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RADIO WORLD

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The First and Only National Radio Weekly

423d Consecutive Issue—NINTH YEAR

Conflicting Principles of Dynamic and Ear

Distortion by Detuning

Smoking Stand Set

Side Frequency Analogies

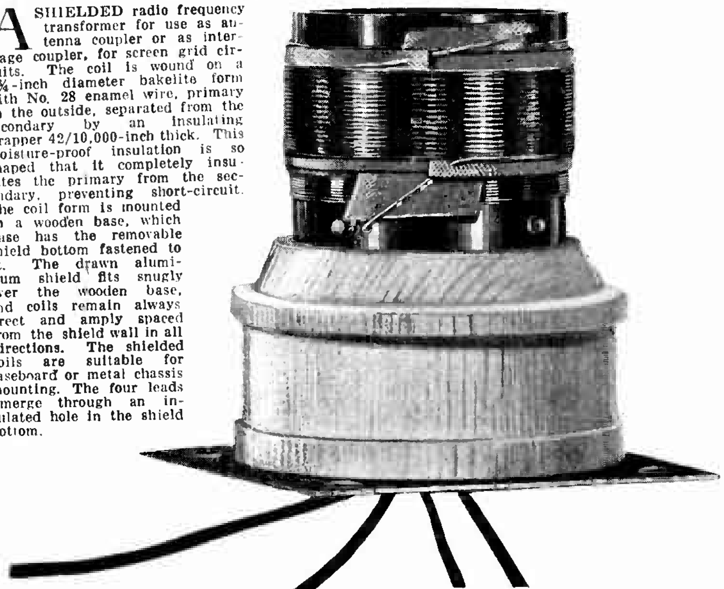
Oscillator Coupling Circuits

Cure for Body Capacity on Short Waves

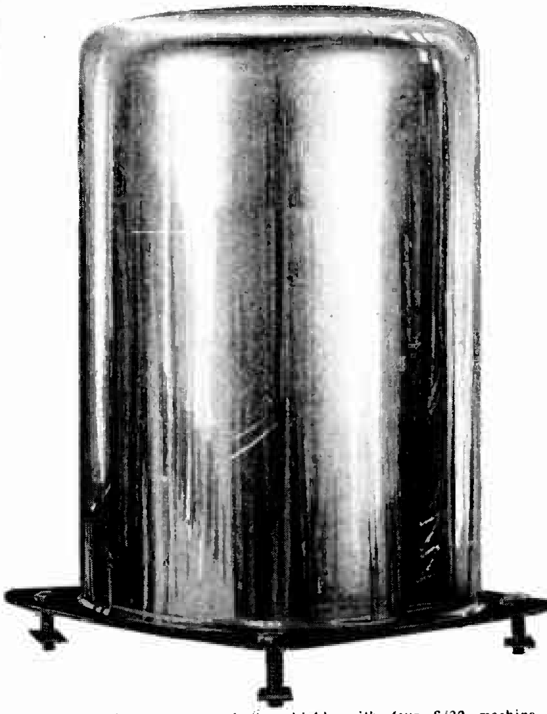
RADIO WORLD, published by Hennessy Radio Publications Corporation. Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager, all of 145 West 45th Street, New York, N. Y.

High-Gain Shielded Coils

A SHIELDED radio frequency transformer for use as antenna coupler or as interstage coupler, for screen grid circuits. The coil is wound on a 1¾-inch diameter bakelite form with No. 28 enamel wire, primary on the outside, separated from the secondary by an insulating wrapper 42/10,000-inch thick. This moisture-proof insulation is so shaped that it completely insulates the primary from the secondary, preventing short-circuit. The coil form is mounted on a wooden base, which base has the removable shield bottom fastened to it. The drawn aluminum shield fits snugly over the wooden base, and coils remain always erect and amply spaced from the shield wall in all directions. The shielded coils are suitable for baseboard or metal chassis mounting. The four leads emerge through an insulated hole in the shield bottom.



The coil comes already mounted on a shellacked wooden base, which is fastened at the factory to the shield bottom. Series A coil is illustrated.



The external appearance of the shield, with four 6/32 machine screws and nuts, which are supplied with each coil assembly.

Precisely Matched for Gang Tuning

ONE primary lead-out wire from the coil, for antenna or plate connection, has a braided tinned alloy covering over the insulation. This alloy braid shields the lead against stray pick-up when the braid alone is soldered to a ground connection. The outleads are 6 inches long and are color identified. The wire terminals of the windings themselves, and the outleads, are soldered to copper rivets. Each coil comes completely assembled inside the shield, which is 2¾ inches square at bottom (size of shield bottom) and 3¾ inches high. High impedance primaries of 40 turns are used. Secondaries have 80 turns for .00035 mfd. and 70 turns for .0005 mfd.

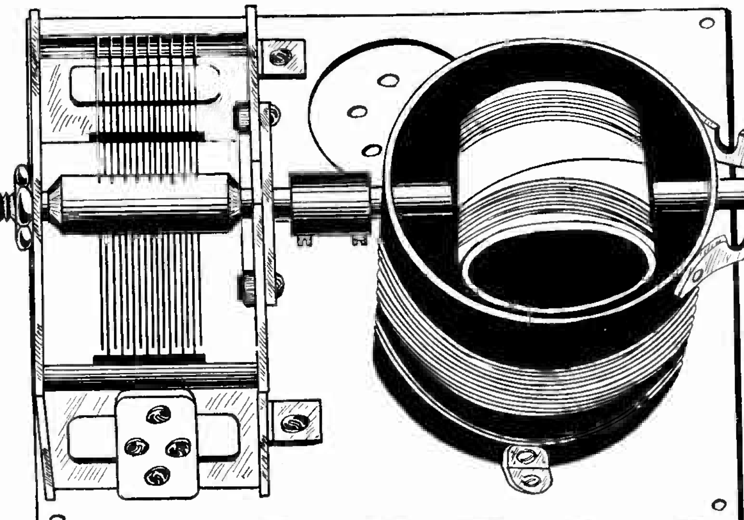
Junior Model Inductances

The Series B coils have the same inductance and the same shields as the series A coils, but the primary, instead of being wound over the secondary, with special insulation between, is wound adjoining the secondary, on the form, with ¼-inch separation, resulting in looser coupling. No wooden base is provided, as the bakelite coil form is longer, and is fastened to the shield bottom piece by means of two brackets. No outleads. Wire terminals are not soldered. Order Cat. B-SH-3 for .00035 mfd. and Cat. B-SH-5 for .0005 mfd.

EXTREME accuracy in winding and spacing is essential for coils used in gang tuning. These coils are specially suited for gang condensers, because the inductances of all are identical for the stated size condenser. The coils are matched by a radio frequency oscillator. The color scheme is as follows: shielded wire outlead is for antenna or plate; red is for ground or B plus. (These options are due to use of the same coil for antenna coupling or interstage coupling.) Blue is for grid and green is for grid return. For .00035 mfd. the Cat. No. is A-40-80-S. For .0005 mfd. the Cat. No. is A-40-70-S.
Where a band pass filter circuit is used the small coupling coil to unite circuits is Cat. BP-6. The connection is illustrated herewith.

Coils for Six-Circuit Tuner

Series C coils for use with six tuned circuits, as in Herman Bernard's six-circuit tuner, are wound the same as type A shielded coils, but the shields are a little larger (3 1/16-inch diameter, 3¾ inches high), and there are no shield bottoms, as a metal chassis must be used with such highly sensitive circuits. Fasten the brackets to the shield and then, from underneath the chassis, fasten the other arm of the two brackets to the chassis. Order Cat. C-6-CT-5 for .0005 mfd. and Cat. C-6-CT-5 for .00035 mfd. Six matched coils are furnished. If band pass filter coupling coil is desired order Cat. BP-6 extra.



For a stage of screen grid RF, either for battery type tube, 222, or AC, 224, followed by a grid-leak-condenser detector, no shielding is needed, and higher per-stage amplification is attainable and useful. This extra-high per-stage gain, not practical where more than one RF stage is used, is easily obtained by using dynamic tuners. Two assemblies are needed. These are furnished with condensers erected on a socketed aluminum base. Each coil has its tuned winding divided into a fixed and a moving segment. The moving coil, actuated by the condenser shaft itself, acts as a variometer, which bucks the fixed winding at the low wavelengths and aids it at the high wavelengths, thus being self-neutralizing and maintaining an even degree of extra-high amplification throughout the broadcast scale.

Two assemblies are needed. For AC operation (224 RF and 224 or 227 detector), use Cat. BT-L-AC and BT-R-AC. For battery or A eliminator operation (222 RF and any tube as detector), use Cat. BT-L-DC and BT-R-DC.

BT-L for the antenna stage and BT-R for the detector input. BT-L consists of a small primary, with suitable secondary for the .00035 mfd. condenser supplied. BT-R has two effective coils: the tuned combination winding in the RF plate circuit, the inside fixed winding in the detector grid circuit.
The moving coils must be "matched." This is done as follows: Turn the condensers until plates are fully enmeshed, and have the moving coils parallel with the fixed winding. Tune in the highest wavelength station receivable—above 450 meters surely. Now turn the moving coils half way round and retune to bring in the station. The setting that represents the use of lesser capacity of the condenser to bring in that station is the correct one. If gang tuning is used, put a 20-100 mmfd. equalizing condenser across the secondary in the antenna circuit and adjust the equalizer for a low wavelength (300 meters or less).

