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The First and Only National Radio Weekly

606th Consecutive Issue Twelfth Year

NOV. 4th 1933

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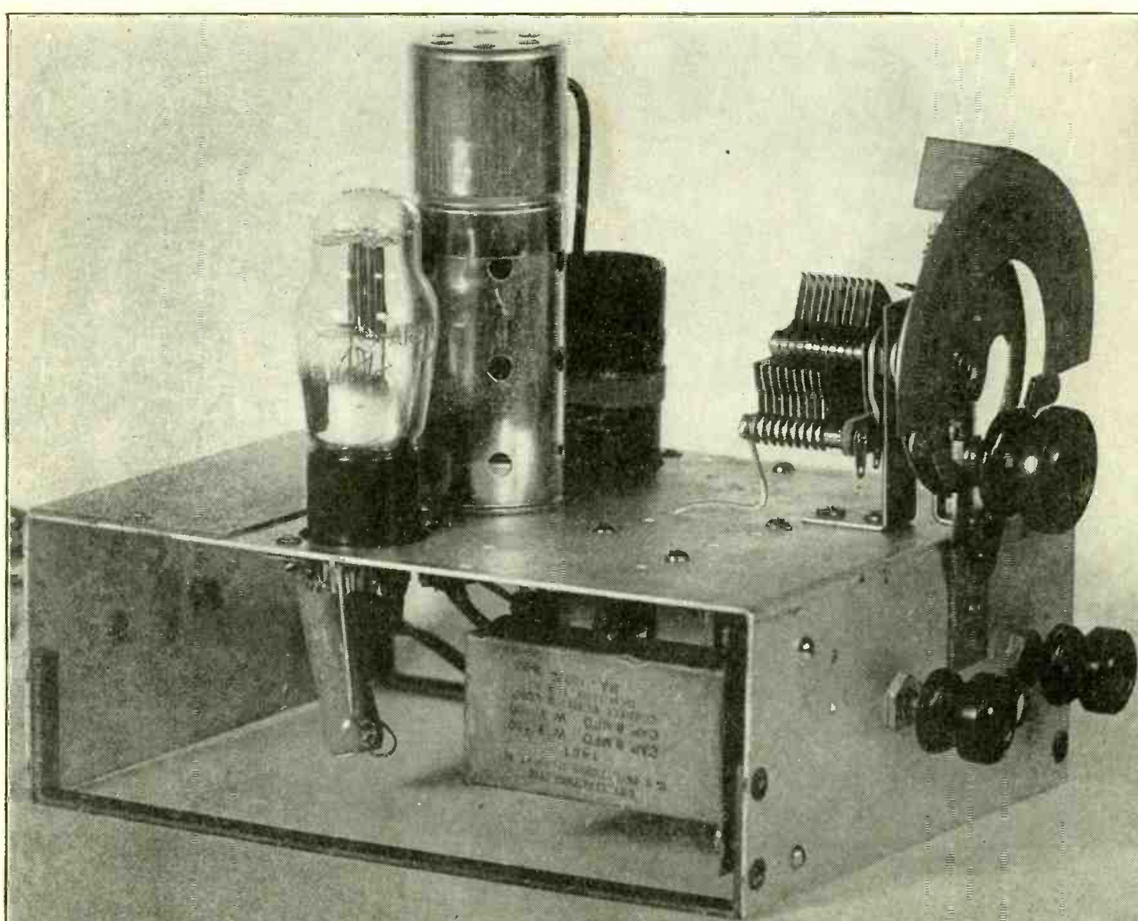
Six-Tube Push-Pull Output Battery Receiver

A-C D-C SHORT-WAVE CONVERTER



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A 7-TUBE D-C SUPER

Band-Pass Filter Pre-Selector, 48 Push-Pull Output

By J. E. Anderson

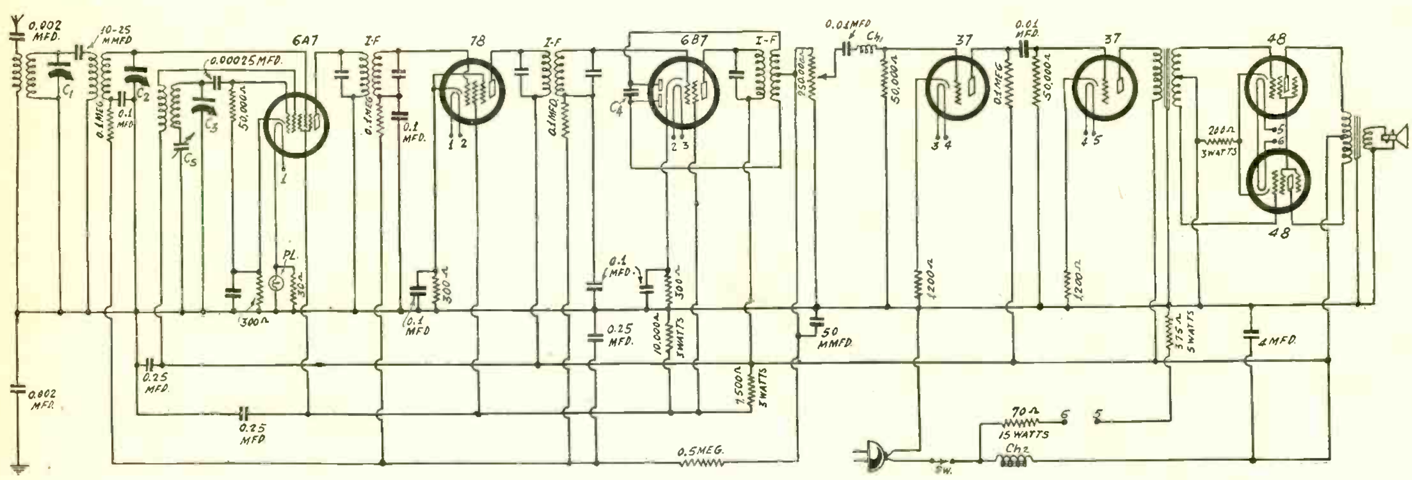


FIG. 1

This is a circuit of a seven-tube direct current operated superheterodyne which is sensitive, selective, and powerful. It is equipped with automatic and manual volume controls together with diode detection.

HERE IS A seven-tube superheterodyne designed to be operated on a d-c line of 110 volts and to given an output comparable with a-c operated receivers with much higher voltages on the plates and the screens. Being a superheterodyne, it has a high selectivity and a sensitivity comparable with the most sensitive a-c receivers with the same number and type of tubes. It has two stages of intermediate frequency amplification and three audio stages, the last of which is of push-pull type. The mixer is of the pentagrid type which combines the oscillator and the first detector in one tube.

The receiver is also equipped with an automatic volume control, with manual volume control, in the input to the audio amplifier, and it employs diode detection.

For selection in the radio frequency level two r-f tuners are used ahead of the first

(*Continued on next page*)

LIST OF PARTS

Coils

- Two shielded radio frequency transformers for 350 mmfd. condensers
- One shielded two-winding oscillator coil for 350 mmfd. condenser and 175 i-f
- Two shielded, doubly tuned 175 kc transformers
- One shielded, doubly tuned 175 kc transformer with centertapped secondary
- One 85-millihenry choke coil
- One push-pull input transformer
- One dynamic loudspeaker with push-pull transformer built in
- One 30-henry, 150-milliampere choke coil

Condensers

- One gang of three 350 mmfd. tuning condensers
- Two 0.002 mfd. condensers
- One 0.00025 mfd. condenser
- Two 0.01 mfd. condensers
- Six 0.1 mfd. by-pass condensers
- Three 0.25 mfd. by-pass condensers
- One 4 mfd. by-pass condenser
- One adjustable padding condenser
- One 10 to 25 mmfd. adjustable condenser

Resistors

- Three 300-ohm bias resistors
- Two 1,200-ohm bias resistors
- One 200-ohm, 3-watt bias resistor
- Three 50,000-ohm grid leaks
- Four 0.1-megohm resistors
- One 0.5-megohm resistor
- One 0.25-megohm potentiometer
- One 375-ohm, 5 to 15-watt resistor
- One 70-ohm, 15-watt resistor
- One 10,000-ohm, 3-watt resistor
- One 7,500-ohm, 3-watt resistor
- One 30-ohm resistor

Other Requirements

- Three grid clips
- One line switch
- One 2.5 volt pilot light
- One vernier dial
- Three five-prong sockets (one for speaker)
- Three six-prong sockets
- Two seven-prong sockets
- One eight-tube chassis
- One line plug and cord

(*Continued from preceding page*)

detector. Two identical tuned circuits are used. Since the radio frequency amplifier is omitted, a method of coupling the two loosely is essential in order that the two may work as nearly independently as possible. Therefore a small adjustable condenser, ranging from 10 to 25 mmfd., is connected between the high potential side of the first tuned circuit and the primary of the secondary. The smaller this capacity is the more selective the circuit will be, but the less sensitivity. The condenser is made adjustable to permit variation in the coupling to suit local conditions. In some instances it may be necessary to make the condenser even larger than the largest value indicated, that is, larger than 25 mmfd.

If the two r-f circuits are closely lined up, and they can be if the coupling condenser is not too large, the circuit will be adequately selective in the radio frequency level.

Selection in the intermediate frequency level is secured by three doubly tuned i-f transformers, all equal except that the secondary of the third is centertapped. These selectors nor only insure a high order of selectivity in the intermediate frequency level but they also insure a high amplification.

The Oscillator

The oscillator is a typical tuned grid as ordinarily used with the pentagrid tube. It has a 250 mmfd. grid stopping condenser and a 50,000-ohm grid leak, connected directly to the cathode of the complex tube. The tuning condenser C3 and the series padding condenser Cs are so connected that both are grounded on one side. This make its possible to use for the variable condenser one of the sections of three-gang, of which two are used for the r-f tuner. It also makes adjustment of the series condenser free from body capacity effects so that precise adjustment can be made with ease.

The inner grid of the pentagrid is used for the oscillator control electrode and the next grid is used for the anode. That is, the plate coil is connected to the second grid, which is returned to the highest voltage available.

The Detector

The 6B7 tube is not used in the regular way in this circuit. Usually the pentode is employed for audio amplification. In this case it is used as an intermediate frequency amplifier. The diode is employed in the regular manner as a detector. Since the diode has two anode plates, the secondary of the third intermediate frequency transformer is centertapped and one terminal is connected to each of the anodes. The load resistance on the rectifier, which has a value of 250,000 ohms, is connected to the centertap. This resistance takes the form of a potentiometer and is used as the manual volume control.

The d-c voltage drop in the load resistance is also used for automatic volume control, the grid returns of all the controlled tubes being connected to the centertap of the third transformer. The radio frequency filter condenser across the load resistance has a value of 250 mmfd.

The load resistance is connected to ground on one side. This fact makes the drop in the 300-ohm bias resistor for the pentode a handicap on the detector, but since the drop in the bias resistor is only 3 volts, the handicap is negligible. The connection obviates the necessity for taking any special insulation precautions in mounting the manual volume control to the metal chassis.

The A. V. C.

The automatic volume control governs the bias on control grids of the pentagrid detector, the intermediate frequency amplifier, and the pentode section of the 6B7. Thus the gain is well controlled when a high gain is not needed.

In each of the grid circuits of the controlled tubes is a filter consisting of a 0.1-megohm resistor in series with the grid lead and a 0.1 mfd. condenser in shunt. In the first circuit the condenser is connected so both the filter condenser and the tuning condenser are grounded. In the two intermediate circuits only the filter condenser is grounded.

These filters effectively prevent feed back from the detector. Yet an additional filter condenser is used between ground and the common lead to the three grids. This has a value of 0.25 mfd. As a means of preventing a short of the audio frequency signal through these four filter condensers a 0.25-megohm resistor is used in series with the common lead to the grids.

Fixed Bias

Each of the first three tubes has a bias resistance of 300 ohms. This is a normal value for these tubes and it insures a minimum bias of about 3 volts for each of the tubes. Each of the bias resistors is shunted by a condenser of 0.1 mfd.

Each of the two 37 audio amplifier tubes has a bias resistance of 1,200 ohms. In view of the high plate coupling resistance for each of these tubes, the bias obtained is a little less than it should be, in theory, but the values used are experimental. They were selected for two reasons, first. for quality, and second, for stability of the amplifier. Higher values did not give as good quality as those employed and neither did they result in a stable amplifier. No doubt, the lack of quality with the higher values of bias was due to the instability.

The usual by-pass condensers across the bias resistors have also been omitted, and they were left out for the same reasons as the resistors themselves were chosen low.

The two 48s in the output stage are biased by a single 200-ohm resistor. This is the normal value for these tubes to give a bias of 20 volts when the effective plate and screen voltage is 95 volts. The condenser across this resistor is omitted because it is not needed in push-pull stage. The indicated rating of the 200-ohm bias resistor is 3 watts because the dissipation in it will be over two watts.

Filament Circuit

All the filaments are in series. Starting with the ground and the first tube in the circuit, we first encounter the pilot light. This is shunted by a 30-ohm resistor for the pilot light takes less current then the heaters of the tubes. The open terminal, marked (1), on the first tube is supposed to be connected to the terminal of the next tube similarly marked. Then the filaments are connected in series according to the numbers of the terminals until we come to (6). This is also connected to a 70-ohm ballast resistor, rated at 15 watts, which is then connected to the positive side of the line.

The 48 tubes require 0.1 ampere more than the other tubes. Hence a resistor of 375 ohms, rated at 5 watts or more, is connected between (5) and ground. This has been determined on the assumption that the voltage drop in the pilot lamp and the shunt resistor is negligible, which is quite allowable. The extra 0.1 ampere pass through the 375-ohm resistor so that each of the eight tubes gets its required current and voltage.

The rating of the 375-ohm shunt should not be less than 5 watts, and preferably it should be 15 watts. The reason for this is that in case a tube, or the pilot lamp, should burn out or should be taken out of its socket when the power is on there will be excessive voltage drop in the 375-ohm resistor, and it might get hot enough to fuse, or at least do some damage in the set. If the rating is high, it is safe.

The line switch Sw is placed in the high voltage side of the line so that it controls not only the filament current but also the plate supply.

Filtering Supply

Very little filtering is required because the d-c supply is partly filtered as it is. However, in the common plate lead is a choke Ch2, which might be one of 30 henries and a current carrying capacity of 150 milliamperes. Or even a 15-henries would be sufficient, although the higher value is preferable.

One 4 mfd. condenser is employed across the high voltage supply. This may be an electrolytic but it is preferable to use a paper condenser for then there is no danger of damaging it in case the voltage should be applied with the wrong polarity. A 0.25 mfd. condenser is also connected across the high voltage supply, and it is placed near the oscillator. This condenser may be omitted if the 4 mfd. unit is of the paper dielectric type. If it is of the electrolytic type it should be used. The purpose of the smaller condenser is to by-pass radio frequency currents. Hence it should not be of the electrolytic type.

Another 0.25 mfd. condenser is used to by-pass the screen supply. This also will function at radio frequency.

The Audio Amplifier

A 0.01 mfd. condenser is connected in the lead from the slider of the diode load resistance to the grid of the first audio tube. Its function is to isolate the d-c in the load resistance from the grid but to pass the audio component. In series with the condenser is also an 85-millihenry choke coil to prevent the radio frequency component of the detected signal from reaching the audio amplifier.

Another condenser of 0.01 mfd. is used between the two 37 tubes. Both these 0.01 mfd. condensers should be of the mica type.

The grid leaks of the two 37 tubes are of 50,000 ohms resistance. These are unusually low, but they were selected after much experimenting on stability of the amplifier and quality of tone.

The output stage is a typical push-pull radio amplifier of the Class A type, requiring one push-pull input transformer and one push-pull output transformer, which may be built into the speaker used.

No provision is indicated for the field of the loudspeaker. However, it should be connected directly across the line and may have a resistance of between 1,200 and 1,800 ohms. Of course, it should be connected so that the single line switch control the field current as well as the plate and filament supply.

Intermediate Frequency

The circuit was built with an intermediate frequency of 175 kc. Hence the three i-f transformers should be adjustable to this frequency. These are available in both the required forms.

Since the oscillator must match the intermediate frequency, the oscillator coil should be wound for 175 kc and the broadcast band. Coils of this type are available for tuning condensers nominally of 350 mmfd. However, since all variable condensers rated at 350 mmfd. do not all have exactly the same capacity, the oscillator coil should not only have been wound for 175 kc intermediate and the broadcast band but also for the particular condenser used. This added condition is met if the two radio frequency coils and the oscillator coil have been matched. A consistent set of coils should be obtained.

Series Condenser

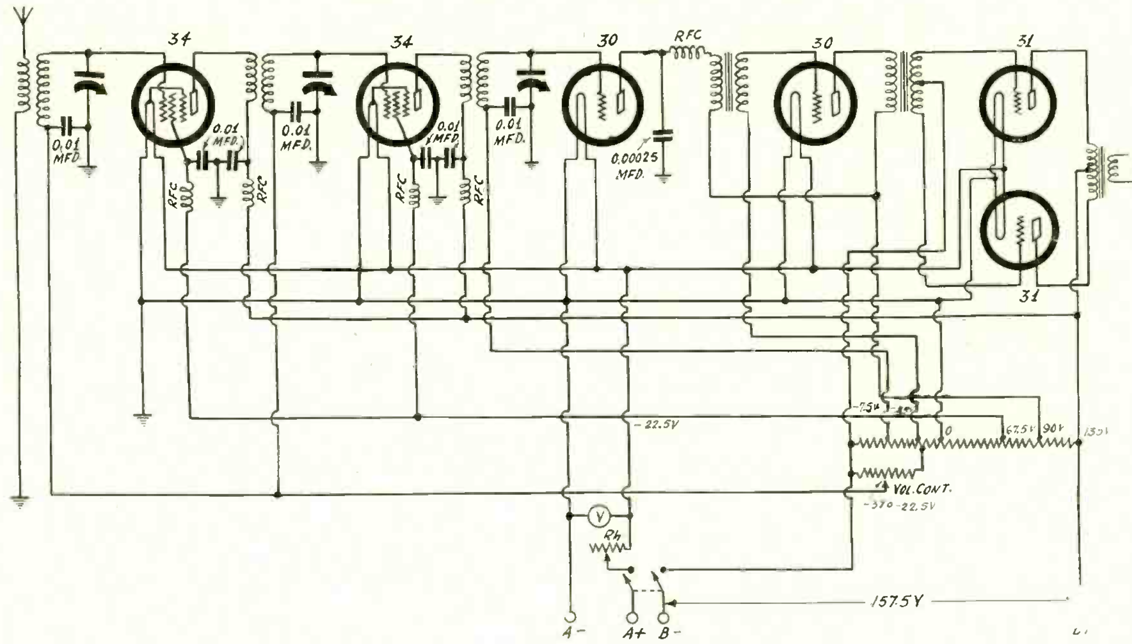
The series padding condenser should also be suitable to the intermediate frequency employed. An adjustable condenser covering the range from 700 to 1,300 mmfd. will cover the case. If a condenser of this range is not obtainable, one that covers the range from about 1,000 to 1,300 mmfd. will do in most cases. If the coils have been wound properly the required capacity in the padding condenser is between 900 and 1,000 mmfd., but in most cases a higher value is needed because the oscillator coil is slightly off. This does not prevent close padding if the padding condenser has the required capacity coverage.

