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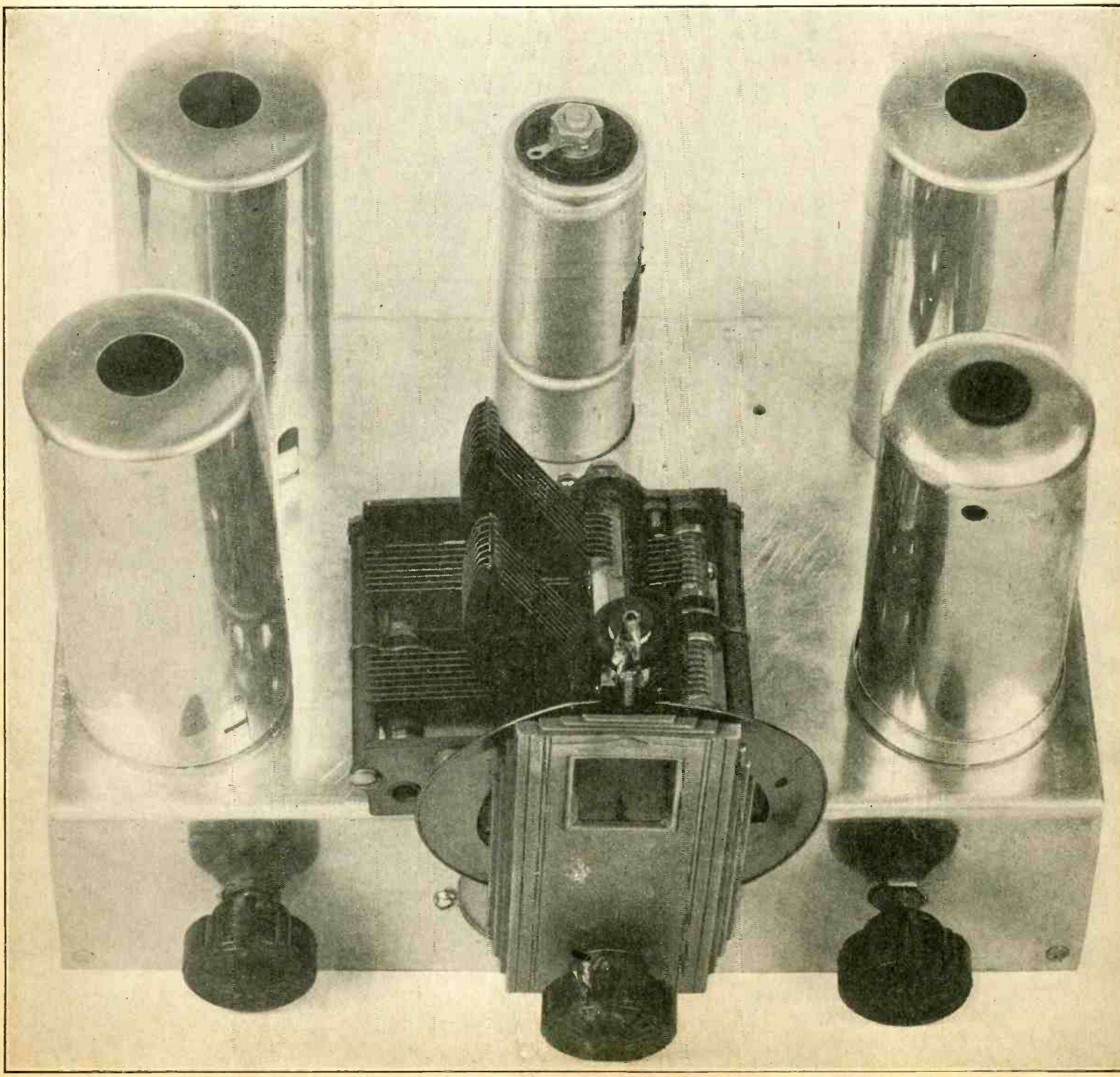
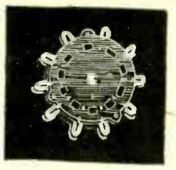
SHORT WAVE CONVERTER PROGRESS

(SEE PAGE 3)





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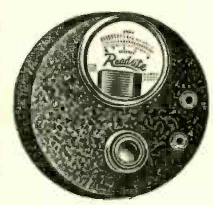

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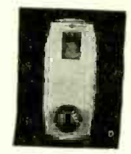

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Vol. XX No. 5 Whole No. 499
October 17th, 1931
[Entered as second-class matter, March, 1922, at the Post Office, at New York, N. Y., under act of March, 1879]
15c per Copy. $6 per Year.

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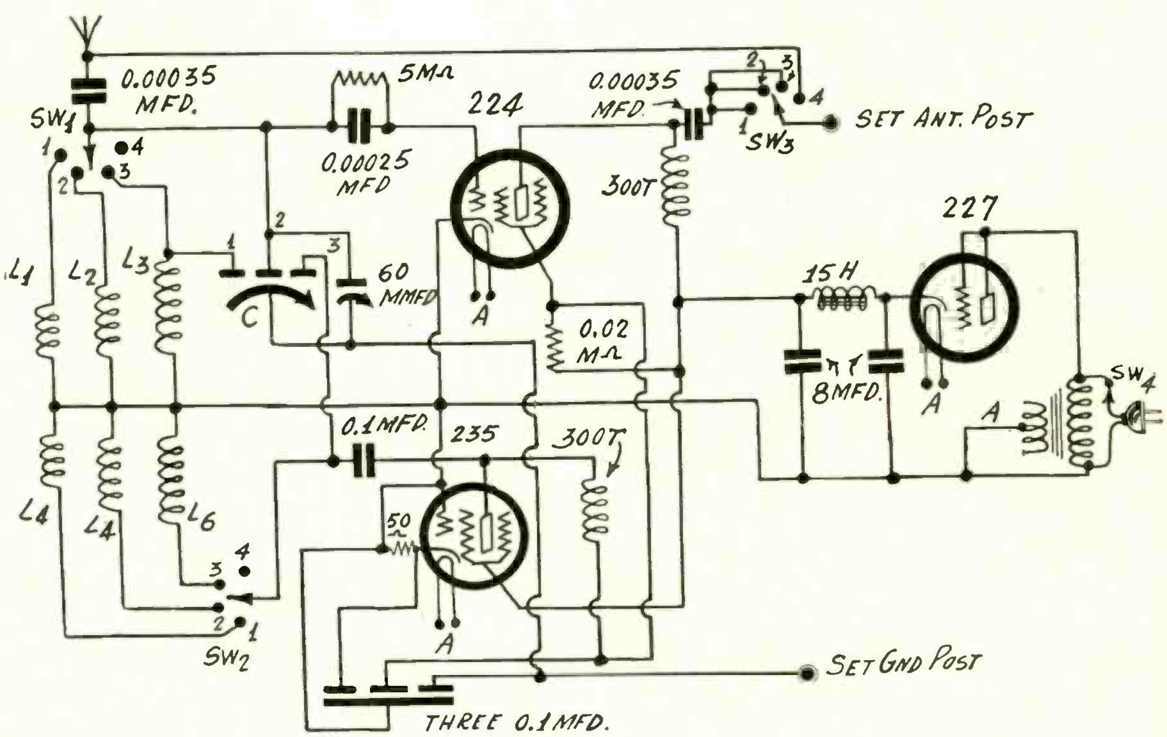
RADIO WORLD, owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.; Roland Burke Hennessy, editor; Herman Bernard, managing editor; J. E. Anderson, technical editor; L. C. Tobin, Advertising Manager

Progress with Converters

Present Authentic Designs and Glimpse of Future

By Henry B. Herman

FIG. 1
A three-tube converter, illustrating the use of a three gang condenser, with one of the sections cut into the modulator's tuned circuit for the lowest frequency band, but omitted for the two other bands. If the capacity of each section is 0.00046 mfd., then C2-3, across L3, tunes virtually in step with C3L6. If the two circuits are 1,500 kc apart at the start (lowest frequencies) they are only 1,800 kc apart at the other end.



ALTHOUGH short wave converter articles have engaged the attention of the radio press and its readers for seventeen months, starting with the series inaugurated in these columns, it must not be imagined that the subject is even nearly exhausted. As improvements are made there is just that much more subject-matter for discussion, and as things in radio, or anywhere else, do not emerge at once in a state of perfection, it is to be expected that much progress will result during the new season. Finally converters will become pretty much standardized, for the number and type of tubes they use, just as broadcast receivers have reached that state.

It is my opinion that the standardized converters will have the B supply built in, as well as the A supply; that band shifting will be done with a switch only (which is virtually the rule already), and that there will be a stage of tuned radio frequency amplification ahead of the modulator, where now there is either no stage at all, or an untuned stage.

The theory that hopeless trouble will follow from attempts to use a stage of tuned radio frequency amplification will meet the same happy end as did the theory that tuning condensers can not be ganged in broadcast receivers, and that tuned radio frequency is not practical ahead of a regenerative detector. Both of these now accepted and everyday practices were condemned by many engineers only seven years ago and hundreds of thousands of words published in support of the theories, backed up (or was it down?) by copious mathematics.

Meanwhile, however, let us use the tools that we have, and admit that the stage of tuned radio frequency requires some developmental work that has not yet even been undertaken.

There are certain factors associated with converters that make for poor results unless given expert attention. The designer should take care of this. Then the builder should not have any difficulty.

One of the points that nearly always gives the designer a slight sensation around the forehead (known as a headache) is the difference in frequency between the modulator and the oscillator tuned circuits. This difference is equal to the intermediate frequency, and remains the same regardless of the signal frequency.

(*Continued on next page*)

Oscillator and Modulator

New Method Has Two 1,500 kc Apart

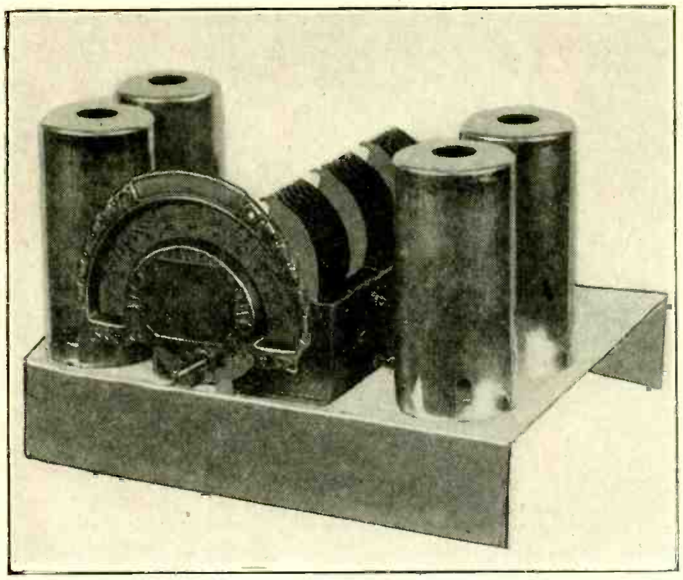


FIG. 1A
A symmetrical layout results if a tube shield is put over the electrolytic condenser. This is a layout for Fig. 1.

(*Continued from preceding page*)

Let us restate the operation of a converter, taking the diagram, Fig. 1, as model. The short wave desired to be received is tuned in by the coil-condenser combination in the antenna stage, at the station's carrier frequency. If we put earphones in the modulator output (224) instead of what is there, we might hear a few stations, if they were close by. Selectivity would be low. We desire, instead, to reach out to great distances, even to bring in stations located in foreign countries, across the sea, or across seven seas and then some, so we must provide more amplification and also more selectivity.

Constitutes a Superheterodyne

To achieve that combination end we introduce an oscillator (235). This we tune also. Then (disregarding the rectifier for the while) we connect the modulator output to the input of a broadcast receiver. That receiver is sensitive to frequencies from, say, 1,700 kc to 540 kc. The broadcast band is from 1,500 kc to 550 kc. If we can produce at the output of the modulator a frequency within the range of the broadcast set, we gain the full amplification and selectivity of the set, and have a fine system of reception, a superheterodyne system, regardless of what type of receiver is used.

The difference in frequencies from one extreme to the other of the broadcast band alone is 950 kc, and the set may cover a little more, say, 1,160 kc, as in the supposed case just cited.

When the original carrier frequency is to be changed to another frequency—a lower one in this instance—resort is had to the beat system. The oscillator is made to oscillate at a frequency that differs from the incoming carrier to the extent of this other desired frequency. Let us make a selection, 1,500 kc. Suppose the short wave station to be tuned in is on 49.97 meters, 6,000 kc. Now we have all the requirements. The antenna stage tuning is to be at 6,000 kc. We may make the oscillator tuning either 6,000+1,500 or 6,000—1,500, but we will select the higher frequency for the oscillator, because of the normally greater sensitivity. Thus the oscillator would be tuned to 7,500 kc.

Diverse Frequencies

Suppose this situation obtains when the condenser plates of the two tuning capacities are totally enmeshed, that is, at maximum capacity. With any equal-condenser, unequal-coil system it is obvious that the same frequency ratio will prevail. For 0.00035 mfd. the ratio is approximately 2.6-to-1, so the modulator, starting at 6,000 kc, will wind up, at minimum capacity setting, at 15,600 kc (19.22 meters), while the oscillator, starting at 7,500 kc, will wind up at 19,500 kc, or (15.38 meters). While the frequency difference between the two circuits was 1,500 at the start, it became 3,900 kc at the

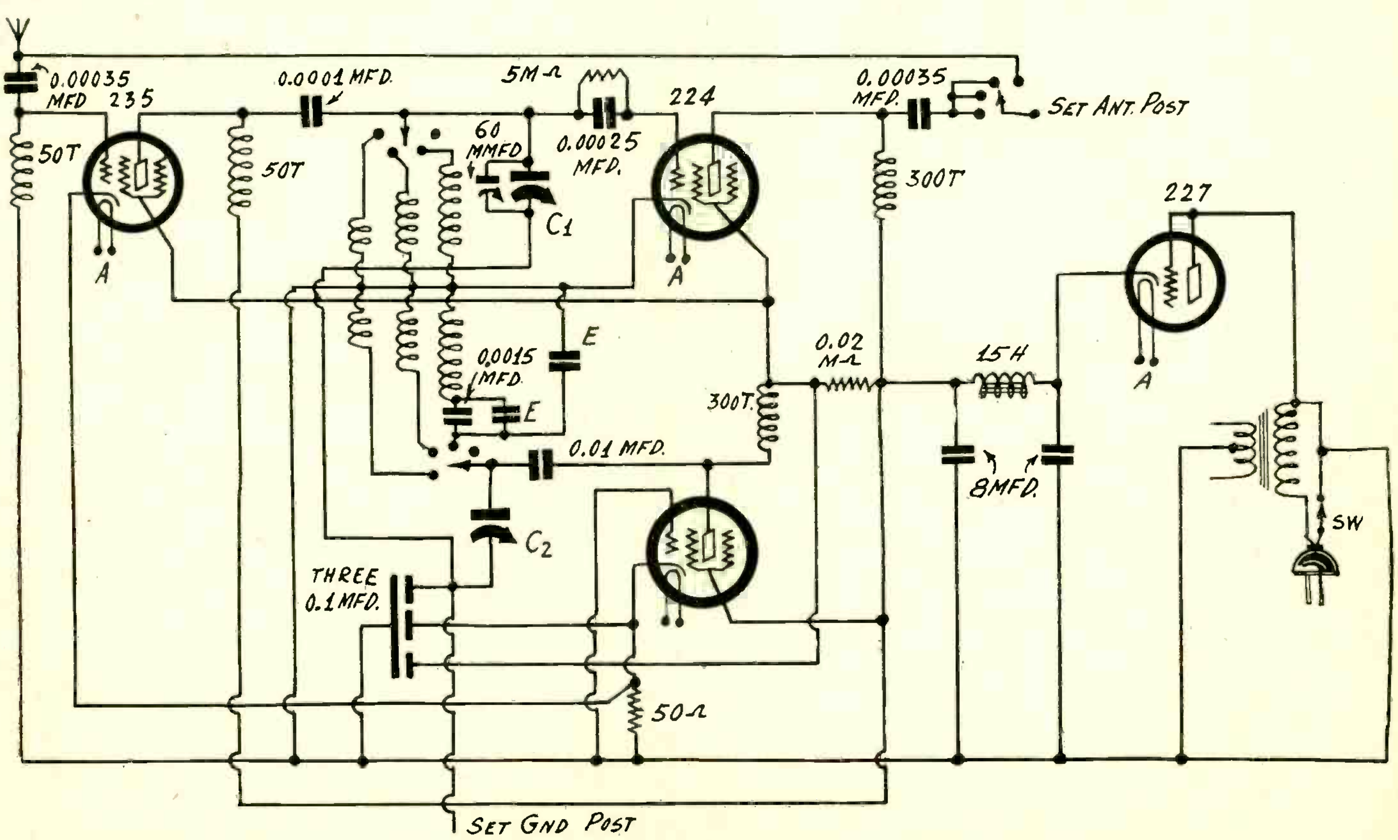


FIG. 2
A stage of untuned r-f is included in this converter, which uses a two gang condenser for tuning, therefore resort is had to padding, which consists of rearrangement of the oscillator tuned circuit, to reduce the capacity of the tuning condenser and the inductance of the coil it tunes, enabling the same frequency difference between simultaneously tuned circuits.