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Technical Accuracy Second to None
NINTH YEAR

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Detuning Changes Quality

When the Carrier is Suppressed Relative to One Side Frequency, Distortion Results

By J. E. Anderson

Technical Editor

IF we accept the conception that a modulated wave consists of a carrier and two side frequencies it is easy to show how the side frequencies are suppressed by the tuner when the circuit is tuned accurately to the carrier frequency, and it is also easy to show the effect of detuning the circuit, for example, detuning it to the point where it is exactly resonant to one of the side frequencies.

A typical resonance curve is depicted in Fig. 1. Just what selectivity this curve represents is of no interest since the frequency scale is not given in quantitative terms. If F is the carrier frequency and F1 and F2 the two side frequencies the curve represents the case when the circuit is tuned exactly to the carrier frequency.

The amplitude of the carrier voltage developed across the tuned circuit is represented by the vertical distance FA. Since the circuit is tuned to F, the amplitude of the signal at this frequency is greater than that of any other frequency, and since the side frequencies are different from the carrier the amplitudes of the side frequency voltages developed across the tuned circuit are less. These amplitudes are given by the vertical distances F_1A_1 and F_2A_2 for the lower and the upper side frequencies, respectively. The vertical distances AA1 and AA2, shown in dotted lines, represent the suppression of the side frequency voltages.

Suppression Large

The suppression indicated is comparatively very large. This means one of two things, first, that the side frequencies differ greatly from the carrier frequency and that the selectivity is moderate, or second, that the side frequencies differ but little from the carrier and that the selectivity is great. If the side frequencies differed still more from the carrier frequency the vertical lines representing the side frequencies would recede further from the line representing the carrier, F1 toward the left and F2 toward the right. The suppression would then be still greater because the selectivity curve continues to fall as it recedes from the maximum point F, and therefore the transmission on the side frequencies, that is, the voltages developed across the tuned circuit at the side frequencies, would be much lower.

There is no frequency band involved in this case and therefore there can be no sidebands. There is only one modulating frequency and hence there are only two side frequencies at equal distances from the carrier. The modulating frequency is represented by F_2—F and F—F_1, which are numerically equal.

Effect of Detuning

The effect of detuning the circuit can be seen by moving the frequency system F1, F, and F2 with respect to the resonance curve. In the ordinary receiver this is done by turning the tuning condenser, in which case the curve moves with respect to the fixed frequencies. In the superheterodyne it is done by turning the oscillator condenser, in which case the frequency system, in the intermediate amplifier, moves with respect to the fixed resonance curve. Whether it is done in one way or the other the result can be represented by the same diagram. Fig. 2 shows the case in which the relative motion of the two have been done so that the upper side frequency F2 falls at the peak

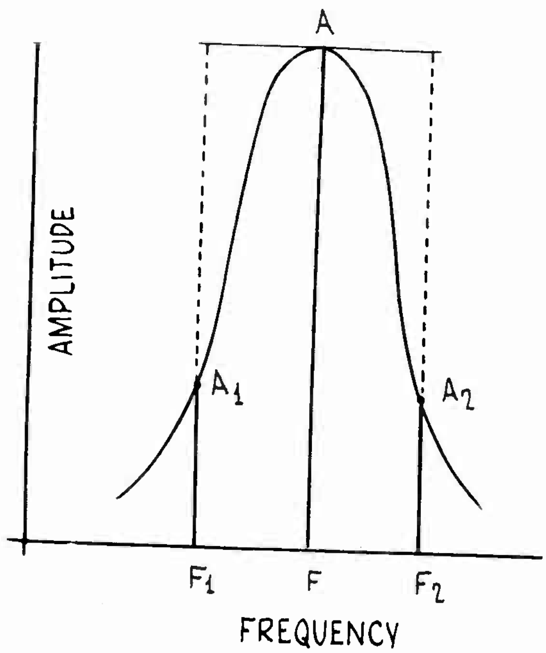

FIG. 1
A RESONANCE CURVE WITH A SUPERPOSED FREQUENCY SYSTEM CONSISTING OF A CARRIER F AND THE TWO FREQUENCIES F1 AND F2. THE CIRCUIT IS ACCURATELY TUNED TO THE CARRIER.

of the resonance curve. The carrier frequency falls at a distance to the left of the peak and the lower side frequency F1 falls at a point still further to the left, or just twice as far.

Now observe that the upper side frequency is brought out more strongly than the carrier, that is, relatively. The side frequency voltage is much less than the carrier frequency voltage in the first place, and may be afterward, too, but the difference will be less because the side upper side frequency now rates 100 per cent. and the carrier less than 50 per cent. Also observe that the lower side frequency has been suppressed much more than it was in the first case.

The question now arises as to the effect on the quality of this suppression. We cannot say definitely because there are many factors entering into the problem which cannot be taken into consideration here, and also because we are here dealing with only one modulating frequency. We must consider at least two modulating frequencies if we are to say whether there is any relative suppression between the two.

However, we note that the vertical distance AF2 is much greater than the vertical distance AF1. If these two vertical distances were the same we would be justified in assuming that

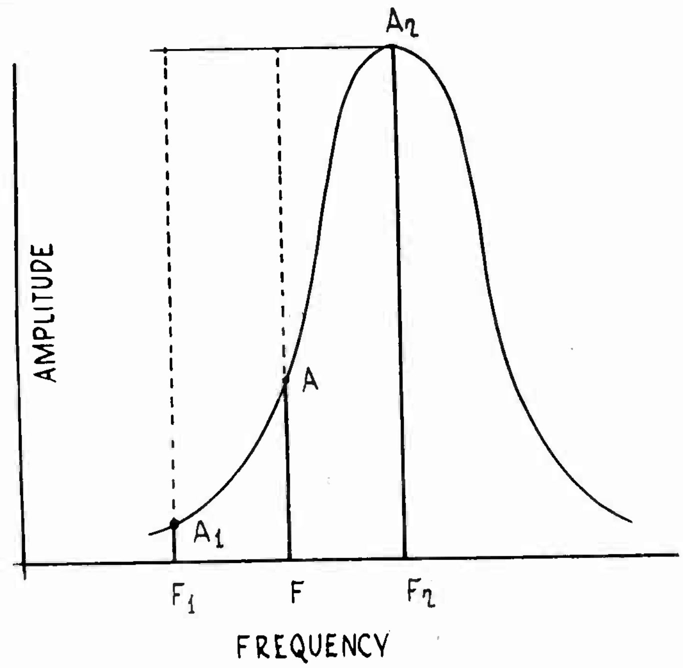

FIG. 2
THE SAME RESONANCE CURVE BUT WITH THE FREQUENCY SYSTEM PLACED SO THAT THE HIGHER SIDE FREQUENCY FALLS ON THE RESONANCE PEAK. THE CARRIER AND THE LOWER SIDE FREQUENCY ARE SUPPRESSED

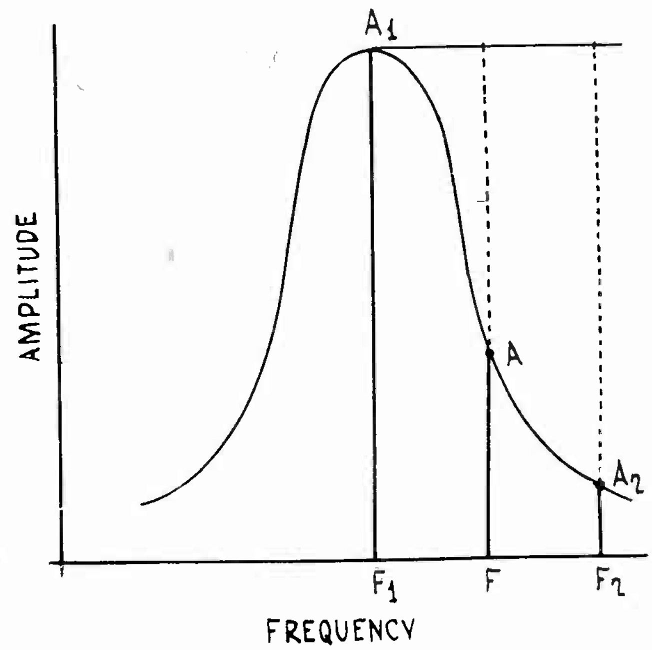

FIG. 3
THIS REPRESENTS A DETUNING IN WHICH THE LOWER SIDE FREQUENCY FALLS ON THE RESONANCE PEAK. THE UPPER SIDE FREQUENCY AND THE CARRIER ARE SUPPRESSED.

there would be no distortion, at least not of the simple amplitude type. But they are not equal. The upper side frequency is tuned in more strongly than the lower side frequency is suppressed. Without going into the detailed reasons for the conclusion, we may say that the modulating frequency will be detected more strongly than it would have been had there been no suppression, relatively, of any of the frequencies.