The receiver was built on a regular metal chassis.

T-R-F BATTERY SET

Six-Tube Receiver, 31 Push-Pull Output

By Roger L. Meeker



The two stages of r-f amplification, using 34's, drive the 30 detector, which is followed by a 30 first audio stage and 31 push-pull output in this battery - operated receiver. The biases are proportioned to the B supply voltage by use of the bleeder resistor. The negative biases are 7.5 and 4.5 volts.

THERE ARE STILL many places where only battery operated receivers can be used. There are boats, camps, and country places where electrical lines have not yet reached or where they never can reach. The only kind of set to use in such places is a battery operated one.

The circumstances are such that a receiver to be useful and convenient in such places it must be economical in operation. It must not draw a great deal of filament current for the power expended in the filament circuit must be kept down to a low minimum. Neither should it draw a great deal of plate current, for the plate power would become excessive. Yet the set should not be such that it only can put out headset volume. It should be capable of operating a loudspeaker with fair volume.

A Suitable Circuit

A suitable circuit for this use is shown in Fig. 1. It consists of two —34 radio frequency amplifiers, a —30 detector, another —30 for audio amplification, and finally two —31's for push-pull power amplification.

The required filament current of such a receiver is just 0.5 ampere and the filament is 2 volts. It can therefore be operated on a single storage cell giving an average voltage of 2 volts. It can also be operated on dry cells provided enough of them are connected in parallel to give 0.5 ampere economically. A No. 6 dry cell is rated at 0.25 ampere. Hence two of them should be connected in parallel. But one cell gives only 1.5 volts, which is insufficient for the tubes. Therefore it is necessary to connect two cells in series, giving 3 volts. Therefore the least number of No. 6 dry cells that should be used to supply the filament power is 4, and they should be connected in series parallel. More cells in parallel would be better if the receiver is to be used frequently and many hours of the day.

Plate Current

A rheostat Rh is connected in the positive side of the filament line to take up the excess voltage when a three-volt battery is used. Since the current is 0.5 ampere and voltage to be dropped is one volt, the resistance of the rheostat should be at least 2 ohms, but one of six ohms may be used. A voltmeter is connected across the filament circuit as an aid in making adjustments. This meter should read 2 volts, and it should be left across the circuit at all times as a constant reminder that the filament voltage should be kept at 2 volts.

The plate current of the set is about 27 milliamperes, assuming all voltages are normal. This current is so small that it can be supplied by a moderately large dry cell battery. If the circuit is to be used every day for several hours a day, it will be more economical to use a large dry cell battery.

The Tuners

The circuit is a t-r-f type, employs three identical tuned circuits, and is taken from the RCA Radiotron-E. T. Cunningham Tube Manual. Condensers and coils are typical and they need not be specified, except that a three-gang condenser with coils to match should be used.

With each tuner is a 0.01 mfd. condenser, which serves to by-pass the C voltage supply. They permit grounding the rotors of the condensers and at the same time give each grid its required negative bias.

Other filters are used in the plate circuits to confine the signal voltage to its proper places. Thus there is a 0.01 mfd. condenser from each screen to ground, with a radio frequency choke, RFC, in each screen lead. A similar filter, that is, a shunt condenser and a series choke, is put in each plate circuit of the radio frequency tubes. Suitable values for the chokes is 85 millihenries, or any value between 10 and 125 millihenries.

In the plate circuit of the —30 detector is a 0.00025 mfd. by-pass condenser and in the plate lead to the audio transformer is another radio frequency choke. This choke can also be of the same value as the others. Its value is not at all critical.

The Audio Amplifier

The audio amplifier consists of two stages, one single sided and one push-pull. First we have a simple audio coupling transformer between the detector and the audio voltage amplifier. Then we have a push-pull input transformer between the —30 and the push-pull stage. Following the push-pull tubes is a push-pull output transformer, which may be built into the speaker.

The most suitable speaker for this set is a permanent field dynamic type. If such a speaker cannot be obtained the next best is a magnetic speaker. In either case the transformer should be designed for the two —31 tubes. The optimum load resistance for one of these tubes is 7,000 ohms, or 14,000 ohms for the two in push-pull.

Plate Voltages

The total voltage of the plate battery is 157.5 volts. This is divided between the plate and the grid circuits. The maximum available for the grids is 22.5 volts, leaving 135 volts for the plates. This voltage is applied to the plates of the two push-pull tubes and also to those of the —34s. The plates of the two —30 tubes is 90 volts, obtained by returning the plates to a point on the voltage divider. The screens of the two —34 tubes get 67.5 volts, and the screens are connected to a lower point on the voltage divider.

At a point on the voltage divider 135 volts from the positive end the negative side of all the filaments is connected. That part of the voltage divider to the left of this point, which is marked O, is used for grid bias. The grid return of the —30 audio amplifier is connected to a point 4.5 volts below the zero point, and the grid return of the detector to a point 7.5 volts below. The grid returns of the two-push-pull tubes is connected to the negative end of the voltage divider, which is 22.5 volts below the zero point.

For bias on the two radio frequency amplifiers another arrangement is used. A high resistance potentiometer is connected between the negative end of the voltage divider and at a point 3 volts below the zero point. The joined grid returns of the two tubes are then connected to the slider. By this means it is possible to vary the grid bias on the radio frequency amplifiers between 3 volts minus

(*Continued on next page*)

TWO BATTERY AMPLIFIERS

AUDIO CHANNELS, ONE PUSH-PULL, OTHER SINGLE-SIDED FOR OPTIONAL USE IN T-R-F RECEIVER

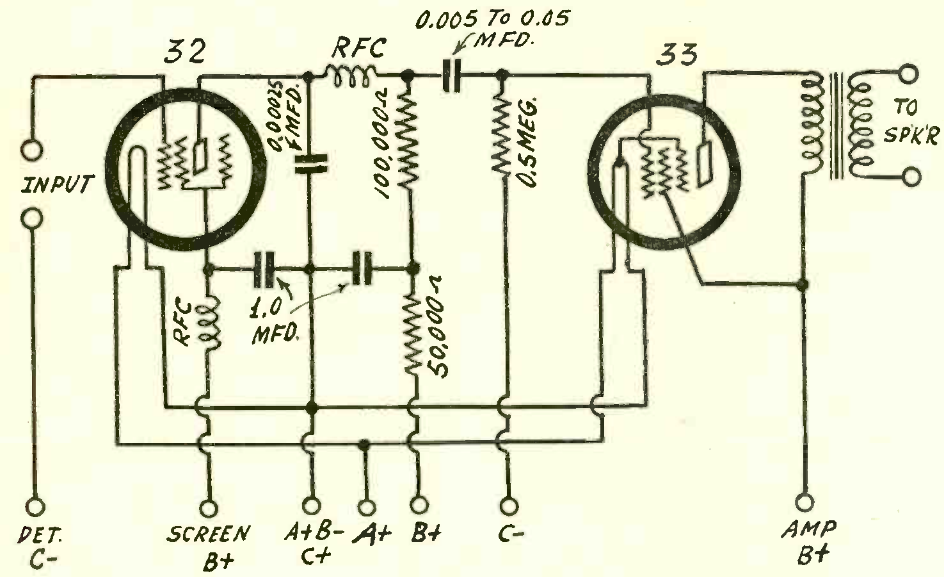


FIG. 2

This is the circuit of an optional detector and audio frequency amplifier which may be substituted for the detector and audio amplifier in Fig. 1

(*Continued from preceding page*)
to 22.5 volts minus. This variable then serves as a volume control, and it governs the gain in the same manner as an automatic volume control does, except that in this case it is done manually.

Limiting Bleeder Current

In a battery operated set it is important not to draw much current from the plate battery, as has been stated. Now the voltage divider is directly across the battery, and for that reason it will draw current. To limit this current to a low value, the total resistance in the voltage divider should be large. Let us limit the bleeder current to 5 milliamperes and then see what the various resistance sections in the voltage divider should be.

The current to the plate of the first audio amplifier is 2.5 milliamperes and that to the two screens 2 milliamperes. The bleeder current has been assumed to be 5 milliamperes. We can neglect the current to the detector. Hence the current in the 90-135 volt sections is 9.5 milliamperes. The drop in the resistance is 45 volts. Hence the resistance should be 4,740 ohms. In the next section the current is 7 milliamperes and the drop is 22.5 volts. Hence the resistance between the 67.5 and 90 volt taps should be 3,220 ohms. In the section between the zero and 67.5 volt points the current is just 5 milliamperes and the drop, of course, is 67.5 volts. Hence this resistance should be 13,500 ohms. Therefore on the positive side of the voltage divider we have a total resistance of 21,460 ohms.

Grid Bias Division

In the three-volt section of the bias resistance the current is 31.1 milliamperes, or 31.2, if we allow a current of 0.1 milliampere for the detector. Hence this part of the resistance should be 96.3 ohms. No harm, of course, results if it is made 100 ohms. Now let us assume that the resistance of the potentiometer across the rest of the bias resistance is 250,000 ohms. It draws so little current that it may be neglected. Hence the same current flows through the rest of the bias resistance. Therefore the resistance between the 3 and 4.5 volt points should be 48 ohms. Between the 4.5 and 7.5 volt taps the resistance should be 96.3 ohms and that between the 7.5 and 22.5 volt taps should be 480 ohms.

Special Switch

Of course, it is not necessary to use these exact values and they are given only as an aid in making the adjustments. A 750-ohm resistor that can be tapped at any point would be suitable for the grid bias voltage divider. Or fixed resistances of the nearest values can be used, connected in series. Thus there would be one 50-ohm, two 100-ohm, and one 500-ohm resistors.

Since the bleeder resistance is across the entire plate battery it is necessary to have a switch in series with the resistance so that the circuit can be opened when the receiver is not in use. This switch may well be combined with the filament switch. Hence we have a double pole, single throw switch, one section in the positive leg of the filament circuit and the other in the negative leg of the high voltage battery.

An Optional Detector-Amplifier

When push-pull output is not desired in the battery operated circuit, the detector and audio amplifier may take the form of the circuit in Fig. 2. A 32 screen grid tube is used in place of the 30, resistance coupling instead of transformer, and a single 33 output tube in place of the amplifier

The output power of the single 33 is greater than that of the push-pull stage using 31 tubes. Indeed, it is nearly twice as great, assuming that in each case he grids are driven to the limit. When the detector and amplifier shown in Fig. 2 is used there will be only four tubes in the circuit. Yet these four tubes will make the set nearly as sensitive as the six-tube circuit, due to the high detecting efficiency of the 32 and the high amplification efficiency of the 33.

Filament Current Economy

The four-tube circuit will also be more economical in respect to filament current. The first three tubes will take 0.18 ampere and the 33 will take 0.25 ampere, or the entire four-tube set will take 0.44 ampere. There is a saving of 60 milliamperes. There will also be an appreciable saving in plate current. While the 33 tube will take more current than the two 31s, the detector will take less, due to the fact that resistance coupling is used, and, of course, the omitted tube will not take any. The difference, however, is less than 2 milliamperes.

Voltage Adjustments

Different grid bias voltages must be used on the amplifier in Fig. 2. The 32 detector takes a bias of 6 volts and the power pentode a bias of 13.5 volts.

The plate and screen of the 33 take the full 135 volts and so does the plate of the 32 detector, but this is applied through high resistances. The screen of the 32 is connected to the 67.5-volt tap on the voltage divider.

If the circuit in Fig. 2 is to be substituted for the detector and amplifier in Fig. 1, a change is necessary in Fig. 2, for this circuit presumes that batteries are to be used to supply the bias, as is indicated by C plus designation at the A plus terminal. Connect the filaments in parallel and ignore the various designations at the terminals in Fig. 2. This connects the negative side of the filaments to point zero on the voltage divider. Now connect "Det. C minus" to a point six volts on the negative side of the zero point and the point "C minus" to a point 13.5 volts below the zero point. Connect "Amp B plus" and "B plus" to the highest positive voltage point and "Screen B plus" to 67.5 volts.

Speaker Impedance

The 22.5, 7.5, and 4.5-volt taps on the grid bias voltage divider are not needed. The 4.5-volt tap might be omitted entirely and the other two might be moved to the required values. These relocations can best be done by making the resistance between the 3-volt and the 6-volt taps 50 ohms and the resistance between the 6-volt and the 13.5-volt taps 125 ohms.

The speaker in this case should have a transformer that has an impedance of 7,000 ohms.

All the values required in the circuit of Fig. 2 are given on the diagram, except those of the two radio frequency chokes. Each may be an 85-millihenry inductance.

The two input terminals in Fig. 2 should be connected across the secondary of the last radio frequency transformer in Fig. 1, not across the tuning condenser.

Single Dial Calibration for Wide Band of Waves

Wide frequency range sets may be readily calibrated if the same frequency ratio is maintained. Suppose the broadcast band is to be covered. A ratio of 3-to-1 would more than fulfill the requirement, i.e., 540-1,500 kc required, 540-1,620 kc attained. A dial thus calibrated for that band would do for the other bands. So Band 2 would require multiplication of scale frequencies by 3 (for 1,620-4,500 kc range), Band 3 would require multiplication by 9, etc.

The capacity ratio is the square of the frequency ratio, or 9-to-1, so the succeeding inductances would be the reciprocal of the capacity ratio, or one-ninth.

Of course for very short waves the frequency ratio should be less than 3-to-1, but whatever it is, it would be the same for all bands, for such dial-calibration simplicity.

COMPARISON OF COILS

Solenoids, Honeycombs, Litz and Solid Wire Results Stated

By Herman Bernard

THE popularity of the solenoid for radio-frequency tuning for the broadcast band and higher frequencies is due to the superiority of this type of construction in keeping the radio-frequency resistance low. A greater inductance is attainable with less wire length than by other methods, including honeycomb winding, and the choice lies with solenoids despite the extra room required on the chasis, and even amid a rage for compactness.

The almost standard diameter of shield used for solenoids for the broadcast band is 2 1/16 inches O.D., and the coils themselves are wound on 1-inch diameter tubing, or, occasionally, ¾-inch diameter. It is possible to use still a smaller diameter, but the wire has to be finer, so that a sufficient number of turns can be obtained to achieve the desired inductance without having an extra-long coil.

The length of the winding space of the coil, or so-called axial length, affects the performance. The general rule is, approximately, that the diameter of the coil, center of wire to center of wire, should be 2.5 times the axial length. As the shape factor becomes disproportionately smaller, that is, the winding length becomes greater in respect to the diameter, the radio-frequency resistance of the coil increases. The increase, however, is small for changes up to axial lengths equal to the diameter.

Shielded Plug-ins

As a practical experiment, coils were wound on ⅜-inch diameter dowel, No. 26 single cotton covered wire, honeycomb style, for the radio-frequency and oscillator levels of a broadcast superheterodyne. The selectivity was far lower and gain likewise, as compared to regular solenoids. In fact, the solenoids that had to be removed from the set were replaced after the test proved that process essential.

However, it is obvious that for shorter than broadcast waves, since fewer turns are required, the smaller diameter tubing could be used for more compact solenoid coils, and perhaps shields of 1.5-inch diameter utilized. A suitable method of construction would be to turn down a tube base until the shield fits snugly over it, and anchor the coil to the tube base prongs. This could be done if there were lugs on the coil form, with stiff wire connections from lugs to the prongs of the base, through the inside of the base.

If there is any space between the shield and the tube base that could be utilized it would be practical to use cement. Then, since the pins of the base have air-tight and water-tight connections, the coils themselves would be air-tight and water-tight.

Protection of Coil

The advantage of having coils safeguarded against humidity changes is that the inductance remains constant, especially if the form on whch the coil is wound is of some material more acceptable than lacquered cardboard so prevalent in commercial type of coils. Special insulating material such as lavite, isolantite, R-31 and the like complete the safeguard.

Besides, the shield offers a protection to the coil against damage due to dropping or abrasion, and even again change of inductance due to slight shifting of the location of the wire due to handling.

In the case of the tube-base type coil just discussed, since there is a shield and the shield must be grounded, it is not sufficient to rely on the contact of the bottom of the shield with a metal chassis when the coil is pressed into a socket. Therefore a lug may be bent to a right angle at the bottom, the pin of the base intended for grid return passed through the hole in the lug, and the bent blade of the lug pressed between outside of tube base and inside of shield as the shield is put on. As there would be some air space by this method, use of cement would become essential. However, the tube base has no relation to the coil proper, which is wound on a separate form or dowel, and therefore the presence of cement is not at all deleterious.

Stabilization Aspects

All this refers to the introduction of some stability in the coil itself, that is, insurance of against changes in inductance. If the coil is to be used at a radio-frequency level, and if the volume control does not change the bias on r-f tubes, the general frequency stability should be good in this channel. However, if the receiver is a superheterodyne it has a local oscillator, and the coil precaution, while helpful, in insufficient alone, because all oscillators have a tendency to frequency-drifting, unless stabilized. The introduction of stabilized oscillators in broadcast receivers is not yet a fact, but no doubt will become so in the fullness of time.

The grid-leak-condenser type oscillator, one of the most stable of the simpler varieties, become unstable at about the geometric mean of the tuning range, assuming around 2-to-1 or greater frequency ratio and the usual low minimum capacity. The low minimum is required in all present-day examples, either if a tracking or a padded section is used, but if the oscillator is separately tuned, then, since the ratio need be only around 2-to-1, a large minimum may be purposely introduced, and thus improve stability. However, even with the low minimum, the grid current type oscillator is very stable at the higher capacity settings, usually from the middle or the dial up (in a capacity sense).

Lower Frequencies

The chief trouble with the grid current type oscillator is the generation of harmonics. Even if there is some radio-frequency tuning, say, two stages, powerful locals will get by this tuning system sufficiently to cause response to a much higher frequency than expected. If there were no oscillator harmonics this trouble could be avoided, so a frequency-stabilized oscillator of the "infinite impedance" type would be preferable (no grid current). A constant-amplitude oscillator, properly stabilized, would seem to fill the requirement, since in the random types of oscillators the amplitude of oscillation varies considerably even over a 2-to-1 tuning ratio.

Honeycomb coils are useful as the frequency becomes lower, that is, in the commercial intermediate frequency bands and below, and besides they are compact, thus serving two purposes well. They may be wound with Litz wire for these frequencies, as the gain is improved in that way.

Litz wire for solenoids for the broadcast band has the effect of equalizing the amplification, because of the greatly increased resistance at the higher frequencies of the band, but a consideration is the reduced selectivity at the higher frequencies, and therefore solid wire is probably preferable.

Intermediate Coils

The general practice is to use honeycomb coils in intermediate transformers, and the more expensive types of transformers have Litz wire. The transformers are of two types: one, with secondary alone tuned, other with both secondary and primary tuned.

Loose coupling must prevail where both primary and secondary are tuned, and the result is an inevitable band-pass filter. It is not possible to get a sharp peak with a doubly-tuned transformer, and the looser the coupling the closer the two humps are together. At the point where they might be considered in theory to merge the coupling would be so scant that the gain from the stage would be very small indeed. And in fact there would still be two humps, only so close together it would be hard to distinguish them.

In practice they are not so close together, as a 10 kc band width is required for quality purposes, anyway. If the band is made smaller, then some compensation has to be introduced in the audio channel, that is, attenuation of the low audio frequencies, because the high selectivity reduces the strength of the higher audio component.