Tracked for Short Waves

at One End and 1,800 kc at the Other

finish. So theoretically the converter would bring in only one station, assuming gang tuning.

While the case has been cited for a medium short wave band, it can be seen that for lower frequencies (higher waves) the intermediate frequency will be a greater percentage of the modulator or oscillator frequencies, and the problem becomes one of major proportions.

Assume tuning in a 2,000 kc carrier frequency (149.9 meters). The oscillator would be tuned to 1,500 kc higher, or 3,500 kc (85.66 meters). The intermediate frequency is three-sevenths of the oscillator frequency. Take 1,600 kc (187.4 meters) as the one desired to be received. Here the oscillator frequency is practically twice the intermediate frequency. So at one extreme the condenser-coil combination must tune to a frequency twice that of the intermediate frequency, but at the other extreme the wave would be 8,060 kc (37.20) meters) for the oscillator, while the modulator would be at 4,100 kc (73.13 meters), a difference of 3,960 kc.

Capacity Solutions

There are, of course, solutions for this difficulty. One method is that of padding, where a fixed series condenser is used in the oscillator circuit, with equalizer across it or across the entire series circuit, so that with less capacity, and coincidental inductance reduction, the two circuits are made to tune at the same point. Then a point at the opposite extreme is made similarly identical. Adjustment of the series capacity, and of the equalizing capacity, enable the establishment of the two points. In between the tuning may not track, and probably won't, but it comes close enough, and a small manual trimmer always will take up the difference. In broadcast set superheterodynes padding is frequently used, but without the manual trimmer, as it isn't vital there. To the same effect, for single band coverage, the oscillator condenser plates may be specially cut to track.

Another method, that shown in Fig. 1, is to use a condenser of twice the maximum capacity of the oscillator circuit for the first band of tuning (highest waves), but equal capacities for the next two bands. Thus the modulator tuning range is lifted from 2.6 frequency ratio to 3.5 for 0.0007 mfd., or if a three gang condenser of 0.00046 mfd. capacity per section is used, the frequency ratio for the oscillator tuned with 0.00092 mfd. would be about 4, whereupon the modulator would tune from 1,500 kc to 6,000 kc, while the oscillator tuned from 3,000 kc to 7,800 kc. It is obvious that at the start the frequencies are 1,500 kc apart, as they should be, while at the end they are 1,800 kc apart, a remarkable proximity, so even a tiny trimming condenser, e.g., 30 mmfd., would compensate for the difference, or the two ends might be tied down, as previously outlined, by inductance and capacity adjustment, and coincidence would be prevalent virtually throughout the entire band.

Higher Frequencies Simplify Problem

In the next band the old trouble would arise, because the condensers are equal, although they may be compensated by padding, or the difference may be left to the manual trimmer. Starting at 6,000 kc, we would wind up at 15,600 kc for the modulator. Starting at 7,500 kc we would wind up at 19,500 kc, a difference at one end of 1,500 kc and at the other of 3,900 kc. But the 3,900 kc difference is only 20 per cent. of the incoming carrier frequency of 19,500 and a manual trimmer of 60 mmfd. would take this up nicely.

In brief, therefore, the problem of dissimilar frequencies becomes less and less as the original carrier frequency increases, because then the percentage of difference between the intermediate and the carrier frequencies becomes less. This is true because the intermediate frequency, whatever it is, remains fixed, say 1,500 kc, while the other frequencies increase.

It is assumed, however, that the set itself will be worked at a high broadcast frequency. If a lower intermediate frequency is used the problem becomes easier, because the difference is smaller, but the sensitivity may be less, due to the characteristic of the receiver.

How Two Circuits Are Coupled

For Fig. 1, therefore, a three grang condenser may be used. If the capacity is 0.00046 mfd. it will be possible to cover from 20 to 200 meters, while if the capacity is 0.0005 mfd., the upper wavelength limit being retained, the lower limit will be decreased, say, to 15 meters. This is with a three-way system for each tuned circuit. Provision of an extra coil would make the frequency span larger.

The coils, L1, L4, and L3, L5, and L3, L6 are in inductive relationship to each other, to provide coupling between modulator and oscillator. However, the total coils are not coupled to one another. Different distances must prevail. The higher the frequencies, the wider the physical separation between the twin windings, because the mutual impedance is directly proportional to frequency.

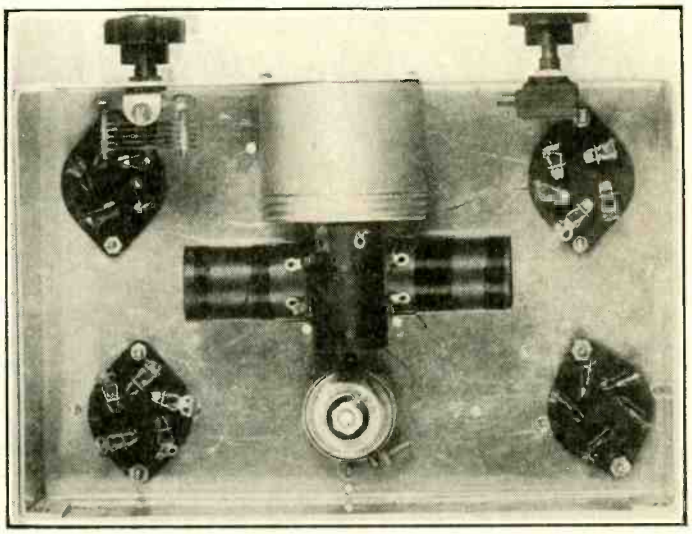


FIG. 2A

Suggestion for mounting the coils. The center coil is fastened to the bottom of the shield can that encloses the switch. Then the two other coils are fitted into predrilled holes. The center coil may be the one for highest frequencies. This layout is for Fig. 2.

The switch used is of the three deck, four point type, and is a rotary selector switch with shaft insulated from all electrical connections. Provision is made for switching the antenna to the broadcast set when you want to use the set alone, and not use the converter. However, when that switching is done (position 4), you should turn the tuning condensers, including trimmer, to minimum capacity, as these are in series with the 0.00035 mfd. fixed antenna condenser, the total series being across the antenna winding of the broadcast set. This, however, has next to no effect on the broadcast set, as the capacity will be less than 50 mmmfd.

Insulation Pointers

If a metal chassis is used, the frame is B minus, but is not conductively coupled to ground, so the ground binding post would have to be insulated. A fixed condenser—a section of a block of three capacities—grounds the chassis that way. However, the tuning condenser may be connected with rotor to the set ground post, if desired, as diagrammed, in which case the condenser, like the post, would have to be insulated from the chassis. It is permissible, however, to have the condenser rotor at B minus rather than at direct ground potential.

The filter capacities, 8 mfd. or more each, may be two in one case, and since that leaves a high voltage terminal at top, the condenser may be enclosed in a tube shield and a bakelite disc placed between the cap of the condenser and the top hole in the tube shield. Also, a symmetrical layout results, as the photograph reveals,.

The circuit is printed particularly to show the use of a three gang condenser to advantage in a short wave converter, while the subject of coils and separation between windings for proper coupling is outside the scope of this article.

A somewhat similar type of converter, except that it uses a double instead of a triple condenser, and has a padding arrangement, is diagrammed in Fig. 2. A fixed condenser of 0.0015 mfd., across which is a 20-100 mmfd., adjustable equalizer, to be set once and left thus, constitutes the series condenser section. In reality, a fixed and an adjustable condenser are in parallel,, while the total is in series with the tuned circuit. Then another equalizer is used across the entirety. Sometimes the total equalizer, instead of being across the inductance and the series capacity, is simply across the inductance, as in Fig. 3, but this is not a vast or vital difference.

(*Continued on next page*)

T-R-F Prophesied for

Some Means Necessary to Provide

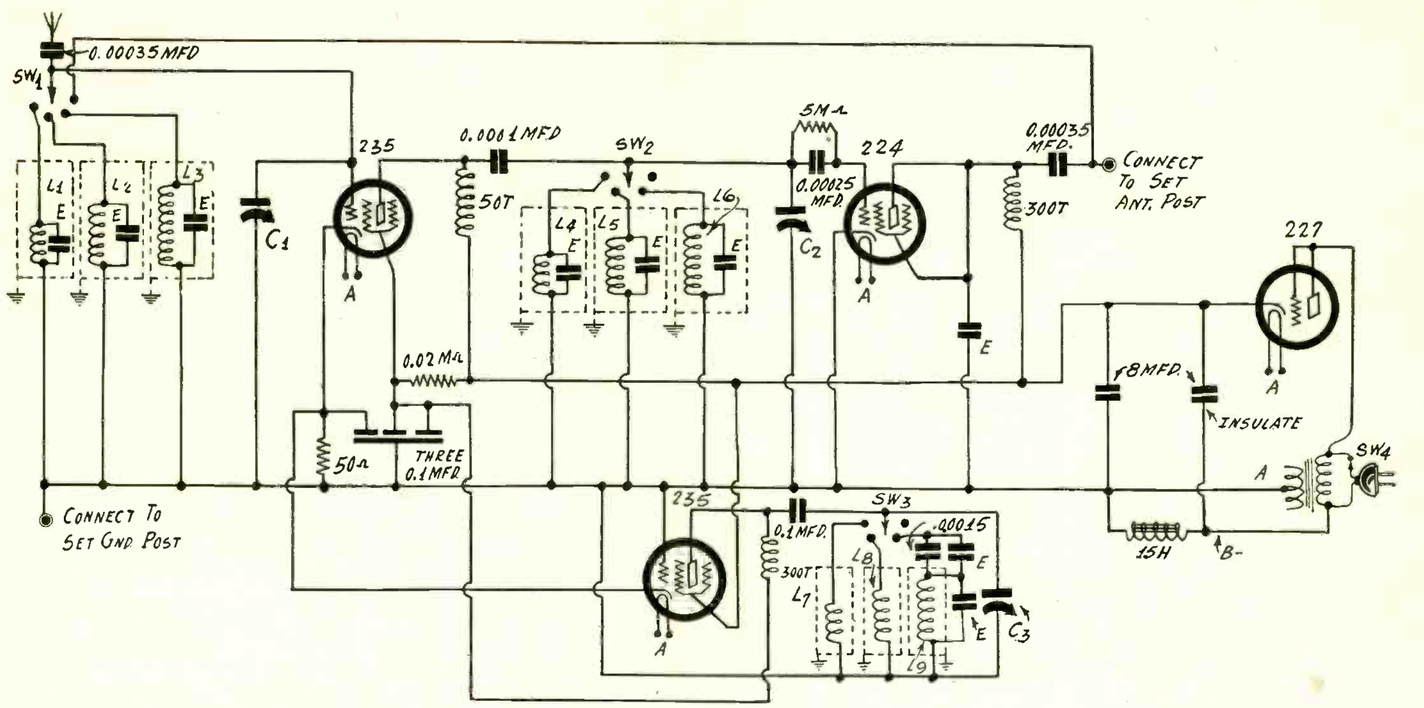


FIG. 3
This circuit shows the use of tuned radio frequency amplification in connection with a short wave converter. This subject has not been developed as yet. The modulator and oscillator coils, though not shown as related, are inductively coupled, each pair on a single form, as explained in the text.

(*Continued from preceding page*)

The padding arrangement will be found in the oscillator circuit, lower tube, Fig. 2. This diagram, as well as the two others, incorporates a dynatron oscillator (235), so grounding of the grid is proper. The oscillation arises from the negative resistance effectuated in the tube circuit when the normal screen and plate voltages are reversed. Here the plate voltage for the dynatron is the screen voltage for two other tubes, and the resistance value, shown as 0.02 meg. (20,000 ohms) is chosen of such a value as to insure oscillation, the voltage then being satisfactory also for the two other tubes. The modulator tube here is a screen grid tube used as such, while in Fig. 1 it was used as a two element tube, with screen and plate tied together. It is suggested that both methods be tried. Both work extremely well, but some will get larger output from the three element hookup.

All three circuits use the 227 as rectifier, the output is direct current voltage, after the choke (assuming 400 ohms the d-c voltage of the line. So for 110 volts a-c you will get d-c resistance for the choke), being about the same as the value of 110 volts d-c after the choke, and this voltage is ample to provide satisfactory operation. However, to attain this voltage it is necessary that the condenser next to the rectifier be 8 mfd., although higher capacity may be used.

The higher capacity is all right here, because this is a heater type tube, and the current rises slowly, so there is no high starting drain on the rectifier. In fact, if a milliammeter is put in series with the rectifier line, at B plus or B minus, it will disclose the gradual rise of the current, without any great spurt.

Current Stated

The current's rise will reach a peak value and then recede a little. For instance, starting at zero, it will rise to about 18 milliamperes and then recede to about 15 milliamperes for the four tube circuit. This will be the current drawn by the r-f tube, the modulator and the oscillator. The modulator normally will draw a little more than either of the others, because the plate voltage is the same, but the bias is zero. The two other tubes have a negative bias, which may be around 1 volt. The figures cited show that the bias will be a trifle less than 1 volt, but this is a good region for sensitivity in conjunction with the tubes used, and in view of the plate voltage.

Next we come to Fig. 3, embodying some of the features of Figs. 1 and 2, but being different from them principally in that a stage of tuned radio frequency amplification is included. A three gang condenser makes resort to padding necessary, as there are three separately tuned circuits, and each requires a condenser sction. However, the thought will strike many that the system outlined in connection with Fig. 1, of cutting in an extra section for the lowest frequency band, is applicable here if a four gang condenser is used.

No connection or relationship between oscillator and modulator is shown regarding Fig. 3, but the same inductive situation obtains here, between the twin windings of oscillator and modulator, as in Figs. 2 and 3. The following pairs are wound on a single form and separated from each other by suitable distance: L4, L7; L5, L8; L6, L9.

B Choke in Negative Leg

The grounding is different in this circuit, for the B supply choke coil is put in the negative leg of the rectifier. This means that B minus is not at ground potential but the other end of the choke coil is. The reason for previous precautions was to avoid shorting the a-c line. Here no such short can result, because if the plug is inserted in the wall socket in one direction ground and the high radio frequency side of the line are unmolested, whereas if the plug is inserted the other way the choke is across the line. But the choke has at least as high an impedance as has the primary of the filament transformer, so it is all right to have the choke across the line. The connection when it is not across the line usually gives more (louder signals).

So six forms will be needed to provide the coils for this circuit. Three will take care of the tuned radio frequency input. Three more forms will take care of the inducit inductively related tuned windings for the three frequency ranges.

Dissimilar Trimmers

The tuning of the r-f stage and the modulator introduces no special frequency problem. The fact must be recognized that the modulator stage will have a higher input capacity even than the antenna stage, especially as a condenser of 0.00035 mfd. or thereabouts is introduced in the antenna circuit. However, if equalizers are put across each of the coils that handle the original frequency level, each condenser may be set for best results and left thus, no manual trimmer then being necessary. As the equalizers are included in the diagram, the manual trimmer is omitted. A good plan would be to use smaller trimmers for the modulator coils than for the r-f

Converters of Future

Results Even on Insensitive Receivers

coil stage, that is, 35 mmfd. for the modulator and 100 mmfd. for the other. Then the minima will be about 7 mmfd. for the one equalizer and 20 mmfd. for the other.

In line with what has been said before, it is prophesied there will emerge from the laboratories converters that include a stage of tuned radio frequency amplification. There is no reason why it should not be done, as the frequency is on the same level for both circuits, and the feedback effects can be prevented by proper treatment, including scientific positioning of the coils so that the inductive coupling is held in check. It is possible to reduce the inductive coupling virtually to zero. Then, for the oscillator, no difference or other problems arise than those applicable to converters that have either an untuned r-f stage or no preliminary r-f stage at all.

It should be borne in mind, however, that the systems now in vogue—no t-r-f and untuned t-r-f stage—highly satisfactory results are obtainable, the only drawback being that the sets of ancient vintage or poor sensitivity, of which there is quite a crop, will not enable easy reception of foreign stations.

Sensitivity of Set

Some converter manufacturers stress the recommendation therefore that the set used with their converter have a sensitivity attained in tuned radio frequency sets with two stages of t-r-f and grid leak detector, or, if the primaries in plate circuits are of screen grid tubes are large, with a negative bias or power detector. But there are many thousands of sets in use that have a sensitivity of 40 microvolts per meter, or less sensitivity, and with them it is not to be expected that short wave converters will work well.

Another factor in favor of the extra stage of tuned r-f is that with some superheterodynes the double mixing process involved—one in the converter, the other in the broadcast set—put the sensitivity back farther than it should be, so. while results are good, they are not nearly what the possessor of the super expects. The t-r-f stage will help these matters along well.

Built-in Intermediate Stage

It is practical to use, instead of a t-r-f stage, a stage of built-in intermediate amplification, to which there is no objection, save that if no means are provided for selection of the intermediate frequency, the set will have to follow the frequency built into the converter, and that limits the operation of the set to a particular region, which may not be encompassed by the frequencies to which the set is most sensitive. A way out is to make the built-in intermediate stage rather broad, so any frequency from 1,500 kc to 900 kc may be used, or 900 kc may be used, or 900 kc may be the broad intermediate frequency, permitting the use from, say, 1,300 kc to 800 kc. But the more broadly the circuit is peaked, the less advantageous is the built-in intermediate stage, from the viewpoint of selectivity.