Translating this conclusion into practical terms, we would say that if the modulating frequency is 10,000 cycles it would be stronger after detection than if it is 1,000 cycles. In other words, if the carrier is modulated with a large number of frequencies ranging from 30 cycles, say, to 10,000 the higher modulating frequencies would be stronger than the lower. The hissing sounds would be prominent in the output. This is borne out by aural observations. Such observations also tell us that there is more serious distortion than simple amplitude discrimination. This is to be expected since the carrier frequency is suppressed.

Opposite Kind of Detuning

In Fig. 3 the relative shift between the frequency system and the resonance curve has been effected in the opposite direction to that in Fig. 2. Now the lower side frequency falls on the resonance peak while the carrier frequency and the upper side frequency are suppressed. The resulting effect of this detuning is about the same as that of Fig. 2 because the resonance curve is very nearly symmetrical. It is exactly symmetrical when plotted on a frequency ratio basis but slightly unsymmetrical when plotted on a straight frequency basis. However, when the modulating frequency is small compared with the carrier frequency there is no appreciable difference.

In practice the detuning never amounts to as much as that shown in either Fig. 2 or Fig. 3, because if it is the quality is noticeably distorted, and the operator will tune the set more accurately. However, it is rarely that the tuning is done so accurately that the carrier falls exactly on the peak of the resonance curve unless the tuning is done with the aid of a meter to show exact resonance. When tuning in distant stations the adjustment is usually more accurate because it is necessary in order to hear the signals.

When the detuning is somewhere between that indicated either in Fig. 2 or in Fig. 3, there is very little distortion of the signal, unless the tuning system is exceedingly selective. For small amounts of detuning the output is practically the same as when the circuit is tuned exactly.

Amplitude of Carrier and Selectivity

The question of the dependence of the selectivity on the amplitude of the signal impressed on a given tuner often arises. For example is the selectivity of a given circuit greater when a feeble distant station is tuned in that when a strong local station is tuned in? The temptation is strong to answer this in the affirmative because appearances favor such a reply. But the answer must be an emphatic negative. The selectivity is a property of the tuner and that property does not change with the intensity of the signal impressed. The selectivity is just as great when a strong local station is tuned in as when a weak distant station is nursed to audibility.

The need for a greater selectivity when a strong local station is in operation is a different matter. A given tuner may be quite selective enough to separate two distant stations even though they may be separated by only one or two channels, yet that tuner may not be selective enough to separate two local stations as much as 5 channels apart. Or it may not be able to suppress the signals from a local station sufficiently to hear those of a distant station even if they are as much as 25 channels apart.

The fact that a strong local station forces itself in on the signals from a distant station makes it appear that the tuner is less selective on the stronger signals. One might as well say that a pound is heavier when a small child lifts it than when a man does it. It only appears heavier to the child, because the child does not have so much lifting power.

Yet we have already stated that there is likely to be a greater suppression of side frequencies from a distant station than from a local. That is true but not because the selectivity of the circuit changes of itself or as a result of the signal. The greater apparent selectivity may be due to greater accuracy of tuning or because of a peculiarity of the ears. The ear is relatively more sensitive to weak signals than to strong.

If the receiver could be adjusted so that the signal input from a local station is the same as that of a distant one without in so doing changing the circuit selectivity, the apparent selectivity would be the same in the two cases, just as the real selectivity is.

Six-Circuit Tuner Construction Next Week

A new metal chassis being made for further experimenting with the Six-Circuit Tuner was not delivered in time to enable the presentation of intended report on results, as the mechanic took sick, so this week we draw a blank. But next week the constructional article will be published, and combined with it will be the report on the new chassis.

It has been found that shielding of the tuning condensers themselves is not absolutely necessary, but arrangements will be made so that those who desire to shield even the condensers may do so. The circuit, for the benefit of those who haven't read of it before, consists of a band pass filter with two tuned circuits, and followed by three stages of screen grid tuned RF. The sixth tuned circuit is the series with the ground lead to the antenna coil only, to compensate for the rising characteristic of tuned RF.

It is expected that this four-tube tuner, with its 227 power detector and two stages of resistance-coupled audio, will prove to be one of the most sensitive of all receivers. It is in semi-final form after six weeks, and only slight changes, if any, will be introduced, as compared with the diagram published last week, April 26th.

What the circuit has done will be told in the constructional article. —Herman Bernard.

Wanted: Pat Analogies

Side Frequencies Hard to Parallel by Exact Example

TECHNICAL EDITOR:

YOU have discussed sidebands and side frequencies a number of times and each discussion helps us fans to get a clearer understanding of the phenomenon of modulation. I believe that the more analogies are drawn between various phenomena the more nearly complete does the understanding become. Your explanation of side frequencies in terms of relative speeds of two motor cars going in the same and in the opposite directions points out a mathematical similarity but it does not show any relationship between speeds and frequencies. One difficulty in my mind is that the two side frequencies can exist at the same time but two cars cannot go in the same and in the opposite directions at the same time. Hence the two relative speeds cannot co-exist.

The analogy between the Doppler effect and the side frequencies was very interesting and instructive. Personally I have never observed the phenomenon of the changing pitch, although I have passed bells on a train thousands of times. However, I have no doubt that I shall observe the effect the next time I have an opportunity. If this change in pitch is real, and I have no doubt that it is, this analogy is much better than that of the two cars. But still I cannot see how the approach and the recession frequencies can exist at the same time. To make the analogy complete, it seems to me, they would have to be audible to the observer at the same time.

I wonder if the side frequencies are ever low enough to be heard. When a radio frequency is modulated with an audio frequency it is my understanding that the side frequencies are of the same order of magnitude as the radio frequency. Would it not be possible to modulate the radio frequency in such manner that at least one of the side frequences falls within the audible range? If that could be done it seems to me that the existence of the lower side frequency at least could be demonstrated.

A discussion of these questions would be welcome to me, and I am sure that there are many others who would appreciate it also.—F. S. Middleton.

It is true, as Mr. Middleton says, that the analogies given to elucidate side frequency production are not exact. It is very difficult to find analogies which are exact without introducing phenomena that are no less complex. If the process of modulation cannot be visualized from the mathematical formulation it must be visualized piece-meal with the aid of analogies as close as can be found, and it may be necessary to utilize several analogies to explain one thing, accepting those features that fit and rejecting those that don't. The main difficulty with the two analogies given, that is, the motor car analogy and the Doppler effect analogy, is that the two side speeds, or the two side pitches, do not co-exist. But they do co-exist in the observer's mind after both have been observed.

Suppose we have a tuner which is so sharp that only one of the side frequencies can be accepted at a time. Then as far as observation is concerned the two side frequencies would not co-exist either. That limitation brings the analogies a little closer together.

The relationship between speed and frequencies is very intimate, although at first it seems to be quite remote. Frequency is a measure of angular velocity, or angular speed. It tells how many times a second something revolves. In the case of a radio signal that "something" is signal vector. The signal may be regarded as a force of constant magnitude rotating at a uniform rate, and that is a rotating vector. Suppose we represent the signal by the minute hand of a clock. This has a certain length, representing the amplitude of the signal. It has also a direction at any instant but this direction is continually changing at a uniform rate. Thus we have a vector of constant length rotating uniformly. Now let us look at this vector, the minute hand, in a direction at right angles to the usual direction. That is, we look at it from the side instead of from the front. Does the length of the minute hand appear to be the same all the time? It does not. It varies according to its position on the dial. The apparent length of the minute hand varies in the same manner as the intensity of the radio signal, and from this fact we get the idea that the radio signal is a rotating vector.

The question of getting an audible lower side frequency is easily disposed of. Set up an oscillator covering the same range as the broadcast receiver and then tune in any station. Turn the oscillator condenser. The characteristic squeal will be heard. This squeal is nothing but the lower side frequency of the carrier of the station tuned in and the frequency generated by the oscillator. At zero beat this side frequency is zero. Hence it can be varied from zero, through the entire audible scale, and then away up without limit.

While the lower side frequency can be heard directly as a disagreeable squeal, or as a steady audio tone, it is also possible to receive the broadcast station's signal on the upper side frequency with another receiver, provided this receiver is tuned to a frequency about twice as high as that of either the carrier or the oscillator frequency.

The upper and lower side frequencies can also be heard simultaneously if we lower the two beating frequencies so that the upper side frequency falls inside the audibility limits. Suppose we sound two organ tones at the same time, one 64 cycles per second and the other 96 cycles per second. Both these tones can then be heard and also their two side frequencies, namely, the lower 32 cycles per second and the upper 160 cycles per second. The distinctness with which the two side frequencies are heard depends on the detecting ability of the ears.—J. E. Anderson.

One Who Builds His Own

One who builds his own set can select the cabinet that suits his own tastes, or the tastes of his wife, and the same applies with respect to the speaker. Perhaps he will want a receiver in which the speaker is dissociated physically with the set in order to take advantage of the flexibility this arrangement affords. The man who buys a commercial receiver must accept the speaker that is in the cabinet or else buy a receiver without a cabinet.

