50
PLATE AND SCREEN VOLTS= 250								
38	—25.0	3.8	22.0	10,000	.25	.10	8.0	2.50
41	—18.0	5.5	32.0	7,600	.25	.10	10.0	3.40
42	—16.5	6.5	34.0	7,000	.25	.10	7.0	3.00
89*	—25.0	5.5	32.0	6,750	.25	.10	10.0	3.40

**As a pentode.*

Andrews' 6-Tube Battery Set

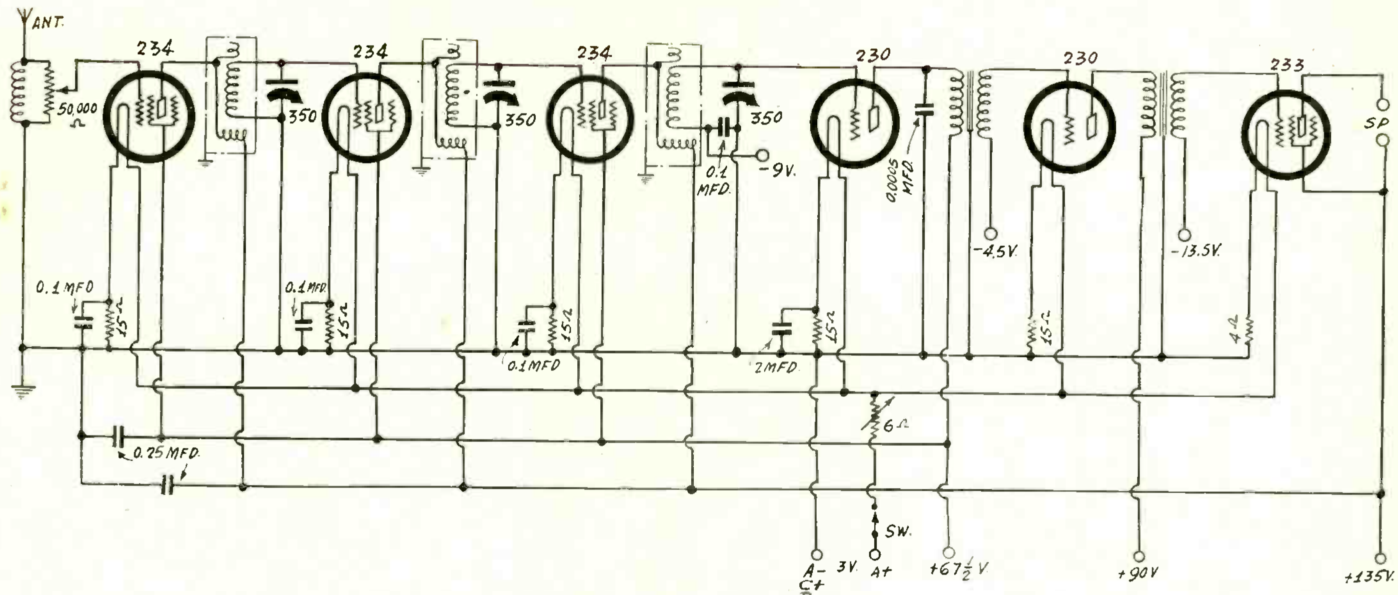


FIG. 1

This is the diagram of a six-tube t-r-f receiver suitable for a portable or for use in places where electric power is not available.

(*Continued from preceding page*)

used, they will constitute the greater part of the weight of the oufit. Likewise, the A batteries should be reduced in weight by using only four No. 6 dry cells in series-parallel.

A suitable grid battery is one having a total voltage of 7.5 volts, with a tap at every cell. Two of these are needed. These are more suitable than those that have become known as "C" batteries because they have a higher voltage and are much smaller. Moreover, the availability of every cell is a distinct advantage in adjusting the bias values on the different tubes.

The Tuner

For tuning the circuit a three gang condenser is used, each section having a capacity of 350 mmfd., nominally. The three coils tuned by these condensers are of the so-called high-gain type. In effect the couplers consist of a choke coil in the plate circuit, a small capacity between the plate and the high potential side of the tuned circuit, and a tuner in the grid circuit. These coils, or couplers, have the advantage that they are nearly as efficient on the low frequency end of the dial as they are on the high frequency end. This is due to the fact that the choke coil used in the plate circuit has been chosen so that it resonates with the plate to cathode capacity of the tube at the low frequency end of the scale.

Ordinarily these tuners are not quite selective as tuners using transformers and loosely coupling, but this is offset by the fact that there are three tuners between tubes so that the antenna has no effect in broadening out the circuit. Besides, the high-gain feature is a decided advantage for it makes the circuit very sensitive on those frequencies that are desired in most instances.

The coils, of course, are shielded, and this fact is indicated on the diagram. They are standard high-gain coils for 350 mmfd. tuning condensers.

Control of Volume

In the antenna circuit is a radio frequency choke coil, which should have an inductance of about 10 millihenries. This can be obtained in the duolateral form. It is not necessary to shield it.

The volume is controlled by means of a 50,000-ohm potentiometer connected across

LIST OF PARTS

Coils

Three high-gain radio frequency coils for 350 mmfd. condensers
One 10-millihenry choke coil
Two audio frequency transformers

Condensers

One gang of three 350 mmfd. tuning condensers
Four 0.1 mfd. by-pass condensers (Three more should be used if r-f bias is increased)
One 0.0005 mfd. by-pass condenser
Two 0.25 mfd. by-pass condensers
One 2 mfd. by-pass condenser

Resistors

Five 15-ohm ballast resistors
One 4-ohm ballast resistor
One 6-ohm rheostat, with filament switch attached
One 50,000-ohm potentiometer, tapered resistance (The filament switch may be mounted on this instead of on the rheostat)

Other Requirements

Two twin binding post strips, one for Ant. and Gnd. and one for speaker
One dial
Five four-contact sockets
One five-contact socket
Three grid clips
One six-tube chassis and panel to match
One 15-volt grid battery, tapped at every cell (This is made up of two 7.5-volt batteries in series)
One A battery, 3 volts and 0.56-ampere capacity
One magnetic or permanent field dynamic speaker matching 233 tube
One battery cable
Tubes: Three 234s, two 230s, and one 233.

the antenna choke coil, with the slider connected to the first grid. The volume range is from zero to the maximum signal that comes in over the antenna. In order to get a slow variation near zero, the potentiometer resistance should be tapered at the ground end. If it is not tapered it may not be possible on strong signals to reduce the volume to zero or even to a comfortable value without cutting out the signal entirely.

Again attention to the use of additional bias on the 34s. It may be necessary to increase the bias even to more than 3 volts in some instances to stabilize the circuit and to make the volume controllable.

The filament rheostat can also be used as a volume control since it controls the emission from the tubes and hence the amplification. This, however, should not be used excessively because it will affect the quality of the output.

By-passing

A by-pass condenser of 0.1 mfd. is used across each r-f ballast resistor as a means of stabilizing the circuit. These condensers also help a bit in increasing the sensitivity. The 0.1 mfd. condenser in the third tuned circuit is used to complete that circuit and to permit returning the coil to the grid battery. As previously stated, a similar arrangement should be used in each of the preceding grid circuits if it is desired to return the grids to the grid battery instead of to the chassis.

The 2 mfd. condenser across the ballast resistance for the detector serves mainly to by-pass radio frequency currents. For audio frequencies it has little effect because the ballast resistance is so low. But because of this value it is not especially needed.

The 0.0005 mfd. condenser from the plate of the detector to the chassis helps to increase the detecting efficiency by providing a low impedance path across the transformer for the radio frequency component of the signal. It should not be omitted even though there seems to be no difference with or without it.

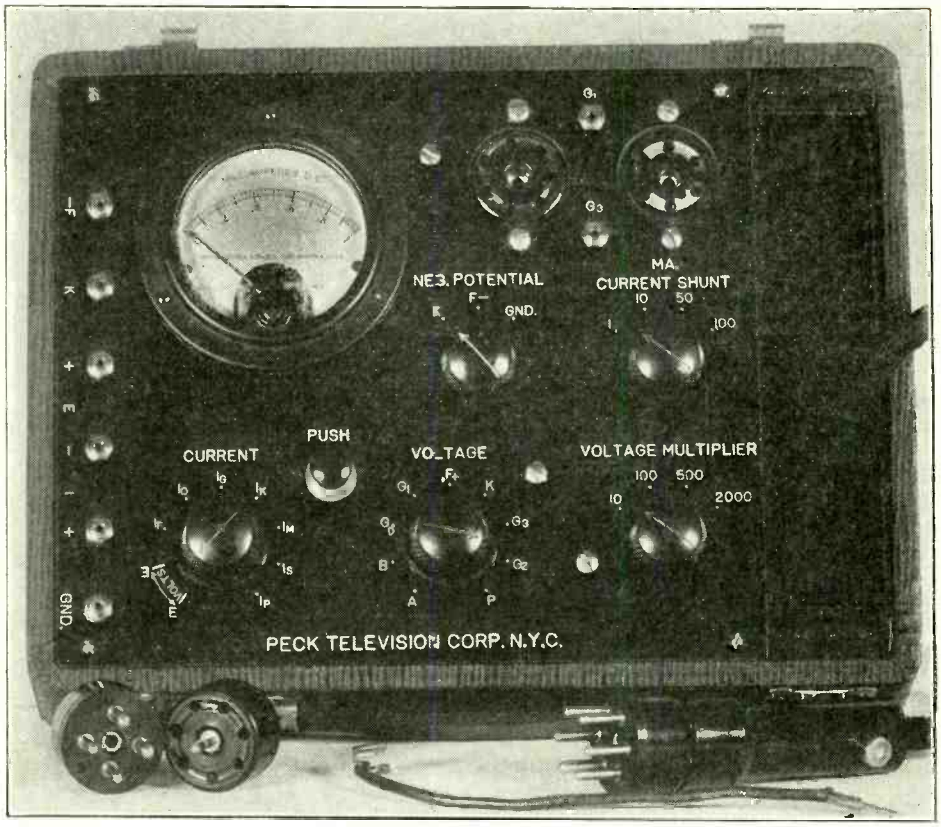
Two 0.25 mfd. condensers are used across the batteries, one for the 67.5 volt tap and one for the entire battery. These serve primarily for radio frequency bypassing. They are too small to be effective at audio frequencies, but for audio frequencies they are not needed for the resistance of the batteries is low. In case there should be motorboating or audio frequency oscillation when the battery becomes old, one pair of transformer leads may be reversed, provided that this pair be not the first. The best remedy, of course, is to use a new battery. Another remedy for this sort of trouble, if it should occur, is to connect an electrolytic condenser across. But its use should not

(*Continued on next page*)

AN AUTHENTICATED ANALYZER

By William F. Peck
Peck Television Corporation

MANY who have a meter, multiplier and shunt resistors, and some other parts, figure that they could build a nice set analyzer if given some preliminary directions, and therefore the present device represents the fulfillment of the purpose. The object is to make the essential tests of set circuits, as to voltage and current readings. Those who like to make resistance tests, too, may include the limiting resistor and battery in each of the two positions between the open switch points at lower right of the diagram and the common line to the left below. The author did not include any resistance measuring method because he has a separate resistance meter.



Above the author is shown holding the analyzer. At right is the view of the panel top. The analyzer plug is shown in right foreground, while two adapters are also in view.

The principal switch used is one that may be put to any one of nine different positions, and due to the almost complete encompassing of the circle, it is hard to show the switch in physical diagram. However, it should not be hard to visualize the switch. It consists of two sections, simultaneously operated. One section, for each position, is a double-pole switch that picks up the meter, by virtue of the contacts by the two-bladed slider SL. To this extent it is a nine-pole double-throw switch. The simultaneous action of the other section is to open a circuit. Thus as the first section discussed closes a circuit, and the second opens a circuit, the switch enables opening a circuit to insert something in it, i.e., the meter. This is just the condition wanted for current readings, when, for instance, the plate lead has to be interrupted, the meter put between, and yet the plate lead rendered continuous again the moment some other switch position is utilized. If the opening and closing sections are put in parallel, this is accomplished.

Overhead Grid Lead

Looking at the diagram, we find that a circle in the form of a socket, with colored leads marked thereon. Actually this represents the bottom view of the plug. From this analyzer plug emerge eight leads. Seven have corresponding pin connections, as shown, but the eighth connects to the eighth lead (green) and is continuous with the two grid caps on the plug. Hence it is the lead for picking up the overhead grids.

Therefore one end of the cable has plug attached, for insertion in the receiver socket. The colored leads are soldered by the constructor to the analyzer end, or tester, not at either of the two sockets in the tester, but to the lines between switches.

Now, the main switch's functions are diagramed above and below the "plug bottom view," the lower oblong enclosing eighteen dots representing switch lugs, the upper oblong enclosing nine crosses, representing also 18 switch points or nine closed circuits which are pried open by the circuit opener CO. On the switch the two front lugs are for the closing switch (SL).