As has been stated, there is still much to be learned about converters, and particularly by manufacturers who now are bringing out their first models. While the difference will be less, it is still worth while to consider the first set a manufacturer turned out, compared to his present model. The difference in performance will be found to be remarkable. Also, the difference in performance between the present crop of converters made by set manufacturers is likely to be remarkable,, compared to what they will be producing two years hence, even assuming no new tubes will come out.

Not Here to Stay

When converters become more elaborate, as they will, the 280 rectifier may be universally included, as it will help out on the t-r-f stage with a voltage of 180 to 200 volts for the 235 there positioned.

Many believe that converters are not here to stay, because sets will be all wave in the future, but consideration must be given to sets now in use, or about to be purchased, that otherwise provide no short wave reception. If the disappearance of the set from the home will take place two or three years, not more, after the purchase of the set (assuming it was bought new), then there may be something to the surmise about converter's life being short, but if the unique sets in persons' homes to-day can be taken as a criterion of how long new sets bought to-day will be retained, then it is safe to assume that five years hence there will still be something doing regarding short wave converters. It depends probably on how much prosperity visits the world in those five years, for so soon as people have plenty of money it is noticed that the latest and best in radio is none too good for them.

Examples of Voltage Divider Design

"HOW shall I proceed in the selection of suitable values for given voltages in a voltage divider? What is the rule of apportionment?"

When a question of this type is asked not only should the voltage distribution be given but also the currents to the various taps. When the current distribution is not known, which is the case in most instances, then the circuit to be served should accompany the question, that is, a diagram of the circuit complete, including all the tubes that are to be used. If the circuit and the tubes are known, then it is possible to make a close estimate of the currents to the various taps and make a computation of resistances that will be accurate enough for practical purposes.

When resistance coupling is used anywhere in the circuit, the values of the plate coupling resistance should be given because resistances will change the plate current. The plate current in a 235 pentode may be 6 milliamperes when there is practically no resistance in the plate circuit, but it will be far less when there is a quarter megohm resistance in the plate circuit. Also, when there is a high resistance in the plate circuit the screen voltage must be less and the screen current to such as tube is so small that it can usually be neglected in determining the resistance values in the voltage divider

A True Potential Divider

When it is only a question of getting potentials it is simple to place the taps to give the desired voltages, for then no current is supposed to be drawn at the taps. When this is the case the same current flows in every section of the resistance of the potential divider. Then the voltage between any two points is proportional to the resistance between those taps. For example, suppose that it is required to put taps so as to get potentials of 45, 75, 180, 250 volts when the total available voltage is 300 volts. We are at liberty to choose any total resistance, and therefore any current.

Suppose we choose 25,000 ohms and put it across the 300 volts. The current will then be 12 milliamperes. Since no current is drawn at any tap, the same current flows throughout the 25,000 ohms. Therefore the resistance between zero and the 45 volt tap should be 45/.012, or 3,750 ohms. The resistance between the 45 and the 75 volt taps should be 30/.012, or 2,500 ohms, that between the 75 and 180 volt tap should be 105/.012, or 8,750 ohms, that between the 180 and 250 volt taps should be 70/.012, or 5,830 ohms. This leaves 4,170 ohms to drop the voltage between 300 and 250, which checks fairly well.

This simple computation holds only when there is no current diverted at any of the taps. Hence it never holds when the device is used to power a receiver. It holds only in certain cases of measurements when voltages are balanced. That is, it holds in true potentiometers. A similar arrangement would hold when the taps are used solely for supplying grid bias voltages, for the grids do not draw any current, or at least never enough to upset the voltage division materially.

Grid Bias Supply

We might illustrate the use of the potentiometer for grid bias supply. Suppose we have a resistance of 10,000 ohms through which a d-c current of 5 milliamperes flows, that is, so that the total drop is 50 volts. This might be used to bias a 245 power tube, or any number of tubes of this type. But let it also be required to furnish voltages of 16.5, 13.5, and 1.5 volts. Where should the taps be placed. The current in every section the current is 5 milliamperes. Between the positive end of the resistance and the 1.5 volt tap there should be a resistance of 1.5/.005, or 300 ohms. Between the 1.5 and 4.5 volt taps there should be a resistance of 3/.005, or 600 ohms. Between the 4.5 and 13.5 volt taps the resistance should be 9/.005, or 1,800 ohms, and between the 13.5 and 16.5 volt taps it should be 3/.005, or 600 ohms. We have 6,700 ohms left, which should be the resistance between the 16.5 volt tap and the negative end. This checks for the voltage drop is 33.5 and the current is 5 milliamperes. This kind of grid bias supply is not recommended because of the coupling among the circuits which will cause, often very harmful.

Curves on the

Pentode Distortionless Power Amplifier,

By J. E.

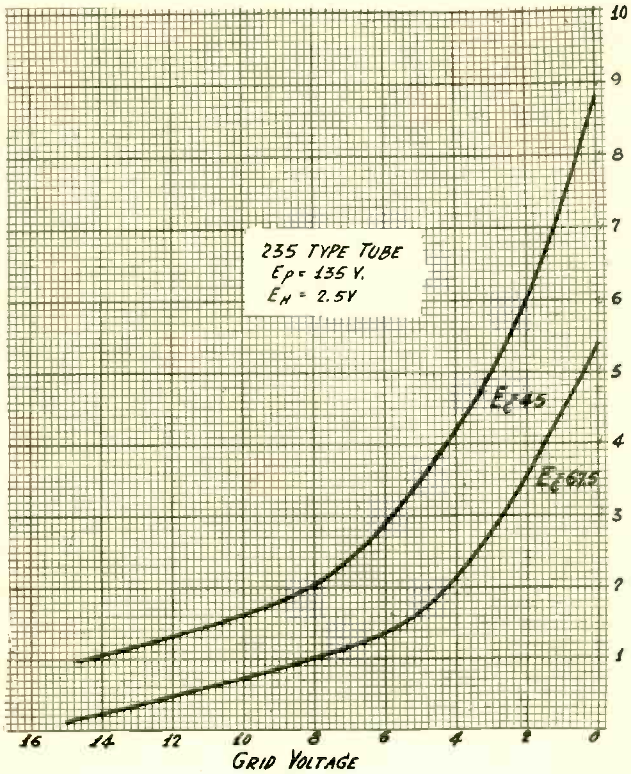


FIG. 1

Two grid voltage plate current curves of the 235 variable mu screen grid tube, showing the gradual variation in the mutual conductance and the effect of changing the screen voltage.

THE variable mu screen grid tube was designed primarily as a radio frequency amplifier. As such it is excellent. But it was also designed to that it could be used in conjunction with grid bias variation volume controls without resulting modulation. This, perhaps, is its principal virtue. The bias voltage may be varied over a range of about 75 volts without completely cutting off the plate current on the higher bias values. As the bias is increased the mu of the tube, or the mutual conductance, is decreased gradually.

The gradual taper of the plate current as the bias is increased is shown in the curves in Fig. 1. Both these curves were taken on a 235 type tube with 2.5 volts on the heater and 135 volts on the plate. For the upper curve the screen voltage was 45 volts and for the lower it was 67.5 volts. The curve for 180 volts on the plate and 75 volts on the screen is practically the same as the upper curve in this figure.

High Mutual Conductance

The variation in the mutual conductance can be seen clearly by computing it for a number of values. Suppose we make the grid bias 0.5 volt. Let the signal vary from zero to one volt. At zero bias, on the upper curve in Fig. 1, the current is 8.8 milliamperes. At one volt bias it is 7.3 milliamperes. Hence a change of one volt on the grid changes the plate current 1.5 milliamperes. This means that the mutual conductance is 1,500 micromhos. Now take the operating point at 1.5 volts and let the signal vary over one volt as before. At one volt bias the current is 7.3 and at 2 volts it is 6.05 milliamperes. Hence at this bias one volt changes the plate current 1.25 milliamperes, and the mutual conductance has dropped to 1,250 micromhos.

Now suppose we put the operating point at 6 volts. At 5.5 volts the current is 3.22 and at 6.5 volts it is 2.83 milliamperes. Therefore the change in the current is 0.59 milliamperes for a change of one volt in the bias. The mutual conductance, therefore, has dropped to 590 micromhos.

Even if the bias is made as high as 12 volts there is still some plate current and some amplification, but the mutual conductance has dropped to a very low value. The change is so small that it is necessary to take a greater voltage change. This does not introduce any appreciable error, for the curve is nearly a straight line. At 10 volts the current is 1.63 and at 14 volts it is 1.05 milliamperes. Hence four volts will change the plate current 0.58 milliampere, and one volt will change it 0.145 milliampere. Hence the mutual conductance has dropped to 145 micromhos, which is less than one-tenth of the mutual conductance at the beginning. As the bias is increased still further the mutual conductance goes down still more. It should be kept in mind that the mutual conductance is a measure of the amplification.

Similarity of Curves

The lower curve in Fig. 1 is essentially the same as the upper, except that it has been displaced to the right. The mutual conductance for a given grid bias is less on the lower curve than on the upper. Thus at 0.5 volts on the lower curve the mutual conductance is only about 860 micromhos. The displacement of the lower curve is 2.6 volts to the right, and if this is allowed for the mutual conductance, is almost the same on the two curves. For example, we just found it to be 860 micromhos at 0.5 volts on the lower curve. The corresponding point on the upper curve is 3.1 volts, at which point the mutual conductance is about 880 micromhos.

Cross modulation is caused by the curvature of the grid voltage plate current characteristic. The variable mu tube was designed to avoid this, and it accomplishes the purpose very well. It will be noticed that at no point is the curve bent sharply. It particularly straightens out as the bias becomes high, so that the volume may be decreased by increasing the bias without danger of introducing serious cross modulation.

From the curves in Fig. 1 we can determine the approximate value of the grid bias resistor to be used for volume control purposes. Since the screen current also flows through the bias resistance we must make allowance for this. This current is about 1/3 as great as the plate current.

Bias Resistance Computation

Suppose we want to operate the tube with a bias of 1.5 volts, with 45 volts on the screen and 135 volts on the plate. At 1.5 volts the plate current is 6.6 milliamperes. We add one-third of this to get the total current through the grid bias resistance and get 8.8 milliamperes. Therefore the required resistance is 1.5/0.0088, or 170 ohms. If we wish to make the bias three volts it is necessary to make the bias resistance considerably higher. At three volts the current is 5 milliamperes, to which must be added the screen current 5/3. The total current is therefore 20/3 milliamperes. Hence the required resistance is 3,000 divided by 20/3, or it is 450 ohms.

Again, suppose we wish to make the bias 12 volts. The current is 1.3 milliamperes plus 1/3 of this, or a total of 5.2/3 milliamperes. The necessary bias resistance is therefore nearly 7,000 ohms. We could well use a variable bias resistance of 10,000 ohms for the purpose of controlling the volume.

In case there are two equal tubes on the same resistance, and if both tubes are operated under identical conditions, the bias resistance should be only one-half as large as when it is used for a single tube.

Tubes Not Critical

The two curves show that either 45 or 67.5 volts can be used on the screen when the plate voltage is 135 volts. Of course, any voltage in between can also be used. And the two values are not limiting values by any means. Thus the tube is not critical as to voltages. This applies equally well to cases where the plate voltage is higher than 135 volts. But it is well to increase the screen voltage in proportion to the plate voltage in order to prevent a too heavy plate current.

When the screen grid tube is used in resistance coupled circuits it is the effective plate voltage that counts and not the applied, because most of the applied voltage is dropped in the plate coupling resistance. Since the effective plate voltage is very low it is necessary to lower the screen voltage in proportion. If this is not done there will be much wave form distortion. Of course, it is perfectly safe to increase

247 and the 235

Variable Mu an Exponential Tube

Anderson

the applied plate voltage since the high resistance limits the current. While the maximum may be 180 volts in a radio frequency amplifier it may be as high as 500 volts if the plate load resistance is 250,000 ohms. When the applied plate voltage is so high the effective plate voltage is proportionately higher and it is not necessary to reduce the screen volt as much, if at all. It is recommended that the applied plate voltage in series with a 250,000 ohm resistance to the highest voltage available in the circuit, which is usually that required by the power tube.

The Power Pentode

Not many characteristic curves are available for the 247 power pentode, and for that reason we are giving a couple for plate and screen voltages of 112.5 and 135 volts in Fig. 2. The current is that in the plate circuit alone.

These voltages are considerably lower than the voltages normally used on this tube, the maximum recommended voltage being 250 volts on both the plate and the screen. But the curves for higher voltages are similar and it is accurate enough to assume that the increase between 135 and any higher voltage is proportional to the difference between the two curves given. For example, at a bias of 9 volts the plate current for the 112.5 volt curve is 7.7 and for the 135 volt curve it is 12.6 milliamperes. Thus a change in the plate-screen voltage of 22.5 volts causes a change of 4.9 milliamperes in the plate current. If we were to apply 250 volts on the screen and plate we would have a voltage increase of 115 volts and by direct proportion we have 4.9:22.5::X:115, in which X is the change in the plate current due to the 115 volts. Solving the proportion we get X = 25 milliamperes. Therefore the total plate current at 9 volts bias with 250 volts on the plate and the screen would be 37.6 milliamperes.

About what would the plate current be at 16.5 volts on the grid with 250 volts on the plate and the screen? It will be noted that the curves are nearly straight so that we may use direct proportion again. The 135 volt curve drops from 12.6 milliamperes at 9 volts to about 1 milliampere at 16.5 volts. The current on the 250 volt curve would drop about the same amount. Hence the plate current for 16.5 volts on the grid and 250 volts on the screen and the plate would be 37.6 less 11.6 plus 1 milliampere. That is, it would be 27 milliamperes. This is 5 milliamperes less than the normal value for the average tube.

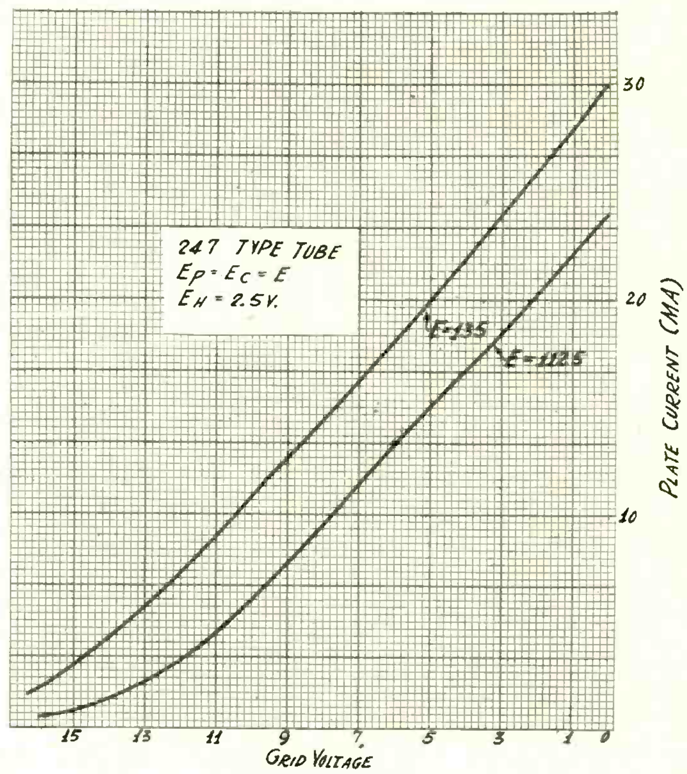


FIG. 2

Two grid voltage plate current curves of the 247 pentode with voltages of 135 and 112.5 volts on the plate and the screen. The curves are remarkably straight, indicating low wave form distortion.

Curves Are Straight

It is usually said that the characteristic curves of the pentode depart considerably from rectilinearity. These two curves do not bear this out for they are more nearly straight than curves for three element tubes. The upper curve in Fig. 2 is particularly straight. This means that there will be comparatively little distortion of the wave form.

The optimum bias for the 135 volt curve is 7.5 to 8 volts. Suppose we make it 7.5 volts. The plate current is then 15.3 milliamperes at zero input and if the signal swings 7.5 volts in either direction the plate current fluctuates between 30 and 3 milliamperes. This will insure an output power in an 8,000 ohm load of 730 milliwatts. Thus a fairly good output power will be obtained with even as low a plate and screen voltage as 135 volts. And there will be remarkably little wave form distortion.

The screen current in the pentode is about 0.234 of the plate current so that the total current through the bias resistance in the case when the screen and the plate voltage is 135 and the bias is 7.5 volts would be 15.3x1.234. We just found that the plate current was 15.3 milliamperes. Hence the bias resistance necessary would be 7.5 volts divided by 15.3x1.234, or 7.5/18.9, or 495 ohms. Remember that the current is given in milliamperes and that we really should divide 7,500 millivolts by 18.9 milliamperes to get the resistance in ohms.

Little Variation in Bias Resistance

When the plate and screen voltage is 250 volts the grid bias should be 16.5 volts and the sum of the plate and the screen currents is 39.5 milliamperes. Hence in this case the grid bias resistance should be 16,500/39.5, or 417.5 ohms. Thus there is practically no change in the bias resistance. We may, therefore, change the plate and the screen voltage without making any change in the grid bias resistance with the assurance that the bias is correct for the new voltage. This is very convenient.