One strong argument for building one's own receiver is that it is possible to make it up to date. New things and ideas continually spring up in radio, which are published in the technical papers. The commercial receivers will not have these things incorporated for at least a year. During the interim the man who builds his own can enjoy the benefits of the new ideas and developments. By the time these are put into commercial receivers and thus made available to the man who buys his receiver other ideas have sprung up which make the commercial model out of date, not as far as the general public is concerned but as far as the technically minded are concerned. When the man who buys a commercial receiver is beginning to enjoy the fruits of new developments, the man who builds his own is already enjoying still more recent developments.

The man who builds his own does not have to sacrifice sensitivity, selectivity, quality, ease of operation, appearance, or any other characteristic of a good receiver, and he does not have to expend enormous sums of money for his set. Not at all. Neither does he have to junk the whole receiver when a new model comes out. He can really have a superior receiver from every view point at a cost comparable with the cost of a commercial receiver of the highest type. Moreover, he gets all the fun out of building the receiver according to his ideas, and that is a large part of the total enjoyment without a doubt.

Impedance Depends on Current

Consider the rate of change of current and voltage in a load impedance. Let us explain the meaning. Suppose there is a circuit in which alternating current is flowing. The current rises and falls in magnitude as well as reversing in direction at regular intervals. Suppose at a certain time the current changes one milliampere in one-millionth of a second. The time rate of change of that current is then 1,000 amperes per second, or it is one milliampere per microsecond, which is the same thing.

The rate of change is not the same at every instant. At the time the current is maximum in one direction or the other the rate of change is zero. At the time the current is zero, which occurs twice every cycle, the rate of change is greatest.

The impedance that a circuit offers to a current is usually said to depend on the frequency, and that is correct because the rate of change of the current depends on the frequency. Really the impedance at any instant depends on the rate of change of the current. The greater the rate of change, the greater the impedance, the voltage being held constant. It is on this fact that the equivalence of the two view points of a modulated wave depends. When a wave is modulated it does not have the same rate of change at every instant as it would have if it were unmodulated. Hence the impedances are different. Therefore, when the wave passes through a condenser, or an inductance coil, or a tuned circuit, the modulated wave will change in a manner different from the way a pure wave will change. If the wave passes a tuned circuit the tendency is for the modulation to be tuned out, provided that the tuned circuit is adjusted to the carrier. If it is adjusted to a side frequency, even if we admit this to be fictional, the tendency is for the side frequency to be emphasized and the carrier to be tuned out. The tuned circuit is ordinarily adjusted to the carrier and therefore the side frequencies are partly tuned out.

... proper remains substantially grounded, since the ground lead to antenna post of the converter goes to the ground through the first choke coil. In other instances best results are obtained only with the regulation aerial, with connection of the ground lead omitted. But in any instance the ground post of the converter must be connected to the ground post of the receiver, as the receiver's ground post is B minus, and it is necessary to pick up the B minus lead to get any plate current in the converter. If it so happens, as it rarely does, that the receiver is grounded through a condenser, then B minus from the receiver must be picked up specially.

Thus the converter is AC operated, furnishing its own heater voltage and current, and depending on the receiver for B voltage. The converter can be used, as diagrammed, only where there is AC house wiring, but it can be used on any and every type of receiver, whether battery-operated or AC. It can be

... frequency. While there will be repeat tuning on some stations, there will be no more than two possible settings of the oscillator for any one station and only one possible setting of the other tuned circuit for the same station. The two oscillator settings are very close together, two or three divisions apart, representing the higher and lower frequency of oscillator setting to produce a frequency that differs from that of the modulator by 1,700 kc. At the higher frequencies considered, 1,700 kc is only a small fraction of the frequency being tuned in.

The oscillator and modulator circuits are united by the mutual inductive relationship of the two coils on the same small panel, but this coupling is rather less than desired, so an additional form of coupling is used, a coil in inductive relationship to the oscillator secondary. Through the pickup coil the grid of the detector is returned to ground. The principal coupling is through this pickup coil. —Herman Bernard.

Freedom from Body Capacity

Oscillation Assured from 15 to 200 Meters

familiar with regenerative broadcast circuits, where a three-circuit tuner is used. The rotatable winding is in the plate circuit,

Methods of Coupling

Type of Circuit for Hook-Up to

By Capt. Peter

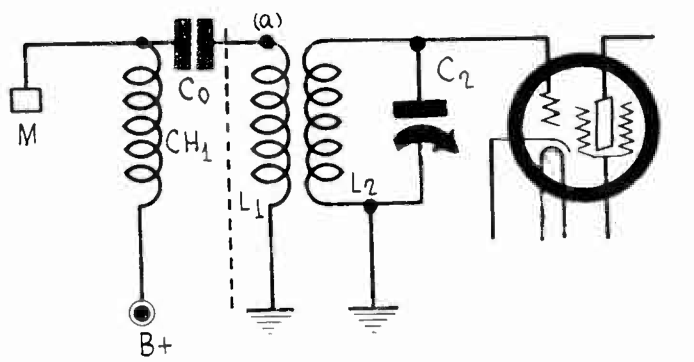

FIG. 1
A METHOD OF COUPLING A FREQUENCY CHANGER TO A BROADCAST RECEIVER WITHOUT MAKING ANY CHANGES IN THE SET, APPLICABLE WHEN THE INPUT TO SET IS TRANSFORMER COUPLED.

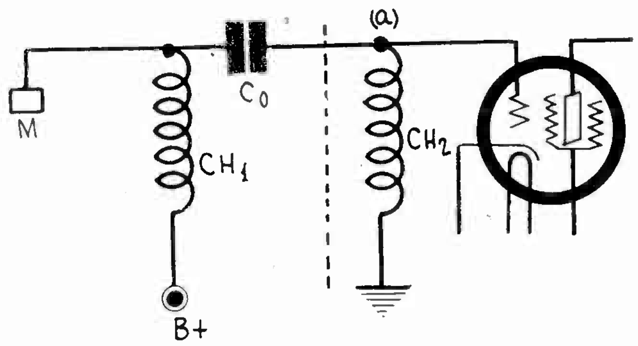

FIG. 2
WHEN THE ANTENNA IS COUPLED DIRECTLY TO THE BROADCAST RECEIVER, EITHER WITH A CHOKE OR A RESISTANCE, THE FREQUENCY CHANGER MAY BE COUPLED IN THIS MANNER.

IN the April 12th issue of RADIO WORLD a number of frequency changers for converting a broadcast receiver into a superheterodyne was published, applying primarily to broadcast waves but applicable to short waves, too. All these converters had the same type of coupling between the modulator and the first tube in the receiver, a type that assumed the first tube in the receiver to be a screen grid tube. Not all receivers are of this kind, so that in many instances other types of couplers are more suitable. Moreover, each one was such that the first tuner in the broadcast receiver was eliminated from the resulting circuit, a change which may be undesirable in many instances.

Just as there are many types of couplers for use between the antenna and the first tube in the receiver, or between tubes, so there are many types for use between the modulator tube in the frequency changer and the broadcast receiver. In Figs. 1, 2, 3, and 4 are shown four different types. One of these may be most suitable in one instance and one of the others in another case. In each of these the dotted vertical line represents the line of separation between the broadcast receiver and the converter, the point (a) when given representing the antenna binding post on the set, and M the plate of the modulating tube.

Transformer Coupling

In Fig. 1 the antenna is coupled to the set by means of a radio frequency transformer with tuned secondary. This is the most frequent type of coupler. Now if L1, the primary of the transformer, has a comparatively high impedance and is coupled rather closely to L2, the coupling to the frequency changer may be as shown in the figure when M is a screen grid tube. If L1 is a small winding and moderately closely coupled to L2 this type of coupling may be used when M is a three element tube like the 227.

It is always possible to adapt the primary L1 to either type of modulator tube by adding or removing turns as the case may require. However, it should not be supposed that results will not be obtained just because the primary winding on the coupling transformer may not have the optimum number of turns or the optimum coupling with the secondary. Fair results will be obtained even if the mismatching is quite bad and it may be that these results may be better than those obtained without the frequency converter.

The method of coupling shown in Fig. 1 has the advantage of retaining the advantages of the extra tuner and also the advantage that no change need be made in the broadcast receiver. The antenna is simply removed from the antenna post and transferred to the antenna post on the converter and one side of C0 is connected to the antenna post of the set.

There is no particular value of C0 that will give best results, and a .001 mfd. condenser is about as good as any other of larger value. This condenser, however, should not be made too small, for example, not less than .00025 mfd. Neither is the radio frequency choke Ch1 critical. Values of 65 or 85 millihenries are suitable, which are standard.

Direct-coupled Antenna

In Fig. 2 is shown the case when the antenna is coupled to the broadcast receiver by means of a choke coil Ch2. As will be noticed, there is no difference in the output circuit of the modulator tube in this circuit and that in Fig. 1. Ch1 and C0 have the same values as the corresponding parts in that circuit, a Ch2, of course, is an integral part of the broadcast receiver. In some receivers this may be a resistance, which does not change the circuit in so far as the connection of the frequency changer is concerned.

The circuit in Fig. 2 has the advantage that the coupling is not selective. It does not pick out the intermediate frequency to the exclusion of all other products of the modulator and leaves it to the tuners in the broadcast receiver to perform the necessary selection.