Single Winding Tuned

While singly-tuned transformers are not so widely used, it is a fact that the selectivity for equal gain may be just as great or even greater than by the band-pass filter method. Indeed, the theory of the circuit indicates that the selectivity would be greater for equal gain, because of the "pointed peak" possibility where two or three transformers are used.

When only one circuit is tuned, it would naturally be the grid circuit, but whatever circuit it is, the coupling between primary and secondary would be much tighter than by the doubly-tuned method.

An exception to the rule about tuning the grid circuit may exist in the intermediate transformer fed by the modulator, as it is advisable to have a sufficient capacity in the plate circuit to bypass stray frequencies higher than intermediate frequency. A minimum capacity of 50 mmfd. is commonly recommended, but if the tuning condenser itself is in this circuit, then of course the capacity will be much greater than the prescribed minimum.

Incomplete Shielding

The superheterodyne as a circuit, because of high sensitivity, has its coil problem closely related to shielding. As a general indication, if a set squeals at the higher frequencies (assuming tracking is satisfactory), this condition is due to capacity feedback, and if it squeals at the low frequencies it is due to inductive feedback. However, inductive feedback may aid the capacity type even at the high frequency end. So pickup by coils, despite some measure of shielding, becomes serious all over the dial, and espe-

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REDUCTION OF NOISE

HIGH GAIN IN FIRST TUBE, PARALLELING OF VALVES IN THAT STAGE, VOLUME CONTROL IN SUBSEQUENT AMPLIFIER, AID SOLUTION

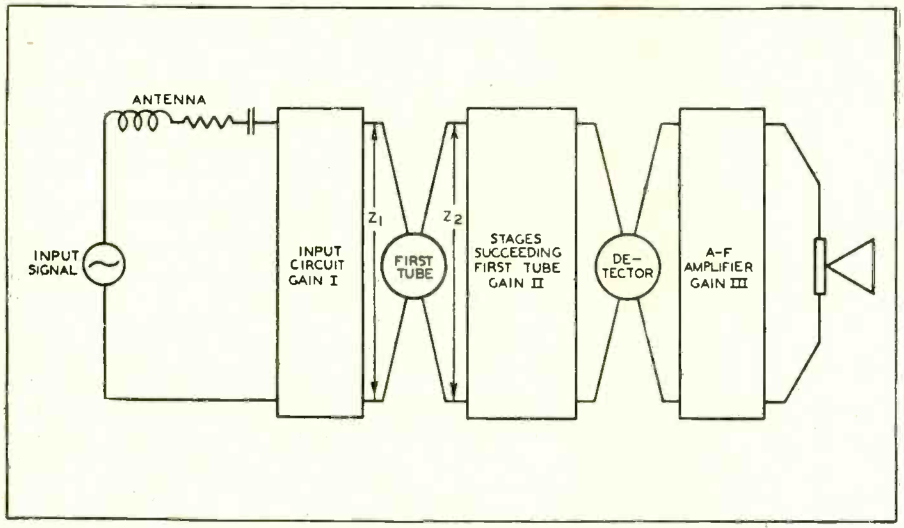


FIG. 1

A block diagram representing a receiver. The increase of the signal voltage from zero increases the audio output voltage increases at first by the square law and later by the linear law.

THE effect of circuit constants on the noise output of a radio receiver is discussed in this bulletin. It is well known that extraneous noise in the output of a radio receiver may be caused in several different ways. A few of these are:

(1) Atmospheric static
(2) Power supply noise
(3) Man-made static
(4) Poor connections
(5) Defective or poor quality parts

There are, however, other noise sources which persistently remain after the above sources have been eliminated. These become evident as a steady hissing sound when the receiver sensitivity is high. When an attempt is made to eliminate these sources of noise, it is found that a certain minimum remains which approaches the value predicted theoretically as due to thermal agitation and "shot" effect.

Noise in Electron Current

Thermal-agitation noise is supposed to be due to the random movements of electrons within a conductor. It has no particular frequency, but consists of a series of pulses.

Shot-effect noise is produced by the emission of electrons. Electricity is not an infinitely fine grained fluid, but consists of discrete particles, that is, electrons. From the theory of emission it can be predicted that a certain noise current is present in the electron current. This noise current consists of a series of pulses similar to the thermal-agitation effect.

On a purely theoretical basis, relations have been derived for calculating both the thermal-agitation voltage and the shot-effect voltage. Measurements show agreement between calculated and measured values.

Theoretical Relation

The theoretical relation for thermal agitation is:

$$\overline{e^2} = 5.49 \times 10^{-23}\ TZ\ df$$

$$\overline{e} = 7.4 \times 10^{-12}\ T^{1/2}\ df^{1/2}\ Z^{1/2}$$

where,

$\overline{e^2}$ = the mean square thermal-agitation voltage
T = the absolute temperature of the conductor = (273 + °C)
Z = the resistance of the conductor or the resonant impedance of a tuned circuit
df = the frequency band width factor

The theoretical relation for shot effect (without space charge) is:

$$\overline{E^2} = 3.18 \times 10^{-19}\ I\ Z^2\ df$$

$$\overline{E} = 5.63 \times 10^{-10}\ I^{1/2}\ Z\ df$$

where,

$\overline{E^2}$ = the mean square shot voltage
I = the electron current
Z = the resonance impedance of the tuned circuit
df = the frequency band width factor

At normal filament voltage, a vacuum tube has sufficient space charge so that the shot voltage is reduced to about one-half of the value obtained without space charge.

Tabulation of Voltages

From these formulas, assuming a temperature of 27°C, a band width factor of 10,000 and a plate current of 4 milliamperes, the theoretical values for the thermal-agitation voltage and the shot voltage are as follows:

Load Impedance Z Ohms	Shot Voltage Without Space Charge $\overline{E}$ Volts RMS	Shot Voltage With Space Charge $\overline{E}$/2 Volts RMS	Thermal Agitation $\overline{e}$ Volts RMS
1,000	3.56×10^{-6}	2.19×10^{-6}	0.40×10^{-6}
2,000	7.12	3.56	0.57
5,000	17.8	8.90	0.90
10,000	35.6	17.80	1.28
20,000	71.2	35.6	1.81
30,000	107.	53.6	2.21
40,000	143.	71.6	2.55
50,000	178.	89.0	2.85
75,000	267.	133.6	3.50
100,000	356.	178.0	4.04
150,000	535.	268.	4.94
200,000	713.	356.	5.71
500,000	1,780.	890.	9.03

Fig. 1 shows a block diagram representing a receiver. Assume a standard signal applied to the receiver input. When the signal voltage is increased from Zero, the a-f output volts increase first as the square of the input voltage, then linearly with input voltage. This is true for diodes as well as other types of detectors. The range of square-law increase will depend on the type of detector. For a diode operated with a large input signal, the square-law range may be entirely negligible. In more modern receivers there is sufficient a-f gain between the diode detector and the tube so that the output will be according to the square law at the 50-milliwatt output level. In general, we may say then, that at the initial noise level, a detector will follow the square law.

Frequently, a receiver has no noticeable noise until a carrier is tuned in. Fig. 2 shows how the noise-output voltage and the a-f output voltage increase as the carrier voltage is increased.

In the square-law range, the noise-output volts increase linearly while the a-f output increases according to the square law. In the linear range the noise-output volts are constant, while the a-f output volts increase linearly.

Proportionality Prevails

The laws of increase of noise and a-f voltage are different. As the signal is increased, both carrier volts and sideband volts increase proportionately. The noise-input volts existing independent of signal appear as a constant sideband voltage. In both instances the output is proportional to the product of the carrier voltage and the sideband voltage.

As the detection becomes linear the output is no longer proportional to the product of the voltages, but is directly proportional to the smaller of the two voltages and is independent of the magnitude of the larger voltage. Since the carrier is the larger volt-

Comparison of Coils

(Continued from preceding page)

cially if the set is worked in a locality where there are several locals that come in strong.

To solve the shielding problem it is necessary to use stage shielding. This has almost passed out of the picture since the depression, but will come back again as the sternness of the requirements is realized. A stage shield consists of a shielded coil, shielded choke, plate bypass capacity, tube and socket all contained in a shield, with leads shielded as they emerge for heater, filament, B plus and tuning condenser connections.

Advantages Stated

Stage shielding enables pressing the gain to much higher levels without any oscillation, and also improves the selectivity, thus also eliminating heterodyne interference in supers, due to the confinement of the input to the antenna lead. With imperfect shielding, as stated, the coils, leads, etc., act as loops and capacity antennas, and some energy gets into a tube without the benefit of prior tuning.

tage, increasing it does not increase the noise-output voltage. The increase in a-f output voltage results because the sideband voltage is increased.

It is interesting to note that the ratio of noise-output volts to a-f volts varies inversely as the signal-input voltage throughout the square law and linear range of operation.

It is evident that as the signal is increased, the noise will become a negligible factor and that as the signal decreases the noise will eventually become greater than the a-f output. This latter condition may occur at an inaudible level.

The noise voltage usually originates either in the grid circuit or in the plate circuit of the first tube. Under conditions of very low gain in these circuits, the second tube may also contribute to the noise.

Since the noise is a series of pulses, it excites the associated circuits in the frequency range to which they respond. It is amplified by the succeeding stages provided they are in tune with the initial circuit either directly or through the medium of a frequency converter. For example, if the noise originates as a band of radio frequencies, it is changed by the converter just as any other signal is changed to the corresponding band of intermediate frequencies. Thus, the noise voltage appears at the detector input and also in the a-f output, although it may be inaudible until sufficient carrier voltage is supplied at the detector input.

Effect of Circuit Constants

Refer to Fig. 1 and suppose the input to the first tube is short-circuited so that only plate-circuit noise is amplified.

Then, by adjusting Gain II the noise-voltage input to the detector may be made any value either large or small.

Changing the plate-load impedance Z_2 has the same effect as changing Gain II. Both noise and signal are changed in the same ratio.

Cutting the frequency band width either in the i-f or a-f stages gives a satisfactory apparent reduction in noise, since the ear is most sensitive to high frequencies. Of course, the higher a-f components of the signal are reduced.

If the noise-volts input to the detector is low enough so that the detector becomes linear before the noise voltage reaches the audible level (approx. 0.1 volt across 4,000 ohms), no amount of increase in signal will produce audible noise. This is evident by referring to the curves of Fig. 2.

In the theoretical tabulation, the shot voltage appears large relative to the thermal-agitation voltage. From Fig. 1, it is evident that when the gain in the first tube is large, the plate-circuit noise voltage will be negligible in comparison with the grid-circuit noise voltage. For example, the tabulation shows for 75,000 ohms resonant impedance that the shot voltage is 133.6 microvolts and the thermal-agitation voltage, 3.5 microvolts. Assume the thermal-agitation voltage appears in the grid circuit and the shot voltage in the plate circuit. If the tube gain is 70, the plate-circuit noise is equivalent to less than 2 microvolts in the grid circuit. In this case, the 3.5 microvolts of thermal agitation in the input circuit will cause more of the noise in the output.

When Gain I is large, the signal is increased with respect to the noise at the first grid.

Choice of Tube and Operating Voltages

Theory shows that the shot voltage increases in proportion to the square root of the plate current of a tube.

The variation of plate-circuit noise voltage with plate current is found to change in proportion to the square root of the plate current and to be almost independent of the plate, screen and grid voltage, and of whether or not the tube has oscillator-input voltage on it.

High gain in the first tube gives low output noise for any receiver sensitivity. For example, in a superheterodyne receiver, a first detector tube gives less gain for the same plate current than an amplifier tube. Hence, for a given sensitivity, a set which uses a first detector in the first tube position will have more noise than a similar set which uses an amplifier.

When gain is controlled in the first tube, the gain decreases faster than the square root of the plate current. That is, noise and gain are both decreased, but the gain is decreased more than the noise is decreased. It would be advantageous then, as regards noise, to secure this decrease in gain in the succeeding stages.

If the first tube can be operated at a fixed bias with small signal input, the lowest noise will be obtained by choosing a tube with high gain and low plate current, and by operating this tube at the highest value of plate current permissible. Operating with high plate current increases the gain more than it increases the noise. It is assumed that the plate resistance is not reduced enough to effect the results.

Similarly, if two or more tubes are put in parallel and the plate resistance remains high enough to be negligible, the gain will be increased n times, where n equals the number of tubes in parallel. The plate current is increased n times, also, and the noise is increased by the square root of n. The noise, for the same overall sensitivity, is thus reduced by a factor of one over the square root of n.

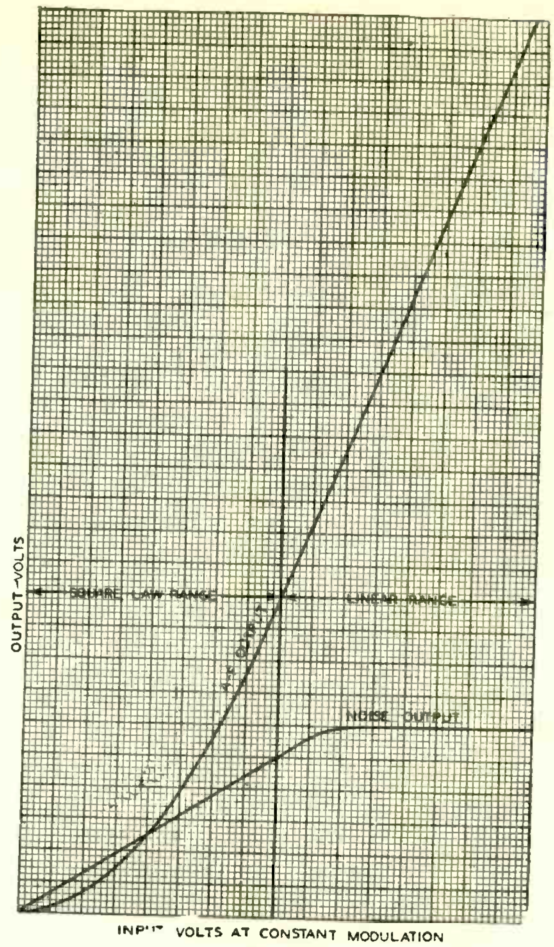


FIG. 2
How the noise output voltage and the audio output voltage increase as the carrier voltage is increased.

Value of Transposition Leadin

Is there any advantage in using transposed leadins for radio receivers? Surely, and users are beginning to realize their advantages. These devices are not equally advantageous in all locations, however.

Consider the country or a residential district where all the houses are low. The antenna is put on the roof or on a pole outside the house. There is comparatively little chance of electrical noise being picked up by the leadin in such cases, and the transposed leadin is not essential. This, however, does not say that it is not advantageous. There may be electrical disturbances in the second story and these might be picked up by the leadin. If the leadin were transposed there would be an improvement.

The proper sphere for these devices is in tall buildings where the antenna is on the roof and where the leadin must pass several floors down to the radio receiver. There is a large number of electrical disturbance sources. There are all the lights, refrigerators, toasters, vacuum cleaners, and a hundred other appliances. Each of these is at one time or other a source of interference with the radio receiver. If the leadin **is** transposed at frequent intervals on its way down past all these disturbances, it will not pick up any of the interfering noises, and reception will be comparatively free of them.

The transposed leadin is in effect a transmission line from the antenna to the receiver. If this line were constructed of a "hot" conductor inside a grounded metal sheath, no noise could be picked up on the way. Two parallel wires also make a transmission line, but this line does pick up some interference—unless it is transposed at frequent intervals. One section of such a transposed line will pick up a certain amount of noise. The next section will pick up an equal amount of the noise, but it will do it in the opposite phase, so that the pick ups of the two sections will neutralize each other. If the whole line is transposed frequently, the neutralization will be better than if there is only one transposition.

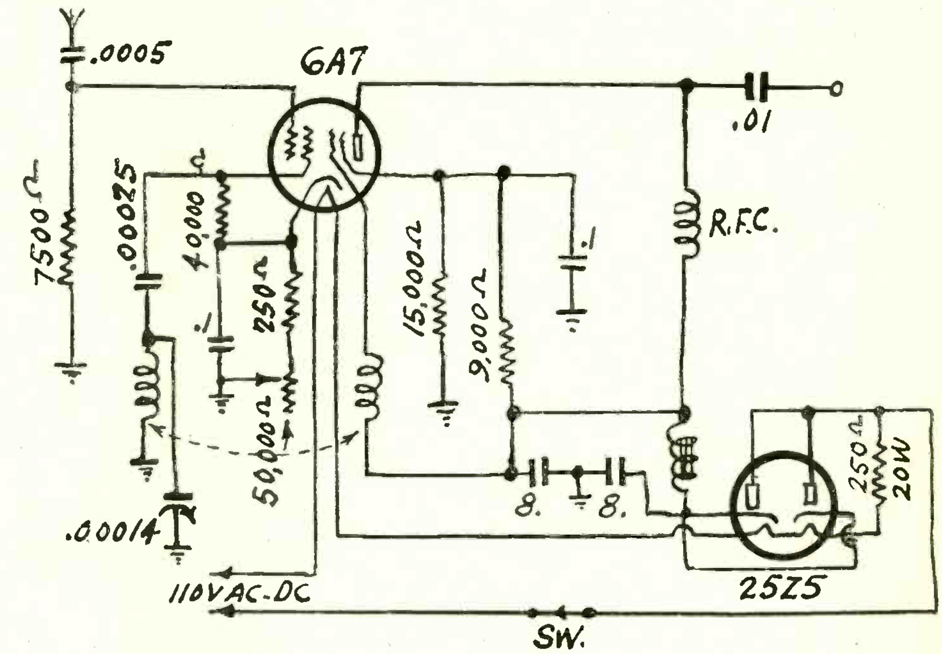
A Short-Wave Converter for A-C and D-C Use

By Herman Cosman
Try-Mo Radio Company

THE pentagrid converter tube enables the ready construction of a single-tube short-wave converter circuit, and if both a-c and d-c uses are to be enjoyed, then a 25Z5 is added. The circuit for this combination use, representing the Baird converter, is shown herewith.

Using plug-in coils, the short-wave range, 15 to 200 meters, may be covered, and if a fairly high intermediate frequency is used (that is, some broadcast frequency near that extreme of the dial), the single-tuned converter circuit will be sufficient.

As there is untuned input to the modulation section, the resultant selectivity is due only to that yielded by the broadcast receiver, and likewise the sensitivity depends solely on the receiver. The short-wave converter simply mixes an untuned desired frequency with the oscillator frequency to yield the intermediate frequency in the output of the 6A7.



Circuit diagram of the Baird short-wave converter. A single tube is used for the mixing process, and a single tuned circuit, that of the oscillator, is employed, thus making for simplicity. The converter works on a. c. or d. c. For a. c., any commercial frequency may be used. The normal line voltage range is 105-120 volts. See front cover illustration of built-up model.

Tune Carefully

The method of using the converter is, first, to remove the aerial from the broadcast receiver and connect it instead to the antenna lead of the converter (usually red), and connect the output lead of the converter (usually brown) to the vacated antenna post of the receiver. Turn on the set and also the converter.

The single condenser simplifies tuning, still, the frequencies being high, very close tuning has to be done to bring in a station as it should come in. This prevails with practically all short-wave outfits.

Plug-in coils are used, as the relative frequencies of the bands may be judged from a view of the coils. Those with the least wire are for the highest frequencies.

If the same intermediate frequency is used all the time, a calibration made for the coil-condenser combinations in the converter will hold for future reference.