Let us try this on the 112.5 volt curve also. The curve is straight to about 12 volts. Hence let us make the bias 6 volts. At this bias the current is 13.3 milliamperes. The total screen and plate current would be 16.4 milliamperes. Hence the bias resistance would be 6,000/16.4, or 366 ohms. There is not enough change in the bias resistance to make it worth while changing. We might say that 400 ohms is the proper bias resistance for the 247 pentode in all practical cases.

Mutual Conductance of Pentode

The mutual conductance of any tube should be taken at the operating point. If we take it at 7.5 volts on the upper curve in Fig. 2 we note that at 7 volts the plate current is 16.2 milliamperes and at 8 volts it is 14.3 milliamperes. Thus one volt changes the current by 1.9 milliamperes and the mutual conductance is 1,900 micromhos. But we really should take the average value over the entire operating voltage, that is, from zero to 15 milliamperes. At 15 volts bias the current is 3 milliamperes and at zero it is 30. Hence 15 volts changes the current 27 milliamperes and the mutual conductance is 1,800 micromhos. This is only slightly less than that at the operating point. This again shows there is little distortion.

If we take the lower curve we have 25 milliamperes at zero bias and at 12 it is 3 milliamperes. Hence 12 volts changes the current 21 milliamperes and the average mutual conductance is 1,750 micromhos. This is almost the same as that for the 135 volt curve.

In the 235 the variation in the mutual inductance was one of the main advantages in the tube. In the pentode there should be no variation. There seems to be a discrepancy here in that in one case, the 235, distortion is avoided by making the mutual conductance vary gradually as the bias varies while in the other, the 247 pentode, it is avoided by making the mutual conductance constant. But there is essentially no difference. The 235 tube is never operated over the entire curve but only

(*Continued on next page*)

Regeneration in Single

Reasons for B Choke in the Negative Leg

By Herman

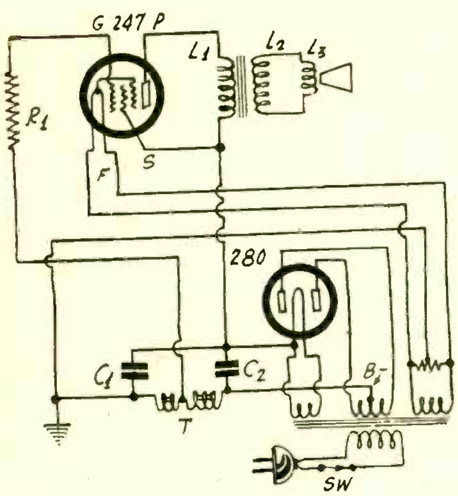


FIG. 1

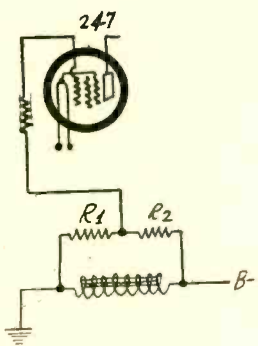


FIG. 2

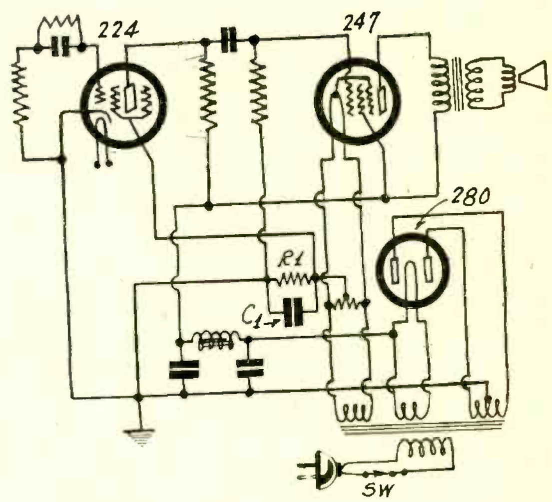


FIG. 3

The circuit of a pentode with rectifier, the B choke in the negative leg, is shown at left. A tapped coil is used. The outer drawing shows how to gain the same effect without a tapped choke. On right the choke is in the positive leg, while the pentode bias voltag is used for the detector screen voltage, reversed.

[*An entirely new aspect of resistance coupled audio, applicable also to other systems, is presented by the author in the series of articles on regenerated audio amplification, of which the following is the third. Feedback is used instead of bypass condensers, so that a tiny resistor or a special connection dispenses with some hundreds of microfarads of capacity otherwise necessary for the same result. The three stage resistance coupled amplifier was described last week, issue of October 10th, while next week the two stage system (224 and 247) will be disclosed. Both of these circuits are the author's inventions. Their performance is of the highest order.*—EDITOR.]

THE use of single stage audio is quite common in receivers, due to the advent of the pentode, combined also with the economy requirements of midgets, and fortunately the system works out very well.

Resistance coupling is used. The introduction of this type of audio into commercial receivers for the first time as an exclusive method should certainly set at rest any fears entertained earlier. About as far as the manufacturers had gone previously was to use one stage of resistance coupling and a push-pull second stage, with a transformer. However, interest is focusing on resistance, and the situation is looming in a new light that sets aside earlier considerations, and marks an exceptional progress.

New Light

The case is much like that of electricity itself, or of the ether. In the beginning, lacking full knowledge, we invent theories to fit the performance. With electricity it seemed, at first, that when voltage was introduced that, on account of resultant current, there must be a flow of electricity. A fluid is a thing that flows, so electricity was described as a fluid. Only a quarter of a century ago this was taught in the public schools. Today we know well that electricity is not a fluid, but that there is an orbital activity, like the satellites about Jupiter, as well as a mass drift of electrons.

The luminiferous ether as conceived by Maxwell served its valuable purpose as a handy model in the days when science had to have models, even if it invented fictions to serve as models. but today we unite electro-magnetism and gravitation in the field theory, as originated by Einstein, and if we still adhere to an ether we leave out the luminiferous part because we treat light no differently than radio waves, but know both to be wave motion of merely different frequencies.

So with resistance coupling. At first it was deemed of little account. The amplification could not amount to much, being confined to the amplification factor of the tube. We had tubes with a mu factor of 8 and there was no comparison with the step-up gained by transformation. Special purpose tubes came along, and with them new troubles. The circuit motor-boated.

It should have become quite obvious then that regeneration was taking place, and some articles along this line were published, but it remained until recently for the capitalization of this regeneration to be effected. If the regeneration could be capitalized, or, if not present, could be introduced, so as to be effective on circuits that were degenerative, not only could bypass condensers be omitted from biasing resistors, but stability could be achieved and fine tone result. Tube mu could be ignored because of regeneration. Such a circuit was discussed in detail last week, in the October 10th issue. The audio amplifier had three stages of resistance coupling, two 227's with a 247 as output.

Even the single stage audio amplifier may be regenerative. There is some feedback naturally present in the circuit diagrammed in Fig. 1. Fig. 2 is simply a variant. Fig. 3 shows purposely introduced feedback not otherwise present. Let us investigate these circuits.

Connections for Fig. 1

In Fig. 1 the output circuit of a 247 is diagrammed, with rectifier and filter. R1 is the grid leak of the pentode tube, which may be 0.5 meg. under the circumstances. G is the control grid, P is the plate, F is the filament to which a screen is attached inside

Analysis of the 247 Pen

(*Continued from preceding page*)

over a very small region about the operating point. In this region there should be as little change in the curvature as possible. The power tube is operated most of the time over the entire characteristic, and in this region there should be as little change in the curvature as possible.

In the radio frequency amplifier curvature of the grid voltage, plate current curve causes detection and, when there are two or more signals impressed, it causes cross modulation. Both effects are the same. In the detector, of course, it is the curvature that is of most importance. We want as much distortion of the radio frequency wave form as possible, although we do not want any distortion in the audio wave form. In the audio amplifier, whether it be an intermediate stage or the final stage, curvature causes wave form distortion in the signal and this distortion appears as harmonics.

The variable mu tube is not suitable for audio frequency amplification of very large voltages because it would induce a very high percentage harmonics. It could, however, be used advantageously to amplify weak signal voltages, that is, such voltage which would not call into play more than a very small

Stage Audio Amplifiers

of Rectifier—Resistance Audio's Advance

Bernard

the tube, while S is the externally connected screen or suppressor grid (K of socket) that kills off the secondary emission and permits the high mu of the tube, the most sensitive output tube we have. L1 is the primary of an output transformer, L2 is the secondary to match the impedance of the voice coil L3 of the dynamic speaker, while the triangular figure represents the cone itself.

The B supply choke coil is also the field coil of the dynamic speaker, although this identity is not shown on the diagram, as it need not necessarily exist. The field coil has a tap T, and is placed in the negative leg of the rectifier circuit. B minus is designated and is the most negative point of the circuit. The voltages toward ground are of the rising or positive order.

All the B current for the set flows through the choke coil, but in the majority of cases this will be principally the B current to the pentode. Say the total is 60 milliamperes, a fair average for five tube midgets (including rectifier among the tubes).

Why in the Negative Leg?

If the d-c resistance from T to ground is 300 ohms, the bias for the pentode will be 18 volts negative, which is satisfactory. The recommendation usually is 16.5 volts negative bias for 250 volts applied, an apportionment of a total of 266.5 volts. Many midgets have a total of 250 volts available, so the bias may be less than 16.5 volts, say 14 volts, leaving 236 volts for the plate.

The d-c resistance of the field coil from T to B minus is usually high, a common value being 1,500 ohms, making the field coil a device of 1,800 ohms resistance tapped at 300 ohms.

The question will arise, Why is the choke coil put in the negative leg?

One reason is that an extra resistor for biasing is dispensed with, another is that the filament may be directly grounded, since ground is positive in respect to any other point on the choke, and another is that some audio regeneration is introduced, so that a large bypass condenser across the biasing section (300 ohms) is unnecessary. The case becomes one similar to that found in push-pull circuits, for the signal current variations in the B current are in one direction through the biasing adjunct (negative) while the signal is introduced also from the grid circuit (positive), hence the grid circuit variations tend to neutralize or cancel out the negative feedback otherwise existing.

Condenser Connections

In push-pull there is no signal current in a common biasing resistor for the two tubes affected, because the instantaneous value of the current is in opposite directions, or the voltages are equal but opposite, so there is a symmetrical circuit. So the negative-leg choke permits of a symmetrical circuit to the extent of the cancellation of negative feedback by positive feedback.

C1 and C2 are the filter condensers. C2 connects from B minus (cathode or case of an electrolytic condenser) to B plus (anode or center post of an electrolytic). Therefore the case is not grounded, and if a metal panel is used the condenser C2 must have its case insulated. For this purpose insulating washers are obtainable with electrolytic condensers. If paper condensers are used the precaution need not be taken, because of the automatic insulation.

So there are three oddities as to connections: (1), the positive lead, from filament of rectifier, goes to the anodes of both condensers, C1 and C2, without interruption by any choke; (2), the condenser nearer B minus must have its case insulated, although this is not true of C1; (3), the filament of the power tube is grounded directly, since any grid return made to any other point must be made to one negative in respect to ground.

Result of Tests

A condenser of 8 mfd. was placed across the 300 ohm section, with no noticeable effect, the situation being experimentally about the same as putting a condenser of like capacity across a push-pull biasing resistor. Of course there was a difference, but the ear could not readily detect it, and the difference was not an improvement, any more than it would be in push-pull. Hence it is plain that a bypass condenser is not needed, which is an outstanding practical outcome.

The Fig. 1 hookup was used after a negative bias detector, a screen grid tube with 30,000 ohms in its cathode-to-ground circuit, across which resistor was a condenser of 0.1 mfd. The screen voltage was dropped from a higher value through two resistors totalling 18,000 ohms. When 8 mfd. was put across the 30,000 ohm resistor there was motorboating, quite pronounced, and when smaller capacities were used there was less instability.

When motorboating is experienced there is positive feedback, so the circuit was one that did not require large capacities for bypassing at detector or power tube. Even 0.1 mfd. from screen of detector to ground was sufficient, as this as its companion 0.1 mfd. served radio frequency bypass purposes abundantly. Regeneration took care of the audio end, but of course not of the radio frequency. It is therefore unnecessary to use even as large a capacity as 0.1 mfd., for 0.0005 mfd. will serve radio frequency purposes well enough.

The circuit under discussion is one printed last week on page 5, designated Fig. 1A.

A New Outlook

Thus a new outlook is developed in respect to resistance coupling particularly, and audio frequency regeneration becomes the important factor in making the tonal response all it should be.

Theories regarding the necessity of large bypass capacities—true where regeneration is not considered—do not apply, and any one who has measured one of the circuits for its aural response will be certain that the curve is excellent, and may wonder at the excellence in the absence of the orthodox requirements as to capacities, but consideration of regeneration will end the doubt.

A tapped field coil is required for Fig. 1. However, many may have a single winding coil. Still the same system may be used, by returning the grid (Fig. 2) to the juncture of two resistors, R1 and R2. These should be of high value and should bear about the proportion of the voltages. That is, the total voltage drop in the choke is present also in the series pair of resistors. If the choke is of low resistance, say 400 ohms, and drops 24 volts, the proportion is 8 for R2 to 16 for R1, or 1-to-2. For the more usual value of choke, around 1,800 or 2,000 ohms, R2 may be 0.25 meg. and R1 may be 0.05 meg. (50,000 ohms).

Low Note Suppression

Fig. 3 is a special circuit, with choke in the positive leg, and with the voltage drop in R1, which is for biasing the pentode, being used also. Although with opposite polarity, for the screen of the detector. This circuit, while distinctly regenerative, is so at the higher audio frequencies, and badly cuts off the low frequencies. It is shown merely as an example of regeneration, and is not suitable for an audio amplifier for receivers.

The leak value in the pentode stage need not be only 0.5 meg., because of the absence of low-note reproduction. Values from 2 to 5 meg. were tried, and stability still was retained. This is a bad sign. With high values of leaks it should always be true that motorboating is present. Lowering the leak values, anywhere in the audio circuit, will effectuate the cure, for the channel, no matter how many stages, should be considered and treated as a unit. The old idea was to analyze each stage independently, but in the new light of regeneration capitalization obviously this was wrong.

A condenser, C1, is necessary across the biasing resistor R1 for radio frequency purposes, and may be 0.1 mfd. As R1 is only 400 ohms, not until the bypass condenser is of the order of tens of microfarads would it become appreciably effective on audio frequencies, and then, on account of the regeneration, it would serve only as a damper.

tode and 235 Vari Mu

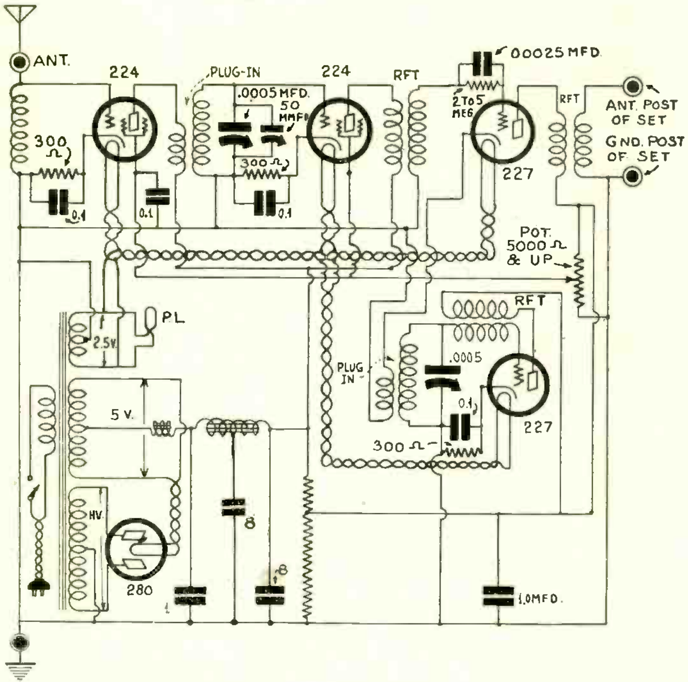
section of the characteristic. For example, it might be used between zero and 2 volts bias provided that a suitable load could be devised. A pure resistance of 250,000 ohms is often used. To use this it is necessary, as was stated previously, to use a very high applied plate voltage, or a comparatively very low screen voltage. If the applied voltage is so high in comparison with the screen voltage that the effective plate voltage is always about twice as high as the screen voltage, there is little distortion. This condition usually limits the signal voltage that may be impressed on the grid.

The variable mu screen grid tube is superior to the fixed mu screen grid tube both for radio and audio amplification because on the whole the curvature of its characteristic is less over any given input voltage swing. However, the fixed mu screen grid tube, like the 224, is better as a detector than the 235 because of the sharper bend in the grid voltage, plate current curve of the 224. When the input signal is very strong the difference is just appreciable in favor of the 224, but when the signal voltage is weak the difference is of a substantial order.

Why Waste Time Sleepir

What Results to Expect—Rege

By Rolan



Here is a short wave converter, a device now immensely popular. This one uses a 280 rectifier and an output r-f transformer.