The advantage of this coupler is its simplicity, since no other tuning than that provided in the broadcast receiver is needed. If the broadcast receiver is selective enough, which it should be,

Right or

QUESTIONS

(1)—Is it possible to have a receiver of zero selectivity, that is, one which does not present any discrimination because of difference of frequency.

(2)—A sound wave consists of alternate condensations and rarefactions of the air, that is, a series of increases and decreases of the air pressure.

(3)—Longitudinal waves similar to sound waves in air may be set up in solid substances such as brass and steel.

(4)—A vacuum tube voltmeter consisting of a grid bias detector and a sensitive milliammeter in the plate circuit is one of the keenest means of making adjustments in a receiver.

(5)—It is not necessary that the vacuum tube voltmeter be calibrated when it is used for finding various adjustments which give maximum output.

(6)—The power tube in a receiver often takes more current from the B supply than all the other tubes in the circuit combined.

(7)—The carrier frequency of a broadcast station varies over wide limits when it is being modulated and it is this frequency variation which is made use of in detection.

(8)—When a carrier frequency is modulated with a 10,000 cycle audio frequency there exists an infinite number of frequencies in the modulated wave ranging from the carrier frequency less 10,000 cycles up to the carrier frequency plus 10,000 cycles.

(9)—When a carrier frequency is modulated by an equal frequency the two resulting side frequencies are one that is twice the carrier frequency and another of zero frequency.

(10)—All the tubes in a multi-tube receiver are operated to their highest efficiency when the circuit is adjusted to maximum sensitivity with the volume control.

ANSWERS

(1)—Right. A resistance coupled receiver in which there are no condensers or inductances would have zero selectivity. It is possible to the extent that is is possible to build a non-reactive receiver throughout.

(2)—Right. A sounding body vibrates back and forth and piles up the air particles when it moves in one direction and detracts from the normal number when it recedes.

(3)—Right. These waves are also defined as sound waves

Frequency Changers

Receiver Depends On the Input to Set

V. O'Rourke

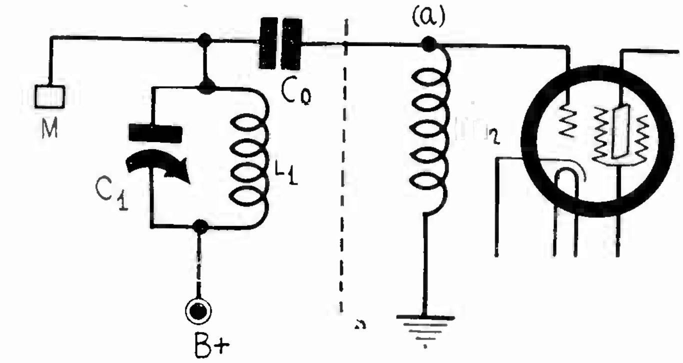

FIG. 3
WHEN THE ANTENNA IS DIRECTLY COUPLED AND IT IS DESIRED TO ADD ANOTHER TUNED CIRCUIT, THE FREQUENCY CHANGER MAY BE COUPLED IN THIS MANNER.

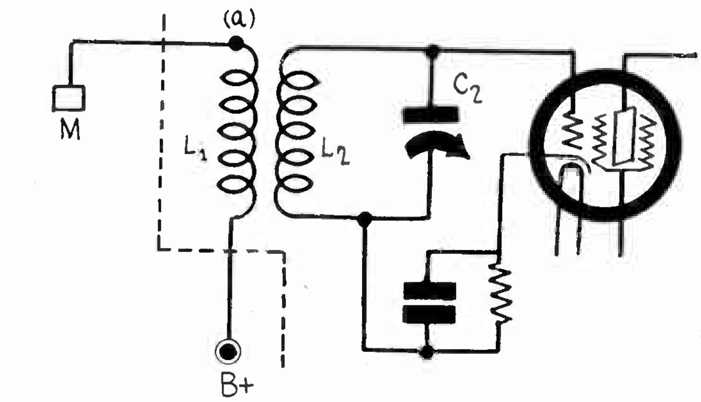

FIG. 4
IF THE GROUND POST ON THE SET IS NOT METALLICALLY CONNECTED TO THE LOW VOLTAGE SIDE OF THE CIRCUIT THE COUPLING TO THE FREQUENCY CHANGER MAY BE DONE WITHOUT A CHOKE COIL AND A STOPPING CONDENSER.

it is not necessary to provide any more selectivity since the receiver will be more selective when used as a superheterodyne, or it may be made so by adjusting the trimmer condensers at the frequency at which the tuner is to be used.

If the input to the broadcast receiver is such as shown in Fig. 2 and the selectivity and the amplification are not sufficient a more effective method of coupling the modulator may be obtained by following the circuit in Fig. 3. The stopping condenser C0 remains as before but Ch1 takes the form of a parallel tuned circuit C1L1. This has several advantages. First, it couples the modulator tube to the receiver more effectively than any other type of coupler. This is especially true when the modulator tube is a screen grid tube. Second, it increases the selectivity of the circuit, since it adds one more selector. Third, it makes the modulator tube more effective as a detector, since the high frequency components of the output of the modulator tube are by-passed with C1.

More Space Needed

But it has disadvantages, too. It necessitates accurate tuning of C1L1 to the intermediate frequency to which the broadcast receiver is set, and it requires more space since a variable condenser and a tuning coil take more room than a simple radio frequency choke. However, it is not necessary to use a large variable condenser for C1. A small fixed condenser and a small midget will do. In some instances it is not even necessary to use the midget because if a fixed C1 and L1 are adjusted somewhere near the desired intermediate frequency the circuit may be tuned with the condensers in the set until it is in tune with C1L1, whatever its frequency may be.

Suppose, for example, that the circuit C1L1 happens to be resonant at 540 kc it is possible to set the broadcast receiver at that frequency and thus to bring it in tune with the parallel tuned circuit. Most receivers can be tuned to 540 kc. However, if the set cannot be tuned lower than 550 kc the turns on L1 can be changed until the natural frequency of C1L1 falls at 555, say, when the final tuning can easily be effected with the condensers in the broadcast receiver.

As in Fig. 2, Ch2 may be replaced with a resistance without change, and therefore broadcast receivers having this form of input can be used with the type of coupling in Fig. 3.

In some receivers the ground post is not connected to the rest of the circuit, that is, the antenna and ground circuit is not metallically connected to the receiver in any way. When this is the case the modulator tube may be connected as shown in Fig. 4. The antenna post on the set is connected to the plate of the modulator tube and the ground post on the set to B plus. L1, the antenna winding on the set, then becomes the plate coil of the modulator tube.

Before this connection is made it is necessary to make certain that there is no metallic connection between the antenna post and the rest of the broadcast circuit, for a connection would result in a short circuit. If the low voltage side of the receiver is grounded as well as the ground post, the circuit in Fig. 1 should be used.

A Variation of Circuit

Another way of coupling the circuit is suggested by Fig. 4. Let the dotted line be run to the right of C2 instead of to the left of L1. Then the grid lead to the first tube in the broadcast receiver would be cut, or removed in the case of a screen grid tube, and the high voltage side of L1C2 would be connected to the control grid instead. This would make the tuned circuit L2C2 with the primary L1 an external tuner and an integral part of the frequency changer. The circuit C2L2 would be tuned in the same manner as C1L1 in Fig. 3.

Note that in these circuits it is not necessary that the first tube in the broadcast receiver be a screen grid tube, except as specially stated. The first tube may as well be a three-element tube. Hence the frequency converter may be used with any sensitive receiver.

Wrong?

because they are of the same nature—longitudinal and consisting of alternate condensations and rarefactions of the solid material. There is no substance so "solid" that it cannot be compressed a little, and there is no substance so tenuous that it cannot be attenuated still more.

(4)—Right. There is no more sensitive means of telling which adjustment results in a greater or less signal voltage than the vacuum tube voltmeter.

(5)—Right. It is not necessary that it be calibrated because absolute values are not required, only relative values. A vacuum tube voltmeter of this type might better be called a vacuum tube galvanometer, for a galvanometer is only a voltmeter or a current meter than has not been calibrated.

(6)—Right. In most receivers the tubes up to the power tube does not take more than 15 milliamperes and the power tube may take from 32 to 55 milliamperes, the current requirements of the 245 and the 250 tubes, respectively. When the power tubes are in push-pull the current taken by the last stage is doubled.

(7)—Wrong. This is the opinion held by many who have an incomplete understanding of modulation, but the fact is that if the carrier is modulated properly there is no change in its frequency. It has the same value whether it is modulated with a 30-cycle or a 10,000-cycle audio frequency. But the side frequencies in these two cases differ.

(8)—Wrong. This is also the opinion of many but it is an erroneous opinion. The modulated frequency may be regarded either as a radio frequency the amplitude of which goes through periodic variations corresponding to the 10,000-cycle frequency or as a complex wave composed of the unaltered carrier and two side frequencies the values of which are the carrier frequency diminished by 10,000 cycles and the carrier frequency augmented by the same frequency.

(9)—Right. The two side frequencies are always the sum and the difference between the carrier and the modulating frequency. Hence when the two are equal one side frequency is twice the frequency of either and the other is zero.