The theory of the circuit is as follows: All waves are brought in by the antenna, but to favor the higher frequencies a series capacity is used. This is in the circuit, 0.0005 mfd. The untuned frequencies are put into the control grid of the 6A7. The oscillator grid is tuned, and inductively related to it is the feedback winding, so that the circuit will oscillate. If it fails to do so, reverse the connections at the socket for the secondary winding, putting to ground the one formerly to grid, and to grid the one formerly to ground.

Two Settings

There is electron coupling due to the unison of the streams of the modulator and oscillator in the common cathode sleeve, and therefore the oscillator will beat with all the incoming waves, but only the mixture frequency desired will be accepted by the intermediate amplifier (your receiver).

The relationship of the intermediate frequency to the desired frequency is the simple one—the difference between the modulator and the oscillator frequencies. It is of course possible that for the higher frequencies one station will come in at two different points on the converter dial, representing in one instance a modulator frequency higher than the oscillator frequency, and in the other an oscillator frequency higher than the modulator, though always the same difference. Sometimes it is advantageous to have this choice, as interference heard one way disappears the other, but in general the more favorable setting, if there is an option, is to have the oscillator frequency higher. This is easily ascertained, as it represents the setting that requires less capacity of the tuning condenser than the other method.

Tuning Reflected

A radio-frequency choke of high inductance in the output circuit makes coupling to the primary of the transformer in the set's antenna circuit satisfactory. This choke may be in the 2 or 3 millihenry class for satisfactory results, and of course may be higher. The stopping condenser is 0.01 mfd., and the transfer is good therefore at all the frequencies concerned.

The tuning of the first stage of the set is reflected back into the converter by the method of coupling converter output to receiver input, because the plate-to-ground circuit of the converter is substantially in parallel with the grid-to-ground circuit of the receiver. This is true because of the coupling media. The proper safeguards against d-c shorting are taken, of course, since "ground" is a radio-frequency description in this instance, and B plus therefore is at an r-f ground potential.

A B supply choke (and it need be only a small one) is included, and there are two 8 mfd. condensers, both in one container, these used for filtration.

Hint for Low Impedance

Sometimes operation is improved if a mica or paper condenser of some convenient capacity, say, 0.006 mfd. up, is used from the output of the B choke (B plus feed to the 6A7), because the bypassing effect of the 8 mfd. may not be sufficient to the high frequencies involved. Sometimes electrolytic condensers have a fairly high reactance to high radio frequencies, so the small extra capacity is recommended for trial.

There is a steady-bias resistor of 250 ohms in the cathode leg of the 6F7, but a series rheostat enables control of volume from the converter itself, which is handy, for otherwise one would have to go over to the set every time the volume is to be changed.

Nevertheless, either or both of the volume control methods may be used, and it is sometimes advantageous to have the set control in mind, if the receiver tends to become a bit oscillatory, due to the removal of the aerial from its usual position at the set to the input of the converter. Of course, the volume should not be reduced by means of the converter control to such a low level that the resultant high bias tends to stop the 6A7 from oscillating.

In point of fact, the bias on the 6A7 remains practically independent of the series resistor and is due to grid current through the 40,000-ohm resistor. The 0.00025 mfd. unit next to the 0.04 meg. resistor is the grid condenser. It is shown that the grid is returned through the leak to cathode, and since bias is measured between grid and cathode, the negative electrons accumulating at the grid because unable to escape through the condenser are forced through the leak, and the rate at which they go through the leak, that is, current value, determines the bias voltage, which is also always negative.

Polarity Considered

The high-wattage 250-ohm resistor (not to be confused with the 1-watt biasing resistor) serves to keep the heater voltage of the rectifier and the mixer tubes at the correct value. The wattage should be at least 20 watts.

The voltage drop in the rectifier heater is needed even on d. c., when the tube is not functioning except as a resistor, but this pre-

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Close Accuracy in I-F Measurement

In the October 28th issue (last week) a method for obtaining intermediate frequencies from beats between broadcast stations was described. It was shown that the percentage of error in the standard thus obtained should not exceed more than 0.2 per cent. To obtain this accuracy the highest frequency broadcast stations were selected and the greatest allowable deviation assumed. In most cases the accuracy is much higher and consequently the deviation in the standard heterodyne will be considerably less.

Multiplying Error

If a pair of lower frequency stations be selected to beat the percentage error will be still less, and if two stations known to have a very high standard of accuracy be selected, the error will be vanishingly small. For example, we may select two stations which do not deviate more than 5 cycles from the asigned frequency, when the error would be only one tenth of what it was before. There is no difficulty about the accuracy of the standard as long as we want it only for tuning intermediate frequency circuits.

For a given absolute error in the frequency of the calibrated oscillator the error on the harmonics will be multiplied by the order of the harmonic, but there will be no change in the percentage of error. But it is the absolute error that counts in certain cases. We may, for instance, attempt to get a 1,500 kc signal by using the 30th harmonic of the 50 cycle oscillator. Suppose now that the percentage error in the low frequency oscillator is 0.2, an absolute error of 100 cycles. The absolute error in the 30th harmonic will be 3,000 cycles. That represents appreciable detuning at 1,500 kilocycles, as it is approximately 1/3 of a channel. However, it will only be noticed in exceedingy selective circuits.

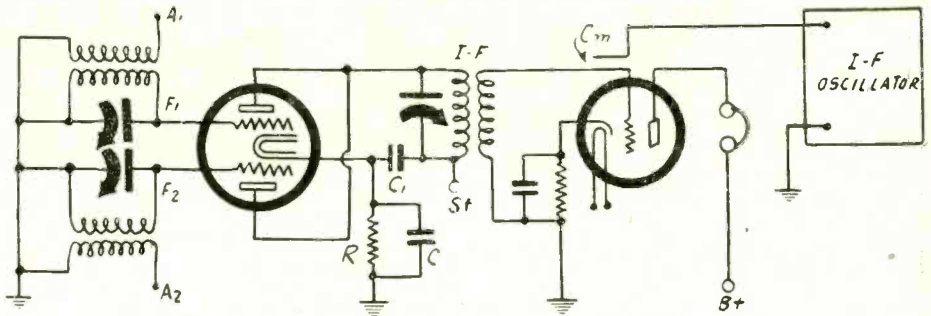

FIG. 1
This circuit illustrates a method whereby two broadcast stations of different frequencies can be used for obtaining an intermediate frequency of high accuracy by employing beats.

Details of Mixer

Referring once more to the mixer circuit in Fig. 1, we have the two tuned circuits identified as F1 and F2, each circuit havin ga primary winding terminating in A1 and A2. If the beating stations are local A1 and A2 can represent the antennas. No other pick-up is necessary. It is not even necessary that the circuits be selective just so they can separate stations 50 kc apart.

The two grids are biased by a single resistor R, shunted by a large condenser C. Of course, the two grids can be biased differently if so desired, by connecting one grid return to a tap on the resistor. This is not necessary, however.

The intermediate frequency tuner is tuned in the primary so as to provide a by-pass for the higher frequency products of the mixing. The secondary is then connected to the grid of a second tube in order to provide some gain for the desired beat signal.

When Beat Is Stronger

Whether the second tube is biased as an amplifier or as a detector is of little importance, but the second and audible beat may be stronger if the tube is a detector.

The use of an untuned grid coil for the second tube makes it practical to couple the oscillator capacitively by Cm as shown. A wire from the plate of the oscillator tube calibrated may be wrapped around the grid lead a couple of times to effect sufficient coupling.

Baird's Converter for Short Waves

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caution is automatically taken. However. for d. c. use it is necessary to observe the polarity of the connections, so that positive side of the line goes to intended positive side of the converter, otherwise nothing will be heard, and besides the electrolytics would be endangered if the wrong connection is permitted to endure for any appreciable time, even ten seconds.

Dimensions

No external ground should be connected to the converter for d. c. use, although such inclusion on a. c. is permissible.

The screen voltage is dropped through a series resistor of 9,000 ohms and a parallel resistor of 15,000 ohms. The higher of these two resistors goes to ground.

The chassis of which the converter was built measures 8½ inches wide and 6¾ inches front to back. The height is 3¼ inches. The chassis is in the usual U-shape, but there are two supporting brackets inverted at left and right, inside, to prevent warpage.

Location Data

The mixer tube is behind the tuning condenser, the coil socket is the one at right and the rectifier socket is at left. No confusion can result as to the coil and rectifier sockets, as the former is four-hole, and the latter six-hole, nor as to the 6A7 either, as that has a seven-hole socket. It is wise to have these different type sockets, for if there were any possibility of mistake because two purposes required the same type of socket there surely would be some trouble.

A converter such as this can bring in foreign stations and give all-around satisfactory service but one must remember that the receiver rather than the converter is the determining factor.

Much Progress Achieved in Oscillator Stability

Much work has been done on stabilizing oscillators. At first the problem seemed one of extreme difficulty. Study has changed that. Now stabilization is very simple. What is the main requirement for stabilizing the frequency? It is simply to put the tube in a non-reactive setting. The plate of the tube works into a pure resistance at the resonant frequency, and at that frequency only. Likewise the grid of the tube looks into a pure resistance at the resonant frequency, and at that frequency only.

The frequency-determining circuit should be placed so that it can oscillate at its own natural frequency when the above conditions are satisfied.

Frequency Independence

That done, the oscillator will generate a frequency that does not depend on the filament current, the plate voltage, the operating grid voltage, the screen voltage, if any, or changes in the load.

These conditions may seem complex. Actually they are very simple. Take the tuned plate oscillator, for example. Usually this has a grid condenser. Choose this condenser so that at the desired frequency of oscillation it resonates with the grid coil. That is the first condition. Next put a coil in the plate circuit and make this equal to the resonant coil. That satisfies the second condition. We have now three tuned circuits. The first of these is the plate coil and the tuning condenser, the second is the resonant coil and the same tuning condenser, the third is the grid coil and the grid condenser. This oscillator is stable.

Cases Cited

The tuned grid oscillator can be treated in a similar manner. The Hartley is stabilized by a condenser in the plate circuit and another in the grid circuit. The Colpitts is stabilized by a coil in each of these circuits. The values of the coils or condensers depends on the resonant condensers or coils.

Most oscillators used in receivers are not stable, except by accident, and then over only the lower frequencies of tuning. But stabilization can not be called such unless complete.

100% MODULATION POPULAR

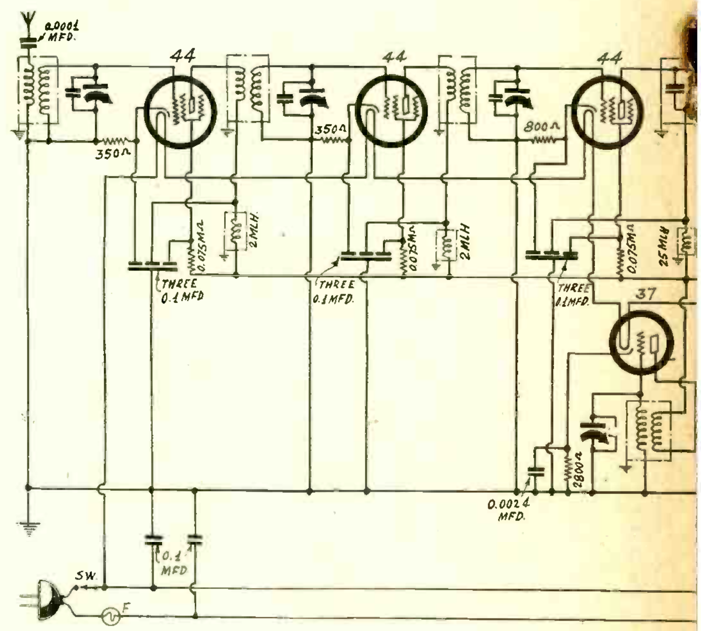
Nearly all of the better-class stations are using 100 per cent. modulation now. This means that the modulation may be varied to 50 per cent. of the amplitude of the carrier. Therefore to measure the percentage modulation it is necessary to know the carrier amplitude. When this is known, a single meter may be used to determine the percentage modulation. For broadcasting work the percentage is constantly shifting, but the term "100 per cent." defines the maximum limit of the modulation swing.

PORTABLE SIGNAL GENERATOR

Up to now the signal generator has been quite an imposing instrument. What it consists of is an oscillator covering a wide range of radio frequencies, a modulator, also covering a wide audio range, an attenuator for the radio frequencies, another for the audio frequencies, with percentage modulation read directly for the effect of the modulation on the oscillation, and decibel readings in conjunction with an output measuring device. Thus one may calibrate a set, as to radio frequencies, note the response as to audio frequencies, and make interstage and overall measurements. However, with somewhat less accuracy, portable devices of this type can be made compactly, and one manufacturer plans to put one in the market in a few months.

2.5-Watt Output
8-TUBE SQUEAL

By Lou



FI

Example of the use of the 25Z5 as a voltage-doubler. T superheterodyne that has a power output conservat series and normally drop 81.5 volts. The remaining limiting

THE use of the 25Z5 as a rectifier in an exclusively alternating-current-operated receiver is diagramed in Fig. 1, the voltage-doubling method being used. Thus instead of around 110 volts a.c. there are around 220 volts a.c., and as a result the output d.c. voltage, provided the resistance of the B filter choke is not too high, will be around 200 volts. This is even more than enough for the output tube, the negative bias on which is raised a little on account of the increase of the plate voltage above standard specifications.

The circuit is an eight-tube superheterodyne, using the automotive series 6.3-volt heater type tubes for the receiver proper and the 25Z5 as the rectifier. There are two stages of tuned radio frequency amplification, separate modulator and oscillator, one stage of intermediate-frequency amplification at 456 kc, a diode detector, and triode first audio stage resistance coupled to the pentode output tube.

2.5-Watts Output

Filtration has been carried out to a justifiable extent throughout, with plate, screen and cathode leads filtered, and large capacity next to the B rectifier, consisting of two 16 mfd. electrolytic condensers.

The output will be about 2.5 watts, due to the increased plate and bias voltage on the 43 output tube. This particular power tube was selected because its current rating is 0.3 ampere in the heater circuit, the same rating as prevails for the other tubes. If the negative bias on the last tube is 23 volts, then the plate voltage actually will be around 177 volts. The power tube has a 2-watt rating at only 135 volts on the plate, 20 volts negative bias. Therefore 2.5 watts under present conditions is a conservative estimate.

The heaters are connected in series, so the five 6.3-volt tubes drop 31.5 volts. The 25Z5 and the 43 both have 25-volt heaters, so the total drop in all the heaters is 81.5 volts. Assuming 114.5 volts a.c. applied, though due to location and the amount of current used by power company customers on the same line the range may be from 85 to 125 volts, there would be 33 volts dropped in an extra resistor. This may be of 20 watts rating, though less than 10 watts are dissipated in this 115-ohms unit.

Tube Connections

No attempt has been made to provide switching so that d.c. use could be practiced also, because the receiver is sensitive as an a.c. set, but the performance on d.c. is not in the same class, due to the voltage being halved.

The choice of tubes is almost compulsory. The 44 is practically the same as the 39, except that it has a little more extended cutoff, and is therefore closer to the 58. Also, it has a suppressor grid, besides the elements shown in the diagram, but since the suppressor is tied to the cathode inside the tube, and no external connection is necessary for the suppressor, it is not symbolized. Another point about tube connections is that the 25Z5 is shown in its conventional symbolic form, which is not literal, as on the socket the plates adjoin the heater terminals, and the cathodes are in a line with those heater terminals.

The 37 is used as oscillator, being equivalent to the 27 in the 2.5-volt a.c. line of tubes, the 85 is akin to the 55, the 43 is like other output pentodes, while the 25Z5 has an individual identity. The 43 is in a class with the 48, which is ruled out because of difficulties arising from the dissimilar heater current (0.4 ampere at 6.3 volts).

Loose Loupling of Oscillator

A series condenser of 0.0001 mfd. is inserted in the antenna circuit to increase the selectivity beyond what it would be otherwise, and while this method reduces the sensitivity, the compensation has been introduced by the selection of the proper tubes in the audio channel. That is, the output of the triode of the 85 will load up the 43 tube nicely, and there is no occasion for using a high-mu triode 75 in this position, particularly as the plate current in the 75 cuts off too soon, whereas the triode of the 85 will perform nicely up to around 25 volts. Thus through the 1.0 meg. diode load resistor the current may be as high as 25 microamperes, which is well within the current capabilities of the paralleled diodes, indeed there is a 75 per cent. safety margin.

The 44 r-f amplifiers and the 44 i-f amplifier are biased by 350-ohm resistors, so that a bit more than 3 volts negative bias will prevail, but the modulator has a somewhat higher bias, due to 800 ohms being used, the better to enable the modulator to stand the oscillation voltage. However, the oscillator is not a grid-leak-condenser type, but is operated at the bend in the characteristic curve, with loose coupling between feedback and grid windings. This coupling should be just enough to provide suitable oscillation at the oscillator's low-frequency setting, 996 kc. (540 kc. r-f level).

Tracking Section Used

There is no padding condenser, as the use of a tracking section is intended, and there is no disclosure of means of coupling the oscillator to the modulator, because in receivers as sensitive as this the coupling usually is sufficient without any special precautions, and is due to stray capacities, but if a little more coupling is desired, two wires, insulated from each other, but tied together, from grid of oscillator to grid of modulator, may be used as the plates of a small condenser. Two-inch lengths would suffice. This extra coupling, however, is seldom required, and the looser the coupling, the greater the freedom from interference.

Correction for Saturation

The principal source of interference, that is, heterodyne due to off-resonant locals getting by the tuner, is satisfactorily taken care of by the three tuned circuits at the r-f level, and the antenna series condenser. The oscillator's loose coupling to the modulator aids in a preventive of such trouble. Moreover, the difficulty some experience of getting a powerful local at two places on the dial is avoided by the separation of modulator and oscillator, which permits manipulation of the degree of coupling between the two tubes, and by the use of the negative-bias type of non-grid-current oscillator, which is relatively free from harmonics, especially if the coupling between the two tubes is essentially due to grid circuits. The oscillator plate circuit is the one ordinarily having harmonics, but in the present instance these are weak.

The screen voltage on the 44 tubes should

in Transformerless
-PROOF SUPER

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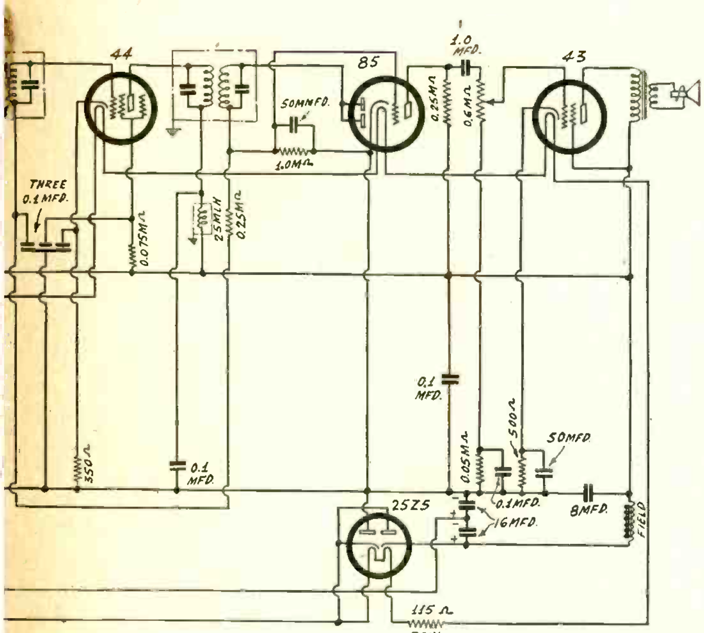


G. 1

'hus no power transformer is needed in this eight-tube ively rated at 2.5 watts. The heaters of all tubes are in ipproximately 33 volts would be dropped in the 115-ohms resistor.

not exceed 90 volts, and the limiting resistors have been selected on the basis of reducing the screen voltage somewhat, though not much, below this maximum. The gain remains high, without oscillation, if the filtration is followed as shown, although in some instances it is just possible that a little oscillation may be present, which may be cured by increasing the biasing resistor in the oscillating stage by 100 ohms.