GREATER demands usually are placed upon radio than it is practical to meet, all conditions considered, so that the situation develops into one wherein promises are made excessive to clinch a sale, or the demands are toned down to reasonable limits. In no case is this more true than with short waves.

It may have been noticed that set manufacturers have turned to short waves, and some of them have produced good devices, but others have had to yank their pet products off the market. It is a sure bet that the general public will not buy the regenerative all wave receiver to-day, and one manufacturer found that out to his displeasure. Also, where converters are concerned, the B supply, as well as the A supply, should be built into a-c models, a fact that the manufacturers will learn.

Dependable Reception Possible

So great has been the publicity given to short waves, and so facile the manner in which the telephone company can take calls to foreign points, that the occasional reception of tremendous distance is easily overemphasized by a manufacturer of short wave apparatus, and the occasional is made to appear as if it were the commonplace. Certainly dependable reception is possible over long distances on short waves. The telephone company does its work dependably and well, for it is able to select most favorable frequencies, as sometimes one frequency will give trouble, and another proves much more satisfactory.

That should be a hint to short wave fans at home. If a foreign station they would like to get, or that they did tune in a few times previously, now is elusive, it should be remembered that the station is probably using the same frequency, and you can not change to some more favorable frequency and still get that same station. You can get some other station, which is on another frequency, but the one you want may not want you just then, so to speak.

Why Can't Relay Be Duplicated?

It should be remembered that the work of the telephone company is not a feat in a strict sense, being reduced to common practice, and were that not so there would be no foreign telephone service. Not only is radio used, but land wires and even cables, and that is where you can't expect to compete.

A person naturally will ask, "When a foreign program is relayed by a local station it comes in clearly, so why can't I do as much or as well with my short wave set?"

The answer is that perhaps as much can be done with the set, if the set will do as much as the other. Think of the comparison in price. Also the radio frequency and audio frequency amplification incidental to the broadcast of the relayed program is thousands of times greater than what you have at your command. Your set, including tubes and speaker, may have cost you something under $100, but the set used in the other case may have cost $10,000 or more, and when engineering development is included, the set may come to $25,000.

It is fair to expect as much, then, of a short wave set in a home? And yet as much is often expected, and moreover, the expectors are encouraged in that dissolute direction by some manufacturers who show pictures of Chinese, Japanese, Esquimaux and Amazons, leaving the impression that programs sent out from the countries where these reside may be brought in regularly on the short wave device. They may be received once in a while, but not often enough to justify the claim.

The Dependable Average

It is only just to give the manufacturer a break. He should not be asked to make up for the shortcomings of his customers or of the ether. Short wave devices should be advertised for what they are and should be bought for what they are, and the purchasers should be content with average reception. This average often means dependable reception of foreign programs, and a very satisfying penetration of all parts of the United States and Canada, as well as good results from Central and South America, but Europe comes in less frequently than any of these, as a rule, and in the main only a few stations in Europe are regular visitors in the average short wave addict's home. Such stations like PCJ, Eindhoven, Holland, and G5SW, Chelmsford, England, are utterly dependable to many listeners on this side of the Atlantic Ocean. And the residents of the Pacific Coast and environs may expect to get a few Asiatic stations with regularity, but should accept what they do get as the best that can be done under the circumstances.

It is too much to ask of a manufacturer that dependanble reception of European or Asiatic stations must be guaranteed, for how can he guarantee what he can not control? You will get your money's worth, and more, from the short wave devices you do buy, and there will be plenty of enjoyment in listening to what you do hear.

Comparison with Broadcast Set

"Why should I have a short wave set?" asked one man. "Suppose it does cover the United States and Canada regularly, with an occasional peep out of some foreign country? I have a very sensitive and selective broadcast set, and it does those things."

Well, the set he has is a very good one, it outperforms the average set in a manner almost beyond verbal comparison, and he paid a few hundred dollars for it. Now, the short wave device he was asked to buy would cost him, complete with tubes, $37.50. While he was absolutely right in stating that he had no reason to buy something that brings in hardly much more than his broadcast set. does he forget that there are persons in this life not so well circumstanced as he, and they, for perhaps one-tenth the amount he paid, can get the same distance results (which they crave), and probably considerably more.

There are two types of receivers used for short wave reception, not including the special television receivers, and the types are regenerative and superheterodyne. The regenerative set usually consists of a stage of tuned r-f amplification, regenerative detector and two stages of audio, for speaker operation, or sometimes there may be three stages, particularly if resistance coupled.

Regenerator and Super

The performance of the two types differs. If I were to tell you that all problems have been solved for both I would be telling an untruth. The regenerative circuit is pretty well licked, but has some disadvantages. The superheterodyne for short waves is a major problem.

Extreme sensitivity is desired, and this may best be obtained with the superheterodyne. But as the sensitivity rises, so does the noise level, and one quickly gets into that plane where

ıg? Short Waves Beckon

ıerator and Super Compared

'd Tookle

the noise is so great it is not only bothersome but prohibitive. I do not mean the tube noises alone, for they are bad enough, but I include also the atmospheric and other troubles, including those from defective electrical appliances.

In general, so far, better clarity on weak signals is obtained from the regenerative receiver, for regeneration is most effective on weak signals, while far more selectivity and better sensitivity are obtained from the superheterodyne. It is, of course, usually true that the super's sensitivity runs rings around the other's, but one has to stop soon on account of the noise.

Very weak signals, then, are built up with less trouble and less extraneous sound with the regenerative system than with the super's. On medium or loud signals the super greatly outperforms the other. Therefore investigation of the shot effect in tubes must be completed, means found for killing off the noise while building up the amplification (a reasonable expectation in view of the abundance of noise), and the weak signal has to be made to come through strongly in the system that eventually will be the main one for short wave work.

Advantages in Both

This is not to say that one should not have a short wave super. If the words were read correctly it would be understood that one should have a short wave set, and that great delight will be afforded, but that each type has its own advantages and disadvantages, and each type works well. I have listened to supers that brought in forty to fifty foreign stations in a night, with good clarity, although somewhat noisier than regenerative sets that brought in twenty such stations in the same period.

There is developing a type of listener who likes the world range of the short wave spectrum so much that he is willing to put up some real money, say around $100, and spend some time building a super that will enable him to tune in Rome when the Pope is talking, and who also likes to make vast trips about the surface of the earth as a short wave radio traveller. There is more of a kick in it for him than the finest of broadcast programs from this country, although he should pay good attention to broadcasts as well, for considerable listening ought to be done to the excellent programs available, and moreover, such listening is sauce to make the short wave fare more relishing. One does not tire of variety, and all short wave and no broadcast makes Jack a dull boy.

Won't Be a Wizard Two Ways

A receiver, if a superheterodyne, may consist of a tuned modulator, a separately tuned oscillator, three stages of intermediate frequency amplification, at a frequency of around 450 kc, and two stages of resistance coupled audio, or one stage resistance and one stage push-pull. The modulator may be a 224, using grid leak and condenser, the oscillator a dynatron, the intermediate amplifiers 235's, the second detector a 224, negatively biased, the first audio stage resistance coupled feeding a 227, and the output pentodes in push-pull.

That makes a 10 tube set (with rectifier), and it can be worked for the broadcast band as well, when it will not be such an outperformer as one might expect, for if a set is built primarily for short waves, it will be only fair on broadcasts, while if it is built primarily for broadcasts it will be only fair on short waves.

The oscillator and modulator may be ganged, but if so a large manual trimmer is necessary, and then it is of scant advantage to hide the absence of really single control, for better results will be obtained with the two dial affair.

Now such a set will do a great deal. It will give the aesthetic foreign station fan all he is asking for, and maybe more (if he isn't asking too much, but probably he is), and while it will set one back plenty, it will put one forward plenty, in another sense.

Intermediate Frequency Suggested

A man building and operating such a set will learn a great many facts himself, and will be able to improve the circuit beyond the point where the designer left off. First he builds it carefully, then he should work it for a few months, whereupon he will be in a better position to make tentative changes, using his own ideas, based on experience, as well as culling ideas from the radio press and from talks with technically minded friends and acquaintances.

The question of what intermediate frequency to use often arises, but is always answerable by the statement that for short wave reception the frequency should be relatively high—for instance may be just below the broadcast band of frequencies. Suppose one used the same frequency popular in broadcast superheterodynes, 175 kc. Suppose one was trying to tune in 30,000 kc. Then the modulator would be tuned to that and the oscillator would be tuned to 30,175 kc. The two frequencies are so close together that probably the two circuits will interlock, and then the behavior is like that of an oscillator tuning alone, or oscillation may stop under such conditions. At any event there is an unnecessarily early limit to the high frequency response. Other factors soon enough will step in to prevent tuning in higher frequencies, but around 10 meters should be expected, particularly as with an intermediate frequency of 200 kc a man once—or was it twice?—tuned in a 10 meter station.

But it is not worth while to rely on the occasional happening, and therefore 175 kc is out for short wave work, because of its frequency limiting factor, and 450 kc may be used, as just outside one end of the broadcast band, or 1,600 kc or thereabouts selected, being just outside the other extreme. But with 1,600 kc the intermediate stages should not exceed two in number, and of course in all cases the coils must be shielded and grounded.

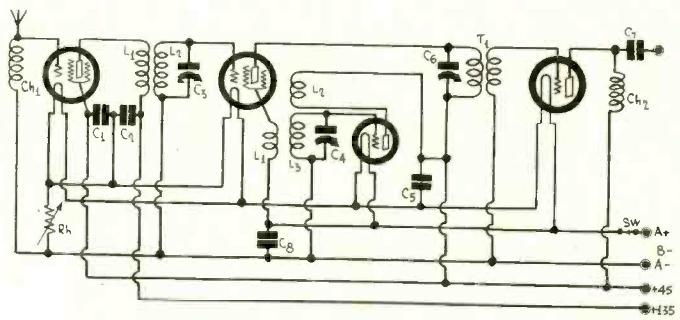
Log Stations You Hear

One of the most important considerations is logging stations, or calibrating the set. This work usually is not done by the manufacturer, except for a statement of extreme frequencies for the bands covered. However it is important and takes time. You need only tune in the station and record its setting as representative of its transmitting frequency. Long listening is required, at first, for in the beginning you will not know just where you are, especially when a transmitter uses one of several frequencies, and you have no means of telling which is being used. Once you do some preliminary calibrating, however, you will be able to make this distinction quickly.

A list of stations, with frequencies, is necessary, or at least desirable, and the best list is the all-inclusive, world-wide, all-frequency, all-service list published by the Bureau International de l'Union Telegraphique, at Berne, Switzerland, and known as "Liste des Frequences des Stations Radioelectriques." It is published annually, and there are corrective supplements. You have to send an international money order for a trifle under $5 to the Bureau at Berne to get the volume and supplements.

It is very difficult to keep abreast of the changes, and while the radio press in this country keeps you well posted on domestic information, the compilation of the vast international list is such a monumental job that it can scarcely be done with great accuracy as a sideline. All changes can be registered in the main volume, including those obtained from the radio press.

By the time you get this far with your short wave work you will consider giving up your position—if you have one—and devoting all your time to listening to foreign stations, logging them, getting their confirmations, etc., but some one in the family will step in to halt your brave endeavor, and you will simply devote much of the night to listening, instead of wasting good time sleeping.



This converter is for battery operation. Somehow many for-gt that millions depend on only batteries for power.

A Set for D-C Operation

Factors Entering Into 110V D-C Installation

By Brunsten Brunn

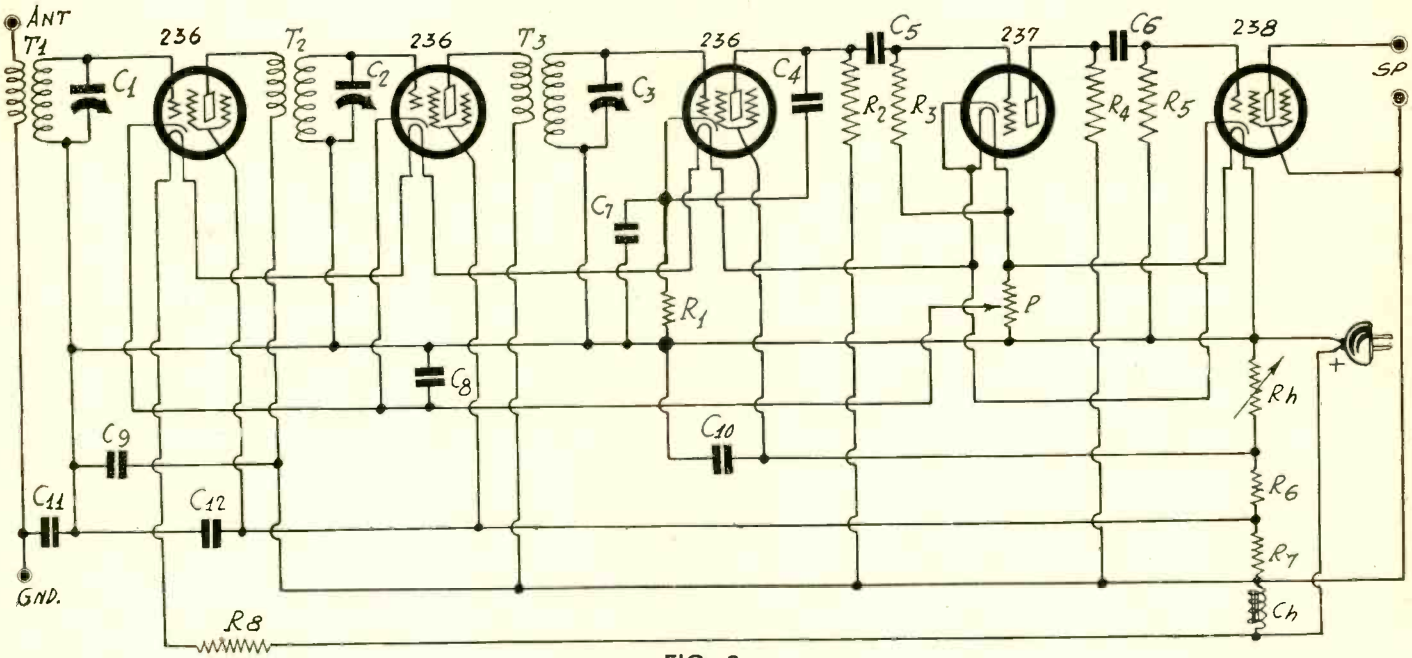


FIG. 2

This circuit is essentially the same as that in Fig. 1, except that the grid bias is obtained from voltage drops in the heater circuit. This is the simpler set, but it may hum slightly.

LAST week we described two receivers for operation on a direct current line, using the automotive type tubes throughout. There is much demand for such receivers in large cities where direct current power is still used. The advent of the automotive tubes was a boon to those who live in d-c districts for they can be used advantageously and economically where the installation of a regular a-c operated receiver would be very costly.

It is unfortunate that the usual line voltage is only 110 volts, for this is hardly sufficient where a high power output is desired. While it is enough to give good room reception for quiet and peaceful entertainment, it is not enough for volume required for dancing purposes, for example.

It was suggested how the volume could be increased by putting two 238 tubes in parallel in the last stage. This is simple to do and does not cost very much. Another way of boosting the output on special occasions is to boost the plate voltage by means o fa battery. The maximum voltage recommended for these tubes is 135 volts, but if it is a little higher no harm results and more volume will be obtained. For example, we might put a 45 volt, heavy duty battery in series with the line and thus boost the total voltage up to 155 volts.

Connecting Booster Battery

This booster battery, of course, should be connected so that it is in series only with the plate circuits and not in series with the heater circuit. The best place, then, for connecting it is in series with the filter choke Ch, on either side of the Coil. The lead connecting the choke to the plus side of the power line might be opened up and the battery inserted in the break. The negative of this battery should be connected to the positive side of the line and the positive side of the battery should be connected to the choke.

The booster battery increases all the steady voltage in the circuit, with the exception of the heater voltage. And the increase is proportional in respect to the plate and screen voltages so that no change is needed in the voltage divider. The grid bias voltages in Fig. 1 are also proportional so that no change is needed in the bias resistances. In Fig 2, however, the grid bias voltages are unchanged, since they are obtained from the heater circuit. It is not necessary to make any change in them, either, for the increase in the plate voltage is not great. However, in case the grid bias on any tube was made less than it should be for 110 volts, it is well to make a change when the voltage is boosted. A change necessitates an increase of at least 6.3 volts since that is the drop in each filament. Since no change is needed in Fig. 1 this circuit is preferable for this reason as well as for the reason already pointed out, namely, less hum. In Fig. 2 the detector is on a bias resistance so that t his bias changes automatically.

One side of the power line is always grounded, usually the positive. If the negative side of the circuit were to be grounded also there would be a short of the line. To prevent this condenser C11 is connected from the ground post to the negative side of the line. This makes it quite safe. It should be pointed out that if a condenser is connected across the line, from plus to minus, no ground is needed because the ground on the line is as good a ground as can be obtained. This condenser need not be larger than 0.001 mfd. for the purpose of ground the circuit to radio frequency currents, but if it is made 4 mfd. it will also serve as an additional filter condenser.

LIST OF PARTS

Coils—
T1, T2, T3—Three shielded radio frequency transformers for 460 mmfd.
Ch—One low resistance filter choke coil.