(10)—Wrong. Nearly all the tubes in a multi-tube receiver are operated far below their maximum. If these were not so the amplification would be so tremendous that it would be impossible to handle the receiver.

Weather and Sensitivity

Discussed in One of Papers in April "Proceedings"

By Thomas J. Walsh

J. K. CLAPP, engineer of the General Radio Co., Cambridge, Mass., in "Proceedings of the Institute of Radio Engineers," for April, describes "Antenna-Measuring Equipment" especially designed for the U. S. Coast Guard for measurements on antenna-ground systems at frequencies below the fundamental frequency of the antenna-ground system. The frequency range of the equipment is 100 to 600 kc for the apparent resistance and capacity, up to 2500 kc for the fundamental frequency. The apparent resistance range is less than 111 ohms and the apparent capacity range is from 200 to 2,000 micromicrofarads.

The equipment is self-contained, with the exception of the batteries, and is portable. A substitution method is employed, adjustment of the calibrated phantom antenna being made to maintain constant frequency and constant amplitude of oscillation in the driving oscillator circuit, as the oscillator is switched from the physical to the phantom antenna. The circuit diagram of the apparatus is given together with the curves showing the experimental results obtained with the equipment.

Distortion on Short Waves

R. K. Potter, of the American Telephone and Telegraph Co., Netcong, N. J., contributes a paper on "Transmission Characteristics of a Short-Wave Telephone Circuit." He describes a method of observing and recording the audio-frequency transmission characteristics of a short-wave radiotelephone channel and shows that these characteristics undergo rapid changes, which appear to be the result of wave interference between signals arriving at the receiver over paths of different group or electrical length, possibly combined with the distortion produced by a progressive change in the angle of rotation of the polarization plane with frequency over the signal band.

Short-Wave Studies

"Summary of Progress in the Study of Radio Wave Propagation Phenomena" is the title of a paper contributed by G. W. Kenrick, Tufts College, Mass., and G. W. Pickard, consulting engineer, Wireless Specialty Apparatus Co., Boston, Mass. The authors review the historical development of the art and the mathematical theory, including the isolated sphere hypothesis, the Kennelly-Heaviside theory, the Stormer-van der Pol echoes, and magnetic and solar correlations.

To this paper is appended a rather complete bibliography of the important papers that have been published on the subject.

Loftin-White Circuits

Constructors will be particularly interested in a paper contributed by Edward H. Loftin and S. Young White on "Cascaded Direct-Coupled Tube Systems Operated from Alternating Current." This is the paper which led to the popular interest in direct-coupled amplifiers now known by the names of these authors. Since this is the "original source" respecting this system of amplification, and since it is quite complete, a study of the paper is recommended.

The authors state that the following characteristics are desirable in any audio-frequency amplifier or detector-amplifier system:

(a) minimum frequency discrimination.
(b) minimum wave-form distortion.
(c) minimum hum if AC operated.
(d) reasonably high gain for the tubes used.
(e) low cost.
(f) permissive large tolerance in manufactured parts.

In AC operated direct-coupled cascaded tube systems the characteristics depend, they state, upon or are influenced by the following features:

1. Maintaining the operation of all tubes at the midpoint of their operating or output current curves, or what may be termed stabilizing against "drift" tending to arise from—
   (a) changing tubes.
   (b) change of constants or conditions due to—
   (A) aging of resistors.
   (B) temperature coefficient effects in resistors,
   (C) line voltage variations,
   (D) grid emission from tubes,
   (E) gas current in output tubes, and
   (F) manufacturing tolerances.
2. feedback phenomena at audio frequencies.
3. the hum problem.
4. motorboating.
5. trigger action.
6. maximum gain of tube.
7. providing current for auxiliaries, such as speaker field.
8. increase to very high gain, such as that required by photo-electric cell operation.

These features are discussed in detail and numerous circuit diagrams are given to illustrate the principles. Performance curves for the two-tube circuit are given for plate load resistance of 0.25 and 0.1 megohms. At the lower resistance the curve is essentially straight from 50 to 10,000 cycles, there being a slight lowering at each end. The amplification over the straight part is 200 times. The 0.25 megohm load curve is also nearly straight, but the lowering at the ends is slightly greater. The amplification in this case is considerably over 300 times, except at 10,000 cycles, where it falls slightly below. Both curves indicate exceptionally good performance. While the curves are given only to 50 cycles the trend shows clearly that the amplification is satisfactory at least one octave lower.

Among the features which are discussed are: the reduction of current drain on the filter, the elimination of motor boating, stabilizing against drift of plate current, the elimination of hum and the provision of automatic change of grid bias with change of carrier input.

Variation of Receiver Sensitivity

Another paper that should prove of especial interest to builders is one by Ralph P. Glover, Crosley Radio Corporation, Cincinnati, Ohio, entitled "Note on Day-to-Day Variations in Sensitivity of a Broadcast Receiver."

A series of measurements of sensitivity on a highly sensitive broadcast receiver over a period of one month indicates that large variations in sensitivity may occur. It was found that the sensitivity varied greatly with the relative humidity of the air, and that the effects were delayed as much as four days. High relative humidity resulted in lower sensitivity, which is ascribed to higher losses in the radio-frequency transformers. This is of interest because it shows that one may expect lower sensitivity in prolonged periods of moist weather, or a few days after such weather.

The author's conclusions:

(1) Broadcast receivers of high sensitivity may show large variations in sensitivity even when maintained under nearly ideal conditions. The changes in characteristics may be sufficiently great to cause oscillation over the more sensitive portion of the frequency range.

(2) Changes in sensitivity appear to be highly correlated with changes in relative humidity in the negative sense: that is, periods of high sensitivity are generally periods of low relative humidity and vice versa.

(3) The effect of humidity changes may be delayed from one to four days, the time-lag being greater at frequencies of relatively low sensitivity.

(4) Changes in sensitivity with humidity are probably attributable to variable losses in the radio-frequency portion of the receiver.

(5) The observed changes in sensitivity, while highly important from the technical standpoint, are of small importance to the average listener, since usually they may be compensated for by adjustment of the volume control.

The conclusion in (5) relative to the importance of changes in sensitivity to the average listener clearly do not apply to those listeners who regularly try to receive remote stations and find that on certain days they are not successful because the volume control cannot be advanced far enough.

The paper points out one more connection between weather and distance reception. Previously much has been written about the correlation between barometric conditions and the reception of distant stations. Possibly some of the effects attributed to barometer really should be attributed to the hygrometer. Since there is a time-lag between humidity and sensitivity and the weather cycle has about the same duration, one would expect good reception in wet weather and poor reception in good weather. During wet weather the receiver would gradually become worse, attaining its worst condition by the time the weather is clear. Then it would gradually get better, as the coils and insulation dried out, getting best when the weather again was worst. Of course, if the dry and wet periods were long the sensitivity would be best in good weather and worst in poor weather, since the time-lag would not be noticeable.

Superheterodyne Studies

"Considerations in Superheterodyne Design" is a paper contributed by E. G. Watts, Jr., formerly with Victoreen Radio Co., Cleveland, Ohio.

Factors involved in the suppression of the characteristic double response of the Superheterodyne are considered. Design details are given for the oscillator circuit, and oscillator-modulator coupling, as affecting the inherently uniform response characteristics. A method of aligning the circuits for single control purposes is also given.

A study of this brief paper will give the Superheterodyne enthusiast many valuable suggestions.

A Smoking Stand Set

Constructional Article on Compact Assembly Is Begun

By Herbert E. Hayden

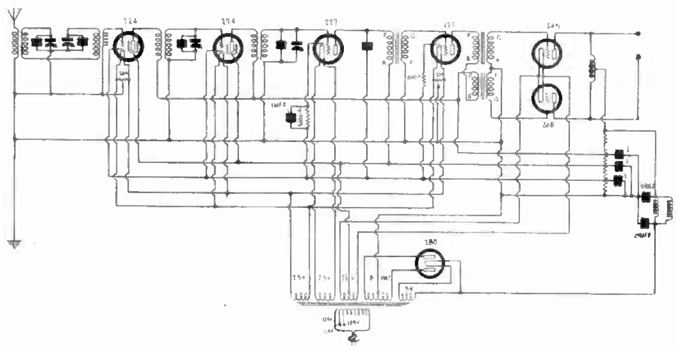

FIG. 1.
THE DIAGRAM OF A SELF-CONTAINED RECEIVER THAT FITS NICELY INTO THE SMOKING STAND DEPICTED IN FIG. 2. GANG TUNING AND PUSH-PULL AUDIO ARE FEATURES OF THE CIRCUIT.

In the April 19th issue of RADIO WORLD a brief article was published on "A Smoking Stand Set." The circuit designed especially for the smoking stand is given in Fig. 1 herewith. It is a seven-tube receiver consisting of two 224 screen grid tubes, two 227 heater type tubes, two 245 power tubes in push-pull, and one 280 type rectifier tube. The circuit is self-contained in all respects with the exception of the loudspeaker.