Coil Information

The circuit is so arranged that there is no reasonable possibility of overloading any of the tubes up to and including the detector. As the triode of the 85 will stand up to only 25 volts, in some few centers where there are numerous stations, the 25-volt limit may be exceeded, in which instance reduce the aerial length, or decrease the capacity of the series antenna condenser. While this voltage may not be readily measured, the condition becomes known readily, due to "something choking up." It would be the triode saturating. This is true even though the output tube would be overloaded long before that happened, but the power stage overload does not produce that choking effect, so it is easy to determine the condition and remedy it. No sacrifice is involved, as the power tube is still loaded up by those strong local stations.

Two condensers are connected from a.c. line to ground, so that, no matter which way the plug is inserted in the convenience outlet, there is radio-frequency bypass across the line. This cures a peculiar hum condition that sometimes develops on any type of set, and particularly such types as have heaters raised considerably above cathode potential.

The a.c. line should be fused. A fuse of 1 ampere capacity is sufficient.

The coils for the radio-frequency level may be wound on 1-inch diameter tubing, 130 turns of No. 32 enamel wire, with primaries of 20 turns, wound over secondaries, near the bottom, insulating fabric between. The kind of wire used on the primary is not important. The oscillator may consist of 78 turns of No. 32 enamel, feedback winding beside it (not over it), 1/4 inch separation, 16 turns. The shields may be aluminum, 2 1/6 inches outside diameter, 2 1/2 inches high.

Chokes

One manufacturer is finishing the laboratory work on small-sized coils for the r-f and oscillator for such a circuit, to be contained in shields of 1 1/2-inch outside diameter, about 1 7/8 inches high.

The radio-frequency choke coils are honeycombs, and are shielded. The 25 millihenry inductance is a 1,300-turn coil, the 2 millihenry inductance is a 400-turn coil.

The 16 mfd. condensers and the 8 mfd., like the 50 mfd., are electrolytic condensers, and the largest capacity, due to the low voltage rating, is in the smallest container.

The field coil of the dynamic speaker may be used as the B supply choke, or a separate B choke used, and a speaker without field excitation connected to the output through a transformer, though matching should be watched. An impedance of between 3,000 and 4,000 ohms is satisfactory.

The sum of the plate and screen currents of the output tube slightly exceeds 41 milliamperes, and therefore it would not be entirely safe to the winding of a magnetic speaker, to connect that winding directly in the plate circuit. A magnetic speaker intended for a single 71A tube would be of the right impedance.

If the B choke, whether field or not, is 300 ohms, then the voltage drop will slightly exceed 20 volts, and the d.c. output will be around 200 volts, as becomes about the same as the a.c. input, and may become even a bit higher due to the effect of the filter condensers.

Trouble-Shooting

The chief source of trouble would be due to the misconnection of the 25Z5 and the wrong value of high-wattage resistor (marked 115 ohms on diagram). Due to unfamiliarity with the voltage-doubling principle, often this tube used this way occasions wiring mistakes, so follow the diagram literally.

LIST OF PARTS

Coils

Three shielded radio-frequency transformers of 242 microhenries secondary inductance.
One shielded oscillator coil of 153-microhenry secondary inductance.
Two shielded 2-millihenry r-f choke coils.
Two shielded 25-millihenry i-f choke coils.
One B choke, 30 henries, few hundred ohms d. c. resistance; may be field, if a dynamic speaker is used.
Two doubly-tuned shielded intermediate frequency transformers, 456 kc.

Condensers

One 50 mmfd. fixed condenser.
One 0.0001 mfd. fixed condenser.
One 0.0024 mfd. fixed condenser.
Four blocks, three 0.1 mfd. in each block.
Five separate 0.1 mfd. condensers.
One 1.0 mfd. paper dielectric condenser.
One 8 mfd. and two 16 mfd. electrolytic condensers.
One 50 mfd. 30-volt condenser.
One four-gang tuning condenser (three 0.00035, with tracking section).

Resistors

One 115-ohm 20-watt resistor.
Three 350-ohm resistors.
One 500-ohm resistor.
One 800-ohm resistor.
One 2,800-ohm resistor.
One 50,000-ohm resistor.
Four 75,000-ohm resistors.
Two 250,000-ohm resistors.
One 600,000-ohm potentiometer, with a. c. switch attached.
One 1,000,000-ohm resistor.

Other Requirements

One a-c cable and plug.
One separate a-c switch (if not contained on potentiometer).
Five UY sockets and three 6-hole sockets.
One 1-ampere fuse with holder.
Antenna-ground binding post assembly.
Tubes: Four 44's, one 37, one 85, one 43 and one 25Z5.
One chassis.
One vernier dial, escutcheon.
Five grid clips.

VOLTAGE DOUBLING

The Principle and Application Explained

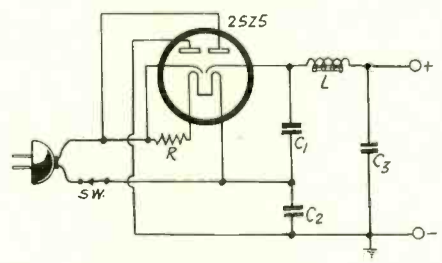
By F. W. C. Lewert

HOW DOES a voltage doubler work? Let us attempt to explain it with the aid of the circuit in Fig. 1. First consider the connections of the anodes and the cathodes of the 25Z5 tube. The cathode of one of the diode rectifiers is connected to the anode of the other. Then the free cathode is connected to the filter choke and one of the condensers in series, and the free anode is connected to the ground side of the filter. The voltage source is connected between the junction of the condensers in series and to the point where the anode and cathode are joined. These are the essentials of voltage doubling.

Suppose now that the line voltage is such that the current in the supply circuit is clockwise. The right hand section of the rectifier tube is then conductive, for the right anode is positive. The left section of the tube is an open circuit for the voltage on the anode is negative. While the right section is conducting current flows into condenser C1 and charges this up to a voltage roughly equal to the applied voltage.

Current Reverses

When the condenser has been charged up, the supply voltage reverses. Now the left section of the rectifier tube becomes conductive, because its anode is positive, while the right hand section becomes an open circuit. During this half-cycle condenser C2 is charged by the current in the left hand section of the tube, and it is charged up to the same voltage as was condenser C1. Now what is the voltage across the two condensers, C1 and C2, in series? It is either zero or twice the voltage across either one. But due to the fact that one anode and one cathode have been connected together, the sum of the voltages across the two condensers cannot be zero, but twice the voltage across either one. The positive side of each condenser is that which is toward the cathode of the charging tube. C1 is connected directly to the cathode and therefore the upper side is positive. The upper side of C2 is connected, through the supply line to the



The 25Z5 used as a voltage doubler. The circuit is transformerless.

cathode of the other section, which charge it up. Or we might look at the anodes. The side of the condenser that is next the anode is negative, and C2 is directly connected to the anode of the left hand section of the rectifier tube. Therefore the voltage across C1 and C2 is twice the voltage across either condenser. As far as the filter is concerned we have doubled the voltage.

What Doubling Means

This doubling does not necessarily mean that the voltage across the two condensers in series is twice the voltage of the supply line. Not at all, for this statement would have no meaning. The supply line voltage is alternating whereas the voltage across the two condensers is unidirectional. But it does mean that the voltage across the two condensers is twice what it would have been had we only used a single rectifier element, or the two elements in parallel. In effect we have two pulse generators and they have been connected in series.

But how can we get any current from the device? Well, we connect the load across the two condensers, C1 and C2. The two condensers will discharge through this load. While one condenser is charging the other will be discharging through the load. But while one is charging the tube charging it will also send current through the load, effectively in series with the discharging condenser. Reversing the current in the line does not alter the current through the load. It will always be as indicated by the signs at the output terminals.

Use of Filter

The fact that a filter consisting of a choke L in series with the d-c line and a large filter condenser C3 in shunt with it has been interposed between the two condensers in series does not alter the voltages, except to the smoothing out of the current flow in the d-c circuit.

Since the current in the d-c circuit comes in part from a charged condenser and since the current that can come from a given condenser, for a certain voltage drop across the condenser, depends on the capacity of the condenser, it is clear that if the voltage is to be kept at a high value across the two condensers, each of these condensers must have a large capacity. If the capacity is small very little electricity can be stored in it, and very little can be taken out. If the capacity is small and a large current is drawn, the voltage falls rapidly. Hence we must use large condensers in the C1 and C2 positions in order to keep the voltage up. Values as large as 16 and 32 microfarads have been recommended for voltage doublers of this type, when the doubler is to be used to supply a radio receiver. With such values it is quite possible to obtain a d-c voltage of 220 volts from a 110-volt a-c line when the rectifier is serving a set drawing 40 milliamperes.

The Ballast Resistor

In Fig. 1 is a ballast resistor R in a series with the heater of the tube. The tube itself requires a voltage of 25 volts and therefore the voltage drop in R must be 85 volts, when the line voltage is 110 volts. The current drawn by the tube at 25 volts is 0.3 ampere. Hence R should have a value of 283 ohms. Naturally, the rectifier is to serve some tubes, and these also will need heater current. Part of the drop, or all of it if there are enough tubes to be served, in R can then be used for the other tubes. There is more than enough drop in R to serve 13 6.3-volt tubes.

The Theory of a Beat-Note Oscillator

The theory of the beat-note oscillator is extremely simple. The device requires two high-frequency oscillators coupled together so that they beat and produce a heterodyne frequency in some detecting circuit. If one of the frequencies is varied in respect to the other, the heterodyne frequency varies over a wide range. The beat may vary from zero up to a high value.

In practice the variation is not as wide as the theory indicates, for sometimes it is impossible to get even near zero beat. Why is this? It is easy enough to get zero beat between a regenerative detector and a broadcast station, or a laboratory oscillator and a broadcast station.

The reason zero beat cannot be obtained in some instances between two laboratory oscillators is that they are coupled too closely. When one of the oscillators is that of a transmitting station there is no practical possibility of getting too tight coupling, and for that reason it is easy to get zero beat.

One Pulls Other

But when two laboratory oscillators are built in the same box and powered by the same source, it is not easy to get loose enough coupling. Because of the excessive coupling, one of the oscillators will pull the other to its own frequency, or, if they are equal in all respects except as to frequency, the two will just pull together.

When the beat has a certain value, depending on the degree of coupling, the two frequencies will rush together, and there is only one frequency of oscillation. Of course, the beat is zero but the trouble is the manner in which the beat varied to the condition. The jump might have been 1,000 cycles. When that is the case there is no possibility of getting those audio frequencies lying between zero and 1,000 cycles.

Special Mixer

The remedy for pulling together is loosening the coupling so that it is just a little bit. It is possible by means of special tube arrangements to make the coupling zero, insofar as the pulling together effect is concerned, and yet have them beat strongly and thus produce a powerful heterodyne beat signal. This is best done by having a special mixer tube with two grids, one grid beating actuated by each oscillator. The two oscillators might be said to be coupled potentially and not dynamically.

A Clinical Epic of the Small Station

By Robert Eichberg

If you picture the average radio station as a magnificent group of studios, thronged with uniformed pages, beautiful hostesses and highly paid broadcasters—you're more than 50% wrong. Only the major stations—the stations which are "keys" of networks or operate on superpower—have such elaborate set-ups, and these are much less than half the total.

All the other stations—and there are well over 500 of them scattered throughout the United States—operate under far different conditions. Simplicity and economy, rather than grandeur, rule.

Small stations are much pleasanter places than the large ones. They're more homelike—less formal. I know. I work for one of them. It's station WHOM, a typical small station, and activities there are nearly identical with those of the hundreds of other regional and local stations now operating.

Forearmed with Records

WHOM is located in Jersey City, across the river from New York. It has one studio in Jersey City, one in Newark, New Jersey, and two in the basement of a New York hotel. The most pretentious ones are in New York, so we'll stick to a description of activities there.

At about 10 a.m. the first New York program goes on. So, at about 9:45 one of the engineers dashes in. He hustles into the control room (which is about as big as a medium-size closet) and calls the transmitter in Jersey. Everything is okay, so the fun begins.

No artist or announcer is there yet. The engineer's hair becomes mussed—his eyes, bloodshot. He visualizes himself announcing and playing a program of phonograph records. He even goes and picks out a set of records that he thinks the audience might like.

But, at two minutes to 10, the announcer dashes in, with the broadcaster in tow. They met and had a cup of coffee, but hurried to get to the broadcast in time. They always get there on schedule, but engineers are a nervous crew and while they may affect a nonchalant air of "What d'I care whether the program goes on?" they would have fluffy grey kittens if it didn't.

Rendezvous of Ambitions

No matter how small a station is (and there are plenty smaller than WHOM), it is forever besieged with people who think that fame and fortune await them in radio. All too frequently all that these have is limitless ambition. In fact, out of some 175 auditioned at WHOM in the past five weeks there was only one act worth putting on the air. This consisted of four young colored men who sing harmony in a way that no song writer ever intended.

All applicants have an equal chance. Occasionally one of them clicks, and either gets a sponsor on the small station or moves to a larger one. Such well-known folk as Rudy Vallee, Breen & de Rose, and so forth, got their start in just this way.

Phonograph records comprise an appreciable part of the small station's programs. You'd think people wouldn't want to listen to phonograph records, but recordings are very popular. It's probably because the average man would rather hear John MacCormack or Cab Calloway on a record than listen to Tillie Gulp singing "To a Wild Rose" in a shaky soprano.

Problem of Living

The engineer is the unfortunate mortal who has to listen to this sort of thing all day—eight hours of it, under the NRA. If you don't think that's work, try listening to any one station—even your favorite—for four hours straight, neither reading a book or talking to anybody.

How to live is the major problem of the small station. That's where the sales staff comes in. These grimly determined gents circulate among potential advertisers, armed with statistics showing station coverage and estimated audience, testimonials from satisfied advertisers, and contract blanks. It's surprising how large an audience a small station has. WHOM put on a daily announcement without any gift offer and drew 200 letters a day.

That sort of thing impresses the advertiser. But of late he has become cagy. So many little stations have sets of prices (the one they ask, the one they expect to get, and the one they'll take) that a one-price station like WHOM is rather surprising.

A Place of Delight

Some stations, by the way, get into amusing jams by having those impromptu prices. They sell a specified time to one advertiser and then find they could have gotten more from another. Usually all they can do is moan faintly, though sometimes they can convince the first advertiser that the time he doesn't want is really better for him.

But, all in all, the small station is a delightful place. The president of the concern and the hired hands call each other by their first names, buy each other drinks and win each other's pay checks on Saturday night when the station has signed off until the following day.

Small Class B Audio Amplifier

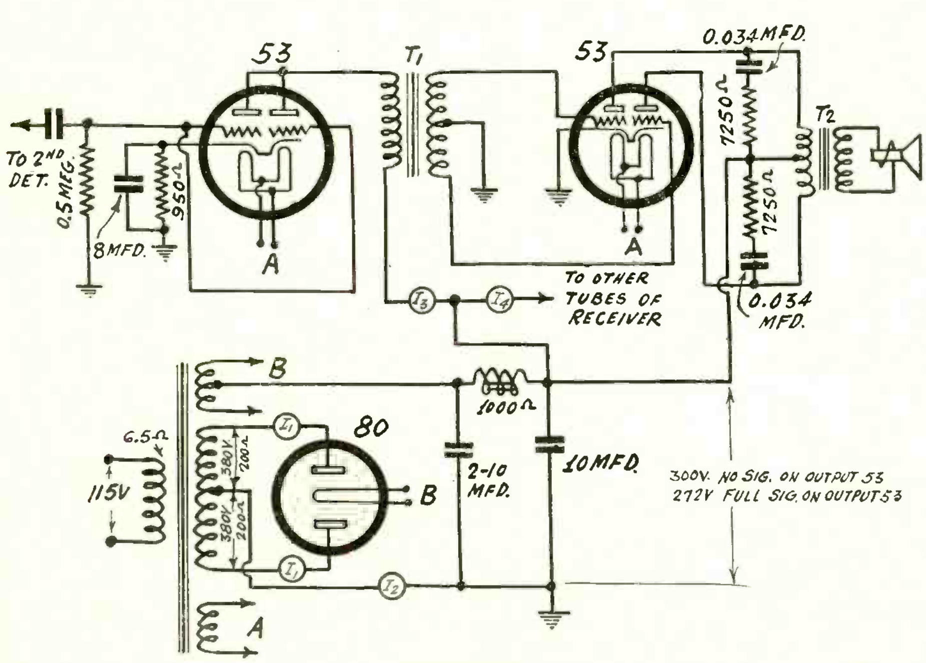


FIG. 1

A three tube audio amplifier and power supply utilizing one 53 as driver and one of the same type as Class B stage. The speaker field is used as filter choke.

In Fig. 1 is a Class B amplifier utilizing only three tubes. The first tube is a 53 in which the two elements are in parallel and the grids are biased for Class A operation. This tube is used as a driver of the second stage, which also employs a 53 tube. In this stage, however, the grids are unbiased and the tube is used as a Class B amplifier.

All essential values are indicated in the diagram, except those pertaining to the design of the audio frequency transformers. The filter choke is marked 1,000 ohms. It is the field of the dynamic loudspeaker.

The intertube transformer T1 should be of the step-down type with negligible impedance in the secondary, and the ratio between the primary and each half of the secondary should be 5.

A single -80 tube in full-wave connection supplies the voltages for the two amplifier tubes.

Adjustments

In five different positions in the circuit milliammeters are indicated. During adjustments milliammeters should be inserted at these places for the purpose of measuring the current. Currents at the two I1 positions should be 85 milliamperes, root mean square. That is, these currents should be measured with an a. c. instrument. The current at I2 should be 130 milliamperes, root means square. That also should be measured with the a. c. instrument. The current at I3 should be 7 milliamperes, direct current, and that at I4 should be 38 milliamperes, measured with a d. c. milliammeter. This current should be diverted to other tubes or to some bleeder resistor in order to give the voltages indicated when all conditions are as shown. When the d. c. milliammeter is inserted in the common plate return of the two sides of the output tube the current should vary between 35 and 50 milliamperes, depending on the strength of the signal.

Radio University

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

Drilling Jig Needed

IN MAKING up duplicate models of a small radio job I have to drill panels exactly the same to fit a steel box, and as the holes are critical I find that I cannot locate them or reproduce them accurately enough. Please describe how I should proceed to make a good job of this.—E. D.