The two rear lugs are for the opening switch (CO). Hence, front to rear, the second and third lugs in line may be joined together and the front and rear

(*Continued on next page*)

Six-Tube Battery-Operated Receiver

(*Continued from preceding page*)

be necessary in a circuit of this type when it is powered with batteries.

Terminals

If the batteries are not built into the cabinet, a cable containing the necessary terminal leads should be used. Eight leads are shown in the diagram, three for bias, three for plate voltage, and two for the A battery. The A minus lead should also be used for B minus and C plus. If the bias on the r-f tubes is to be increased as has been suggested, there should be another lead for the r-f grid bias. The three grid returns are joined together before the lead is brought out. It may be convenient to place the grid battery in the cabinet, in which case all the grid return leads need not be included in the cable. This simplifies the set a great deal.

One binding post should be provided for the antenna and another for the ground connection. There should also be two terminals for the loudspeaker. There are twin terminals available for these purposes, suitably marked, and they are preferable to simple binding posts.

Layout

The circuit should be built around the three-gang condenser. Its dial should be placed in the center of the front panel and the two other variables, the potentiometer and the rheostat, should be placed symmetrically with respect to the condenser dial and near the bottom of the chassis. Suitable six-tube chasses with panels to match are available. But there is no reason why the circuit should not be built on some other chassis for an extra tube socket makes no difference.

(*Continued from preceding page*)
lugs in line joined together, except that two of the circuit-opening positions are not used (and so marked), while the cathode connection on the closing device is reversed, to give positive reading. The last two closing positions are for meter reversal.

Range-Increasing Purposes

Now let us see the sequence of operation so far.

We have a receiver operating. We have a plug and cable. The plug is inserted in the socket of the receiver that is to have that circuit tested. The voltages and currents are thus brought up to the tester, into which the tube removed from the set is put, hence switching must take place between the voltage and current feed and the tube, that is, for current indications the meter is put in series with the measured circuits, while voltage readings may be taken also. See the lower left oblong, under E, which puts the circuit in voltage-reading position, an extra switch at right picking up the desired circuits for such voltage reading, with an independent switch for selecting the proper series multiplier.

We need not only series multipliers, for correct range, but for current readings we need shunt multipliers, and these will be on the basis of the meter used. Assuming a 0-1 milliammeter, which will afford in all instance a voltmeter of 1,000 ohms per volt rating, the multipliers would be 1,000 ohms for every volt; hence, for 0-10 volts, 10,000 ohms, for 0-100 volts, 100,000 ohms, and for 0-1,000 volts, 1,000,000 ohms. Such resistors should be accurate, and the usual wire-wound series multiplier resistors should be used.

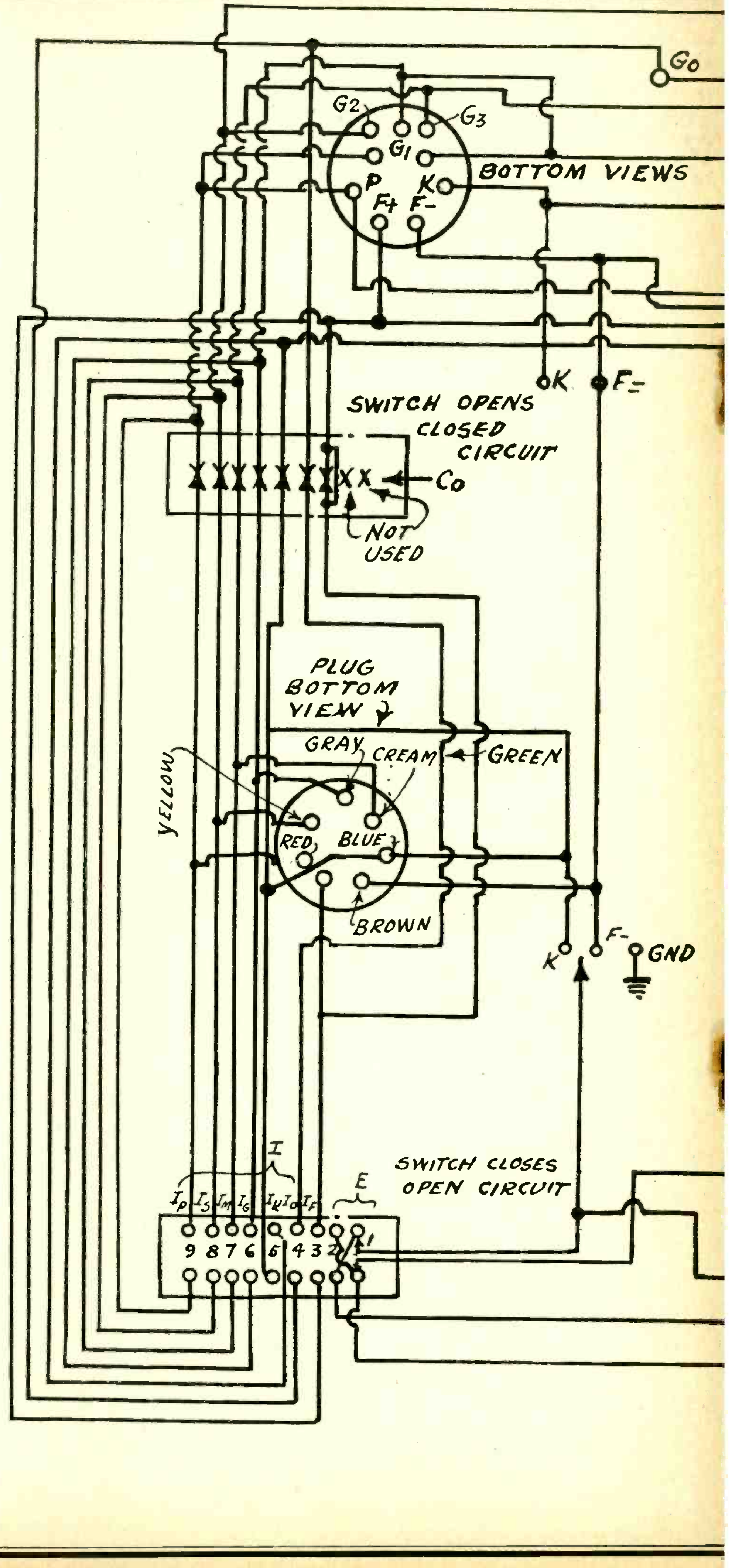
Making a Shunt

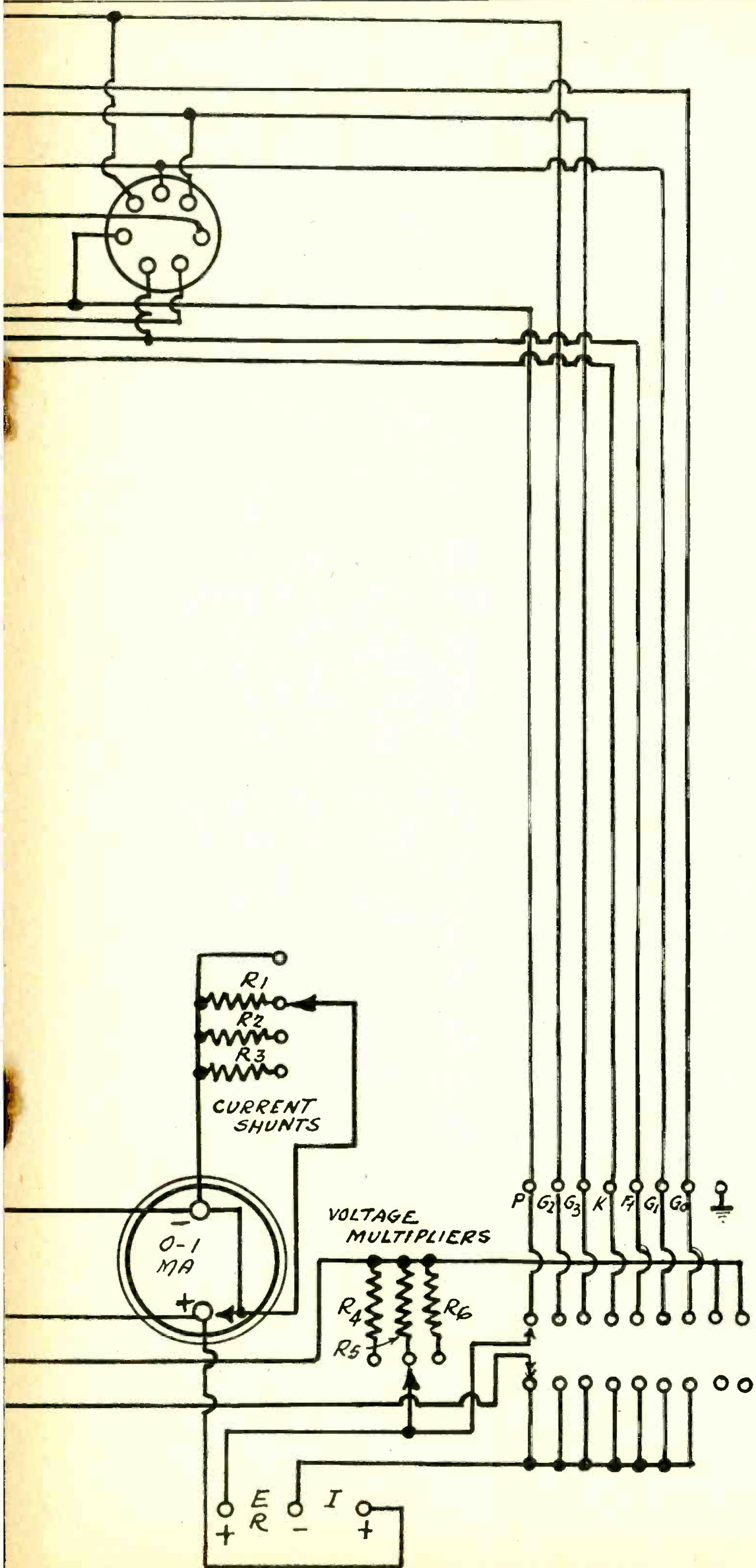
The voltage ranges may be such as you desire, depending on the usual ranges you expect to encounter. So also of the shunts. While the meter itself reads 0-1 milliamperes, infrequently the current is that low, and if three shunts are used they may be for 0-10 milliamperes, 0-50 milliamperes, and 0-100 milliamperes. These selections are left to the constructor, and if he hasn't the necessary shunts, but can get an accurate meter within range, he can make his own shunts by using No. 26 wire or so, winding it around a pencil, and using so much wire as will make his meter read what it should on the basis of the current through the primary meter. Any one point selected will suffice, say, if 50 ma are registered on the primary meter, then the shunt may be adjusted to cause the needle on analyzer meter to read 50 ma, or half position, whereupon full-scale deflection for the analyzer meter would be 100 ma. Or current shunts may be purchased, on the basis of the known resistance of the meter movement. This resistance, indeed the very shunts, may be obtained from the meter manufacturer.

Currents Grouped

The currents read are grouped under I in the lower oblong, the voltage position for the meter is either obverse or reverse, for the last two (right-hand) positions, and, as stated, a separate switch is manipulated to pick up the correct multipliers, still another for current shunts, and another switch to pick up the points between which and, say, B minus, readings are to be taken.

It is usual to read to B minus, as this is always accessible, but this is not necessarily the most desirable datum. Suppose that you desire to read from cathode, which in heater type tubes is the datum.





It is then necessary to pick up cathode as one side, and, say, plate as the other. The plate voltage is not that between ground or B minus and plate but between cathode and plate. Suppose that you are testing a battery set where ground may not be the same as B minus, as, for instance, C minus may be grounded. To take care of these three conditions a separate switch is used for picking up K, F minus and ground. K will seldom be B minus, an exception being the case of a 2A5 or other type of power tube with biasing resistor in the negative leg of the rectifier, e. g., tap on a B choke. F minus normally will be B minus in battery sets and in a-c sets where the tube is of the filamentary type. Ground is a point in reference to which numerous readings may be desired, nevertheless normally this would be chassis, and a tester will pick up only the socket connections, none of which may be grounded. Hence a binding post is advisable, and a lead is run from that to chassis, and ground continuity is established.

The 2B7 and 2A7

The tester has two sockets, one of the so-called universal type, which, without possibility of error, receives the UX, UY and six-pin base tubes. For the seven-pin-base tube (medium size) the extra socket is used, and connections made from one socket to the other as shown. This medium-sized base for seven pins takes care of the 59, but not of the 2B7 and the 2A7, which require a smaller size, but there are two adapters to take care of this, one to reduce the larger 7-pin socket on the tester the smaller one required, and the other to increase the 7-pin socket in the set to the larger requirement, that of the plug.