There are three tuned circuits, one of which might be called double, since it contains two identical tuning condensers and two transformers. The coupling device between the detector and the first audio frequency amplifier is an ordinary audio transformer and that between the first amplifier and the output stage a coupler composed of two similar transformer connected so that the signal output of the first audio tube is divided equally between the two output tubes in push-pull relation. The output coupling device is a center-tapped choke coil capable of carrying the currents from the output tubes. The speaker is connected directly from plate to plate. There is no practical limitation as to the kind of speaker that may be used since the output impedance is matched to magnetic and inductor speakers and also since dynamic speakers are provided with appropriate coupling transformers.

Selectivity Assured

A high selectivity is assured by the three tuned circuits since the four-section condensers used are provided with trimming condensers. The selectivity is enhanced by the double tuned circuits because of the loosening of the coupling between the antenna and the first grid which this arrangement effects.

The four tuning coils are essentially alike, each tuned winding consisting of 80 turns of No. 28 enameled wire on bakelite tubing 1.75 inches in diameter. The primaries consist of 40 turns of the same kind of wire wound on the same tubing, with a separation of one-fourth inch between the windings. Each of these coils is placed inside an aluminum shield to prevent inter-stage coupling.

Grid bias is provided automatically for all the tubes by suitably returning the grids and the cathodes to the voltage divider. A grid bias resistor of 5,000 ohms is also provided for the detector to supply the high bias necessary for grid bias type detection. This resistor is shunted by a one microfarad condenser to eliminate undesired feed-back. All grid returns are connected to the most negative point in the circuit, which point is also grounded. A separate bias resistor of 800 ohms is also provided for the 227 audio amplifier tube.

The object of providing separate bias resistors for the detector and the first audio tube is to avoid as much as possible the feed-back which a common bias resistor would cause. This precaution is desirable, even though the last stage is push-pull and hence feeds very little energy into the voltage divider, because it is not practical to select two output tubes with identical characteristics.

Voltage Division

A voltage divider with three taps is provided, a one microfarad condenser being connected from each tap to ground. The drop in the lowest section of the divider is only 1.5 volts, the bias needed by the two screen grid tubes. This 1.5 volt drop is also added to the drops in the 5,000 and the 800 ohm resistors. There is an advantage in obtaining the drops for the two 227 tubes in this manner, that is, in two parts. The feed-back

LIST OF PARTS

- **Four radio frequency transformers as described.**
- **Three audio frequency transformers.**
- **One center-tapped output choke coil.**
- **Two single unshielded filter chokes.**
- **One four-gang .00035 mfd. tuning condenser with trimmers.**
- **One .00035 mfd. by-pass condenser.**
- **Four 1 mfd. by-pass condensers, 200 volt test.**
- **One 6 mfd. by-pass condenser, 400 volt test.**
- **One 8 mfd. by-pass condenser, 400 volt test.**
- **One 5,000-ohm grid bias resistor.**
- **One 800-ohm bias resistor.**
- **Two 20-ohm potentiometers.**
- **One voltage divider.**
- **Four five-prong sockets.**
- **Three four-prong sockets.**
- **One power transformer.**

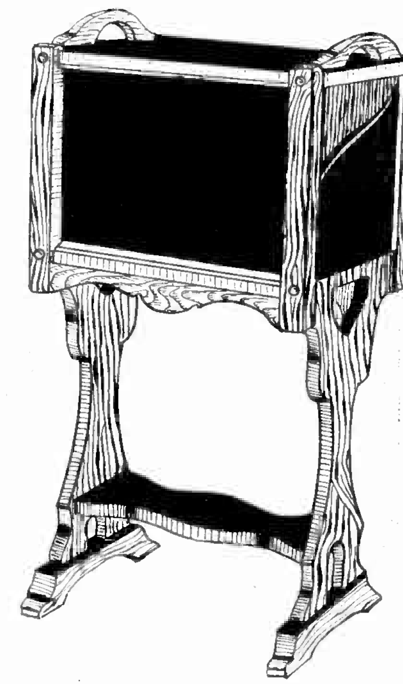

FIG. 2
A SMOKING STAND THAT IS ADMIRABLY ADAPTED FOR A RADIO CABINET.

through the individual resistor is such as to reduce the amplification, and hence to stabilize the circuit. The feed-back through the common resistor, on the other hand, is usually such as to increase the amplification by regeneration. The two together produce a neutral condition for each tube, which is highly desirable.

The center-tap of the filament winding that supplies the two push-pull tubes is connected to the second tap from the bottom of the voltage divider. Thus to get the required 50 volt bias on these tubes the drop in the second section of the voltage divider should be 48.5 volts. This point is also connected to the screen of the two 224 tubes, and therefore the screen voltage is 48.5 volts. The screen voltage is not 50 volts because the cathodes of the screen grid tubes are connected to the 1.5 volt point. The plate return of the detector tube is also connected to the second tap, and therefore the voltage applied to the detector plate is something less than 48.5 volts. In fact, it is less by the amount of drop in the 5,000 ohm resistor. Since the detector tube is followed by a transformer this voltage is ample.

The third tap on the voltage divider goes to the plates of all the tubes with the exception of the tubes in the output stage and the detector. Since the screen grid tubes should have a plate voltage of 180 volts, the drop in the third sections of the voltage divider should be 134.5 volts. However, since it makes no practical difference whether the voltage on the plates of these tubes is 180 or 135 volts, a considerable variation may be tolerated in the drop in the third section of the voltage divider. It is not well, though, to make the total voltage on these tubes higher than 180 volts, because this is the nominal maximum limit set by the tube manufacturers.

Voltage on Power Tubes

The voltage applied to the plates of the two power tubes is the total voltage delivered by the B supply, less the 50 volt bias. The power transformer is such that the total voltage on full load is approximately 300 volts, so that the plates of the power tubes get 250 volts, the proper value for the 50 volt bias.

The power transformer contains three 2.5-volt windings, only one of which is center-tapped, which is reserved for the power tubes. One of the other windings is reserved for the detector tube alone. The third 2.5-volt winding is made to serve the two screen grid tubes and the 227 amplifier tube. Two separate, low-resistance voltage dividers are connected across this winding, one connected to the heater terminals of the first socket and the other to those of the 227. The center-taps of both are grounded. The object of these is to minimize hum. Two are used because the radio frequency tubes and the audio tubes may need separate adjustments for least hum.

(Continued next week)

Non-Resonant Dynamic C

Flat Response Curve Sought, but th

By John C

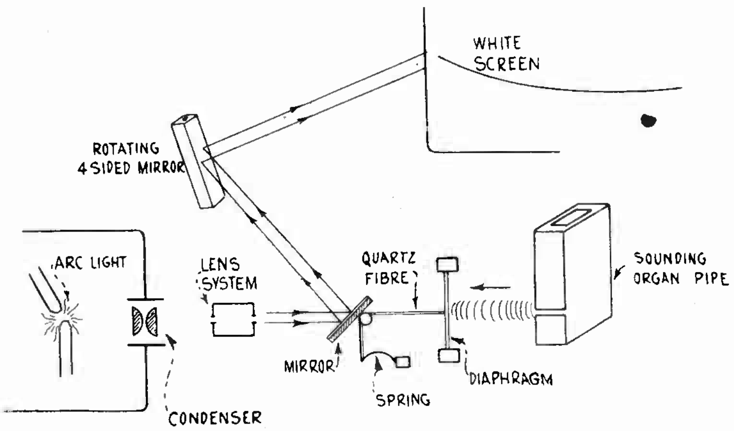

FIG. 1

ARRANGEMENT OF THE PHONODEIK.

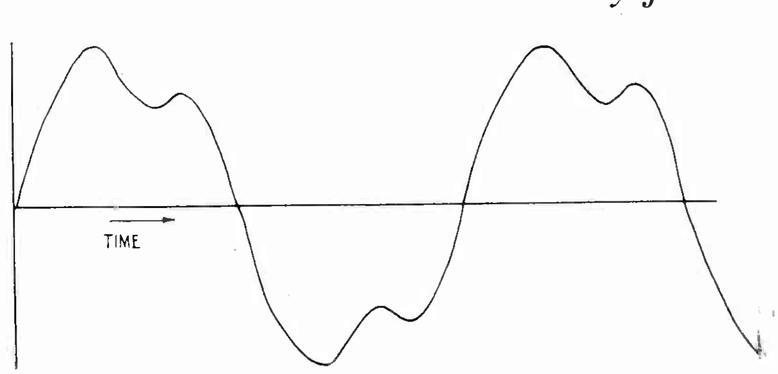

FIG. 2

SOUND-OUTPUT CURVE OF ANOTHER MUSICAL INSTRUMENT.

[The following article is the eighth of a consecutive series on dynamic speakers which began in the March 15 issue wherein "Design of Dynamic Speakers" was discussed. The pot magnet, voice coil, and baffle were treated. The second article, "A Comparative Test of Dynamic Results," appeared in the March 22nd issue, in which comparisons were made between magnetic and dynamic speakers. In the March 29th issue "Hum Reduction in Dynamic Speakers" was discussed, reverse-wound coils and condenser-choke systems were included. In the April 6th issue "Wave Forms of Hum Reducers" was the topic. The use of the bucking coil, and some remedies for hum were discussed. In the April 12th issue the subject was "Why Coils Have Lag and Condensers Lead." The effect of potential difference on atomic stability was shown. The subject treated in the April 19th issue was "Why Dynamic Speakers Sound So Well." The effect of baffles, cone stiffness, and dampers was analyzed. The issue of April 26th contained a discussion on "Dynamic Sound Waves" and dealt with complex sound pressures and even harmonics.—EDITOR.]