The best practice is to get some cold rolled steel and accurately find the position of the holes and drill them through the steel plate. This is not a difficult drilling job, and can be done with a hand drill. The result may be compared with the requirement, and if the holes are a bit off, another plate can be made, until one is obtained with holes just in the right position. These holes then should be drilled a trifle oversize, to pass the required drill to be used later, and the drilling jig taken to a heat-treatment laboratory. The jig should be braced, and if you can not work the braces the laboratory could do it for you. The tempering of the steel will render the jig free from expansion of the holes due to use of the jig as a drilling template. You would clamp the jig over the work and drill through the holes in the jig to the piece that is to have the counterpart holes. This method is frequently used in manufacture.

* * *

Calibration Trouble

AS I AM VERSED in radio technique to some extent, I carefully built a superheterodyne, and calibrated a 5¾-inch diameter dial disc for frequencies 10 kc apart. I used an air type padding condenser, by putting two in parallel, adjusting one to maximum and the other to what was needed. The intermediate frequency transformers are of the air-dielectric condenser type. Yet the frequencies do not hold perfectly, and indeed at the high frequency end of the broadcast band a change in reading of 10 kc from night to night, somewhat according to the weather, is not unusual. I wish you would direct me to the proper remedy for this.—J.T.W.

You have taken the necessary precautions in the intermediate amplifier and in the padding of the oscillator, but there are two loopholes at least: the forms on which the radio-frequency, oscillator and intermediate frequency transformers are wound, as well as the mechanical rigidity of the dial. As to the coil forms, these should be of some material that is as nearly as possible impervious to moisture effects, and the coils themselves should be slightly wax-covered. The commercial run of r-f and oscillator coils is wound on what constitutes really cardboard treated with a phenolic cement and is not impervious to moisture, varying quantities of which change the inductance of the coils, and therefore the calibration is thrown off by humidity. The mechanical insecurity of the dial, that permits the collar or hub to slip a bit, or the scale to be displaced a trifle in respect to the mechanism proper, would cause the difficulty you mention, but is easily checked and corrected. The coil-form trouble would require substitution of coils to provide the proper form, which may be lavite, isolantite or the like. Intermediate coils with such insulation form are obtainable. A consideration not treated above is the possibility of frequency drift of the oscillator, but that is not regarded as nearly so likely to produce such a large change as you mention, while the other factors quite likely would cause the trouble.

* * *

Plotting Honeycombs

I HAVE SEVERAL large honeycomb coils and would like to reduce their inductance to certain values for wide frequency range in an oscillator or perhaps also in a receiver. Will you please describe some simple method whereby I could determine how many turns, as the coils are similarly wound with the same size and insulation wire?—K. L. C.

The largest coil should be put in an oscillator, with some feedback method supplied extra, such as a small honeycomb tickler put no closer to the secondary than is necessary to support oscillation at the highest capacity end of the dial. Then a condenser of a known commercially-rated maximum capacity is used for tuning, and if it has a trimmer on it, this is turned all the way out. Add 20 mmfd. to the rated maximum and use the resultant value as the capacity in circuit. Then measure the resonant frequency and compute the approximate inductance, or read it from one of the charts in Edward M. Shiepe's book, "The Inductance Authority." You now have the inductance of the largest winding. Remove 25 turns at a time and note the frequency resulting in the oscillator, the condenser at the same position. A receiver or other device is used to determine the oscillation frequency either directly or, by harmonics of the oscillator, indirectly. Compute the inductance for every step of 25 turns, note the turns removed, and later you can draw a curve relating the number of turns and the resultant inductance. At first you will not actually know the absolute number of turns, but as you remove 25 turns at a time, note the number of turns removed for each test, and also the maximum, thus: (a) maximum, (b) maximum minus 25, (c) maximum minus 50, etc. Then when there are only a few turns left, count them until you remove the last turn of wire, and the sum of the number of turns removed is the total number of turns originally. The absolute values of numbers of turns are then ascribed by subtraction of 25, 50, 75, etc. Do not be surprised if the inductance change is very small per 25 turns in the beginning and then suddenly becomes a large change, as this is normal. Roughly, the turns are proportionate to the inductance in microhenries, one turn for so many microhenries, where the number of turns removed is small compared to the total number of turns, but the relationship is upset, naturally, at the critical stage previously mentioned.

* * *

Two Speeds Needed

I HAVE A DRILL-PRESS, but when I turn on the motor to drill a fairly large diameter hole the drill wobbles in the chuck, or the entirety wobbles, and doesn't want to stay put at the place where I want to drill the hole. Please tell me what to do to get the same steady result I get when using small diameter drills.—T. R. S.

The reason for this unsteadiness is the excess speed of the motor. The drill press, for large diameter holes, should be provided with a means of reducing the speed by adjustment of the belt to another pulley. If there is no such provision you will have to stick to drilling small holes with the press, unless you can reduce the speed by adjusting the voltage to the motor. See if your press hasn't the dual-speed provision.

* * *

"Stickem" for Coils

WHAT WOULD YOU suggest as a good binding material for use on coils wound at home, to prevent them from losing their winding position and also to provide some protection from moisture effects?—H. C. M.

Flexible collodion, a liquid, can be bought in any drug store, and this serves the purpose well, and may be applied with a small brush.

* * *

Inductance Formula

I HAVE BUILT an oscillator and know the inductance of the coil in it (260 microhenries). Also I know the capacity in circuit, not precisely, but fairly accurately, from computation verified well enough by actual frequency testing. I should like to use this set-up for determining the values of inductance of various coils, mostly larger in inductance than 260 microhenries, and yet do so without having to tear apart the oscillator to insert each of these coils. Have you a method and a formula?—H. E. H.

Since the secondary inductance of the oscillator is known, some frequency generated with most of the condenser capacity in circuit may be taken as the capacity guide. Thus, the total capacity may be computed for the frequency, since the inductance is known. Now take the unknown coil and put it across the oscillator secondary and without changing the setting of the oscillator condenser now measure the higher frequency now resulting. Since the capacity has not been changed (except trivially, due to addition by the distributed capacity of the unknown coil), the net inductance may be computed, or read from charts. The formula for the unknown inductance is

$$Lx = \frac{L_1 \times L_2}{L_1 - L_2}$$

where Lx is the unknown inductance, L_1 is the known inductance in your oscillator and L_2 is the net inductance as computed.

* * *

Impedance of Transformer

WHAT IS THE IMPEDANCE of the primary of an output transformer when that is feeding a loudspeaker? How is it related to the inductance of the primary winding?—G. J.

If the primary and secondary windings of the transformer are so closely coupled that there is no leakage reactance, and if the loudspeaker presents a pure resistance load to the secondary, the impedance of the transformer looking from the tube is a pure resistance and it is equal to the loudspeaker resistance multiplied by the square of the ratio of turns. Thus if the speaker presents a resistance of 10 ohms and the ratio of turns is 25-to-1, the tube looks into a resistance of 6,250 ohms. When the secondary winding is open, the impedance of the primary winding is the reactance of that winding. Thus if the inductance of the primary is 20 henries, the impedance at 400 cycles per second is nearly 50,000 ohms. But at 40 cycles per second it is only 5,000 ohms.

* * *

Ultra-Short Wave Converter

IS IT PRACTICAL to build a superheterodyne mixer to receive ultra-short waves in the same manner as the waves between 15 and 200 meters are received? If so, what precautions should be taken to insure good results? Has any mixer, or converter, ever been constructed to work below 10 meters?—S. W. M.

Converters have been constructed to work on wavelengths below 10 meters, using an intermediate frequency of 1,500 kc. They give plenty of trouble however. If any converter is to work well there should be a strong radio frequency signal so that noises will not drown out the signal. One precaution that should be taken is to stabilize the oscillator in regard to frequency and another is to provide a tuning arrangement that is not subject to body capacity and that can be tuned in very fine degrees. In other words, the range of the tuning condenser should be narrow.

* * *

Short-Wave Collectors

IN PICTURES of ultra-short wave receivers I have seen vertical rods of metal. I am not quite sure what their purpose is. Will you kindly explain?—W. E. B.

The rods serve as antenna and counterpoise. For highest sensitivity of a device like this the length of each rod should be ¼ wavelength, or the total length should be half wavelength. It is difficult to tune such a collecting system since it would have to be done by shortening or lengthening the rods.

* * *

Diode Biased Amplifier

WHEN A DUPLEX DIODE pentode is used as detector and audio amplifier, diode biased, I have noticed that the circuit easily chokes up as the signal strength is increased. will you kindly explain why this is and also give a remedy?—E. W. H.

The bias in the diode biased amplifier is directly proportional to the signal strength. If the signal is too strong the bias is so high that the pentode is greatly overbiased. That is, the bias is so high that the plate current is cut off. It may be cut off only part of the cycle or all of the cycle. The result is "choking up." The remedy is simply to cut down the signal to a value that the pentode can handle. It will not help much if a fixed bias is used on the pentode, for the tube will overload anyway. A badly distorted signal would result. The duplex diode pentode has been designed for a weak signal. If the signal must be strong it is better to use a duplex diode triode, for that will not choke up so easily. But even this is not exempt from the trouble. If the a. v. c. does not keep the signal down sufficiently, it will be necessary to introduce a manual control somewhere ahead of the diode detector.

* * *

Effect of Baffle Board

IN WHAT WAY does a baffle board function to improve the quality of sound from a loudspeaker? Many of the latest receivers do not have a baffle board at all and others have just a little bit of a baffle. Perhaps the baffle board is just one of those things thought necessary in the early days of broadcasting, but in reality is no more important than the low loss tuner and other devices that have gone by the board. —W. C. C.

Suppose you take a darning needle and swing it back and forth. There is not much air resistance, is there? The needle goes through the air easily because it does not set much air in motion. It simply flows around the needle. Now take a large sheet of light paper and put it in a light frame so that it is flat and reasonably rigid. Swing this back and forth through the air, with the flat side at right angles to the direction of motion. It is much more difficult to swing this and the resistance of the air can be felt distinctly. More air is now set in motion because the air cannot flow around the edges easily. The diaphragm of a loudspeaker moves back and forth in the air. It sets air in motion and creates sound. If the diaphragm is large the air offers greater resistance than when it is small, because the air cannot so easily flow around the edges. More air is set in motion in the form of sound, and therefore with the large diaphragm the sound is louder. Now, the baffle board has the effect of preventing the air from flowing around the edges of the diaphragm, and the larger it is the greater is its effect. The effect of the board then is nearly the same as increasing the size of the diaphragm, or of the piston. A small diaphragm can set a good deal of air in motion when the frequency is high, but when the frequency is low, a large one is necessary. Therefore the baffle helps a small diaphragm to set much air in motion on the low frequencies, that is, to increase the effectiveness of the speaker as a producer of low frequency sound. That this is a fact requires only a few minutes to test, provided that the baffle board is handy. It can easily be tried with a small radio receiver that has no baffle. Just put the set against the baffle so that the speaker in the set is opposite the hole in the baffle. This hole should be no larger than the opening in the set, but it may be a bit smaller.

* * *

Propagation of Waves

LATELY I HAVE BEEN studying wave motion. I have learned that sound waves are longitudinal and that electromagnetic waves are transverse. I can see how longitudinal waves are possible in air or in space containing any continuous medium for propagation. I can also see how transverse waves can exist on a string, or on the surface of water, but I am utterly unable to conceive the possibility of transverse waves in space having a continuous medium. What would a transverse wave in air be like, or in water, not on the surface? I cannot form any conception of transverse light or radio waves. We are taught that such waves are transverse because of certain experimental facts. Yet we have not been presented with any mechanism making such waves possible. My reason for asking the question is to find out whether anybody else has the same difficulty as I have.—W. C.

Polarization phenomena require that light waves be transverse. Hence, they are said to be transverse. Undoubtedly, you are not the only one who is unable to see how a transverse wave can exist in a continuum of three dimensions. Maybe we can avoid the difficulty by assuming that light waves exist on some space strings. But that leads into other difficulties. Perhaps it is necessary to do away with the space continuum as well as the strings. As far as practical utilization of light and radio waves is concerned, it makes no difference whether we are dealing with transverse or longitudinal waves.

* * *

Making High Frequency Chokes

IS IT NECESSARY in making a choke coil that should be effective at 50 and 60 megacycles to connect several small chokes in series and placing them a short distance apart in order to reduce the distributed capacity?—F. W. N.

It is necessary to make the distributed capacity as low as possible, but it is not necessary to use the particular method which you suggest. However, it is a good method and is used in many coils designed for this frequency range.

Producing Second Harmonics

WOULD A CLASS B radio frequency amplifier make a good frequency doubler if the two plates of the tubes are connected together and the load is connected to the common lead? Or would it be better to use a regular Class A push-pull amplifier, taking off the double frequency from the common lead after the plates have been connected?—T. Y.

No doubt, there will be a greater output from the tubes if they are much overbiased. Impress the signal to the grids in push-pull, connect the plates together and put a resonant circuit tuned to twice the frequency in the common lead. A single tube used as a grid bias rectifier will also give good results. Tune the grid circuit to the signal frequency and the plate circuit to twice this frequency. It is also possible to get higher harmonics by tuning the plate to the harmonic desired. Of course, the intensity of the output will decrease rapidly as the order of the harmonic is increased.

* * *

Mixing Methods

WHICH IS THE BETTER mixer: the one using the pentagrid in the regular hook-up or the —24 tube as autodyne? Just before the pentagrid came out the —24 was used in nearly all commercial superheterodynes, and the tube was used both as mixer and oscillator.—W. B.

The pentagrid has some advantages, naturally, since it has been designed especially for this service. It has not merely been adapted to it like the —24. But when a first-rate superheterodyne is to be constructed, where the number of tubes used does not matter a great deal, there are many other mixers much better. A separate oscillator cannot be beat. Build an oscillator for oscillation, a detector for detection, and an amplifier for amplification. Then each can be adjusted to the function it is to serve.

* * *

Precision Dials

WHICH IS BETTER: to have a six-inch dial with 100 divisions or a four-inch dial with 180 divisions, when each has a vernier by which 1/10 of the smallest division can be read? Where highest precision is to be had is it not all right to have a worm drive to the shaft of which is a drum divided into 100 divisions, these 100 divisions representing one-tenth of the main scale?—G. W. L.

The six-inch dial can be read accurately to 1/1000 part of the full scale and can be estimated to 1/2000 part. The four-inch dial can be read accurately to 1/1800 part and can be estimated to 1/3600 part. Hence it

(Continued on next page)

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would seem that it is better to have the dial that is divided into 180 divisions. If the six-inch dial is also available in the 180 division scale, that, of course, is better than a smaller dial. The worm-drive dial you describe can be read to 1/1000 part at full scale, and the drum on the worm shaft can possibly be estimated accurately to 1/5. Hence the setting can be estimated to 1/5000 part. That is better, apparently, than any of the vernier dials. However, in a worm drive mechanism there is always lost motion which renders any setting uncertain. This might amount to a full division on the drum, in which case this sort of dial would not be any better than the vernier dials. If the lost motion is very small, and if the pitch of the driven gear is small so that, for example, one turn of the worm advances the main dial 1/100th of the total scale, then a high degree of accuracy is possible. But lost motion will develop with wear.

* * *

Too Stable Oscillator

IN BACK ISSUES you have described a tuned plate oscillator that was stabilized by means of a coil in the plate circuit and in which grid current was prevented by operating the tube on the negative bias region entirely. Now, I have tried such an oscillator, but it will not work for me. Will you explain why and tell what can be done to make it work?—T. B.

If the L/C ratio is too low it will not oscillate. As was always said when this oscillator was discussed, oscillation can be started by increasing both the filament voltage and the plate voltage. The mutual conductance of the tube must have a certain value if oscillation is to occur, and this must be lower the lower the L/C ratio. Now the mutual conductance can be increased by increasing the filament temperature. As the filament temperature is increased the plate voltage must be increased in order to keep the saturation point in the negative bias region. If grid current does flow the plate coil alone will not cause frequency stability. A more satisfactory oscillator was described in the May 6, 1933, issue, on page 6. While this is not stabilized at all settings of the tuning condenser, it is exactly stabilized at 1000 kc. and very nearly at all other settings. This oscillator is not critical.

Measuring Minute Capacities

ALL CALIBRATED condensers are useless for measuring accurately capacities of the order of 0.01 mmfd., such as the capacity between the plate and the control grid of a screen grid tube. Is there any way of using a calibrated condenser of larger value for obtaining such a small capacity?—P. A.

If you connect a large calibrated condenser in series with a small condenser of known value, you can measure extremely small capacities accurately. Suppose, for example, that we have a calibrated condenser having a total capacity of 1000 mmfd. and that its scale is such that we can read to one micromicrofarad. Now connect this condenser in series with a condenser of 50 mmfd. Suppose the small known condenser is C1 and that the large condenser is C2. Then if we change the value of C2 by dC2, the change in the capacity of the two condensers in series in very nearly equal to

$$dC2C1^2/(C1 + C2)^2.$$

Substituting values we have

$$dC_2(50/1050)^2, \text{ or } dC_2/441.$$

Now, since we can read a change in C2 of one micromicrofarad, we can detect a change in the series capacity of 1/441 mmfd. That is adequate for measuring accurately the capacity between the plate and the control grid.

* * *

Adjusting Coil Inductances

CAN YOU SUGGEST simple method of making small adjustments in inductance coils so as to make them equal? The coils are wound to be equal, but due to slight variations in wire dimensions and coil form dimensions variations occur which I wish to adjust.—F. E. W.

If the coil has two windings it may be connected in an oscillating circuit and the turns adjusted until zero beat occurs with some steady oscillator. If all the coils of the type to be adjusted are put in the same position, one after the other, and each adjusted to generate the same frequency, as judged by the zero beat with the steady oscillator, the inductances will be equal except for any possible differences in the distributed capacities of the coil. These differences will very likely be exceedingly small so that the inductances can be said to be equal after the adjustment. This is a method employed by some coil manufacturers. If the coil has a single winding it can be connected in series with a condenser and an a.c. milliammeter and then coupled loosely to a constant frequency oscillator. The coupling should be as loose as possible and it should always be the same. Adjustments can then be made until the current is greatest. This is not quite so accurate as using the beat method.

* * *

Tuning by Varying Bias

IT HAS BEEN SAID that accurate tuning can be effected by varying the bias on an oscillator. How does this work, if it is a fact that the frequency can be varied in this manner?—W. H. C.

It is a fact that the frequency of an oscillator, that has not been stabilized, will vary a little with the grid resistance and the plate resistance. Varying either will therefore vary the frequency. The resistance in either circuit can be varied by varying the grid bias, and therefore small changes in the frequency can be effected by grid bias variation. This will work better the more unstabilized the oscillator is. In a stabilized oscillator the frequency does not depend on either the grid or the plate resistance and therefore in such oscillator the frequency cannot be changed by changing the bias.

* * *

Availability of Frequency Standards

I WISH TO CALIBRATE an oscillator with as high precision as possible. Will you kindly tell me where I can get reliable frequency standards? Could I send my oscillator somewhere to have it calibrated accurately?—B. C.

If you have a radio receiver of average sensitivity you have at least 25 highly accurate standards, for every one of the better broadcast stations can be used as a standard. You can also send your oscillator to some laboratory to have it calibrated accurately, but chances are that by the time you got it back the calibration would not be as good as that which you could get by comparing your oscillator against broadcast station frequencies. Shipping does not do the oscillator any good. Remember that the frequencies of the larger stations are at least accurate to one per cent. of one per cent. If you are not satisfied with that accuracy, pick out those stations which are accurate to at least 5 parts in one million. Measurement of frequency used to be one of the major problems in physics. Now it is one of the easiest.