Adapters

Since the analyzer plug has only one terminal condition, equal to medium-sized seven pin, naturally this plug will not fit into any kind of socket except the very one for which it was intended. Hence adapters are used, and it is fortunate that the adaptation is downward, that is, from a more numerous pin base to a fewer-springed socket. Hence to use the plug with a six-pin socket, an adapter of the medium seven-hole top is used, to receive the plug, while the bottom of the adapter has six pins. A special locking device prevents the adapter from sticking in the set when the plug is pulled out. A latch must be sprung to release the plug from the adapter.

The designations on the main switch diagram, lower oblong, are: Ip for plate current; Is for screen current; Iu for suppressor current; Ig for grid current; Ik for cathode current; Io for overhead grid current; If for heater or filament current. Since filament or heater current is large, and the meter normally wouldn't read it, the circuit-opening element above is shorted to protect the meter. This may be a permanent short if filament or heater current readings are to be neglected, as they usually are, or may be a short that is opened only by depressing a key.

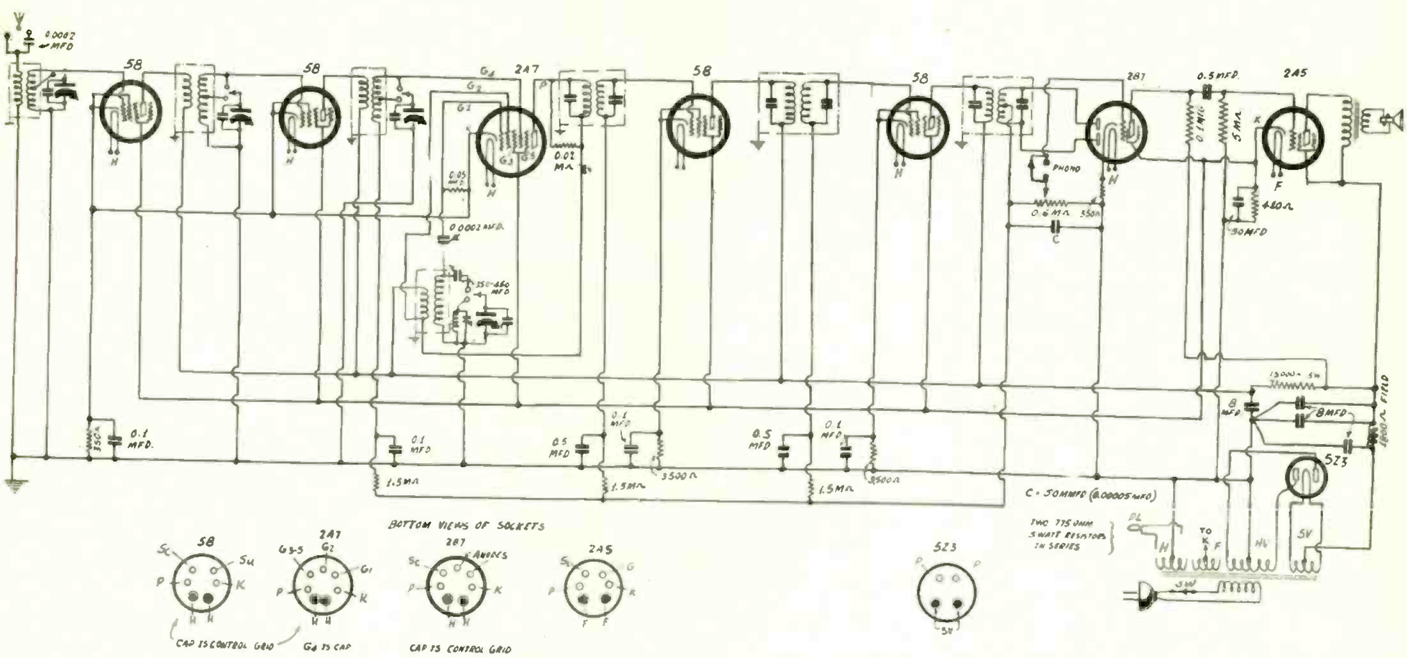
The Confusing Grid Numerology

Ig, for grid current, relates to whatever element occupies the normal control grid position for four-pin tubes, or 227 tube, but of course in the case of the 235 the socket position that would be the control grid in the case of the 227 is the screen grid. For this reason, and other reasons, the numerical grid designations are not consistent, the main reason being that they are not so in the formal numerology

(*Continued on next page*)

Detailed Construction Data on the 8-TUBE DIAMOND

By Herman Bernard



An improvement has been introduced in the oscillator for short waves by using a separate winding as the tuned circuit. The above diagram of the 8-tube Super Diamond shows this method. Coil connection data will be found on the diagram of the 12-tube model. The 2A5 output tube is shown. The 2A3 circuit was printed last week.

THE eight-tube model of the Super Diamond has practically the same tuner as has the twelve-tube set, built-in oscillator is omitted, however, and the total audio amplification is that obtainable from the pentode of the 2B7 and from the 2A3 or 2A5 output tube.

Concerning the output tube, there is a general misunderstanding regarding rated power output and sensitivity. Some think that a tube with large power output should provide large amplification. Not only is this not true, but in general the larger the rated power output, the less the sensitivity of the tube, that is, the more must be put into it to develop a certain quantity of output. The sensitive output tubes are the pentodes. The large power-handling type tubes are generally triodes. Hence to get a large quantity of sound output it is necessary to put in a husky signal, and this is achieved by plenty of amplification ahead of the detector and some after it. So here we have the audio amplification, exclusive of output stage, confined to the pentode of the 2B7, but a practical gain of 50 is easily attained. The 2A3 provides 3.5, a total audio gain of 175 or, with the 2A5, a gain of 1,000.

7 Watts Output

Therefore the receiver will have a power tube that will not be overloaded by anything that will be put into it, particularly as the plate voltage is 300 volts, and the bias has been lifted to 64 volts, and the power output is about twice that ordinarily obtainable from a single 2A3, hence is around 7 watts.

There has been some difficulty concerning the working of the 2B7 as a detector and audio amplifier. The trouble concerns the a-f operation. However, if the screen is returned to around 32 volts, assuming a normal signal of 1 volt, the effective screen voltage is 31 volts and under such conditions the plate load resistor preferably should should be 0.1 meg. (100,000 ohms), and the maximum filtered voltage, 300 volts, may be fed to the plate load resistor.

The tube has the same characteristic as the 55 whereby the amplification cuts off when the signal input becomes too high, but this is not a bad feature, as it further prevents any possibility of overloading the power tube. The remedy is to retard the volume control. The quantity of sound is then sufficient to come close to loading up the last tube. It is necessary to take off only a little more than 1 volt of rectified voltage at the detector, by potentiometer slider, to load up the 2A3 tube, due to the high gain in the 2B7 amplifier.

The circuit will be discussed now in sequence related to that of the list of parts published herewith.

Coils

The three radio frequency coils are alike, and have a tap enabling switching to the police band. Some data concerning them were given last week in the discussion of the 12-tube model. However, a change has been made in the hookup of the oscillator for police waves. Instead of secondary tap, an extra winding heretofore marked "not used," but suggested previously as to its possession of this possibility, becomes the police band tuned circuit. A small variable

Peck's Compact Switch Analyzer

(*Continued from preceding page*)
of the multifarious grids of the present assortment of tubes. But a general plan is followed, the exceptions to which the user must be familiar with as part of his work, and these exceptions are obtainable from general tube characteristics charts.

It will be observed that a slider SL is definitely connected to the meter, being conductive. But the circuit opener is not connected anywhere in the circuit, for its sole function is that of an insulator prying apart two other closed connections, and closing them again after the circuit opener is slid to some other position on the rotary switch.

While control grids are accessible, and grid current may be read, it is only such current as results from actual set operation, as in general the grid bias can not be made positive by any switching of which the tester is capable, but may be made zero. Ordinarily this suffices, as tubes in nearly every position will draw current on zero bias due to the presence of some signal voltage, for the signal voltage runs positive in respect to the bias. To this extent only is the device a tube tester, for no provision is made for interposing the positive-biasing battery for change from negative to positive bias as an indication of plate current effect or mutual conductance, but this isn't imperative.

The usual adapters are used with the plug, except that the adaptation to UX and UY bottoms (all tops are 7-pin) should be of the type that picks up the control grid rather than that which picks up the screen.

Analyzer Plug, Type 907-WLC, includes 8-lead cable and locking device. Pin-reducing adapters for receiver: 7 top to 4 bottom, 974 DSG; 7 top to bottom, 975 DSG; 7 top to six bottom, 976 DS; 7-medium top to 7-small bottom, 977A; 7-small top to 7 medium bottom, 977B. Sockets: 456E and 437E.

LIST OF PARTS

Coils

Three shielded radio frequency transformers, secondary tapped for 1,400-4,500 kc.
One shielded oscillator coil, three windings, separate one for 1,565-4,965 kc.
Two shielded Hammarlund intermediate transformers, air - dielectric - condenser tuned, both as to primary and secondary; 465 kc.
One shielded Hammarlund intermediate transformer, air - dielectric - condenser tuned, both as to primary and secondary; secondary center-tapped; 465 kc.
One 90-watt power transformer; primary, 115 volts, 50-60 cycles; secondaries: (H), 2.5 volts, 8 amperes, center-tapped, for heaters; (F), 2.5 volts, 3 amperes, center-tapped, for power tubes; (c), 5 volts, 3 amperes, center-tapped, for rectifier; (d), 750-volt center-tapped for high voltage of full-wave rectifier; stands 150 ma (@) 400 volts d.c.
One dynamic speaker, 12 inch diameter: 1,800-ohm or higher resistance field, output transformer for 2A3 tube. Cable and plug attached.

Condensers

One four gang 0.000041 mfd. tuning condenser with trimmers built in; shaft 3/8-inch diameter, 1 1/8-inches long.
One padding condenser, 350-450 mmfd.
One midget variable condenser, not more than 50 mmfd.
One 50 mmfd. mica fixed condenser.
Two 0.0002 mfd. mica grid condensers.
One 0.5 mfd. stopping condenser.
Six 0.1 mfd. bypass condensers.
Four 8 mfd. electrolytic condensers (two in each of two cases).
Two 20 mfd. electrolytic condensers.

Resistors

One 350-ohm pigtail resistor.
Two 775-ohm 5-watt pigtail resistors, wire-wound.
Two 3,500-ohm pigtail resistors.
One 15,000-ohm 5-watt pigtail resistor, wire-wound.
One 20,000-ohm pigtail resistor.
Two 50,000-ohm pigtail resistors.
One 100,000-ohm pigtail resistor.
Three 1.5-meg. pigtail resistors.
One 0.6 meg. potentiometer with switch attached.
One 5-meg. pigtail resistor.

Other Requirements

One five-pole, double-throw switch insulated shaft type.
Six grid clips.
Nine sockets: four six-hole, one five-hole (UY), two four-hole (UX), two 7-hole medium. The extra UY socket is for speaker plug.
Six tube shields and bases.
One a-c cable and plug.
One antenna-ground binding post assembly.
One phonograph twin jack.
One vernier dial, traveling light type, with pilot lamp and escutcheon.
Length of flexible wire for pilot lamp connections.
One roll of hookup wire.
Four 12/24 nuts for power transformer.
Three dozen 6/32 nuts and bolts.
One a-c cable bracket with lug affixed.
Three knobs.
One chassis 15 x 3 x 10 inches.
One metal bottom piece to fit chassis.
Six insulated bushings tapped at both ends for 6/32 screws.
Six lugs.
One 6/32 bolt, 1 1/2 inches long, for wave switch.
One a-c cable bracket with lugs affixed.
Three knobs.
Tubes: four 58's, one 2A7, one 2B7, one 2A3 and one 5Z3.

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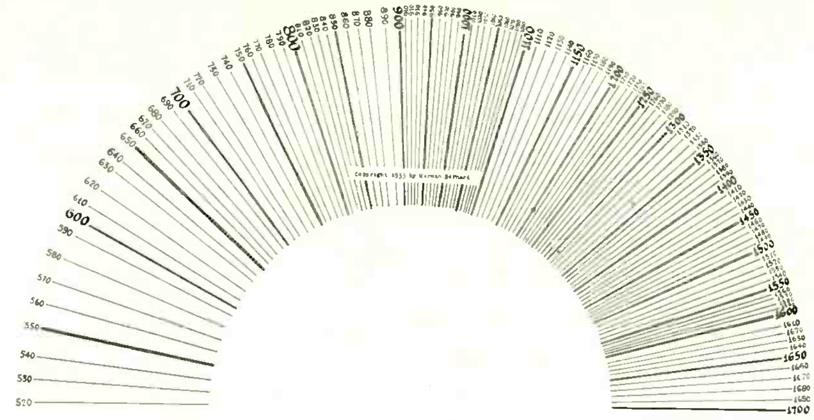
condenser is put across this winding.