Condensers—
C1, C2, C3—One triple gang of 460 mmfd. tuning condensers.
C4—One 250 mmfd. condenser.
C5, C6, C8—Three 0.01 mfd. condensers.
C7, C10, C12, C13—Four 2 mfd. by-pass condensers.
C9, C14—Two 4 mfd. by-pass condensers.
C11—One 0.001 mfd. condenser.

Resistors—
Rh—One 2,500 ohm variable resistor.
P—One 400 ohm potentiometer.
R1—One 30,000 ohm resistor.
R2—One 250,000 ohm plate resistor.
R3—One 2 megohm grid leak.
R4—One 100,000 ohm plate resistor.
R5—One 1 megohm grid leak.
R6—One 1,300 ohm resistor.
R7—One 6,500 ohm resistor.
R8—One 262 ohm heavy duty resistance, 25 watts or more.

Other Parts—
Five UY sockets.
Four binding posts.
Four grid clips.
One dial for condensers.
One line plug.

A Nine Tube Super

The Elimination of Image Interference

Burton Williams

[The first part of the article describing a nine-tube superheterodyne appeared in the preceding issue, Oct. 10, 1931. It gave the layout of the parts, both on top and under the subpanel, the circuit diagram, and the list of parts used in the construction. The present instalment concludes the discussion.—EDITOR.]

TWO radio frequency tuned stages are used in the receiver for two reasons, first, to increase the sensitivity, and second, to eliminate cross talk from image interference.

There is but one way of eliminating image interference, and that is to tune sharply in the radio frequency level so as to exclude thoroughly the signal which might cause interference. The interfering signal is always separated from the desired signal by a frequency equal to twice the intermediate frequency. Thus in this circuit which has an intermediate frequency of 175 kc, the interfering station is separated from the desired by 350 kc. Suppose, for example, that we wish to tune in a station having a frequency of 660 kc. Any station having a frequency of either 310 kc or 1,010 kc would cause interference if it were operating simultaneously with the 660 kc station provided that the signal of either could get through to the first detector.

The 310 kc signal is not likely to cause interference because it is not in the broadcast band and even if the signal were present it would be eliminated in the tuner. The 1,010 kc signal, however, is in the broadcast range and might cause continuous interference in the form of a whistle if it got to the first detector. But a sharp tuner should have no difficulty to separate between 660 and 1,010 kc. Two accurately tuned resonant circuits are usually sufficient to eliminate most cross talk of this type. The tuner, of course, is what does the selection, the tubes being used to boost the sensitivity. Unless the two tuned circuits are always adjusted to the same frequency, the desired one, the two stage amplifier does not suppress the image interference. Not only should these two tuners be adjusted to the desired frequency but the oscillator tuner should be accurately set to a frequency 175 kc higher than this. The intermediate frequency amplifier, no matter how selective it may be, does not help to eliminate image interference.

Intermediate Amplifier

In the intermediate amplifier are three shielded transformers, T4, T5, and T6, each of which is doubly tuned with small inbuilt trimmer condensers. The transformers are mounted in aluminum shield cans measuring 2.5 inches in diameter and 2 inches high. These transformers are the three that may be seen in Fig. 2, which is a photograph of the bottom of the set. The transformers are so mounted that the adjusting condensers inside are accessible from the top through holes drilled in the subpanel as well as in the tops of the coil shields. Thus the adjustment of the intermediate frequency tuner can be effected any time from the top without tipping the set up, and the adjustment may be made with an ordinary screw driver, provided it is thin enough, while the set is playing. Thus it is only necessary to turn the adjusting screws until the volume is the loudest.

If all the intermediate coils are mounted in the same way there is some coupling between them and this may give rise to oscillation at the intermediate frequency. To prevent this, the middle coil is mounted so that the line passing through the coils inside is at right angles to the corresponding line of the other coils. This makes the field of the middle coil at right angles to the fields of the other two coils.

The second detector and the audio frequency amplifier are typical of modern circuits. The detector operates on the power detection principle and is followed by a resistance-capacity coupler. The grid bias resistance R4 is 30,000 ohms and it is shunted by a condenser C10 of 2 mfd. A condenser C4 of 0.0005 mfd. is connected across the line in the plate circuit of the detector. C5, the stopping condenser, has a value of 0.01 mfd. and the grid leak R7 a value of one megohm.

A 30-ohm potentiometer P is connected across the filament of the power amplifier and the bias resistance R5 is 400 ohms, shunted by 4 mfd.

The control of the volume is done in the radio frequency amplifier by means of a variable grid bias resistor Rm. This should be a value of about 3,000 ohms to give a wide range to the control. Both the 233 r-f amplifier tubes are on this resistance so that the control is doubly effective in reducing the amplification when needed.

In case there is a strong station near the receiver it may be that the 3,000 ohm volume control will not cut down the amplification sufficiently to reduce this station's signal to reasonable volume. In that even a 10,000 ohm variable resistance might be substituted. It may even be necessary in some instances to substitute a variable resistance for R3 as an added control of the volume, or better, to connect the variable resistance in series with R3, leaving this resistance at 150 ohms. About 1,000 ohms should be sufficient for this extra control resistance.

The values of the various voltage divider resistances were specified in the list of parts. It must be stated that these values are not inflexible. There are so many chances of variation in the voltages that the exact values cannot be given. Fortunately, they are not critical because the tubes will work well with both lower and higher screen and plate voltages than those ordinarily recommended.

Voltage Divider Computation

It has been found that under the conditions of operation of the second detector, the screen voltage should be 30 volts. This, then, should be the drop in R10, which has been specified at 3,500 ohms. This fixes the bleeder current at 8.67 milliamperes. Either the value of R10 or the value of the bleeder current is quite arbitrary, but not both, since the drop in the resistance must be 30 volts. The bleeder current also flows through R9, as well as through all the other voltage divider resistances, and in addition the screen current of the detector flows through it. This current is very small and may be neglected, but for simplicity we might assume that it is 0.33 milliampere so that the total current in R9 is 9 milliamperes. Now if we want to apply a voltage of 75 volts to the screens of the various tubes, except that of the detector, the drop in R9 should be 75 less 30 volts, or 45 volts. The list of parts calls for 4,000 ohms for R9, which will make the screen voltage 66 volts. This may be even better than 75 volts in some cases as it will tend to make the operation of the intermediate and radio frequency amplifiers more stable.

R8 is to drop the voltage from 180 to 66 volts, or 114 volts. The current through it is the sum of all the screen currents, the bleeder current, and the plate current of the oscillator, approximately 20 milliamperes. This will call for a value of 5,700 ohms for R8. The list of parts specifies 5,500 ohms because this is more easily obtainable. The change in the screen voltage is not enough to cause any upset of the circuit.

There is one resistance left in the voltage divider, R11. It is to drop the voltage from about 275 to 180 volts, or 95 volts. The current through it is the current through R8 plus the plate currents of five screen grid tubes. Of these four take about 6 milliamperes each and the other about one. That makes the total current through R11 45 milliamperes, and the value of R11 should be 2,100 ohms. The list of parts specifies 2,500 ohms, which is all right in view of the fact that the total voltage may be higher than 275 volts and the current through R11 may be slightly different.

The computations above are based on the supposition that the rectifier maintains a voltage of 275 volts across C15. Line voltage fluctuations may change this, making it either greater or less. But the changes are proportional throughout so that the circuit remains in adjustment as far as the steady voltages are concerned.

Tuning of Intermediates

Although the intermediate frequency transformers are mounted under the subpanel, they are tuned from above. It takes four holes in the subpanel for each of these transformers. Two are for mounting and the other two for access to the trimmer condensers screws. The two mounting holes should be drilled with a No. 28 drill and the two other holes with a 5/16 inch drill. The adjusting screws are not connected to either side of the condenser so that there is no danger of short circuiting anything while adjusting even if a steel screw driver be used.

The tuning of the intermediates is best done by ear just as the tuning is ordinarily done to stations. When the circuit is first turned on it may be assumed that the intermediates are in approximate tune. If the radio frequency tuner and the oscillator be tuned to a strong local signal, something will undoubtedly come through even without exact tuning of the intermediate. Without touching the adjusting screws tune the station in as loud as possible with the r-f controls. Then leave these controls and adjust each of the six trimmer condensers in the intermediate for loudest signal, reducing the volume whenever the signal becames too strong. After all the intermediates have been tuned in this way the radio frequency tuner should be adjusted by adjusting the trimmer condensers both in the r-f amplifier and the oscillator. It is not at all necessary to have an auxiliary oscillator during the adjustment.

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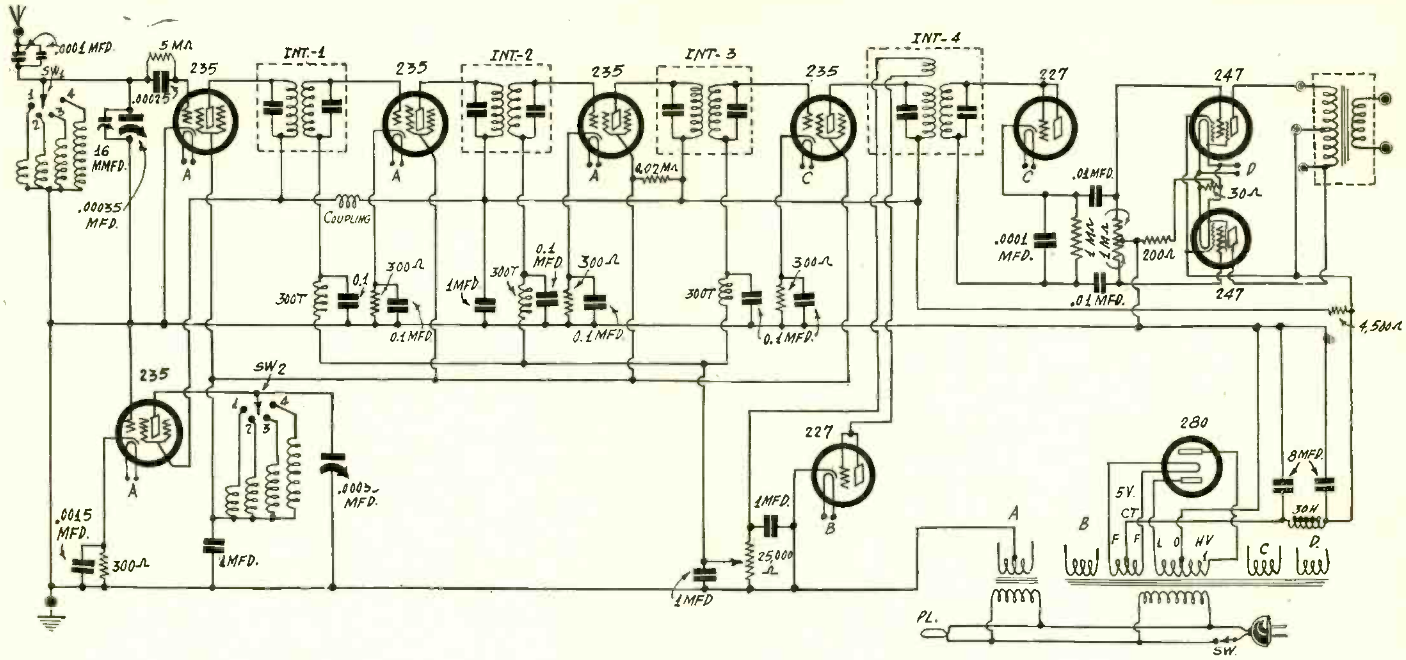

Fig. 958
The circuit of a ten-tube superheterodyne in which several special features are incorporated, adapting the circuit to experimentation. Automatic volume control, dynatron oscillator, and a rectifier type detector are some of the features.

Circuit for Experimenting

I AM looking for a circuit of a superheterodyne with which I can experiment. The circuit should contain a dynatron oscillator, an automatic volume control, push-pull output, preferably 247 tubes, and a rectifier type detector. If you have such a diagram will you kindly publish it?—A. D. F.

In Fig. 958 is a diagram of a circuit which seems to fit your requirements. In all it contains ten tubes. The 235 in the lower left corner is the dynatron oscillator, the 227 at lower center is the automatic volume control tube, and the tube at lower right is the rectifier. The circuit was intended to be an all-wave receiver, and it is for that reason that each tuner has four coils.

* * *

Best Output Coupling

WHAT is the best method of coupling a 247 pentode to a Ferrand Inductor or a magnetic speaker? The plate current is too heavy for direct coupling, so an indirect must be used.—W. A. G.

There are two other methods left, choke-condenser and transformer. Of the two the choke-condenser method is the better if the impedance of the loudspeaker is about the same as the optimum load impedance of the tube. For other speakers transformer couplino is better, assuming that the ratio of the transformer is such as to effect correct matching.

* * *

Feedback in Resistance Coupled Circuit

IF two audio frequency amplifiers to be put on the same grid bias resistance and no condenser is put across the resistance. will there be feedback which might cause oscillation if the amplifier is resistance coupled?—F. W. R.

Either oscillation or damping may result. depending on the phases. The question does not give sufficient details.

* * *

Short Wave Radio Frequency Amplification

MANY circuits have appeared in which there is an untuned radio frequency amplifier. It has been mv experience that such amplifiers do not work well below about 80 meters. What do you say?—E. W. H.

Well, you are about right. On the higher frequencies an untuned radio frequency amplifier is not very effective because there is much distributed capacity across the line. acting to shunt out the signal. Whether the practical limit is above or below 80 meters depends on a variety of factors. It is easy enough in any case to try the receiver without the untuned stage to determine whether it is better with or without it. The primary of the coil in the plate circuit of the first tube can be used as antenna coil. Disconnect the lead from the plate and then connect a small variable condenser between the antenna and the top of the primary. Remember in trying this that the primary is "hot" with high voltage.

* * *

Elimination of Odd Harmonics

RECENTLY I read a statement to the effect that the pentode tube was not desirable for circuits in which quality was the first consideration because of the prominence of the odd harmonics. Why would it not be all right to use push-pull and thus get rid of the harmonics?—B. W. T.

Push-pull does not remove the odd harmonics. It removes only the even harmonics. If it were to remove the odd harmonics it would also remove the desired portion of the signal, for this is the first harmonic, which is odd. Any tube or circuit in which the odd harmonics above the first are strong is unsuitable for audio frequency amplification.

* * *

Supersensitive Short Wave Set

WHAT type of receiver would you recommend for the reception of overseas short wave stations? I want something that is fairly reliable.—W. H. J.

A short wave superheterodyne perhaps gives the best promise of reliable reception of stations far away. Of course, not all supers would do the trick. We suggest a tuned modulator, a tuned oscillator with separate condensers, two stages of 235 screen grid amplification with an intermediate frequency around 450 kc, and a power detector coupled to a 247 pentode by means of resistance-capacity.

* * *

Connecting Rectifiers in Parallel

WOULD it be safe to connect two 280 type rectifiers in parallel to get a higher plate current? Are there any precautions to be observed in making the connections?—T. L. Y.

It is quite safe. There are no special precautions to observe. Since the object of connecting two in parallel is to get more current than a single tube will give, it is necessary to provide a power transformer that will handle the current also. The requirement extends to the choke coils in the filter.

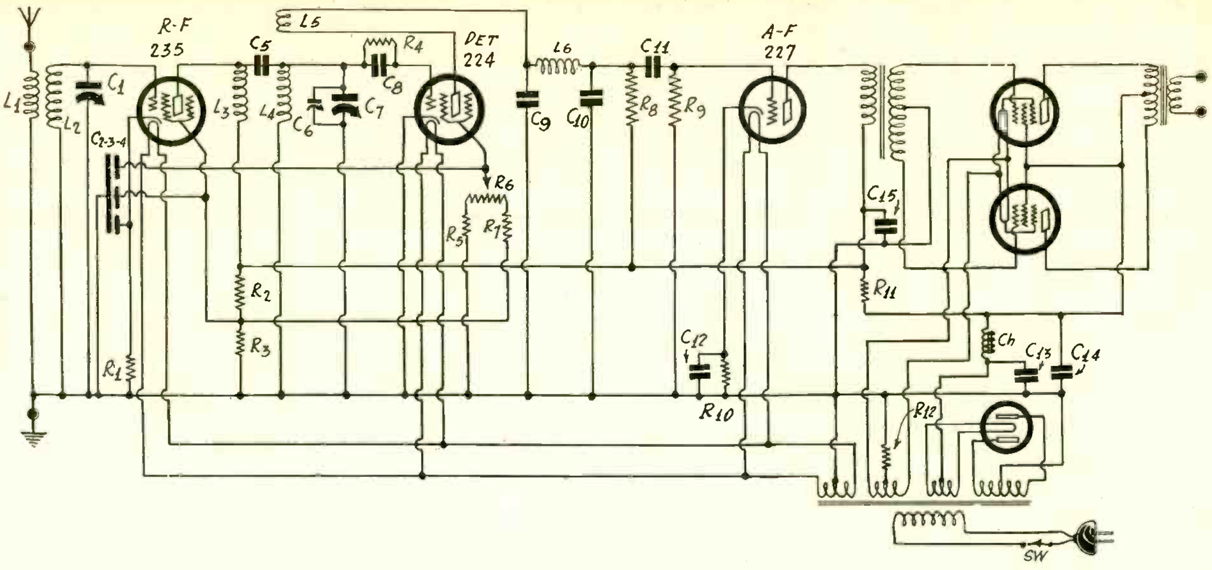

Fig. 959
A six tube receiver which is capable of high output as well as of high sensitivity. It may also be assembled at moderate cost.