* * *

Radio Frequency Resistance

IS THERE a simple way of obtaining the radio frequency resistance of a tuned circuit from the resonance curve? If so, please give the method.—T. M.

If the tuned circuit is used as a wavemeter with a thermocouple galvanometer in series with the coil and the coil is coupled loosely to an oscillator the frequency of which is accurately known, there is a simple way of getting the resistance. First note the frequency at which the deflection is maximum. Then change the frequency until the deflection is one-half as large. (Note that this is the deflection on an instrument where the deflection is proportional to the square of the current.) Observe the frequency when the deflection has been reduced to one-half. Let f be the difference between this frequency and the resonant frequency. Then if f is small compared with the resonant frequency we have $R = 4\pi fL$. The resistance obtained by this method contains the resistance of the thermocouple, but this is usually known so that it can be subtracted from the R obtained by the formula. As an example, let us suppose that the resonant frequency is 1,000 kc. and that the frequency change required is 5 kc. Then if the inductance of the coil is 250 microhenries, $R = 5\pi$, or about 15.7 ohms. It may well be be that the resistance of the thermocouple is 5 ohms, which would leave 10.7 ohms as the resistance of the tuned circuit.

The Review

Questions and Answers Based on Articles Printed in Last Week's Issue

Questions

1. Is it possible that a short circuit will be present in a tube only when the filament or heater is heated, and be absent when this element is cold?

2. What is the general method used in determining shorts in tubes? How is the test applied to the several elements of a tube?

3. By virtue of what function does a tube work? Define what determines the quantity of this function.

4. What factor or characteristic is the best general one for determining a tube's performance? Define that characteristic.

5. Distinguish between the static and the dynamic conditions of operation of a tube.

6. Describe one method of measuring the power output of a tube.

7. Is the effective value of a. c. voltage greater or less than the peak value, and by what amount? What is the relationship of the peak value compared to the effective value? What is another term for effective value of a-c voltage?

8. Where does one ascertain the ohms load in testing for the power output of a power tube? Can you suggest what relationship the permissible percentage of distortion bears to the power output rating?

9. What is a tolerable amount of distortion in a power output stage? From what does this distortion arise?

10. Define self-bias and fixed bias and state if there is any difference in power output, and an approximate ratio.

11. Between what points of a filament type is the bias measured for a-c operation. Is there any difference in bias required if d. c. is applied? If so, how much difference? What would be the case if a heater type tube were compared, a. c. against d. c. on the heater?

12. If a variable resistor is in series with a fixed condenser across a line, how does tone control arise, and in what direction does it work?

13. Why are two speakers sometimes used instead of one? Is it possible to get as good quality with one speaker as with two? If so, why should two be used?

14. At standard voltages, approximately what value of biasing resistor should be used in the cathode leg of a 59 used as triode, for what bias voltage, what bypass capacity across this resistor would be suitable, and what connections does one make at the socket to constitute the tube a triode?

15. Give the values for a suitable fixed tone filter for the output of 59 push-pull Class B circuit, and state the connections.

16. Specify a suitable type power tube to follow the triode of a 55, where there are only two audio stages. Specify suitable tube where the triode of the 55 is to be followed by this tube as driver of a push-pull Class A triode output, e. g., 45's or 2A3's.

17. At 300 plate volts, and 62 volts negative fixed bias additional, state the newest recommendation for the ohms load, plate to plate, for push-pull 2A3's at what power output, and define what ohms load refers to.

18. If a neon lamp is to be used as resonance indicator, across a series limiting resistor in a receiver B supply circuit, if the lamp gets dimmest at resonance state what method may be used to make it burn brightest at resonance and state a safeguard for the lamp, and reason.

19. Is there any appreciable difference in time between cause and effect in the illumination of a neon lamp?

20. May the 1A6 be used as a diode tetrode and if so what is a preferred method of use?

Answers

1. It is not unusual for a tube short to show up only when the cathode is emitting, and not show up when the cathode is kept cold.

2. Tube shorts are generally determined by having lamps in series with voltage scources that feed the elements in such a manner that if there is a short the lamp will light. For testing several elements there would be a voltage source and a lamp for each element.

3. A tube works by virtue of its emission. The quantity of emission is determined by the number of electrons emitted at by the cathode at the operating temperature.

4. The best all-around characteristic for determining the condition of a tube is the mutual conductance. The mutual conductance is the reciprocal of the plate resistance and is defined as the ratio of the change in the plate current to the change in the grid voltage that produces that change in the plate current, the plate (and screen, etc.) voltage being held constant.

5. The static condition of operation of a tube refers to d-c input, the dynamic condition of operation to a-c input.

6. The power output of a tube may be measured by actual determination of the amount of power in the a-c output (plate) circuit. Alternating current would be applied to the input.

7. The effective value of a-c voltage is 0.707 of the peak voltage, or, the peak is 1.41 x the effective. Another term for effective value of a-c voltage is root mean square (rms).

8. The value of ohms load for power tests is taken from the specifications given by the tube manufacturers. The permissible percentage of distortion should be stated as a function of the power rating, as the lower this percentage is, the lower the power output rating due to this circumscription.

9. A tolerable amount of distortion in a power stage is 5 per cent. total harmonics. The distortion arises from the curvature of the characteristic of the tube, that is, the fact that the relationship of voltage to current is not linear.

10. Self-bias is the attainment of the bias voltage due to the voltage drop in a resistor through which flows the current of the biased tube or tubes. Fixed bias is the attainment of the bias voltage from some other source, which may even include the biased tube's current, but at least is a bias not changed much by the signal amplitude. The power output for equal amount of distortion is greater by the fixed bias method in the ratio of about 6 to 5.

11. The bias for an a-c operated filament tube is measured between the center of the filament (cathode) and grid or grid return. For d-c operation the voltage may be less by about half the filament voltage. In the case of heater type tubes the bias would be the same whether a.c. or d.c. is applied to the heater, because the heater is independent of the cathode, i. e., not in the biasing circuit.

12. If a variable resistor is in series with a fixed condenser across a line, tone control results from adjusting the resistor because the lower the resistance the closer the condenser alone comes to being across the line, and a condenser across the signal line reduces the amplitude of the higher audio frequencies. Thus, reducing the amount of resistance accentuates the low notes.

13. Two speakers are used instead of one where the speakers have markedly diffenent characteristics, and are matched so that one handles the higher audio frequencies well, the other the lower audio frequencies well, and the other frequencies are compensated for in mutual design of the speakers. It is possible to get as good quality from one speaker, but the design and construction of such a speaker are more difficult and expensive, and the two speakers to attain the same end therefore may be made more quickly and economically.

14. For the 59 used as triode, standard positive d-c voltages, the biasing resistor may be 1,100 ohms. A suitable bypass capacity across the resistor for audio frequencies would be 8 mfd. The bias should be 28 volts negative. The connections of the tube, or at the socket, for triode operation are to tie the two extra grids to the plate, the control grid alone being used for input.

15. For a fixed tone filter for 59's in push-pull, Class B, use 3,500 ohms and 0.06 mfd. in series between plate one tube and ground, and an identical circuit between plate of other tube and ground.

16. Where there are two stages of audio, the triode of the 55 constituting the first stage and the power tube the second stage, a suitable output tube is a pentode, 59, 47 or 2A5. If the triode of the 55 is to be followed by a second audio stage that drives triode push-pull output, (total, three audio stages) then the tube following the 55 triode should be a power tube, e. g., a 59 used as a triode, as a fairly high bias is necessary (28 volts here). The transformer primary, filtered or otherwise, may be in the 59 plate circuit, the secondary feeding push-pull 2A3's or 45's.

17. The ohms load, plate to plate, for the 2A3 tubes in push-pull, 300 plate volts, 62 volts negative bias fixed bias extra, is now recommended at 4,000 ohms. The ohms load refers to the load presented by the primary of the power transformer to the plate circuit of the tube in terms of equivalent pure resistance.

18. If the neon lamp grows dimmest at resonance, it may be made to grow brightest at resonance by removing the connection from the positive side of the limiting resistor in the radio circuit and making the connection to ground instead. An extra limiting resistor to safeguard the lamp may be necessary, the reason being that the voltage between the circuit resistor and ground may exceed the specified voltage for the normal operation of the neon lamp.

19. There is no appreciable difference in time between the application of a different voltage to the neon lamp and the indicated result of that application in the lamp illumination, as the response of a neon lamp is practically instantaneous.

20. The 1A6 may be used as a diode tetrode by using the No. 2 grid as the diode anode, a preferred method for very low distortion, although the rectification efficiency is higher by other methods.

NEED OF LIGHTNING ARRESTER

IS IT REALLY necessary to use a lightning arrester with a radio receiver? What I mean is, will the lightning arrester prevent lightning from striking, or if it does strike, will the arrester protect the set and the house?

Perhaps most sets are not equipped with a lightning arrester, and nothing serious has happened. The theory of the lightning arrester, though, is sound. It might prevent a strike in some instances. If a healthy strike should occur, it is doubtful that the arrester would protect the set—L. P.

Some of the Inside Facts on What Makes a Talk over the Air a Success

IN A chapter entitled "Presentation of the Broadcast," Cline M. Koon, senior specialist in education by radio, Office of Education, Department of the Interior, gives many facts that reveal the mastery necessary for what may be regarded merely as "a simple talk" on the air. The chapter is contained in the Departments' Bulletin, 1933, No. 4, "The Art of Teaching by Radio." Listeners will find much of interest in the entire bulletin, obtainable at 10 cents from the Superintendent of Documents, Washington, D. C. The chapter on "Presentation" sets forth the following:

It is difficult to suggest specific directions for broadcasting, since so much depends upon the personality of the speaker and his individual style. Just as some teachers make an educational subject interesting and others do not, some broadcasters are naturally interesting and others are not. Some experienced speakers can keep to the original timing and have more spontaneity by using carefully prepared notes. Other equally effective broadcasters follow their manuscripts verbatim even though they have rehearsed them until they have practically memorized them.

Even though delivery should not be the focal point of attention of either the broadcaster or the listeners, it is of paramount importance, since the voice, and the voice alone, is expected to give the message effectiveness. Therefore, it is not out of place to analyze delivery, as it is of even greater importance in broadcasting than in classroom lecturing or public speaking. Although not mutually exclusive, delivery may be considered under the headings of attitudes, microphone technique, and diction. They will be considered in order.

Attitudes

Back of the delivery itself are certain mental attitudes that the speaker needs in order to interpret the broadcast properly. He must be able to visualize his audience, banish affectation, and think anew the thoughts of the broadcast as he delivers it in an unassuming, intimate, natural, delightful manner. Let him think of the microphone as a sensitive-eared person, fairly close to the speaker, whose ear the speaker does not want to offend.

Cooperate closely with the station management. It will prove to be mutually advantageous for the broadcaster to work in close harmony with the station management during the broadcast as well as during the preparation for the broadcast.

Program directors point out that the broadcaster should be on hand and have everything ready for the broadcast 15 or 20 minutes in advance of actually going on the air. Punctuality is of extreme importance. The announcer in charge of the program should be notified immediately when the broadcaster arrives.

The announcer and operator should do everything they can to make the speaker or artist comfortable and at ease. The studio should be properly heated, ventilated, and available to the broadcaster at least 15 minutes before he is to go on the air. If the broadcaster wants to stand, let him stand.

If he wants to sit, let him sit. If he desires to work in his shirt sleeves, by all means permit him to do so. Sometimes a speaker will want some one to sit in the studio across from him as he broadcasts. Most stations will permit visitors to be in the studios under these circumstances, provided the visitor observes good studio decorum—which requires that the visitor remain quiet and not move around or leave the studio during the program.

The microphone should be placed in such a position that the speaker can see the announcer or the control operator during the broadcast. Periodical confirmation of the quality of the broadcast by the control operator, the announcer, or the production man is desirable. Code signals need to be understood, and only one person should communicate with or direct the artist or speaker during the broadcast.

Importance of Confidence

Assume a friendly, respectful attitude toward the listeners. Mental contact leading to confidence on the part of the individual listeners must be established. "Confidence," says B. A. Fenner, "is the secret of broadcasting, whether for sustaining or commercial programs." A friendly, respectful attitude tends to build confidence. Sir Walford Davies says that minds held in common must be mobilized on both sides of the microphone, and that, above all, the broadcaster must hold fast to the faith that the common mind everywhere is ready to take delight in simple beauty in music, or in simple truth in a talk, or in any high exercise of the heavenly faculty of imagination, with which every ordinary man, woman, or child on God's earth seems to be endowed.

A dogmatic, domineering attitude on the part of the broadcaster is not likely to gain confidence. Political broadcasts frequently defeat their own purpose by trying to force conclusions upon the listener. The broadcaster can submit the evidence and appeal to the listener to judge for himself what the conclusions should be. He should make a definite mental appeal to the listeners, but leave the conclusions to the listener's own intelligence.

The broadcaster should remember that each listener is in his own home and will listen closely if he is talked to as an individual rather than as a member of a tremendous audience. If the radio speaker will imagine himself holding a conference with someone across the office desk—someone whose opinion he respects and wants to impress—this attitude will lend an attractive ease and a spontaneous, intimate, and personal story.

According to Prof. J. C. Jensen, a genuine interest in the unseen audience and a lot of enthusiasm were the characteristics of Nebraska Wesleyan University's most successful radio instructor.

The consensus of opinion indicates that a normal conversational tone with a sparkle of informality is more conducive to building confidence than a platform or academic style of delivery. Preachment, advice, and generalization should be minimized. The message should be humanized and personal applications made frequently. In actuality broadcasts the listener should be made to feel that he is with the speaker and seeing what the speaker sees.

Persuade Rather Than Command

When the occasion warrants, the broadcaster should speak in a straightforward manner with conviction. Since he wants to persuade rather than command, however, he should not be dogmatic or too positive in his viewpoint.

He should correct immediately any mistake he makes just as he would if the listener were present. Other pitfalls to be avoided are a superior attitude, overacting, and a patronizing, affected manner.

Think the thoughts and live the part while broadcasting. "The most deadly faults in broadcasting are to let listeners get the impression that you are simply reading a manuscript," says Dr. Frank F. Nalder, of the State College of Washington. The subject should be presented in an impressionistic fashion which strikes the imagination of the listener and provokes his creative activity. The broadcaster should be able to communicate his enthusiasm to the listeners by projecting his personality over the air. The audience can detect the subtle difference in phraseology between the written and the spoken word. Besides the actual difference in pronunciation, the written word lacks vitality and authority. Mechanical reading will not create the impression of naturalness and sincerity which are valuable attributes on the air B. H. Darrow says, "Do not iron out flat. Leave in the pauses, changes of speed and pitch that make conversation more attractive than reading."

Natural ability is the first requirement in broadcasting. No set of rules can produce it. If the broadcaster is blessed with a natural poise and clear-cut speech, he should be natural. Otherwise, he should try to overcome the difficulties that interfere with his broadcasting effectiveness or stay off the air.

Amos 'n' Andy Quoted

Gosden and Correll point out that the broadcast should be natural, human, and simple. They say:

> In radio we as Amos 'n' Andy first of all try to be natural. We never use any phrasing or words the meaning of which we think some few might not clearly understand. Even in the continuity we write for the announcer giving the synopsis of the episode or a brief of what has gone before, we make it as plain as possible, bearing in mind that we are catering to the masses.
>
> There is nothing further we could tell you about radio broadcasting other than when the speaker is before the microphone he should be natural and human. Occasionally when some physician or public speaker gets before the microphone after he is introduced he will clear his throat in the face of the radio audience before starting his talk. His next remark is "Good evening, ladies and gentlemen," and then he tightens up, overemphasizing throughout his speech.
>
> Our personal idea of a good educational program is one with many interesting facts and true incidents of interest injected into the talk, with the speaker giving us the impression that he is leaning back in a big overstuffed chair, with his feet on the ottoman, talking to us in our own library.

Individual Styles of Talkers

Radio must present ideas in a living fashion. A realistic and colorful delivery adds to the attractiveness of the broadcast provided it seems natural. Every speaker has a style of his own. If the speaker's delivery naturally varies in regard to speed, stress, intonation, etc., he should be encouraged to utilize these variations. If not, any attempt to force a varied style is almost certain to create an affected delivery. Affectation, as well as dullness, drives listeners away.

A sense of the dramatic which enables the individual to make the most of his personality as he lives the part he is presenting may be called showmanship. If so, showmanship is essential in broadcasting. The real showman can conform to the best practices in delivery without permitting the thoughts of microphone technique, diction, etc., to become a complex that will destroy his naturalness. After all, the thought of the radio speaker must be on the ideas he is presenting during the broadcast and not on the method of presenting the ideas.

Microphone Technique

Microphone technique is an expression that has grown up in broadcasting circles to describe the proper use of the microphone as to position, volume, pitch, avoidance of extraneous noises, etc. In a leaflet entitled "Getting Acquainted with the Microphone," the Columbia Broadcasting System points out the microphone which picks up the voice of the speaker as a very sensitive instrument. Its improvement from year to year only tends to make it more sensitive. The slightest sound, even one that is almost inaudible to the speaker himself, is picked up by the microphone and amplified in transmission so that the sounds intended for the listeners may be clearly reproduced in the homes of those who make up the radio audience.

The limitations which the microphone imposes upon the broadcaster tend to make him "mike conscious." The mastery of the art of broadcasting implies that the speaker has learned to perform in front of the open microphone in such a manner as to produce the desired effects upon the audience. This section will be devoted to a discussion of some of the rules to be observed in mastering the microphone.

Avoid extraneous noises The microphone magnifies some qualities of the voice and amplifies certain extraneous noises. Many interesting instances might be given of the effects of studio noises on listeners. Lawton relates an instance that occurred during the early days of broadcasting. Radio station KFI at Los Angeles received an appeal by mail from Cuba, "For heaven's sake, turn off that faucet; I hear that dripping of water every time you put on a program and I tune in." An examination of the studio revealed a leaky water tap. Eliminate all interference possible. Carpenter gives an instance of an orchestra leader who believed himself unfortunate in that his orchestra was forced to play classical music only in the hotel dining room where they were working. This type of music was not conducive to applause, but he felt that applause was needed to impress his invisible audience. He solved the difficulty by having several members of his orchestra gather closely around the microphone and click their teeth as loudly as possible. This sounded very much like hand clapping to the radio audience.

Position at Microphone

Sudden loud noises such as coughing or sneezing blast the microphone. Heavy breathing, walking, the rustling of a manuscript, keeping time with the feet, the clearing of the throat, lip noises, tapping on the microphone or a table, even the clicking of the finger nails or the rubbing of a careless finger over a half day's growth of beard may completely confuse the audience. One program director recommends a pinch of salt to loosen the throat just before entering the studio.

Often, for a brief period before the speaker begins his address and after he has finished, the microphone is open and alert. During the time the microphone is open, the instrument itself, the standard on which it rests, and the cables running to it should not be touched in any way. Absolute silence should be maintained. A red light or some other signal is used in nearly all studios to indicate when the studio is on air.