The receiver is primarily intended for broadcast reception, and the police band is purely incidental. Nevertheless, since an improvement is achieved by the change, it is well to adopt it. Moreover, while it is better to have a smaller and more selective input for the broadcast frequencies, a larger input is advisable for the short waves, where the selectivity doesn't matter so much.



Calibration of frequencies tuned in on the broadcast band, with 20 kc overlap at the low-frequency end and 200 kc overlap at the high frequency end. Each of 119 channels is located.

Due to difficulty in padding for short waves by the usual method, most receivers omit padding, although in this instance at least inductive padding is introduced. Much greater sensitivity results when the little manual tuning condenser acts as trimmer for the main tuning condenser of the oscillator, which on the police band isn't padded. The capacity may be up to 50 mmfd., although less would be sufficient, say, 30 mmfd. The usual 50 mmfd. condenser has seven plates.

The circuit then is keenly alive all over the dial when the switch is turned for short waves, although the points at which particular police transmitters come in best must be borne in mind, and calibration will hold, to the extent that when you desire to tune in the station again, turn to the same dial position, and then very slowly adjust the manual trimmer.

Careful Tuning Needed

It should be remembered the usual closeness of tuning is, if anything, magnified by the considerable selection ahead of the oscillator, and at least the same patient, careful tuning is required as for any other short-wave reception in this wide band (1,-400-4,500 kc).

There are no dead spots on the dial anywhere—on broadcast or short waves.

The diagram for connecting up the coils, including the oscillator in the improved fashion, will be found on the circuit of the 12-tube model.

The intermediate frequency transformers, made by Hammarlund, are peaked at the factory at 465 kc, but when put into a set there would be naturally a slightly different frequency. However, those who desire to build the 8-tube set and have no test oscillator, may leave the first transformer as it is, and peak the remaining transformers on that basis, to give loudest output after the set is built. This is not the best plan in the world, but it will do in a pinch.

The transformers without center-tapped secondary, of which there are two, have grid cap lead emerging from side of the shield, while underneath these are two flexible leads and a brass projector. The B plus connection is made to the projector, the green flexible lead goes to plate of preceding tube while the black is the grid return and, in this circuit, connects to the potentiometer through a bypassed high resistance.

Speaker Considerations

The center-tapped transformer feeds the 2B7 and has the same primary connections (green and projector), while the two black leads go to the diode anodes and black is the return or center-tap, connected to the high side of the potentiometer.

The power transformer has all secondary windings center-tapped.

Although a field coil of 1,800 ohms is specified for the dynamic speaker, constructors who possess speakers with somewhat larger resistance field coils, up to 2,500 ohms, may use what they have, but the output transformer should be for the general type of low-mu tubes. The usual rating is 2,500 ohms output impedance for a single 2A3, but up to 5,000 ohms output impedance may be used, because of the extraordinarily high negative bias in this particular circuit. Thus, a speaker for single 245 tube could be used. For the 2A5 the output load may be 7,000 ohms.

Condensers

The four-gang condenser has a maximum capacity of 0.00041 mfd. and will tune from above 1,700 kc to 520 kc at the r-f level, or from 2,165 kc to 985 kc on the local oscillator. The total inductance of the r-f secondaries is 230 microhenries and that of the oscillator secondary is 126 microhenries, for this condenser.

For the oscillator a padding condenser of 350-450 mmfd. is used, and the correct setting is near maximum. As a first approximation, set this condenser at maximum, then turn the setscrew out 1 1/4 turns. The final and correct adjustment should be made on the basis of a frequency around 600 kc at the signal level, while the other end is trimmed at or near 1,450 kc.

There are two 20 mfd. in the 2A3 circuit, one to bypass the total biasing resistance of 1,550 ohms, the other to bypass half of that resistance, or 775 ohms. The total consists of two series-connected 775-ohm units. Only one 20 mfd. is in the 2A5 circuit.

Electrolytic Condensers

For the screens of the 58 tubes the 64 volts as obtained from the 2A3 tube biasing resistor are sufficient, and indeed there may be oscillation at the r-f level and also at i-f, so two extra resistors, to be discussed later, are shown on the diagram. Also the 20-odd 2A5 bias volts are enough for screens.

The 20 mfd. condensers are of a lower voltage rating than the 8 mfd. used in the B filter, hence are much smaller physically. There is room for four cans. However, there are combinations of two 8 mfd. in one can, hence two cans take care of four 8 mfd. condensers, and the two extra chassis holes are used for the separate 20 mfd. units.

Resistors

Of the resistors, the 350-ohm unit provides a negative bias of around 4 volts on the two r-f tubes and the 2A7 combination oscillator-modulator. It is true that if the resistance value is somewhat lower, hence the bias voltage reduced, the sensitivity will be increased, but there is likelihood in the first instance that there will be r-f oscillation, and it has always occurred in the sec-

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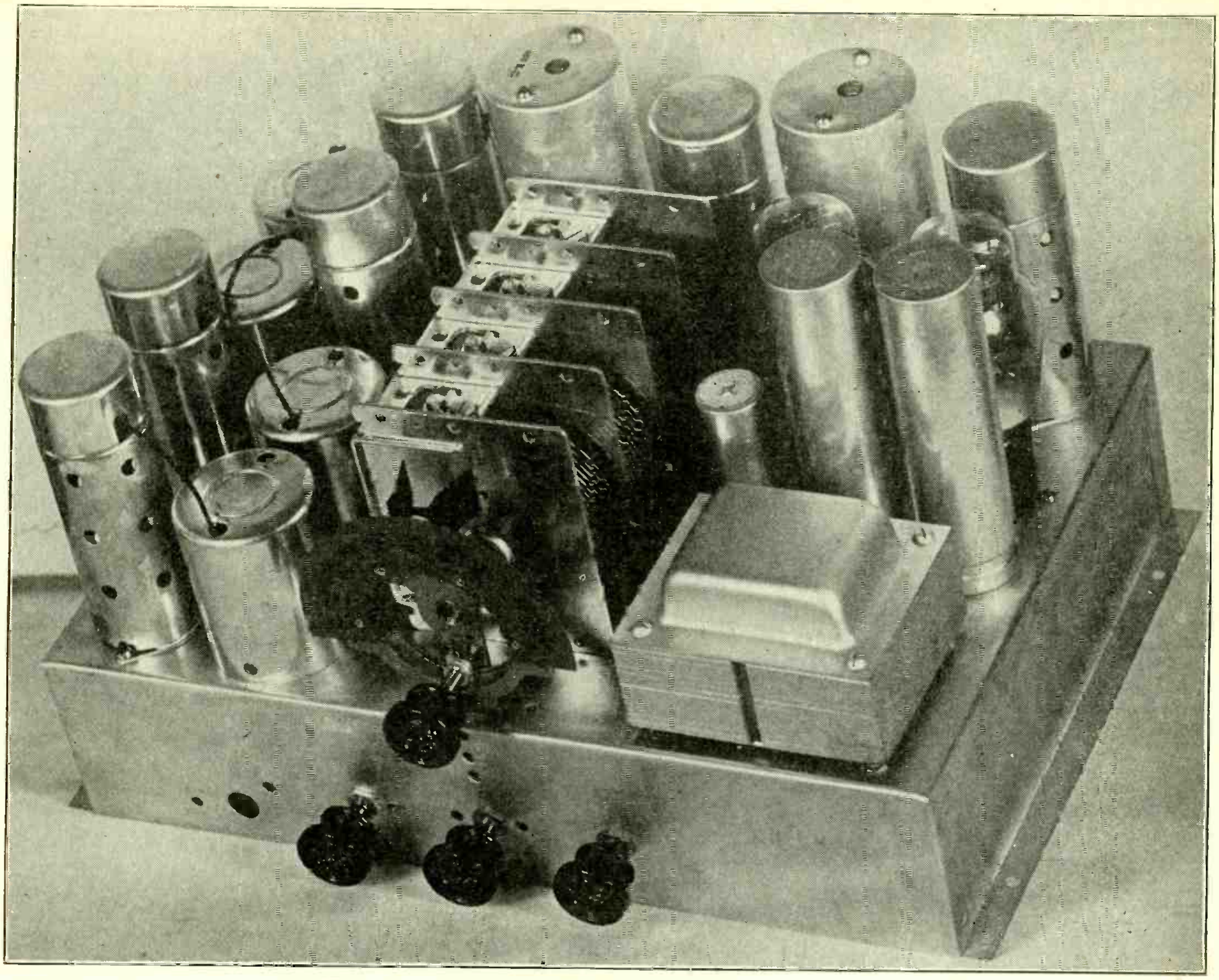

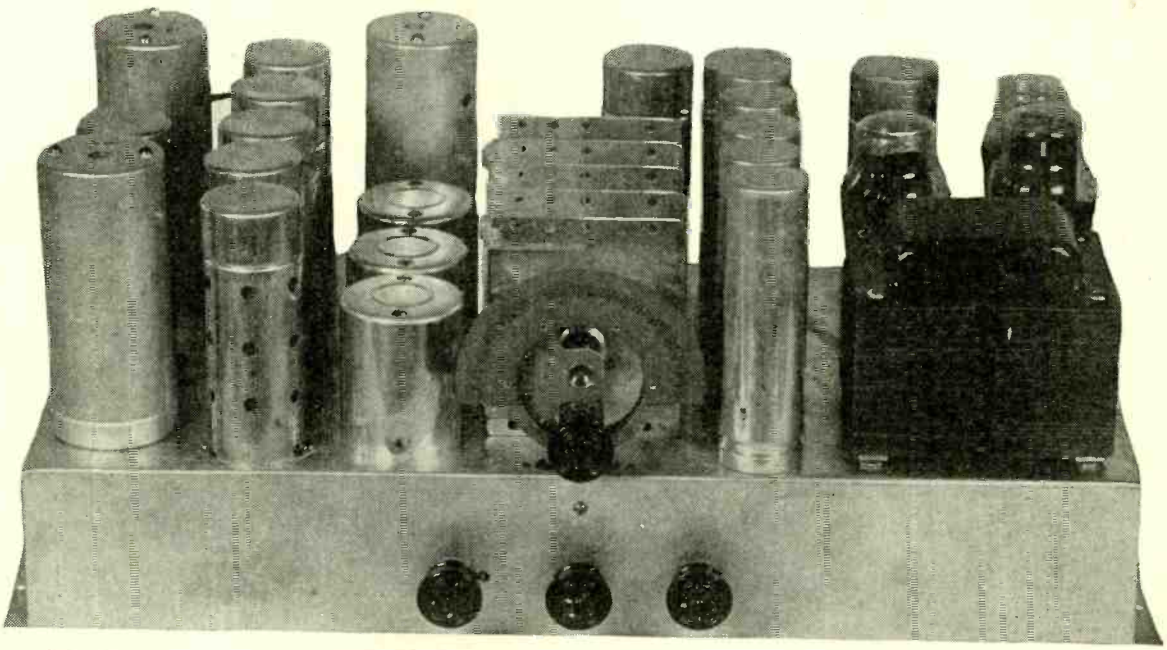

The 8-tube chassis is illustrated above and the 12-tube chassis at right. These circuits have the same "front end."

(Continued from preceding page)

ond r-f stage. Hence a resistor of 50,000 ohms is optional across the grid winding or full secondary in the second r-f stage. This always has cured the trouble, but there are other methods, discussed last week in connection with the 12-tube model.

The i-f oscillation is associated almost always with the second i-f tube, but the cure may be applied across the primary of the first i-f transformer, hence a resistor of 20,000 ohms is shown in that position. In exception iinstances the 20,000 ohms were necessary instead across the next load. However, the better plan is to omit these two squeal-eliminating resistors in the construction and put them in only if necessary. Moreover, the values are average. Do not use higher values than necessary to correct the trouble, and use lower values if those cited do not produce the result, except that first shift the resistors to different equivalent circuits to make sure that you are not trying to apply the remedy where it will not be most effective. For instance, oscillation at these levels produces a galaxy of squeals, so if you put your hand between grid cap and shield can, using two fingers, or palm and one finger, if the squeals stop that is the stage that is oscillating.