IF you have a six-tube receiver with a stage of r. f. amplification, a regenerative detector, a stage of resistance coupled audio and a stage of push-pull, will you kindly publish it? Can a circuit of this type be made sensitive enough for the reception of stations 500 miles away?—W. H. J.

Fig 959 shows a circuit like this. The power tubes are 247s, and the rectifier is a 280. The other tubes are marked. A circuit like this can be made very sensitive indeed. Even without the regeneration it is sensitive enough to do what you expect of it.

* * *

Impedance Nature of Loudspeaker

WHAT is the impedance of a loudspeaker and of the primary of a transformer that has a loudspeaker in the secondary? Is the impedance a pure resistance, an inductance, a capacity, or a combination of the three?—G. J.

The impedance of the primary of a transformer that has practically no leakage reactance and a pure resistance load in the secondary is almost a pure resistance. It is slightly inductive. The impedance of a speaker may be inductive, capacitive, or resistive, depending on the frequency and a number of other factors. The ideal speaker has pure resistance.

* * *

A Howling Set

THERE is a very strong hum or oscillation in my amplifier, a two stage resistance coupled circuit. I have tried everything without luck. I built the amplifier exactly as described, except that I used a common grid bias resistance for the tubes. Can you suggest a remedy?—R. H. B.

You might try first using separate bias resistances for the tubes. If you do not care to do this, you might connect a very large condenser across the common bias resistance.

* * *

Experiments with Supers

IN the September 26th, 1931, issue, you had the circuit of a six-tube superheterodyne for short waves. Does this circuit work? I have tried it out but I cannot get anything out of it. If the circuit is all right, where do you suppose my trouble may be?—B. W. H.

The circuit is all right. In fact, it is a good one. Perhaps you made a mistake in the wiring. Where, it is not possible to say without checking the circuit. There is a possibility that you do not have the right coils. The input circuit of the modulator is tuned and the antenna is coupled directly to this circuit. Hence the input is efficient at all frequencies to which the circuit C1L1 can be tuned. When choke or resistance input is used there is an upper frequency limit beyond which the circuit does not work well, if at all.

* * *

Natural Frequency of Choke and Grid Circuit

THE first tube in my set has a 10 milliampere choke in its grid circuit. The self capacity of this choke is supposed to be 2 mmfd. The grid to cathods capacity of the tube, I imagine, is added to this, so that the total capacity of the coil, in effect, is about 7 mmfd., the tube capacity being assumed to be 5 mmfd. If this is right, what is the natural frequency of the coil and the capacity across it, and what is the highest frequency at which the coil is useful as such?—T. C. R.

The natural frequency of the circuit is 1.9 megacycles, or the natural wavelength is about 159 meters. The coil is not much good above 2,000 kc or below 150 meters. When short waves are to be received this form of coupling should not be used but the input circuit should be tuned. This will require a much smaller inductance in the grid circuit, so that the tuning will be effected by a capacity larger than the distributed capacity. It is reasonable to assume that the minimum capacity of a tuned circuit, counting that of the tube, of the coil, and of the condenser, is 25 mmfd. Suppose, then, that we wish to go down to 20 meters, or up to 15,000 kc. The inductance in the grid circuit cannot exceed 4.5 microhenries. Even when the input voltage is obtained from the drop in a high resistance the distributed capacity in the tube prevents reception. Suppose the resistance is 250,000 ohms and the capacity is 5 mmfd. The impedance of this parallel combination at 15,000 kc is 2,120 ohms.

* * *

Coil for 500 mmfd.

HOW many turns of No. 24 double cotton covered wire will be necessary to tune to 550 kc with a tuning condenser of 500 mmfd.? My condenser has a little less capacity than this but I intend to put a trimmer across it, which will just about bring the total capacity to 500 mmfd. The diameter of the tubing on which I want to wind the turns is 1.75 inches.—F. W. E.

It will take 80 turns.

* * *

Extent of Coil Field

REFERENCE is often made to the field of a coil and it is said that something or other is in that field. How large is the field of a coil and what is it?—F. H. L.

The field of a coil is the magnetic force around it and it extends to infinity in all directions. There is only a field when the coil carries current. If the current is steady the field is always in the same direction at any given point. If the current is alternating the field is also alternating at every point. The strength of the field decreases rapidly as the distance increases. The field may be limited in all or in any desired direction by means of a metal shield. If the field is steady it requires iron to deflect it.

* * *

Voltmeter Errors Again

WHEN I put both of my voltmeters across two points in a circuit the two read the same voltage. When I take either off, the voltage reading of the other goes up. One meter changes the voltage about 10 per cent, while the other changes it just a little. Will you kindly explain this? Why do both meters not change the voltage by the same amount, why does the change occur, and why do they not read the same when they are connected across the same points separately?—G. B. C.

In the first place you have one good voltmeter and one that is not so good. The good one reads higher when it is connected alone across the two points in question. When both meters are across these points they read the same, for they have the same voltage across their terminals, but this voltage is less than the voltage indicated by either meter alone. The fact that the voltage drops when either or both meters are connected across the terminals indicates there is a high resistance in the circuit through which the current taken by the voltmeters must flow.

* * *

Connecting Plate and Screen Together

WHAT happens when the plate and the screen of a 224 or 235 are connected together? Does the tube become a three-element tube or does it remain a screen grid tube?—U. D. R.

It becomes a three-element tube. The screen becomes a part of the plate. The 235 connected in this way makes a good detector.

(*Continued on next page*)

(*Continued from preceding page*)

Narrow Band Receiver

WHEN a receiver is to cover only a very narrow band of frequencies, say from 5,500 to 6,500 kc, is it not possible to use a comparatively large tuning coil and a midget condenser for tuning? Is not the circuit more sensitive when the ratio of the inductance to the capacity is high? Supposing a 25 mmfd. tuning condenser is used, how much should the inductance of the coil be to tune in 5,500 kc and up?—F. W. E.

If the band to be received is very narrow, a small variable condenser is the thing to use. The sensitivity is greater the larger the L/C ratio, as you suggest. If the narrow band to be received is to be spread out over the dial, it is usually necessary to have a fixed capacity which is always in the circuit but does not vary as the variable condenser is turned. Condensers specially made for this purpose are called band-spanning condensers. If the maximum capacity of the variable midget is 25 mmfd. and if we assume that the distributed capacity in the circuit is 10 mmfd., the total when the condenser is set at maximum is 35 mmfd. To make this tune to to 5,500 kc we need an inductance of 23.9 microhenries. If the minimum capacity in the circuit is 10 mmfd., the highest frequency to which this coil will tune is 10,290 kc. Hence even a smaller condenser could be used. We can easily find the fixed capacity needed to make the 25 mmfd. condenser tune from 5,500 to 6,500 kc. The frequency ratio is 11/13. The capacity ratio is the square of this, or 121/169. This is equal to the fixed capacity divided by the sum of the fixed and the 25 mmfd. variable. Hence the value of the fixed capacity must be 63 mmfd. The variable condenser changes the total capacity from 63 to 88 mmfd. The inductance needed in this case is 9.48 microhenries.

* * *

Constant Howl in Set

THERE is a constant howl in the loudspeaker of my set. This builds up gradually after the power has been turned on. For a few minutes the music comes through quite clearly but then the howl starts and soon gains the upper hand. What is the cause and how may it be remedied?—G.A.E.

From the symptoms you describe it sounds as if the howl is due to a microphonic tube, probably the detector. If you cannot stop it by finding a more rugged detector tube, you have to kill the feedback from the speaker to the tube. The coupling between the two may be through the chassis. That is, the coupling may be purely mechanical. In that case mounting the speaker on rubber, or the tube on rubber, or both, might stop the howling. But the feedback may also be through the air. In that case you should do something to keep the sound from the speaker from hitting the detector tube. You may possibly stop it by surrounding the tube with cotton or something like it. If you use any inflammable material you have to be careful about fire. May be asbestos would be the best material. Putting the speaker a long way from the set is also a way of stopping the feedback.

* * *

Screen Grid Tubes on Testers

A TUBE tester that I built according to a diagram in a radio journal tests all three element tubes all right but it will not test screen grid tubes. The circuits is a-c operated entirely. Can you suggest any reason why the tester does not work on screen grid tubes?—B.W.

Not knowing the exact circuit, we can only make a guess, which may or may not be the right one. In one tester circuit similar to the one you say you built there was no provision for screen voltage. The screen circuit was left open. If this is the case in your circuit connect a battery from the screen to the point in the circuit representing B minus, or from the cathode of the tube. The value of this battery would depend on the effective voltage that the plates are getting.

* * *

Errors in Ohmmeter

THERE is always an error in the ohmmeter that I constructed. I built it with a 0-1 milliammeter, using a scale supplied by the meter manufacturer, an internal resistance of 1.500 ohms, and a battery of 1.5 volts. The error is such that the resistance is less than zero when I short circuit the terminals for the unknown resistance. What can be done to correct the error?—B. G.

Since the deflection is too high when the terminals are shorted the 1,500-ohm resistor is evidently not quite 1,500 ohms. Hence to correct the error you should connect a rheostat in series with the 1,500 ohm resistor and adjust its value until the deflection shows zero ohms when the input terminals are shorted. This rheostat can be used as an adjustor when the battery voltage runs low. The value of the rheostat to use depends on the amount by which the deflection is excessive. If the deflection is 10 per cent off the series resistance is 10 per cent low and the resistance of the rheostat should be 10 per cent of the nominal value of 1,500 ohms. That is, it should be 150 ohms. But chances are that the error is not more than 5 per cent, in which case the rheostat should have a resistance of 75 ohms.

Determining Proper Detector Bias

MY midget receiver contains a 224 power detector. In the plate circuit is a 250,000 ohm resistance and the applied voltage is 260 volts. The screen voltage is 40 volts. What should the grid bias resistance be? How can the proper value be determined by experiment without setting up a special circuit?—F.W.G.

A bias resistance of about 50,000 ohms should be right. However, to find the right value by experiment you might proceed as follows: Connect a 0—1 milliammeter in the plate circuit, that is, in series with the 250,000 ohm resistance. Connect a voltmeter across the bias resistance and also connect a grid battery across this resistance and the voltmeter. Vary the voltage of this battery in steps of one cell and take the plate current at each value. Plot a curve of the plate current and the grid bias. The proper bias is that at which the plate current is approximately 0.1 milliampere, or that bias at which the plate current curve bends most rapidly. The curve will show what this bias is. Divide the bias by the corresponding current and the result is the proper grid bias resistance to use. Suppose, for example, that the bias is 5 volts where the curve bends most rapidly and that the current at this point is 0.1 milliampere. Then the proper grid bias resistance is 5/.0001 ohms, that is, 50,000 ohms.

* * *

Magnet Wire Table for Radio and Audio Coils

THE table herewith is based on measurements at 68° Fahrenheit. Different temperatures will give slightly different results. In practice some slight variations are to be expected from the tabulated values, including particularly turns per linear inch, as the number of turns stated is based on accurate machine winding.

Abbreviations: *B & S*, Brown & Sharpe, same as American wire gauge. There are six other gauges in use, but *B & S* is used in radio in the United States. *SS* is single silk, *DS* double silk, *SC* single cotton and *DC* double cotton. For direct current *CC* is used to avoid confusion with *DC*, that represents double cotton. *CC* stands for continuous current, which is synonymous with direct current.

		TURNS PER LINEAR INCH								
B. & S. Gauge	*cc. Ohms per 1,000 Feet*	*Single Silk*	*Double Silk*	*Single Cotton*	*Double Cotton*	*Enameled*	*Enameled SS*	*Enameled DS*	*Enameled SC*	*Enamaled DC*
14	2.525			15.6	13.6	15.2			14.1	13.3
15	3.184	16.9	16.3	16.1	15.1	17.0			15.6	14.8
16	4.016	18.9	18.2	17.9	16.7	19.1	18.4	17.7	17.4	16.3
17	5.064	21.2	20.3	19.9	18.2	21.5	20.5	19.7	19.3	17.9
18	6.385	23.6	22.6	22.1	20.2	23.9	22.8	21.8	21.4	19.7
19	8.051	26.3	25.1	24.4	22.2	26.8	25.4	24.2	23.6	21.5
20	10.15	29.4	27.8	27.0	24.3	30.1	28.4	26.9	26.1	23.6
21	12.80	32.7	30.8	29.8	26.7	33.7	31.6	29.8	28.9	25.9
22	16.14	36.6	34.2	33.0	29.2	37.7	35.0	32.8	31.7	28.1
23	20.36	40.6	37.7	36.2	31.6	42.3	39.0	36.4	34.9	30.6
24	25.67	45.2	41.6	39.8	34.4	47.1	43.1	39.8	38.1	33.1
25	32.37	50.2	45.8	43.6	37.2	52.9	47.8	43.8	42.8	35.8
26	40.81	55.8	50.5	47.8	40.1	59.1	52.9	48.0	45.7	38.6
27	51.47	61.7	65.5	52.0	43.1	66.2	58.4	52.9	49.7	41.4
28	64.90	68.4	60.9	56.8	46.2	74.1	64.5	57.8	54.0	44.4
29	81.83	75.1	67.1	61.3	49.2	83.3	71.4	64.1	58.8	47.6
30	103.20	83.1	79.2	66.5	52.5	92.2	77.8	69.2	63.0	50.3
31	130.10	91.5	79.3	71.9	55.8	103.4	85.6	75.3	68.1	53.5
32	164.10	100.5	86.5	77.2	58.9	115.6	93.8	81.6	73.2	56.6
33	206.90	110.1	93.6	82.8	62.1	129.3	102.7	88.2	78.5	59.7
34	260.90	120.4	101.0	88.4	65.3	144.9	112.3	95.2	84.0	62.8
35	329.00	131.4	108.5	94.3	68.4	162.3	122.5	102.4	89.6	65.9
36	418.80	142.8	116.2	100.0	71.4	181.8	133.3	109.8	95.2	68.9
37	523.10	155.0	124.2	105.8	74.3	202.4	144.1	117.1	100.6	71.7
38	659.60	167.7	132.2	111.6	77.1	227.7	156.4	125.1	106.4	74.6
39	831.80	180.5	140.2	117.2	79.8	252.5	167.7	132.2	111.6	77.1
40	1,049.00	194.5	148.3	122.8	82.3	280.1	179.5	139.4	116.6	79.5

List Prices of Tubes

The following table gives the prevailing price lists of the various tubes:

Tube	Price	Tube	Price	Tube	Price
227	@ $1.25	551*	@ $2.20	240	@ $3.00
201A	@ $1.10	224	@ $2.00	WD-11	@ $3.00
245	@ $1.40	171A	@ $1.40	WX-12	@ $3.00
280	@ $1.40	112A	@ $1.50	200A	@ $4.00
230	@ $1.60	232	@ $2.30	222	@ $4.50
231	@ $1.60	199	@ $2.50	BH	@ $4.50
226	@ $1.25	199	@ $2.75	281	@ $5.00
237	@ $1.75	233	@ $2.75	250	@ $6.00
247	@ $1.90	236	@ $2.75	210	@ $7.00
223	@ $2.00	238	@ $2.75	BA	@ $7.50
235	@ $2.20	120	@ $3.00	Kino	@ $7.50

*This tube comparable to the 235.

NINE STATIONS ARE AWARDED 50,000 WATTS

Washington.

The Federal Radio Commission has granted nine of the country leading broadcasting stations temporary permission to increase their power to the maximum of 50,000 watts. While the permission is temporary, it is believed that it will be made permanent when the Commission makes formal announcement of the decision.

The decision, which is in accordance with General Order No. 40, as amended, providing that high powered stations can operate only on four channels in each zone, filled nine vacancies. The stations are:

WOR, Newark, N. J.
WCAU, Philadelphia, Pa.
WSM, Nashville, Tenn.
WSB, Atlanta, Ga.
WCCO, Minneapolis, Minn.
WHO-WOC, Des Moines, Ia.
KOA, Denver, Colo.
KSL, Salt Lake City, Utah.
KPO, San Francisco, Calif.

WOR Wins, WJZ Loses

In most instances the Commission sustained the recommendations of Chief Examiner Ellis A. Yost. The examiner had recommended that the assignment in the First Zone be given to WJZ, New York, but the Commission decided to give it to WOR. WJZ is an outlet of the National Broadcasting Company, which company has WEAF, New York, on 50,000 watts.

Twenty-four applicants have been competing for the nine maximum power assignments available under General Order No. 40. Hearings on the applicationsz were first held in September, 1930, before Chief Examiner Yost, and continued for one month.

After the hearings, in his report to the Commission, Examiner Yost recommended that General Order No. 40 be amended to permit all qualified stations operating on cleared channels to increase their power to the maximum.

How Ninth Vacancy Arose

The Commission remanded the report and instructed the examiner to select the eight stations which he thought should receive the high power assignments, and subsequently in a supplemental report he recommended eight stations. At that time there were only eight vacancies, the ninth occurring when KNX, Los Angeles, Calif., surrendered its construction permit for a 50,000 watt station.