Master the microphone. The statement "master the microphone" is used to denote skill in adjusting one's position in reference to the microphone to facilitate the hearers' getting the correct understanding of the broadcast. For example, J. E. Bryan, general manager of radio station KTAT, gives the following suggestions:

> To arouse excitement, stand back 5 or 6 feet from the microphone and raise the pitch of the voice and increase the rate.
>
> To command attention, raise the head slightly and speak with gravity and authority.
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> To elicit sympathy, stand close and practically murmur—but distinctly.
>
> To develop loyalty, speak in a kindly, quiet voice near the microphone.

The proper position of the speaker before the microphone depends upon the acoustical characteristics of the studio, type of microphone used, and the character of the voice. The acoustical characteristics of a studio are materially affected by atmospheric conditions. Sometimes it is necessary to arrange the various instruments in the orchestra after the final rehearsal because of atmospheric changes. Station managers are learning to appreciate more and more the importance of suitable atmospheric conditions in the broadcasting studio. Proper temperature, ventilation, humidity, etc., not only contribute to the comfort of the broadcaster but also improve the transmission.

Engineering improvements are being made constantly in microphones which increase the fidelity of tone reproduction and affect microphone technique. Microphones have been developed recently that will pick up the speaker's voice satisfactorily 6 or 8 feet away. This gives the speaker more freedom and thereby facilitates naturalness. The lapel microphone which proved to be a technical success at the Democratic National Convention brings several innovations, especially for actuality broadcasts and dramatic productions. By means of the small microphone attached to the speaker, or to a page who moves from speaker to speaker, more freedom of movement is insured, eliminating the ever-present "mike consciousness," and raises the possibility of better outdoor broadcasts with natural sounds. Recent experiments with the nondirectional microphone indicate that engineering developments may greatly increase the freedom of the broadcaster with reference to the position of the microphone.

Free and Easy

Actual experimentation with the cooperation of the radio-station staff is necessary to determine suitable distance and angle of the speaker from the microphone. The type and nature of the speaker's voice is an important factor in determining proper placement of the speaker. The broadcaster should learn to perform with freedom and ease within the prescribed limitations of the microphone as determined in rehearsal. Fortunately the technical operator has considerable control over the transmission. This should relieve the broadcaster of much concern while on the air. If the performer is comfortably placed, with the microphone at the proper height and distance from him, the transmission can be left very largely to the operator as the broadcaster gives his full attention to the thought of the broadcast.

Sutton points out that a speaker with a good broadcasting voice—clear, resonant without a nasal or metallic twang—may stand close to the microphone and talk intimately into it; and that a speaker with a voice of less pure quality gets a better effect by standing at right angles to the disk and speaking across it. The volume of voice that the speaker may use varies with the distance from the microphone. As the volume of the voice is varied, the speaker moves back and forth from the microphone. Unlike stage delivery, where the speaker steps forward and increases the volume to emphasize a point, broadcasting requires that the speaker either step back from the microphone and raise his voice or speak very close to the microphone in warm, intimate tones when he wants to stress a point. Sudden changes of the direction in which the broadcaster is speaking affect the volume. Crowding or overloading the microphone, as well as getting beyond its range, should be avoided. Weaving about and turning of the head away influence the pick-up.

Galvanometer Watched

Precisely how the voice comes over depends also upon the way in which the operator controls transmission. Too much current destroys the overtones; too little gives only the fundamental vibrations. The galvanometer in the control room is calibrated from 1 to 60 points, and the speaker should control his voice so that the needle fluctuates between 10 and 20. The rasp of the metallic voice and the twang of the nasal are always magnified. When the current of transmission is too great, they come over with ear-splitting harshness.

Annette Bushman, who has had extensive experience in directing dramatic productions, gives an interesting account of some of the technical problems to be considered when a radio drama is being properly produced. She says:

> An actor unfamiliar with radio finds it difficult to acclimate himself to this somewhat strange medium. On the stage he must project his voice so that he can be heard in the last row of the second balcony. On the radio the last row in the balcony becomes the first row in the orchestra. If he attempts to project farther than the first row, he "blasts;" that is, he uses so much volume that his voice is just a raucous noise. . . . The actor must "trick" his voice to register correctly on the galvanometer and still maintain the emotion and feeling of the character which he is playing. He must stand only 8 or 12 inches from the microphone; if he is farther away than this, we still may be able to hear him distinctly, but, in the terms of the theater, he is not center stage. Sometimes this is desirable, but we must keep in mind the effect to be produced. If the action of the play demands that an actor speak from a door or a window, he will back away from the microphone, using a slightly higher pitch in voice, and deliver his line to the person at the "mike." If the listeners are to "see" the actor make the movement, he must move while speaking, and raise his voice in slight crescendo. Entrances are made 6 or 7 feet from the "mike;" the actor starting with his voice pitched higher than usual will gradually walk into the microphone, lowering his voice in a gradual diminuendo until he arrives at the "mike." If the listener is to see the actor move, the actor must always keep talking as he moves, for if he makes a pause in his lines while he walks it may sound like two different voices.
>
> In a mob scene in the theater the actors top the noise in the background by projecting their voices above the noise. Quite the opposite is true on the radio. Two actors, speaking in ordinary tones, 6 inches away from the microphone, will be heard above any noise made by the mob in the background. Unfortunately, the natural instinct of the actor at the microphone is to raise his voice above the mob, but his scene must be rehearsed over and over again until this defect is remedied.

When Two Speak

If more than one person are in the broadcast, or if musical setting or sound effects are used, particular attention should be paid to the microphone set-up. In radio conversation between two speakers the broadcasters can stand or sit close together on opposite sides of the microphone and then forget it. In case more than one person are using a microphone no one should appropriate it to himself. The balance of voices should be considered when different participants have fixed positions in reference to the microphone. One program director reports an instance when four persons were speaking at a long table. A very bad effect was created by having two gruff, heavy-voiced men in the center near the microphone and two feeble-voiced women at the extreme ends.

Radio Abroad

In foreign countries there are many more talks on the air than in the United States. This is due in part to the control of radio by the government and the use of the microphone for political propaganda. Pronounced examples of this are found in Germany and Russia.

The government does not directly run radio administration in Britain, but the government stands in the position of a parent company to the British Broadcasting Company. Talks are more numerous than here, also the programs are in a slower and less lively tempo. In South America and Central America an attempt is made to follow our method.

Station Sparks

By Alice Remsen

COMMERCIALS BEING RENEWED

Renewals are in order for commercials which started early in the season. The Happy Wonder Bakers are among them; these boys, Frank Luther, Jack Parker and Phil Duey, have had their contracts renewed for another series over an extended network; their soloist is changed, however, Vivian Ruth taking the place of Harriet Lee; this program is sponsored by the Continental Baking Company and is heard over WABC and the Columbia network each Monday, Wednesday and Friday at 8.00 p.m., EST. . . . November 9th brings a broadcast from "Merrie England"; it's a very unique one, too—the traditional Lord Mayor's Banquet held at the Mansion House in London upon the occasion of the new Lord Mayor of London assuming office; Ramsay MacDonald, Prime Minister of England, will enunciate the British Government's policy for the ensuing year at this time; time is 4.15 p.m., WABC. . . Felix Bernard, of The Playboys, has seven Scotch terriers. . . . It seems that Guy Lombardo and Burns and Allen will never get together, even though they broadcast on the same program; the orchestra and the two comics are always in different places; for instance, George and Gracie are now on their way to the Coast to make a picture; consequently they stopped off in Cincinnati to do their radio stunt; at that time the Lombardos were in Detroit; when George and Gracie broadcast from KHJ, Los Angeles, the Lombardos will broadcast respectively from WHK, Cleveland, November 1st, WCAO, Baltimore, November 8th, WJSV, Washington, November 15th and 22nd, and WCAU, Philadelphia, November 29th. Remarkable, isn't it! . . . Hal K. (Yess man) Dawson, the super-salesman of the "Elmer Everett Yess" program over WABC, should be able to sell a bill of goods—he started out in life as a salesman. . . .

CAB CALLOWAY'S NEW ONE

You will probably hear a new song on the air very shortly—one written by Cab Calloway, and dedicated to Sally Rand; it is called "The Lady With the Fan"; Amy Spencer, the colored singer introduced it for the first time in Cab's new floor show at the Cotton Club, New York. . . . Leonard Liebling, music critic of the New York "American" and editor-in-chief of "Musical Courier," is this season's commentator for the WABC-Columbia and Canadian network broadcasts of the New York Philharmonic Symphony Orchestra; he is heard each Sunday afternoon during the concert intermissions; Mr. Liebling is a native of New York and is descended from a family prominent in musical circles both in America and Europe for nearly a hundred years; he was the first Amercan piano pupil of Leopold Godowsky, and, after completing his studies in Europe, he went on the concert stage; Liebling is what you might call a musical jack-of-all-trades, for he is prominent as a journalist, editor, critic, pianist and composer; he even ventured into the musical comedy field, writing the book for Sousa's "The American Maid." . . . The American Oil Company has one of the new programs for this month; it is called "The American Revue" and stars Ethel Waters, colored singer, and George Beatty, from vaudeville, who is the comedian and master of ceremonies; the Dorsey Brothers Orchestra supplies the music; WABC and Columbia network, Sundays at 7.00 p.m. . . . Jesse and Mrs. Crawford are on the road, presenting in different cities a thirty-minute concert at the twin organ console. . . . You may now hear that swell music of Glen Gray and his Casa Loma Orchestra from the Essex House, New York, via WABC and network, each Saturday, Sunday, Monday and Friday night at midnight, EST. . . . Dick Robertson, CBS tenor, bagged a four-hundred-pound bear on a recent hunting trip in Ulster County, N. Y. . . . The Beaux-Arts Apartments have a magazine of their own, edited by Russel Patterson, L. Porter Moore, and Ted Deglin; an interesting little paper of eight pages, with pictures, advertisements, news items, 'n' everything. . . .

VAUGHN DE LEATH IN VAUDEVILLE

Vaughn De Leath is on a vaudeville tour; she appeared recently at a Sunday soiree sponsored by the Beaux-Arts management and arranged by Mr. and Mrs. Keith McLeod. The Leaders, radio singing trio; Muriel Pollock and Vee Lawnhurst, Jack and Loretta, Jacques D'Avrey and Charles Austin entertained the many guests of the Beaux-Arts at this function, which I understand will be repeated again in the near future. . . . Still another movie star has gone radio; Irene Rich is broadcasting from Chicago for the makers of Welch's Grape Juice; the program goes over WJZ twice weekly, 7.45 p.m., EST, Wednesdays and Fridays. . . . Station WLS in Chicago is giving a series of dramatic playlets, twice weekly, for the benefit of "The Cradle," a nationally known adoption nursery at Evanston, Illinois; the playlets, written by R. T. McClaughry under the general title of "Cradle Dramas From Life," will be presented on Fridays at 2.30 p.m., CST, during Martha Crane's Homemakers Hour, and on Sundays at 3.00 p.m., CST. . . . Gene Autry is back on WLS again; Gene is known as the Oklahoma Yodeling Cowboy; he is back from a six weeks' tour of personal appearances throughout the Middle West; he is now heard on the Sears programs at 8.30 a.m., Tuesdays, Thursdays and Saturdays. . . . Percy Hemus, that veteran radio artist, is making a hit on the Tom Mix broadcasts. Percy plays the role of Wrangler, and plays it well, too; tune in and hear him each Monday, Wednesday and Friday at 5.30 p.m., EST, WEAF. . . . William Wirges and His Mountain Music may now be heard on Wednesday evenings, over WJZ and NBC network, at 11.00 p.m., EST; tune in and her this unique broadcast; it's well worth a listen. . . . Just finished listening to the new Amco broadcast, which I mentioned previously; George Beatty made a very excellent master of ceremonies—not too obtrusive, with a few good and well-chosen gags, and a short comedy continuity; keep up the good work, George, old chap! Ethel Waters did a marvelous job on "Stormy Weather," which was not surprising, as she has done it so much. A jolly good show, taking it all together; music was fine, too. Don't miss it next Sunday! . . .

WHAT'S TO BE DONE?

Can you explain this to me? I moved my radio from the back to the front of the house; at same level—in the back of the house I could get WTIC, Hartford, easily, but not WTAM, Cleveland; in the front of the house I can't get WTIC, but can get WTAM—and I'm mad, because I particularly want to get WTIC; isn't a little thing like that annoying?. . . The NBC music library has been moved over to Radio City from 711 Fifth Avenue. . . . Studios will be used by the last of this month. I have not yet seen them, but they are supposed to be the last word in studios. Shall tell you something about them very shortly. . . . Richard Nicholls, William C. Stoess, and Grace Clauve Raine were in town from Cincinnati last week looking for talent to take back to Station WLW with them; have not yet heard what they picked. . . . Jan Peerce, Radio City Music Hall tenor, who is heard over NBC as John Pierce, will hereafter be known both on the radio and on the stage under his nom de theatre—Jan Peerce; the young singer is a protege of "Roxy." . . .

"BOTTLE" IS A SULKY MAN

Harry McNaughton, the young Englishman known as "Bottle" in the Phil Baker broadcast, believes that he is the world's luckiest man, and I think he is, too—for Harry went through the World War for three years and nine months without receiving a scratch; later he was in the ill-fated Pathe studios when they burned down to the ground, and he again escaped without injury; he is always in minor accidents such as railroad wrecks, car wrecks, swimming accidents and the like—and nothing ever happens to him. . . . But something will happen to me pronto if I don't hurry and get this copy into the hands of my friend the editor—so here goes for a subway over to Manhattan!

A THOUGHT FOR THE WEEK

WHEN Guglielmo Marconi says something, the world stops and listens. Hence his recent reaction to the television experiments he saw worked out at the RCA-Victor laboratory was not only interesting but convincing. The famous scientist expressed himself as being ready to acknowledge that television had advanced actually in both a practical and commercial way and that it now seemed probable that the time was near at hand when television sets would be ready for the American market. All of which is much more reassuring to the public than all the wild claims of concerns whose chief object has been to sell stock in promotion companies rather than to prove that they have something practical to offer to seekers for television sets that will work.

Winning Programs Not Easy

Although advertising agencies that place programs for their clients with stations large or small are ever on the alert for a drawing card, numerous trial efforts are yanked off the air after a short run, because unsuccessful. Not only is there no pat solution to the problem of pleasing the public, but public taste changes. This change is usually slow, but it is still fast enough to keep all program-builders on their toes.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor, Radio World, 145 West 45th Street, New York, N. Y.

Donald Brown, The Saskatoon Radio Service (sound work and specialties), 330 3rd Ave., South, Saskatoon, Sask., Canada.
W. L. Goodhart, 104 W. Main St., Louisville, Ky.
Charles Panush, 1617 So. Morgan St., Chicago, Ill.
Kenneth Davis, 236 No. 17th St., Bloomfield, N. J.
Karl Kosen, 266 New York Ave., Union City, N. J.
John C. Dallas, Garfield Hospital, 11th & Fla. Ave., N. W., Washington, D. C.
F. F. Baker, 608 Second National Bank Bldg., Akron, Ohio.
John Gindel, 1423 Jamaica Ave., Astoria, L. I., N. Y.
George F. Monson, 14 Ford Street, Deposit, N. Y.
E. L. Horne, Bateshurg, S. C.
D. J. Dougherty, 122 Willow St., Prescott, Ariz.
M. K. Bennett, Howser, B. C., Canada.
Leo E. Otis, 222 W. Chestnut St., East Rochester, N. Y.
Jim Richesin, Box 724, Lefors, Texas.

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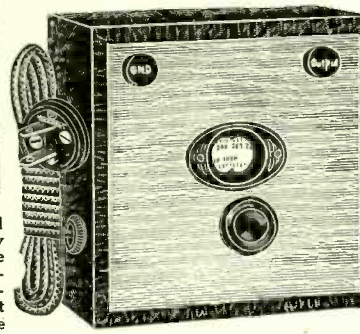

Over-All Size Is Only 5x5x3"! Dial Reads Frequencies Directly!

A NEW TEST oscillator, Model 30, has been produced by Herman Bernard, so that all the requirements for lining up broadcast receivers, both tuned radio frequency and superheterodyne types, will be fully and accurately met. This device may be connected to 90-120-v a.c., any commercial frequency, without regard to polarity of the plug, and will function perfectly. It may be used also on 90-120-volt d.c. line, but plug polarity must be observed. One of the plug prongs has a red spot, denoting the side to be connected to positive of the line. If you don't know the d.c. line polarity, you may connect either way, without danger. The oscillator will work on d.c. only when the connection is made the right way. Moreover, 90 volts of B battery may be used instead of either of the foregoing, simply by connecting two wires between the plug at the batteries, observing polarity. No separate filament excitation is required. The oscillator is modulated with a strong, low note under all circumstances. It uses a 30 tube.

THE dial of the Bernard Model 30 Test Oscillator is directly calibrated in kilocycles, so there is no awkward necessity of consulting a chart. The fundamental frequencies are 135 to 380 kc, so that nearly all commercial intermediate frequencies as used in present-day superheterodynes are read on the fundamental. The points for other intermediate frequencies, e.g., 400, 450, 456 and 465 kc, are registered on the dial also, two harmonics, with which the user need not concern himself, being the basis of these registrations. Besides, the broadcast band is taken care of by the fourth harmonic and the dial is calibrated for that band, also.

The divisions on the dial for the fundamental band, 135 to 380 kc, are 1 kc apart from 135 to 140 kc, 2 kc apart for 140 to 180 kc and 5 kc apart for 180 to 380 kc. For the broadcast band, 10 kc apart from 550 to 800 kc, 20 kc apart from 800 to 1,500 kc.

The test oscillator may be used also for short waves, by resorting to higher harmonics.

Send $12 for 2-year subscription for RADIO WORLD and order Cat. BO-30 sent free, with tube (prepaid in United States and Canada).
Another model, BO-30-S, same as above, except frequencies are ten times as high, hence instrument is for short-wave work only, is available on same basis.

540-4,500 kc Tuning Units

The Tuning Units consist of a four-gang 0.00046 mfd. condenser, with trimmers on it, 3/8-inch diameter shaft, 1 1/8 inches long, mounting spades, condenser closing to the left; and a set of four shielded coils. The condenser is the same for tuned radio frequency sets or superheterodynes, but for superheterodynes a series padding condenser is supplied also. For t-r-f sets the four coils are alike. For supers three coils are alike and there is a different coil for the oscillator, with a selection for 175 kc, 456 kc or 465 kc intermediate frequency.

For t-r-f construction, three stages of t-r-f and tuned detector input, four equal shielded coils, tapped for the police band and properly matched to the tuning condenser which is supplied also. Order Cat. TRFTU, which will be sent free, postpaid, on receipt of $10.00 for 86-week subscription for RADIO WORLD (86 issues).

For superheterodyne construction, two stages of t-r-f, tuned oscillator and tuned input to modulator, three identical coils and an oscillator coil, with the proper padding condenser and the four-gang condenser, are supplied as noted below:

175 kc—For use with 175 kc intermediate frequency. Unit includes four-gang condenser, three r-f coils, the proper oscillator inductance and 800-1,350 mmfd. padding condenser. Send $12.00 for two-year subscription and order Cat. SUTU-175, which will be sent postpaid.

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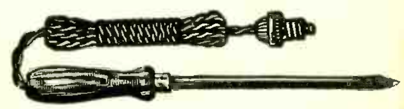

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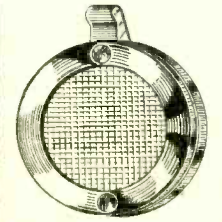

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