Increasing Sensitivity

The 775-ohm resistors will get hot, but that does not matter. The 15,000-ohm resistor should be of 5 watts rating, and will not get so hot. The value of 15,000 ohms was selected as a safe one, in view of the great sensitivity of the set, but there will be somewhat greater sensitivity if this is a smaller resistor, and it is suggested that a 1-watt resistor of 25,000 to 50,000 ohms be placed in parallel with it. Also 800 ohms, more or less, may be put in parallel with the 350-ohm biasing resistor already discussed. If the increased sensitivity is un-

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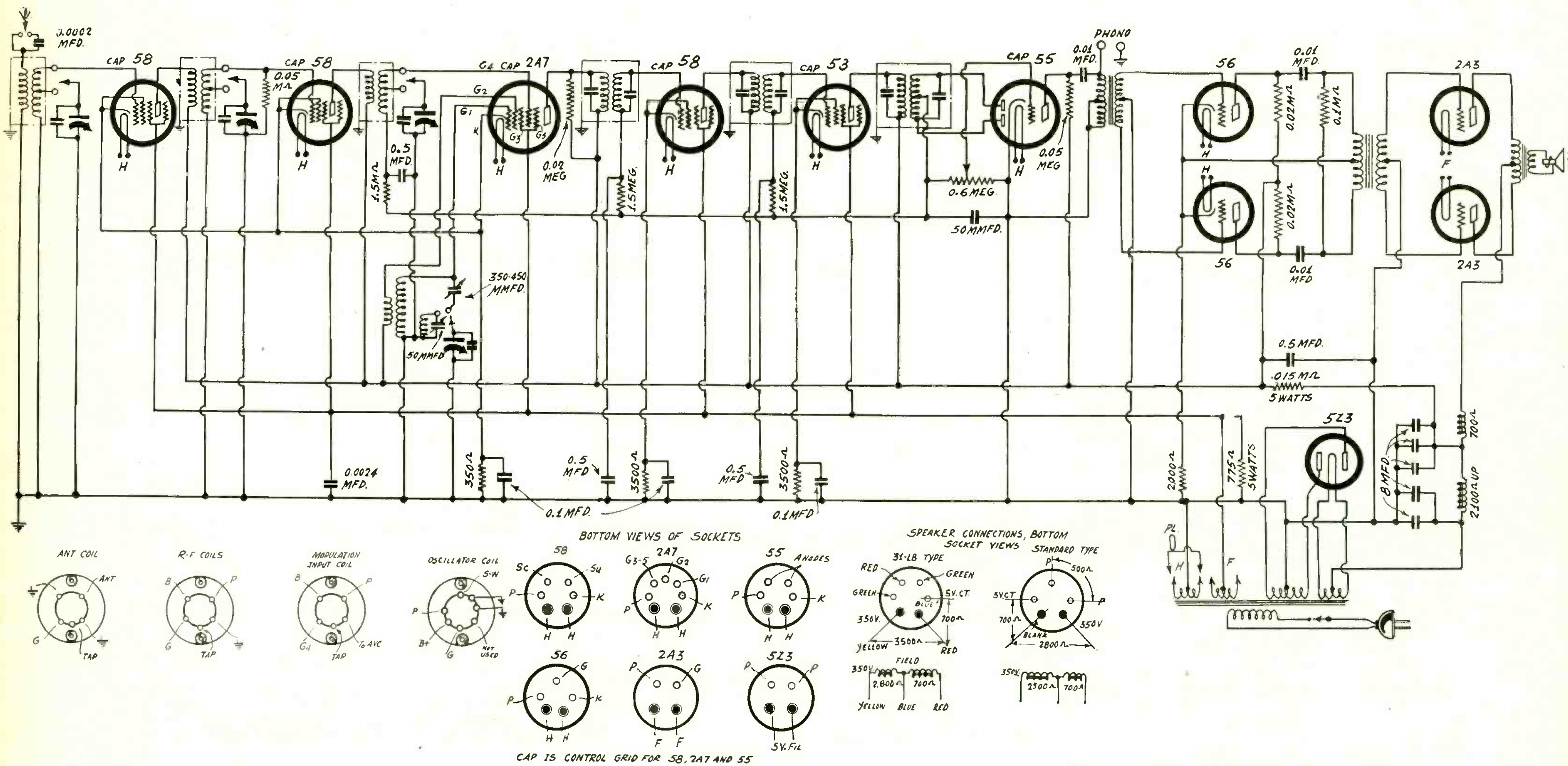
DEFINITIVE DIAGRAM of the 12-TUBE DIAMOND



The Twelve-Tube Super Diamond, with double push-pull audio-frequency amplification, and including a more effective manner of working the police band, and also reducing the hum to a minimum. The short-wave improvement results from use of a separate winding, the diagram being shown below, under "Oscillator Coil." The hum is reduced considerably by the 0.1 meg. resistor between the two 0.01 mfd. stopping condensers. The tube connections are shown below, also the connections for the two types of speakers used with this circuit. The twelfth tube would be the built-in 116.25 kc oscillator described last week.

Radio University

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

Complete Cure for Hum

WILL you kindly explain what to do to eliminate all hum from a broadcast receiver? I have tried everything that has been suggested and there is still some hum left.—W. P. E.

Use batteries for all voltages—plates, screens, grid bias, and filaments. Also use batteries for the speaker field, and after that move away from all electrical power lines and select on those broadcast stations which are completely operated on batteries. Perhaps the hum can be reduced to below audibility with less radical changes, but the question was to reduce the hum completely. To reduce the hum practically you may have to use a heater type tube in the output stage, use filtered current in the field, improve the filtering all around.

* * *

Measuring Grid Bias

WHEN I connect my voltmeter between the cathodes of the r-f amplifiers and ground I get a reading of 20 volts. This does not change when I vary the volume control which should control the bias on the tubes. The set does not work and I wonder if the trouble is excessive grid bias.—W. R. T.

Apparently you have no connection between the cathodes of the tubes and the chassis until you connect the voltmeter, and then the only connection is the voltmeter. That accounts for the high voltage reading and also for the fact that the circuit does not work. What you are doing is using the voltmeter as a milliammeter and then read the current in volts. The reading is the voltage drop in the meter due to the plate current that flows through the meter. If you put a milliammeter, or a voltmeter, in series with one of the plate circuits you should not get any reading if the cathode connection is open.

* * *

2-Volt or 6.3-Volt Tubes?

IN LOOKING OVER the tubes available for the construction of a battery set, I am at a loss to decide whether to use the 2-volt series or the 6.3-volt series, as the higher voltage heater series seems to afford possibilities for better performance, although at much greater drain. Do you consider the 2-volt series satisfactory?—I. D.

Yes. In fact, the 2-volt series tubes are exclusively intended for battery operation of the filaments. If you use the 2-volt tubes you will make no mistake. The circuit and constants choice will determine the result more than the selection of one tube type or the other, whereas the 2-volt series will prove much more economical.

* * *

Grids of 2A7

PLEASE define the five grids of the 2A7 mixer tube.—E. J.

Grid No. 1 is oscillator control grid; No. 2 is oscillator plate; No. 3 is screen; No. 4 is modulator control grid (cap). No. 5 is tied to No. 3 in the tube.

* * *

Transformer Range

WHAT range is possible with audio frequency transformers? That is, is it possible to make the gain uniform up to 10,000 kc, or 20,000 kc? I have heard that it is possible to make audio transformers that will cover all the frequencies required for a television receiver.—A. B.

Transformer manufacturers claim that they can make transformers that have a uniform characteristic from about 30 cycles to 100,000 cycles. But such transformers are very expensive. The wider the uniform transmission characteristic the more the transformers cost.

Conversion Conductance

WHAT IS MEANT by the conversion conductance of a tube such as the 2A7? Why is the grid current type oscillator invariably recommended for Grids Nos. 1 and 2 of this tube? Would not a negative bias method work better?—P. O.

The conversion conductance is a measure of the efficiency of the tube as a mixer. It is the ratio of the input radio frequency voltage to the output intermediate frequency voltage. The rating for the 2A7 is indeed high, more than 400. The grid current type oscillator is the only one with which highly satisfactory results have been obtained to date with this tube, although perhaps the steady negative bias method may be worked out later. As the tube is made at present, so soon as the bias is more than a little bit negative the tube does not oscillate well. Both methods, however, are really of the negative bias type, though one depends on grid current through a leak to develop this bias, and the other has a steady bias due to the cathode current. It should be observed that if the oscillation amplitude exceeds the steady bias value, grid current starts to flow even in the second instance, therefore grid leak and condenser might be well included as a precaution, or check.

* * *

Zero Voltage Twice a Cycle

IS IT TRUE that in all radio sets the signal actually stops once in every cycle? And if it is true, why does not this appear as a form of interference?—Y. W.

The stoppage occurs once during each alternation or half-cycle, hence twice each cycle. This is true of alternating current in all its manifestations. Starting from zero, the current (or voltage) builds up to maximum of the positive cycle, then declines to the zero axis, and further builds up to the maximum negative value and declines again to the zero axis. There is actual interference if the frequency is low enough, which it never is in general radio experience, for the radio frequencies are out of consideration in this regard, and if the lowest audio frequency is assumed to be 50 cycles, then the stoppage takes place 100 times a second, and the ear does not detect this, because of the minute duration, compared with the signal frequency. It is about the same situation as in the movies, where flicker is utterly avoided by using 24 pictures a second, in conjunction with a triple shutter. In the movie instance persistence of vision takes care of the absence of the picture, while in the radio example persistence of hearing comes into play.

* * *

Kerr Cell

FOR TELEVISION PURPOSES, while a Kerr cell may be used as the light source, it is normally necessary to put a high positive bias on it (around 500 volts usually). Can not some way be provided to avoid this high biasing voltage?—U. E.

It should be practical to operate the cell at zero bias, and to have the signal swing it, that is, maintain polarization by signal bias. This method would constitute the cell a detector, and it seems likely that the output of television receivers will be detectors in the near future. Right now there is a sort of television hiatus, but with improved economic conditions no doubt the expensive television research will be carried on even at a greater pace than in the past.

* * *

Why Two I-F Stages?

IN THE CONSTRUCTION of superheterodynes, using two intermediate-frequency stages, requiring three coils, I find that there is always considerable oscillation, and I wonder whether one stage (two coils) isn't enough? The introduction of automatic volume control does not seem to diminish the tendency to oscillation.—C. L. F.

Enough gain is obtainable from a single intermediate tube, somewhere between 100 and 200 for the stage, and so the real reason for the extra stage is more selectivity. In the sense that the gain can not be pressed very much beyond that obtainable from a single stage without intense filtration, there is hardly an advantage in the extra stage. But from the viewpoint of selectivity there is certainly a real advantage. In fact, some manufacturers have intermediate coils with coupling between primary and secondary adjustable, so that it may be made as loose as necessary consistent with absence of oscillation. Another way of accomplishing the same result is to increase the negative bias on the intermediate tubes. It must be expected that oscillation will be present in the two-stage system, unless the coils are inordinately far apart and the voltages rather low, but the trouble is easily curable. One may put a 20,000-ohm resistor across the primary of the first intermediate-coil, and increase the negative bias by using resistors of around 2,000 to 3,000 ohms or so in the individual i-f cathode legs. The advantage of the two-stage system can be proved rather easily by the separation afforded between a strong local and a weak distant station 10 kc removed from that local. The single i-f stage system will not permit the uninterfered reception of the DX station, but the double-stage system will, despite long aerial.

* * *

Squeals in a Super

IN THE COURSE of trying out several superheterodynes that I have built I find that there is less squeal interference at 175 kc intermediate frequency, rather more at 465 kc and thereabouts, and also that in all systems there is no sure-fire way of getting rid of squeals. At least two squeals must be expected—unless you have some evidence to the contrary. Which intermediate frequency is preferable?—L. L.

The principal cause of squeals is insufficient selectivity ahead of the modulator, and as a precaution in this direction three tuned stages are commonly employed in the better receivers, not counting the oscillator, i.e., a four-gang condenser is used, although there are not always tubes between coils. The cause is obvious from the consideration of the images, or alternate frequency responses, for if the desired signal frequency (carrier) does not come in exclusively, there is danger that enough voltage is present at the image or alternate frequency to cause a squeal, because the same oscillator frequency is consistent with the reception of both frequencies. The higher the intermediate frequency, the less the danger of image reception, hence at 465 kc there are images possible only from 1,470 kc up. For an i.f. of 175 kc the images may appear from 890 kc up. If the i-f channel is generating harmonics, or if these are present in the second detector for any reason, then squeals will result, due to beating, and the higher i.f. cause more trouble then, because the interfering harmonics are of a lower order (second and third). Finally, if the circuit is not padded correctly, and if the i-f level is not accurately set at one frequency, squeals will be heard. Thus it is very important to have the i-f channel lined up perfectly, for if it cuts off at the equivalent of 10 kc (expressing the situation on the basis of the broadcast channel), two channels will not go through the i-f amplifier. There is not much to choose between 175 kc and the higher intermediate frequencies, except that if shorter waves than broadcasts are to be received, of course the higher i.f. helps reduce image interference, because maintaining a greater frequency difference between oscillator and modulator. See that the r-f and i-f amplifiers are not oscillating or regenerating, pad accurately, line up the i.f. accurately, and use three tuned circuits ahead of the modulator for the broadcast band. Then you should not experience any squeals. Many superheterodynes are being built these days that are utterly squealless.

* * *

Amplification Cutoff

MY EXPERIENCE with the 55 and 2B7 tubes has been that only so much signal voltage can be put into them, and if this voltage is exceeded the amplification becomes less, and finally when the voltage rises high enough, the amplification cuts off distortedly. Is this not detrimental? I have not tried the 75 and the 2A6, but I presume they show the same effects.—E. F.