NEXT WEEK—

The Two Stage Regenerated Resistance Audio Amplifier

Air Teaching Now Reaches 50,000 Schools

Many different educational radio program and special courses of instruction sponsored both by commercial and educational groups will soon begin another school year series, destined to play an important role in the 50,000 schools throughout the Nation now equipped with receiving sets, according to a statement by Dr. C. M. Koon, specialist in education by radio, made orally at the Federal Office of Education.

The Ohio School of the Air will commence its fourth year this Fall with a well rounded out program consisting of current events, civil government for upper grades, and nature study for the fourth and fifth grades. Other programs, arranged definitely and covering specific subjects daily and weekly, will include literature, travelogs, a series in physics, botany, and chemistry for high schools, geography for grades five through eight, health stories, and plays.

On the Pacific Coast, the Standard School Broadcast is also entering its fourth season, sponsored by the Standard Oil Company of California, with an introduction in the form of the history of the foundations of music. Here certain fundamentals in the historical development of music are being broadcast rather than a digest of dates and names. Music is to be presented in its development in the manner that language is presented in its growth.

The Standard Symphony Hour concerts will again be played during the regular symphony season by the entire San Francisco Symphony Orchestra, under guest conductors, Issay Dobrowen, of Russia, and Basil Cameron, of England, and the Los Angeles Philharmonic Orchestra, directed by Dr. Artur Rodzinski. These orchestras will alternate week by week.

The American School of the Air, sponsored by the Columbia Broadcasting System, will open its third season this Fall. In 1930, the American School of the Air was broacast over a chain of 45 stations, and it is understood that many more stations have joined the chain since then. The educational program of this school is not yet ready for publication.

The fourth of the Music Appreciation Series sponsored by the National Broadcasting Company and conducted by Walter Damrosch, is already under way. It is estimated that millions of new listeners have been added to this series.

Sundry Suggestions for Week Beginning October 18th

Sunday, Oct. 18:—N. Y. Philharmonic Symphony .... WABC—3:00 p.m.
Monday, Oct. 19:—James Melton, Tenor .... WEAF—8:30 p.m.
Tuesday, Oct. 20:—Don Voorhees Orchestra .... WJZ—8:00 p.m.
Wednesday, Oct. 21:—Singing Sam .... WABC—8:15 p.m.
Thursday, Oct. 22:—WEAVer of Dreams .... WOR—10:00 p.m.
Friday, Oct. 23:—Jessica Dragonette .... WEAF—8:00 p.m.
Saturday, Oct. 24:—Little Symphony .... WOR—8:00 p.m.

BASIS IS CITED IN REGULATING PRICE OF TIME

Washington.

The Sta-Shine Products Company, Inc., of Freeport, N. Y., has asked the Interstate Commerce Commission to compel a radiao broadcasting station to rudce the rates it charges for the "transmission of intelligence for hire in interstate commerce," on the ground that such charges are unreasonable and in violation of the Interstate Commerce Act.

The complaint is against the National Broadcasting Company and WGBB, of Freeport, together with H. H. Carman, proprietor of the station, and alleges that the defendants are engaged in the transmission of intelligence for hire in interstate commerce and therefore subject to the provisions of the law to regulate commerce.

It was claimed that the Sta-Shine Products Co., Inc., whic is engaged in the sale of furniture polish, has sent messages via the Freeport radio station to points in Connecticut and has paid for the same, and that while the company still desires to continue sending messages, it is restrained from doing so because the rates are "exorbitant."

Charges Law Violation

The complaint said that the company had been charged $146.48 for 15 minutes to transmit the message through one station and $1,480.49 for "chain transmission," all to the great damage of the complainant. It also said that the National Broadcasting Company had failed to furnish facilities. It was also asserted that the rates charged are "unlawfully discriminatory, because all persons are not accorded similar treatment, all to the great damage of complainant."

It was further charged that the company had violated the law by failing to file tariffs with the Commission and that it has not submitted its properties for valuation nor filed annual reports in compliance with the law.

The Commission was urged to institute an investigation into the charges alleged in the complaint and require the defendants to cease and desist from the violations of the law charged, and that reperation be awarded to the corporation "in such sum as may be determined upon proof adduced by complainant."

Jurisdiction Accepted

Henry A. Giesler, president of the Sta-Shine Products Company, Inc., signed the complaint.

This is the first time that the question of the Interstate Commerce Commission regulating broadcasting station activities has been brought up for determination, it was said. The case has been formally docketed, assigned a number and will come up for hearing in the same manner as a case involving railroad practices. The Commerce Commission assumed jurisdiction to proceed with the case and will so continue until the defendant questions it.

IMPORTANT NOTICE TO CANADIAN SUBSCRIBERS — RADIO WORLD will accept new subscriptions at the present rates of $6 a year (52 issues); $3 for six months; $1.50 for three months; (net, without premium). Present Canadian subscribers may renew at these rates beyond expiration dates of their current subscriptions. Orders and remittance should be mailed not later than October 24, 1931. Subscription Dept., Radio World, 145 W. 45th St., New York, N .Y.

A THOUGHT FOR THE WEEK

NO jug of wine, no desert palm,
no bough;
But tender eyes, a radio——
and thou.

RADIO WORLD

The First and Only National Radio Weekly
Tenth Year

Owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.
Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager; J. E. Anderson, technical editor; L. C. Tobin, advertising manager.

$50,000 Business

ONE manufacturer reported that at the public radio-electrical show in New York he took orders for $50,000 worth of short wave merchandise, principally receivers and converters. He is a izing in short waves is proving profitable. Also, he has apparatus that performs superbly.

This is quite a large business to do during what other manufacturers sadly realize is a depression, but which this manufacturer finds a period of good business and profit.

The sales volume attending that week-long occasion attests anew to the high interest in short waves. Buyers nisist that the devices do what they are supposed to do, and this manufacturer's reputation for reliability brought him the business. All who are interested in radio, either commercially or as a hobby, or for both reasons, should take due heed of the high interest in short waves. A situation public and manufacturers should unite like this compels close attention.

Pointed Opinions

CHARLES CURTIS, vice president of the United States: "Never before in history has the President of the United States been able to speak to such gigantic audiences as has Mr. Hoover. Whereas President Theodore Roosevelt and others traveled extensively and spoke frequently at public gatherings, it is doubtful whether they addressed as many persons in their lives as our present Chief Executive addresses in a single broadcast when both of the major networks carry his messages to every section of the nation. And these speeches for the most part have been delivered directly from the White House. Thus President Hoover, escaping the necessity of long trips, has been able to devote more time to urgent matters of State."

* * *

DAVID SARNOFF, president, Radio Corporation of America: "Ignorance is the greatest asset on the balance sheet. What we do not know is colossal. I have been in radio for twenty-five years. I have sent messages and received them. I do not know how they get from the sender to the receiver. I have never found anyone who knows."

* * *

RAY H. MANSON, chief engineer, Stromberg-Carlson Telephone Manufacturing Company, President Institute of Radio Engineers: "The pentode output tube has found wide use in the 1931-32 receivers due to cost savings, but unfortunately the noticeable distortion, due to odd harmonics, rules out this type of tube for receivers where best audio quality is featured."

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers concerning standard parts and accessories, new products and new circuits, should send a request for publication of their name and address. Send request to Literature Editor, RADIO WORLD, *145 West 45th Street, New York, N. Y.*

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Station Sparks

By Alice Remsen

Children Simply Worship Uncle Don and I don't blame them. He sure has a way with them. He understands the psychology of children, and instead of treating them like babies, he puts them on a level with the grown-ups and reasons with them in a sensible manner. I bet many a mother has blessed Uncle Don for curing fractious children of annoying little habits. The power of suggestion works wonders and Uncle Don knows how to use that power in a tactful and charming manner.

* * *

Carveth Wells, the explorer, who broadcosts as "The Jungle Man" over WEAF, every Thursday afternoon at 4:45, receives a letter every week from a fan in Texas who adorns the outside of the envelope with original and well-executed cartoons. The letters, with their clever drawings, are eagerly awaited, not only by Mr. Wells, but by the entire staff in the NBC mail room as well.

* * *

Lew Conrad is back in his old stamping ground, Boston. He and his orchestra may now be heard twice weekly, Friday and Monday, from 12:30 to 1:00 a.m. over an NBC-WEAF network, broadcasting from the Hotel Statler in that city.

* * *

Vincent Lopez has returned with his orchestra from a six-weeks tour through the South and West under the auspices of the NBC Artists Service. He covered nearly 5,000 miles by train and plane.

* * *

"Seth Parker" (Phillips H. Lord) and his cast of NBC actors left New York last week to begin a tour that will carry them into twenty-three states, and two Canadian provinces. They will be absent from New York City until the last of December and will be seen and heard during that time from Vancouver to Miami and from Pittsburgh to San Diego.

* * *

H. V. Kaltenborn, who "Edits the News" at WABC, has been a military news editor, war editor, dramatic editor, foreign news editor, assistant managing editor and European correspondent. In addition to his journalistic activities, at one time or another he has been a clerk, soldier, sailor, lumberjack and canvasser.

* * *

Allan Broms, WOR scientist extraordinary, received the surprise of his life last week. Broms had announced a personally conducted museum tour and lecture on aeronautics for the Sunday following his broadcasts. No less than seven hundred people attended and he had to take them in relays, dividing the crowd among himself and two guest leaders.

* * *

Now Bing Crosby has been sold to a commercial. The Street Singer moves up to the best selling spot on WABC, 7:00 p.m. Mr. Crosby sings rings around the much touted crooning baritones who have sprung into existence recently, and we may expect to hear him on a commercial program in the near future.

* * *

"The Footlight Echoes" program on WOR, Sundays, 10:30 p.m., is using prominent stage stars for guest artists each week. Recently Queenie Smith sang the hits from "Irene" on this program and did very well. She is such a tiny person. A special low "mike" had to be hastily commandeered for her use. Her husband, Robert Garland, dramatic critic of the New York World-Telegram, gave an intimate talk on musical comedy hits of the past, speaking as a "theatrician," (his own word). Mr. Garland has a subtle sense of humor that manifested itself in several gentle quips. Very enjoyable.

* * *

Among the Nicest Things Heard recently over the air waves was Vaughan de Leath's presentation of "The Wedding of Micky Mouse" on her childrens program over WEAF, Mondays, 6:30 p.m. Singing Sam's rendition of "Blue Kentucky Moon" on WABC; and "The Street Singer's" charming way of singing "How Soon We Forget."

* * *

THE SHADOWS

(Uncle Don, WOR, 6 p.m. Daily)

I DO not like the dark, it's true, but oh, how hard I try to;
I cover up my eyes from view and then my hands I spy through.
It seems the shadows in my room just grow an' grow gigantic;
All over my white bed they loom until they drive me frantic.
A cold beam from the silver moon sends down a ghostly ladder.
The crickets chirp a lonesome tune which only makes me sadder.
I feel that I would like to fly, for danger seems to huddle
Around my bed, and, fearful, I into the pillows cuddle.

Oh, I'm so brave, just like a man—I scrooge my eyes up tightly,
An' I don't scream, although I can—perhaps I whisper slightly.
I need my mother awful bad, I wish that I could call her!
I wish that I could see my Dad! The shadows now grow taller!
Then down into my bed I dig; my inside feels all hollow.
My Adam's apple grows so big—so big I cannot swallow.
And now I know I'm goin' to cry, although I'll try hard not to,
I'll call to mother bye an' bye—because I've simply got to.

—A. R.

SIDELIGHTS

GUY LOMBARDO is 29 years old . . . ENRIC MADRIGUERA makes a hobby of flying . . . COLONEL LEMUEL Q. STOOPNAGLE is working on another invention—an anti-depression balloon to keep his stocks up . . . H. V. KALTENBORN is a tennis enthusiast . . . JACK MILLER hails from Boston . . . BURT MCMURTRIE first entered show business at the age of sixteen, in San Francisco . . . ANGELO PATRIE is an amateur landscape artist . . . ABE LYMAN first played traps in a movie house in Chicago . . . NAN DORLAND swims as well as she acts, and that's saying something . . . BOB MACGIMSEY, champion whistler of NBC, is also an attorney and a cotton planter . . . WAMP CARLSON was named after three Swedish Kings, Gustave, Eric and Waldemar . . . JOHN F. ROYAL was born in Cambridge, Mass. . . . ROY C. WITMER, was born in Lockport, N. Y. . . . HELENE HANDIN and MARCELLA SHIELDS have written a book culled from their radio program. It's called "The Two Troupers." . . . TWELVE-YEAR-OLD IRMA URAN sings in six languages . . . IRMA GLENN is studying astronomy.

Biographical Brevities

THAT LOMBARDO GANG

Guy Lombardo was born in London, Ontario, 29 years ago. Weighs 158 pounds. Although he holds a violin and conducts with a bow, has never played said violin. It cost him twelve dollars and it has one only string. He always listens to other people's opinions and then goes his own way anyhow. His ambition is to sleep nights instead of days. He has a radio installed in his phaeton car. Is a genial host. Hobby is speed boating. Believes from observation that no two couples ever dance alike. Enjoys New York. Has an appreciative sense of humor. Forgets appointments and is late if he remembers one. Is always well dressed.

Carmen Lombardo plays first saxophone, sings solo numbers and composes song hits. More proud of his backgammon playing than anything else. He is now writing a book on the subject. Plays the game until dawn and can talk about it and make it interesting even to the non-player. His hobbies, favorite sports, diversions, etc., may be summed up in two words—backgammon and backgammon.

Leibert Lombardo is the third of the tribe. Twenty-five years old and crazy about the movies. Jean Goldkette once offered three trumpet players for him. Has invented and built his own home radio and television apparatus that is enhanced by both color and sound; gives regular shows for friends. On Sunday he attends four different movie theatres. He used to sing with the orchestra until he needed his wind for trumpet playing.

Victor Lombardo is the ladies man of the group. He is 21 but tells people he is older. Plays baritone saxophone. Began at the age of 14. Once directed a band known as the Lombardo, Jr., Orchestra. His favorite sport is swimming. Answers to the sobriquet of "useless." Continually fidgets with his tie. Dislikes pajamas. Has a favorite movie actress but can't remember her name, ditto his favorite song. Greatly resembles his brother Guy. Parts his hair on the left side. Likes girls brunette and sensible.

Fred Kreitzer, the pianist, is 28 years old. Favorite author is Dumas. Loves potatoes. Biggest thrill coming to New York. Ambition is to live in California. Takes long walks alone in the wee hours of the morning.

Derf Higman is 23, and the tallest member of the band. His eyebrows meet. His hobby is going down to the Bowery and buying meals for derelicts. Once bet on horses, but not now.

Ben Davies, bass horn player, is 26. Once studied to be a tool-maker. Favorite sport, tennis. Scientific text-books comprise his only reading. Physics is his hobby and his home resembles a laboratory.

George Gowan, drummer of the outfit, wants to be an aviator. Was star pitcher on his school team. Smokes incessantly. Favorite song is "What'll I do?" Lives in Long Island.

Jim Dillon is 28 and a swell trombone player; is also a star amateur hockey player. Reads every newspaper. Favorite actress, Loretta Young; favorite radio entertainer, Morton Downey. Cadman's "At Dawning" his favorite song.

Francis Henry plays guitar and banjo. Is composer of the song hit, "Little Girl." Lives in Forest Hills. His pride is a wire-haired fox terrier, by name, "Drags."

Larry Owen plays second saxophone and makes many of the arrangements. Is 28. A moustache adorns his upper lip. Is the only member of the band not from London, Ontario. He hails from Cleveland.

A great gang, these boys. All of them are fine musicians, have great personalities and are easy to get along with.

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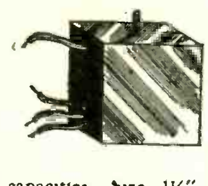

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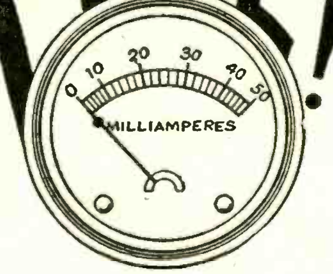

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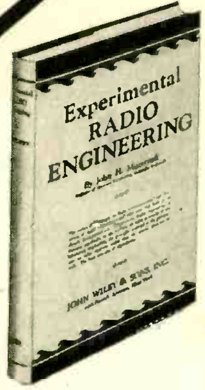

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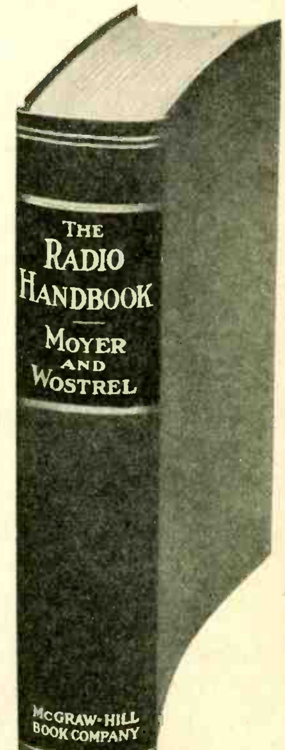

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