The condition you describe actually exists, but whether to call it a detriment is a matter of opinion. In one sense it may be regarded as a virtue, as it precludes the possibility of overloading the power tube, and besides there is abundant amplification present, that is all-sufficient quantity of sound, before the cutoff or semi-cutoff condition arises. While the volume control may be retarded at any time to introduce correction, if there is automatic volume control this remedy may not be complete, and it would be preferable to reduce the aerial to such size that the pickup prevents the excess signal voltage on the second detector. The antenna reduction may be by series condenser. It is presumed the circuits you built have the diode-biased triode or diode-biased pentode. Otherwise, instead of the cutoff you refer to, the signal keeps on rising, but grid current begins to flow, another form of distortion, and really no better or worse than the form previously discussed. The diode-biased method introduces direct and non-reactive coupling, and thus gets away from the distortion due to the stopping condenser. The formal tube data do not include the diode-pentode tubes (e.g., 2B7) for diode bias, probably because of the low signal voltage handled, around 2 volts, say. However, the amplification in the pentode is so large that at 2 volts input there could be 100 volts output, provided the applied plate voltage were in excess of 200 volts. That is why the plate resistor is often returned to 250 or 300 volts. We do not regard the condition you describe as detrimental at all, especially as a shorter aerial improves the selectivity without requiring the addition of any tuned circuits.

* * *

He Waited Six Years

BELIEVE IT OR NOT, I have not built a circuit in six years. In fact, the set I have was the Diamond of the 1926 vintage, which I built the next year. So you see I am not a hurried person. However, I would like to build an a-c set now, and would you please recommend a circuit using seven or eight tubes, preferably a superheterodyne from which the bugs have been extracted? I have seen so many different circuits, and the claims for them are so extensive (without exception) that I do not know which one to choose.—W. D. S.

We recommend you build the 8-tube Super Diamond, discussed in the present issue. If you want a 7-tube set you may follow the same diagram, but omit one intermediate stage. It is valuable, however, to include the extra intermediate stage if you desire selectivity up to just below the point of sideband-cutting. We believe the bugs have been taken out of this as much as from any other super, and we know that scarcely any trouble has been experienced by others who have built this set.

* * *

Interference Remedy

IN MY LOCALITY I am troubled with interference due to a cause unknown, but it is periodic, about 200 throbs per minute, and it causes me no end of displeasure, often ruining programs, so I have to shut off the set and (alas) go to bed, two things I hate to do prematurely. If I could abate the nuisance somewhat, I would be temporarily satisfied. Can you suggest some means of tracking down the trouble?—F. McC.

An easy help is to put a small condenser in series with the aerial, say, 0.0001 mfd., or even half that value. While signal strength will be reduced, the interference will be cut down at a greater rate. We do not know just why this should be so, unless that the natural period of the antenna system becomes so much higher in frequency that the lower frequency interference is substantially bypassed. Anyway, under similar conditions we tried the remedy and it worked well. While the frequency of the interference exists as a modulation, as you report it, the actual source of interference is a higher frequency, obviously, if the interference comes in through the aerial. You may determine the fundamental of the interference by noting the frequencies at which the interference is heard loudest on your set, say, 900, 1,000, 1,100 kc etc. Then as the harmonics are 100 kc apart, the interfering frequency is fundamentally 100 kc. The trouble no doubt is due to an oscillator, that is, a generator of radio frequencies. You can locate it with a loop receiver, encircling the suspected location, and tracking it down by the direction the loop points.

Station Sparks

By Alice Remsen

Music

For Channon Collinge, WABC

The Cathedral Hour, Sundays, 4:00 p.m. EDST

Through the stained glass the dappled sunlight seeps,
Weaving varied patterns on the chancel floor;
Into the silence a subdued murmur creeps;
Wanton breezes enter through the open door.

Up from the choir comes harmony profound,
Angelic music, seemingly supernal,
Reverberating there, a lovely sound,
Leaving an echo, magical, eternal!

A. R.

* * *

And during the Cathedral Hour, conducted by Channon Collinge, you will be wafted to a quiet cathedral close; to an atmosphere of old-world charm and spirituality. The blended voices of the choir will inspire you with devotion and reverence. A soothing and beautiful period of relaxation.

* * *

The Radio Rialto

Up at WABC

It did seem like old times the other evening up at WABC; in Studio One working on the Standard Oil Five Star Theatre program with Solly Ward and "Snoony"; Johnny Hart was the straight man for Solly Ward, which made it seem all the more homelike. I had a good time singing "Tom Thumb's Drum." Something about that lively little song that I like. Noticed Jackie Osterman floating around the studio for no good reason. He's putting on weight these days. . . . This was the last program of the season. All the Standard Oil productions are going off for the summer. So it was really in the nature of a farewell. . . . Met up with Peter and Arlene Dixon after the program. They are still doing their clever little skit, "Raising Junior," on WOR. Getting plenty of mail on it. Here's a tried and true program which some sponsor should buy. Great for a kid's product, interesting to grown-ups, too. . . . Potash and Perlmutter are due on the air some time in June, sponsored by Health Products, Inc.; network not yet decided upon. Joseph Greenwald will play Potash, and Lew Welch, Perlmutter. The McCann, Erickson agency is handling the account. . . . Carolyn Gray, formerly staff pianist for NBC, is now acting in that capacity for Columbia. This clever girl has started a new series of programs, each Monday at 2:15 p.m., in which she makes a radical departure from her usual classical style; she's doing jazz, musical comedy, popular and classical selections, running from one to the other without any announcement. . . .

DAVID ROSS ON DECK

Received an enthusiastic greeting from David Ross; we had not seen each other for six months—he's still the same happy little fellow. Hope he doesn't forget to send that autographed picture to his very ardent admirer, Peter Grant, the ace announcer of WLW, Cincinnati. Peter is a great fan of David's; listens in to him whenever he gets a chance and thinks that David is the greatest reader of poetry on the air. I think he's pretty good myself. . . . A social organization for radio artists has been formed, it has been named the Remote Control Club, rumor has it that they will rent an entire building somewhere in the "Frantic Fifties." . . . The National Vaudeville Artists are conducting a drive to gain radio artists as members. Here is a cause which is worthy of support. The dues are only ten dollars a year, and the benefits to be derived are numerous and gratifying. . . . Don Carney, (Uncle Don to the kiddies) rejoined the N. V. A. after performing at one of their Saturday Night get-togethers. It is a gracious gesture, when well-to-do artists think of their less fortunate brethren and help to support an organization like the N. V. A., which does so much good for the needy and sick of the theatrical profession, regardless of creed or race. . . . Merle Johnston has a brewery account twice weekly on WOR, Mondays and Fridays, 9:00 to 9:30 p.m. It is sponsored by King's Brewery. Al and Lee Reiser, Elmer Feldkamp, and Irene Taylor are on the program. Merle has a fifteen-piece band which has the title of "The King's Men." . . . Received a nice long letter from Gene Brown, the publicity gal of WBAL, Baltimore. She tells me that Melva Forsythe, the radio contralto, played five straight months with Grace Moore in "The Dubarry," with a nice speaking part n'everything. Understand she is due in New York soon and hope she looks me up. . . .

NO SCANDAL; NO, SIR!

Received a letter from one of my readers asking how come I never print any scandal about radio artists. Well, I'll tell you. In the first place I don't believe in printing scandal, I leave that to the yellow press. If I can't say anything good about people I just don't mention them at all; and in the second place, I don't believe anybody could find much scandal among radio artists; they are a pretty clean bunch of people; at least, I've found them so. . . . Went to see the picture "Adorable," with Janet Gaynor, and the new Continental star, Henry Garat, at Radio City Music Hall. It is a very enjoyable film with nice music, and good photography but a silly little plot. Garat is quite good looking, with a fine screen personality. The Music Hall is an immense place, extraordinarily well wired for sound, the singing and talking from the stage registered well—but—guess I'm a bit of a sentimentalist, for I found myself thinking rather sadly of the cosy, homelike little theatres of yesteryear. . . . There has been a time change for the juvenile program, "The Stamp Adventurers Club"—for New York, Boston, Hartford, Buffalo, Philadelphia, Providence, Worcester and Albany there will be a broadcast each Friday from 6:00 to 6:15 p.m., EDST. For Baltimore, Cincinnati, Columbus, Fort Wayne, Syracuse, Cleveland, Akron, Rochester, Washington, Pittsburgh and Toledo, the program will be heard one hour later, from 7:00 to 7:15 p.m., EDST. From Chicago, where the program originates from the Columbia studios, there will be a special broadcast from 6:45 to 7:00 p.m., EDST. . . .

BY ARRANGEMENT WITH C. B. S.

Acceding to a petition submitted by the Columbia Broadcasting System, King George has agreed to postpone his opening address at the World Monetary and Economic Conference until 3:00, p.m. EDST, on June 12th, at which time it will be heard over the WABC-Columbia network from London. . . .

Harriet Britton, who was heard with "Sweet Adeline" and "Hit the Deck" in New York, with the St. Louis Municipal Opera Company, and more recently over NBC networks, gave a song recital at the Barbizon-Plaza Theatre a short time ago. She proved to be a dramatic soprano of extreme versatility, including in her program the works of such composers as Handel, Sarri, Scarlatti, Strauss, Wagner, Brahms, Schubert, Debussy, Saint-Saens, Kramer and Campbell-Tipton. Miss Britton gave a very excellent performance which was thoroughly enjoyed by a large audience. . . .

NO YOU KNOW

Did you know that John Seagle, NBC baritone, is married to the former Helen Peters, a Smith College graduate and his boyhood sweetheart? that Welcome Lewis, the blues singer, is the daughter of Katherine and John Lewis, professional dancers, and that the mother of Bess Johnson, dramatic actress, played with Lillian Russell and other stage celebrities of another generation? . . . President Roosevelt will get an honorary degree of Doctor of Laws from the Catholic University of America on June 14th; the event will be broadcast over an NBC network and WAF at twelve noon, EDST. . . . And I'm going to get myself a cup that cheers but doesn't inebriate—tea, toasted muffins and blackberry jam . . . and then for the biography of a man who also likes tea and muffins, the conductor of the famous WABC Cathedral Hour—Channon Collinge.

* * *

Biographical Brevities

About Channon Collinge

The story of the life of Channon Collinge reads like an adventure tale. He was born in the tiny town of Salterhebble, in the West Riding part of Yorkshire, England. As an infant he was taken to Poona, India, where he lived for three years. The following three years of his life were spent at sea, sailing the briny between England, Asia and Africa. At six, young Channon Collinge was attending kindergarten in his home county of Yorkshire and at twelve he was back in India. Two years later he returned to England to finish his education. At his father's death he was forced to leave school and take the family business of cotton manufacturing, and despite a complete distaste for the business, Collinge applied himself so diligently that he won the gold medal for excellence in work on cotton manufacture.

Young Collinge had always shown definite talent for music, and as a child had improvised tunes on the piano. At the age of eight he began the serious study of the violin, and at the age of ten had organized a children's orchestra. At twelve he was composing school operettas, and at twenty was a professional musician. He later directed the Dublin Choral Society, the University Choral Society of Dublin and the Drogheda Society of the same city. Unable to continue devoting himself to business he left Yorkshire and attended Dublin University, where he later became Professor of Music. During his vacations he traveled all over Western Europe, Egypt, Algiers, Australia and the East Indies.

In 1907, exhausted from overwork, he decided to visit America. For more than a year he traveled through the United States from California to the Atlantic seaboard, going down to South America, West Indies, Cuba and Bermuda. Coming back to New York he wrote the music to the opera, "Seminary Girl," and went on the road with the company. Then he met

(Continued on next page)

PERSONALITIES

Carveth Wells sits up and takes notice when Mrs. Wells says she has been shopping.

"See anything interesting?" asked Wells, absorbed in the writing of his next lecture-broadcast.

"Yes. I bought something."

"What?"

"A place in the country."

Wells bounded from his chair and instead of remonstrating—as most husbands would have done—he danced a sailor's hornpipe! "A place in the country" has been his life-long dream.

Mrs. Wells' purchase turned out to be a delightful old farm house located on a three-acre plot on the Saugatuck River near Norwalk, Conn.

* * *

Three members of the cast of "Penrod," the play in which Ben Grauer, NBC announcer, made his Broadway debut in 1918, are today famous in the theatre. They all made their stage debuts in the Booth Tarkington play at the Globe Theatre. They are Helen Hayes, Helen Chandler and Lillian Roth.

Grauer played the role of Georgie Bassett.

* * *

Whenever Sherlock Holmes' (Richard Gordon) pronunciation of an English word fails to meet with Watson's approval, the Sherlock of the air promptly hears about it from his studio partner, Leigh Lovel. Gordon recently turned the tables and informed Lovel after a program there was one word he always pronounced wrongly.

"What may that be?" Lovel asked, jamming his monocle into an eye.

"Wrongly" quipped Gordon.

* * *

Fannie Brice, the comedienne, has four dogs.

* * *

John Brewster, whose poetry hour, "Golden Treasury," is a weekly chain feature, was called upon to judge a poetry contest recently at Julia Richman High School, New York City.

* * *

Welcome Lewis, radio songbird, is going to Washington for a week's engagement in vaudeville. She will be featured with Kelvin Keech, announcer in her Musical Scrapbook of the Air, the program in which she was heard over networks from New York.

* * *

Lee Sims, pianist who also runs a music school, has a busy business brain. He hopes to launch a chain of music schools, with himself as the long haired maestro at the head . . . . the big link of the chain, as it were.

* * *

An organization in Toronto, Canada, requires members to cultivate a dialect like Jack Pearl's. Members must also remain absolutely quiet during a Magic Carpet program featuring the Baron. The penalty is a $5 fine that is turned over to charity.

* * *

NBC's 19-year-old Loretta Poynton, who has taken up housekeeping near the studios because her home is too far away, has found a place for the jigsaw puzzles in her new abode. She uses them as decorations for the end table because she likes the pictures.

* * *

Lanny Ross' doorbell rang. It was a messenger with one big lily in a flower box. And it was the night that Lanny was opening a week of personal appearances at the Roxy. Lanny thought that it was just someone's grisly sense of humor until he looked at the card in the box. The name of the sender was Johnny Weismuller. How about this, Tarzan?

Reading on, Lanny found that it was all a mistake. The flower had been delivered to the wrong address—but Lanny refuses to divulge the name of the lady.

* * *

"Teach Me to Smile," written a number of years ago by Don Bestor, is still the orchestra director's theme song for his NBC broadcasts from the Hotel Lexington in New York.

* * *

Tom Howard, of the "Musical Grocery Store," says there was a run on his young son's bank during the moratorium, but the kid got there first when daddy tripped.

* * *

While studying voice in Italy, Robert Royce, tenor, had a narrow escape from death. As he was watching a Garibaldi Day parade in Milan disperse, a violent anti-Fascist battle broke out, and the singer found himself caught between the rival lines, bullets whizzing past him from both directions. The battle ended as suddenly as it had begun, and Royce escaped unhurt.

* * *

If Sigmund Spaeth spent much of his time at his clubs, he wouldn't have time to broadcast as the Tune Detective.

A few of the organizations of which he is a member are the Triangle Society, Founders Club, Bachelors Club, Nassau Club, (Princeton), Princeton Club, Dutch Treat, Green Room, Friars, Lambs, University Glee Club, the Bohemians, Kiwanis and National Arts Club. Spaeth is one of the few men in radio with a Ph.D. degree. He obtained it at Princeton. His A.B. and A.M. degrees were received at Haverford College. He is a member of Phi Beta Kappa and Phi Mu Alpha.

* * *

Eddie Duchin has made over 100 records for Columbia, Victor and Brunswick in a year. . . . Aviator "Swanee" Taylor is teaching both Fred Waring and Ted Husing to fly. . . . The Lombardos are getting themselves sunburned, preparatory to donning their traditional white linen suits—an annual rite. . . . When a writer's misprint erroneously reported that only four letters were drawn by the recent New York Philharmonic Symphony broadcasts, several hundred indignant fans wrote CBS, apologizing for not writing sooner. . . . Most said it was the first fan letter thay had ever written, but not the last.

TRADIOGRAMS

By J. Murray Barron

A new 5-tube all-shieded, self-contained electric automobile set is now commanding considerable attention. It employs a late and proved circuit, incorporating the newest tubes and in the majority of cases does not require suppressers. From various known tests this unit came out with an excellent record and stands high. It may be had either in electric or battery type and in each case works efficiently. It comes equipped with remote control and is very simply mounted with two large bolts. The outfit comes completely wired and ready to operate unit, or may be had as a kit, with simplified diagram with complete instructions for assembly of the electric or battery model. A full description is scheduled for publication in RADIO WORLD soon, possibly the June 17th issue, by the Engineers of the Postal Radio Corp., 135 Liberty Street, N. Y. City.

* * *

A new item recently offered to the fan and experimenter and which comes in a variety of combinations is the Shielded Short-Wave Battery Receiver made by Leotone Radio Co., 63 Dey Street, New York City. This uses the low drain tubes, 30, 32, 33 and 34. The outfit comes completely assembled in shielded cabinet and with coils. It is also offered as a complete kit with coils, or the metal case, chassis or shielded compartments may be bought separately.

One of the very finest radio catalogs to be published this season is now making its appearance through the mails and very shortly will be available across the counter. There are 108 pages, listing thousands of items in parts, complete kits, receivers and everything else in radio. It is a beautiful job, complete with fine illustrations and shows the handiwork of a skilled artist. Mr. Sydney Bass, the advertising and merchandising consultant now associated with the Try-Mo Radio Co., Inc., engineered its production. Copies may be obtained by addressing the organization at 85 Cortlandt Street, N. Y. City.

* * *

The small ac-dc universal radio receivers made considerable stir along radio row and chain stores elsewhere on account of an advertised low price. It is not always possible to get sets that are advertised in windows at very low figures, for often the whole story is not always told. When questions of understanding arise it is safer and in the long run better to insist on all the information first. There will be no dissatisfaction if one buys from reliable firms and from advertisements clearly stated.

8-Tube Diamond

(*Continued from page 16*)

accompanied by reappearance of oscillation, of course use the extra sensitivity.

Other Requirements

The switch used for shifting from one band to the other requires four positions or poles, two throws. Thus the stator of a condenser is moved from the grid terminal of the secondary to the tap. Hence the tuned circuit is between tap and ground, and the secondary itself acts as an autotransformer, of which the tuned circuit (tap to ground) is the primary and the entire secondary (grid to ground) is the secondary. Since there is a primary already, in the plate circuit of the preceding tube, or in the aerial circuit, the secondary may be considered technically as the tuned circuit when short waves are received, and the full large winding as the tertiary. Hence there is double step-up.

Besides the connections for the band shifting there is another double-pole section that works simultaneously, and this is used for cutting in the full aerial capacity for short waves, but introducing a series capacity for broadcasts. This series capacity may be less than 0.0002 mfd. if a long outdoor aerial is used. The reason is that the input has to be gaited to the capabilities of the 2B7, so as not to introduce the amplification stoppage too soon. Since broadcasting stations deliver greater power input to the antenna winding, and as greater selectivity is needed, the series condenser is introduced. For the opposite reasons the full aerial input is used for short waves, and then the excellent results on the broadcast band are duplicated in the short-wave realm.

Station Sparks

(*Continued from preceding page*)

an old friend from a London music house who persuaded him to remain here as the head of the house's American orchestra department. Then he went with Erlanger, and among the stage successes he helped produce were "The Silver Star," "The Girls of Gottenburg" and "Chin-Chin." In 1920 he decided to return to Europe, instead of which he joined the staff of the old New York Tribune as artist for the Children's page of the paper, producing the well-known "Dinny Doodle," "Jingle Jangle" and other comic strips. Tiring of this he returned to music, and in 1927 signed with Columbia and radio.

Ten Years Ago!

(Radio World *of June 9, 1923, paid type and pictorial attention to the following matters, among other things.*)

"How to Build a Battery Charger for Use with 110 Volts A.C." was the title of an article by Stuart A. Hendrick.

Amateur station 5ZA, in Roswell, New Mexico, was described in text and pictures. It was one of the outstanding amateur stations of that period.

C. White told our readers how to make a super amplifier, and a schematic design indicated that things were different in 1923.

The General Electric Company announced that it was starting on the construction of "the first plant to be used exclusively for popular broadcasting."

Secretary of Commerce Herbert Hoover announced the first Interdepartment Radio Advisory Committee to be organized for the Federal Government.

Our own J. E. Anderson was responsible for an article entitled "Simple and Easily-Made Neutrodyne Condensers."

Carl H. Butman, Radio World's Washington correspondent, wired that the American broadcasters totaled 592 for the end of that current week. "Swat the Birdies" said one of that week's contributors in referring to rules for minimizing re-radiation.

Arthur S. Gordon declared that there was no need for roars, clicks, shrieks and the awful scram of interference—and then endeavored to prove that they could be done away with in most cases.

George Freisinger, a noted amateur station owner told our readers all about his new station 2ABT, which cost $5,000.

Elizabeth, N. J., started a campaign to stop the use of large phonograph horns in front of radio stores. If memory serves us right, Elizabeth didn't get very far with her protest.

NEW MODEL SHIELDED TEST OSCILLATOR!

AN improved modulated test oscillator, fundamental frequencies, 50 to 150 kc, enabling lining up of intermediate frequency amplifiers, t-r-f and oscillator circuits, is now ready. It is shielded in a metal box 9½" wide x 6¼" deep x 4½" high, with beautiful Japanese finish. The test oscillator is obtainable in two models, one for a-c operation, the other for battery operation. The same cabinet is used for both.

The a-c model not only is shielded but has the line blocked, that is, radio frequencies generated by the oscillator cannot be communicated to the tested set by way of the a-c line. This is a necessary counterpart to shielding, and a special circuit had to be devised to solve the problem.

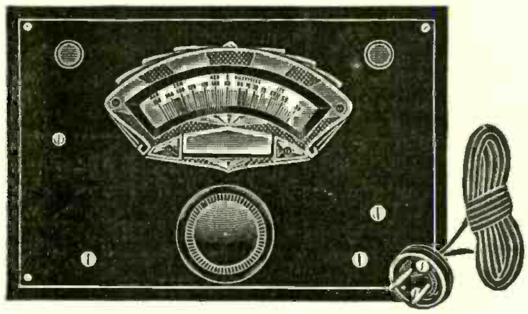
The modulation in the a-c model is the a-c line frequency, 60 cycles, effected by using the line voltage on the plate of the tube. In the cabinet there is a very high resistance between the shield cabinet and the a-c, a double preventive of line-shorting and application of a-c line voltage to the user.

The oscillator is equipped with an output post. No ground connection need be used, as the circuit is sufficiently grounded through the power transformer capacity to prevent body capacity effects in tuning.

The frequencies are more accurately read than normal use requires, being never more than 2% off, and usually not more than 1% off, many readings being right on the dot (no discernible difference). The frequency stability is of a high order from 100 to 50 kc, and somewhat less from 100 to 150 kc. Zero beats are guaranteed at all frequencies.

The oscillator was designed by Herman Bernard and is manufactured under the supervision of graduates of the Massachusetts Institute of Technology.

Either model FREE with two-year subscription for Radio World (104 issues) $12.00



The test oscillator has a frequency-calibrated dial, 150 to 50 kc, with 1 kc separation between 50 and 80 kc and 2 kc separation between 80 and 150 kc. Intermediate frequencies are imprinted on the upper tier. Broadcast frequencies are obtainable on tenth harmonics (500 to 1,500 kc).

RADIO WORLD

145 West 45th St., New York, N. Y.

THE a-c model is completely self-operated and requires a 56 tube. The battery model requires external 22.5-volt small B battery and 1.5-volt dry cell, besides a 230 tube. The use of 1.5 volts instead of 2 volts on the filament increases the plate impedance and the operating stability. The battery model is modulated by a high-pitched note. Zero beats are not obtainable with the battery model.

Directions for Use

Remove the four screws and the slip 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.

For testing some particular set, follow the directions given by the designer or manufacturer. In the absence of such directions, use the following method.

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 broadcast frequency. Connect a wire from output post of test oscillator to antenna post of set. Leave aerial on for zero beats, off otherwise. At resonance the hum will be heard. Off resonance it will not be heard. For testing intermediate frequencies, connect the wire to plate of the first detector socket. The first detector tube may be left in place and bared 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.

SOLDERING IRON FREE!

Works on 110-120 volts AC or DC, power, 50 watts. A serviceable iron, with copper tip, 5 ft. cable and male plug. Send $1.50 for 13 weeks' subscription for Radio World and get these free! Please state if you are renewing existing subscription.

RADIO WORLD

145 West 45th St. N. Y. City

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115 Circuit Diagrams of Commercial Receivers and Power Supplies supplementing the diagrams in John F. Rider's "Trouble Shooter's Manual." These schematic diagrams of factory-made receivers, giving the manufacturer's name and model number on each diagram, include the MOST IMPORTANT SCREEN GRID RECEIVERS.

The 115 diagrams, each in black and white, on sheets 8½ x 11 inches, punched with three standard holes for loose-leaf binding, constitute a supplement that must be obtained by all possessors of "Trouble Shooter's Manual," to make the manual complete

Circuits include Bosch 54 D. C. screen grid; Balkite Model F, Crosley 20, 21, 22 screen grid; Eveready series 50 screen grid; Erla 224 A.C. screen grid; Peerless Electrostatic series; Philco 76 screen grid.

Subscribe for Radio World for 3 months at the regular subscription rate of $1.50, and have these diagrams delivered to you FREE!

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Radio World, 145 West 45th St., New York, N. Y.

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Having assembled 2,000 diagrams of commercial receivers, power amplifiers, converters, etc., in 1,200 pages of Volume No. 1 of his Perpetual Trouble Shooter's Manual, John F. Rider, noted radio engineer, has prepared Volume No. 2 on an even more detailed scale, covering all the latest receivers. Volume No. 2 does not duplicate diagrams in Volume No. 1, but contains only new, additional diagrams, and a new all-inclusive information on the circuits covered.

Volume No. 2—Perpetual Trouble Shooter's Manual, by John F. Rider, Shipping weight 6 lbs. Order Cat. RM-VT @........................$5.00

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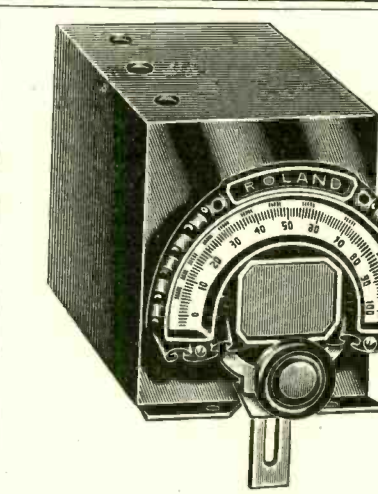
145 West 45th Street New York City

BOOKS AT A PRICE

"The Superheterodyne," by J. E. Anderson and Herman Bernard. A treatise on the theory and practice of the outstanding circuit of the day. Special problems of superheterodynes treated authoritatively. Per copy. (Cat. AB-SH), postpaid..50c

"Foothold on Radio," by Anderson and Bernard. A simple and elementary exposition of how broadcasting is conducted, with some receiver circuits and an explanation of their functioning. (Cat. AB-FH), postpaid 25c

Guaranty Radio Goods Co., 145 W. 45th St., N. Y. City

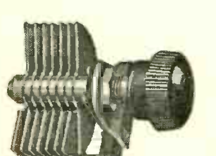


0.0005 mfd. Scovill tuning condenser, brass plates, shaft at both ends so condenser takes 0-100 or 100-0 dials and two can be used with drum dial; sectional shields built in, trimmers affixed; total enclosed in additional shield as illustrated. Access to trimmers with screwdriver. Side holes for bringing out leads to caps of screen grid tubes. Cat. SCSHC @....$1.95

Same as above, with ghost type dial (travelling light). Cat. SCSHC-DL @........................$2.85

DIRECT RADIO CO., 143 W. 45 St., New York City

FREE with a $1.00 8-weeks Subscription



NEW STAR MIDGET CONDENSERS

Choice of 15, 25, 50 and 100 mmfd. capacities. Single hole panel mount.

Here is your opportunity to get the latest product of Hammarlund, a Star Midget condenser. Send $1 for 8 weeks subscription and get any one condenser free. Select the desired capacity.

Any two condensers free with $2 for 17-week subscription.

Any three condensers free with $3 for 26-weeks subscription.

Any six condensers free with $6 for one-year subscription (52 weeks).

RADIO WORLD

145 West 45th St., New York City

BLUEPRINTS OF STAR CIRCUITS

8-TUBE AUTO SET

Sensitivity of 10 microvolts per meter characterizes the 8-tube auto receiver designed by J. E. Anderson, technical editor of Radio World, and therefore stations come in with only six feet of wire for aerial, and without ground. Most cars will afford greater aerial pickup, and besides the car chassis will be used as ground, so with this receiver you will get *results*. The blueprint for construction of this set covers all details, including directions for cars with negative A or positive A grounded. The circuit features are: (1) high sensitivity; (2), tunes through powerful locals and gets DX stations, 10 kc either side; (3), latest tubes, two 239 pentode r-f, two 236 screen grid, two 237 and two 238; push-pull pentodes, all of 6-volt automotive series; (4), remote tuning and volume control on steering post, plus automatic volume control due to low screen voltage on first detector; (5), running board aerial. The best car set we've published. This circuit was selected as the most highly prized after tests made on several and is an outstanding design by a recognized authority. Send for Blueprint 631, @ 50c

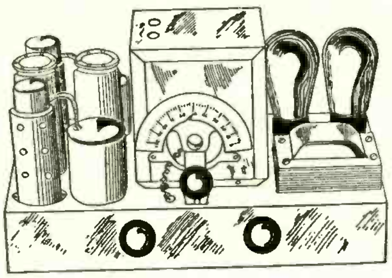
SHORT-WAVE CONVERTER

If you want to build a short-wave converter that costs only a very few dollars, yet gives good results, furnishing all its own power from 110 volts a-c, and uses no plug-in coils, you can do so from Blueprint 630. Price.........25c

5-TUBE AC, T-R-F

Five-tube a-c receivers, using variable mu r-f, power detector, pentode output and 280 rectifier, are not all alike by any means. Forty circuits were carefully tested and one selected as far superior to the others. This prized circuit was the 627, and if you built it, you will always be glad you followed our authentic Blueprint, No. 627. This is the best 5-tube a-c t-r-f broadcast circuit we have ever published. Price 25c

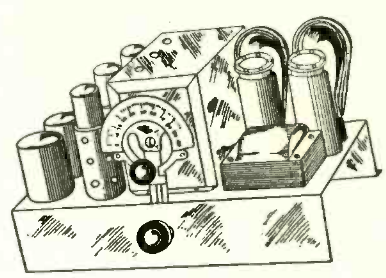
RADIO WORLD, 145 West 45th Street, New York, N. Y.



BLUEPRINTS, COILS and CHASSIS

FOR THE TUNED R-F

DIAMOND OF THE AIR



FOUR-TUBE DIAMOND

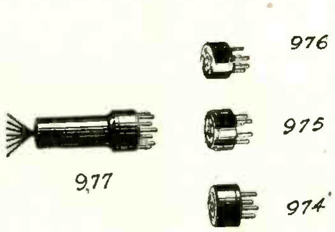
Extremely fine performance, including fetching tone quality, marks the Four-Tube A-C 1933 Diamond of the Air, blueprint of which is now available (half-scale). Many have been surprised that so much can be accomplished on a t-r-f set that costs so little to build. The circuit uses a two-gang 0.00035 mfd condenser. Special coils are required. The chassis is metal, 13.75 x 6.75 x 2.5 inches.

Send $3.00 for six months subscription (26 issues) and get the blueprint, two official shielded coils and the drilled metal chassis free. Order PRE-D-4-COMB.

FIVE-TUBE DIAMOND

The Five-Tube A-C 1933 Diamond of the Air provides greater sensitivity than the four-tube model, also somewhat more selectivity, as a three-gang condenser is used. An infallible method of permanently suppressing oscillation is introduced, so that besides having a sensitive and selective set one will have a stable receiver. The tone is most excellent. Send $4.00 for 34 weeks subscription (34 issues) and get the blueprint, three shielded coils and drilled metal chassis free. Chassis is 13.75 x 9 x 3 inches. Order Cat. PRE-D-5-COMB.

Analyzer Plug and Adapters



For constructing a set analyzer, an analyzer plug, to go into a receiver socket, is necessary. We offer the exclusive seven-pin analyzer plug, plain long handle as illustrated, and three adapters that enable putting the plug connections into UX, UY and six-pin receiver sockets. The plug has 5-foot 7-lead cable. All four parts sent free on receipt of $6.00 for one-year's subscription (52 issues). Order Cat. PRE-ANPLAD.

RADIO WORLD and RADIO NEWS } $7.00

Get both of these mazagines for one year for $7.00, although the regular subscription price of RADIO WORLD alone is $6.00 a year and that of "Radio News" alone is $2.50 a year. Instead of paying $8.50 you pay $7 and you get 52 issues of RADIO WORLD (one a week) and 12 issues of "Radio News" (one a month). "Radio News" recently bought "Citizens Radio Call Book," and "Technical Review" and consolidated them with "Radio News." This offer at this combination price applies only to United States and possessions. Send $7.00 and order Cat. PRE-RWRN.

To Canadian and other Foreign subscribers the combination price offer is at $8.50 for these two magazines. Order Cat. PRE-FOR-RWRN.

RIDER'S MANUAL

The standby of the service man is John F. Rider's "Perpetual Trouble Shooter's Manual," of which Vols. 1 and 2 have been published.

Vol. 1 consists of 2,000 diagrams of commercial receivers, power amplifiers, converters, etc. Total pages, 1200.

Vol. 2 contains additional diagrams on the same basis as above, but in Vol. 2 there is no duplication of any of the diagrams printed in Vol. 1.

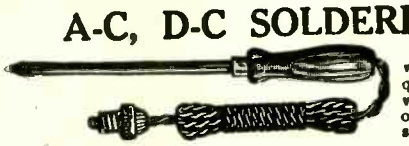
To get Vol. 1 free, send $9.00 for 1½-year subscription (78 weeks) and order Cat. PRE-RM-1.

To get Vol. 2 free, send $9.00 for 1½-year subscription (78 weeks) and order Cat. PRE-RM-2.

PHONOGRAPH MOTOR

Allen-Hough synchronous phonograph motor, 78 revolutions per minute; takes up to 12-inch records. Works from a-c line, 50-60 cycles, 105-120 volts. Equipped with felt-covered turntable. To start the motor give it a slight impetus. Fits into 3-inch depth, hence handy for compact installations. Given free with 34-weeks subscription at $4.00. Order Cat. PRE-PHOMO.

A-C, D-C SOLDERING IRON



A serviceable iron that works on a-c (any frequency) and d-c, 105-120 volts. Sent free on receipt of $1.50 for three-months subscription (13 issues). Order Cat. PRE-SOLIN.

0-10,000-Ohm Resistance Meter

A 0-10,000-ohm ohmmeter and continuity tester. A rheostat is built in for correct zero resistance adjustment. The unit contains a three-cell flashlight battery. Supplied with two 5-foot-long wire leads with tip plugs. Case is 4-inch diameter baked enamel. Sent you for an order for one year's subscription for RADIO WORLD (52 weeks) at the regular rate of $6. Order Cat. PRE-500.

We do not pay postage on resistance meter. Average postage 17c.

DOLLAR SPECIALS

R-F CHOKE COILS

These coils have 50, 100, 200, 400 and 800 turns, diameter 1 inch, and are suitable for detector plate filtering, screen filtering, grid and plate loads, etc. The 50 is for short waves, 100 for television band, 200 for broadcast band, 400 for high intermediate frequencies (450 to 300) and 800 for lower intermediate frequencies. Any four, or four of a kind, or combinations not exceeding total of four, sent free on receipt of $1.00 for 8 weeks trial subscription. Order Cat. PRE-4-CH and state chokes desired, by quantity and number of turns.

TWO BOOKS BY ANDERSON AND BERNARD

"The Superheterodyne," by J. E. Anderson and Herman Bernard. A treatise on the theory and practice of the outstanding circuit of the day. Special problems of superheterodynes treated authoritatively.

"Foothold on Radio." A simple and elementary exposition of how broadcasting is conducted, with some receiver circuits and an explanation of their functioning. Both books sent free on receipt of $1.00 for 8 weeks trial subscription. Order Cats. PRE-SH-FH.

CHOICE OF PANEL TYPE METERS

One meter sent free with each $1.00 trial subscription (8 weeks). Order Cat. PRE-MTR and add the number of the meter to the catalogue number. Any number of meters may be ordered on the equivalent extended subscription basis.

0-6 Voltmeter D.C.	No. 326
0-50 Voltmeter D.C.	No. 337
6-Volt Charge Tester D.C.	No. 23
0-10 Amperes D.C.	No. 338
0-25 Milliamperes D.C.	No. 325
0-50 Milliamperes D.C.	No. 350
0-100 Milliamperes D.C.	No. 390
0-300 Milliamperes D.C.	No. 399
0-400 Milliamperes D.C.	No. 394

HANDY PACKAGE OF PARTS

One grid condenser of 0.00025 mfd., with clips; one 5-to-7 meg. fixed grid leak; one knob with ¼-inch shaft; one a-c cable and plug. All sent on receipt of $1.00 for 8-weeks trial subscription. Order Cat. PRE-HANPKG.

SHIELDS FOR 57, 58 TUBES

Aluminium shields of the type specified by the tube manufacturers for sensitive circuits, so that the shield top fits snugly about the tube dome, are obtainable. six free on receipt of $1.00 for 8 weeks trial subscription. Order Cat. PRE-TUBSH.

RADIO WORLD, 145 West 45th Street, New York, N. Y.

(WE PAY POSTAGE ON ALL PRODUCTS LISTED ON THIS PAGE, EXCEPT OHMMETER).