FIG. 1 shows the essential arrangement of a device to project the resultant wave form of a sounding body on a screen. A brilliant source of light (arc light) is placed behind a condenser lens which transforms the radially impinging light rays to parallel rays which pass through the lens system and strike the small light-weight mirror, which is rotatably mounted on a light weight steel pivoted axle. A quartz fibre is attached to the diaphragm, passing around the axle two or three times and being attached to the spring, which places the whole moving (mechanical) system under a slight tension.

The light beam, already focused on the small rotatably mounted mirror, is reflected to the four-sided rotating mirror shown, and this mirror is now started, resulting in a steady arc of light being projected on the screen. Next the organ pipe is sounded, by blowing it easily, and the arc of white light on the screen assumes the form of the curve of Fig. 2 (of last week's article). Thus we can see what an organ tone looks like, and tuning forks, violins and voice outputs may be pictured also.

Psychological Effect of Harmonies

Figs. 2 and 2A show curves such as would be shown by the Phonodeik. The left one is due to a wind instrument and shows a fundamental and two higher harmonics. A harmonic analyzer would show the exact contour of these components, and below is shown the resultant of a single violin tone—the presence of harmonics is plainly shown and it can also be seen that they are much further apart than the harmonics of the upper curve are.

These curves are magnified quite a lot but on a phonograph record, though smaller, the outline would be just as accurate as the ones shown. Earlier in the present article mention was made of the psychological effect of harmonics and particularly of nonharmonious sounds. A resultant acoustic output curve of a once popular (?) automobile horn was once shown via the Phonodeik—reports were generally that after a few blasts the quartz fibre was broken. The curve was obtained and showed a few weak even ratio harmonics but most of them were odd harmonics of irregular amplitude. The three-tone horn now used is very much more pleasant to listen to, thought it does not inspire sudden action as the previously described type did.

The result of all this past research on sound effects is daily being reapplied to the solution of new sound problems in the acoustic field, and though modern designers may like to credit themselves with what they think is something new—in all probability they are simply re-discovering the applications of principles known and applied in different ways many years ago.

But the analysis of musical tones, though a highly fit subject for an harmonic analyzer because it presents no special problem to this machine, is nevertheless not capable of predicting the effects that will be produced by harmonics related or unrelated. That is, the harmonic analyzer will show the number of components in a complex wave and also their phase relationship but it cannot predict in advance what effects will result from certain combinations only the acoustical brain can predict this from experience.

I have written previously of the psychological influence of musical tones and shown that the predominance of related harmonics is connected with our sound sensation in such way as to make it extremely pleasant to listen to sounds that contain related harmonics, but it is not always a simple matter to produce these desired harmonic effects, especially when we are trying to modify a speaker's acoustical output so as to make improvements in the matter of realism.

One of the greatest problems has been to make a large diaphragm reproduce, under conditions of great amplification, the sound of a person speaking and at the same time have the same cone faithfully reproduce music and individual musical instruments. The related harmonics of the voice are not the same as those of musical instruments and therefore engineers have striven to produce a speaker with a so-called flat response curve, a condition which may be approached in theory and reasonably well approached in practice too, but never fully realized. The problems are many, and one way of surmounting some of the troubles that beset designers is to provide a speaker set-up that consists of one speaker for voice reproduction, and another for the production of musical tones.

Of course the element of expense cannot be ignored by most of us, and also the fact that two speakers cost more to run, in the case of dynamics, than one. But is this a valid excuse for not availing ourselves of the best possible results? I think not.

Years ago I used to recommend that five speakers be used, all connected in series and each tuned to a certain pitch range but one overlapping another a little. This meant a variety of horns, beginning with a small short one and ending with a big one similar to the old Western Electric 10-D. This scheme using horn type speakers worked out well, although it was elaborate.

The Ear as a Sound Receiver

Loudspeaker response problems can be approached through various means, including that of the analog—and for this purpose I will briefly discuss the ear, as a sound receiving device.

I fully realize that there are sounds the the ear cannot hear, but these have no influence on a speaker discussion, as the best

haracteristics Unlike Ear's

e Human Organ is a Tuned Device

. Williams

speakers cut off well below the upper limits of audibility, which lies in the neighborhood of between 15,000 to 30,000 cycles.

The ear consists mainly of a receiving diaphragm (the ear drum) that is connected by means of a sensitive lever mechanism to the inner ear from which received sounds travel along a curved canal that contains resonant nerve ends that communicate to the brain. The ability of a person to hear well depends mainly on the sensitivity of these nerve ends, and consequently the ability of these nerve ends to resonate to impinging pressure variations.

Now the comparison between a loudspeaker cone and the ear is this: whereas the ear consists of a series of specially tuned resonators (and the larynx, our voice producing apparatus, is a tunable sound transmitter), a loudspeaker cone is not readily tunable and is therefore not efficient. Hence the argument for a multiplicity of speakers, in order that we may attune each cone to a limited frequency range.

I have even thought of constructing a lot of cones, each resonant to a certain note, and I am sure that if a similar (though necessarily complicated) series were arranged all along the line, preceding the battery of speakers, the results would more than repay the effort. An example of this multiplicity of sounding bodies is the organ, which can easily be made to imitate any sound, queer or natural. Thus loudspeaker response is seen to be seriously limited by the fact that we have to attempt the obviously impossible problem of making a heavy cone reproduce the entire musical range with a degree of realism.

Material Used for Cones

So in the absence of many loudspeakers we persist in trying to make one cone do the trick, and so distort the output that it sounds fairly "natural", by experimenting with the influence of several media. These are the air column length, the kind of material by which the air column is enclosed and the various kinds of cone material.

Paper is easily a favorite because it can be obtained in such a wide variety of textures and finishes. The next is the fabric cone, which is usually made of formed buckram, afterwards treated with aluminum paint, with an amyl acetate content lacquer as the liquid vehicle, and lastly there is the metal cone. The others are formed plain or ribbed and this ribbing suppresses undesirable longitudinal vibration components by raising their frequency away above what it is when the cone is not ribbed. The consequent effect is to make the cone seem "deeper" by contrast. In fact, the output of any one loudspeaker that supposedly covers the acoustical range is in reality the result of many design compromises and these are revealed when acoustical output curves are taken.

The metal cone and the flat ribbed diaphragm have been made but are not very popular because the metal of the cone or flat diaphragm has to be made so thin that it is too easily subject to fracture by crystallization, but otherwise when properly constructed they are reasonably good if not overloaded. A flat metal plate of considerable size and thickness perhaps would seem to have possibilities, but when it is remembered that longitudinal vibrations of frequency range comparable to the natural period of transverse disturbances would be set up it will be apparent that the thickness of such a plate would have to be very much reduced to increase the above difference so as to bring the transverse vibrations near the desired relative acoustical level as would be observed by comparison with usual loudspeaker outputs.

But even when this is done the odd harmonic characteristic remains and so to further dampen out the longitudinal vibration it is necessary to create some further resistance to their propagation, and so we rib the flat plate, preferably with equidistant radial depressions, not unlike the form of a standing-wave, and the results of acoustic measurements will be found to be more satisfactory. All of the above is assumed operative in connection with a diaphragm of not exceeding 10 inches in diameter, or 10 inches square.

You are doubtless aware that flat metal membranes are used very effectively to produce thunder effects, and waves washing along a beach, and even the groan of a badly injured person etc., all of which are due to the wave forms set up in the metal plates, whether ribbed or not.

Muslin or silk, when treated with airplane varnish (or dope, as it is called) has some highly individual acoustic properties which are directly traceable to the elastic constants of varnish films. In general the stiffer the film the more pronounced the low frequency response, because the higher frequency transversed period gets more nearly like the longitudinal waves pitch.

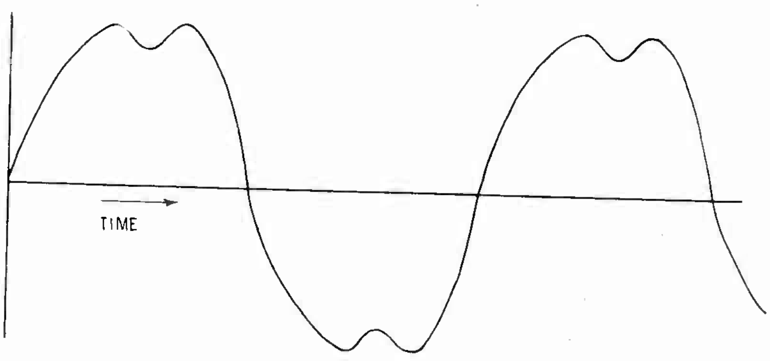

FIG. 2A

SOUND-OUTPUT CURVE OF A MUSICAL INSTRUMENT.

Tunability by Use of Baffles

The influence of baffles has also been previously hinted at but the effect of the tunability of a speaker by baffle changes has not been mentioned.

The velocity of sound in air at constant pressure and temperature is always the same, but if either is varied the velocity is changed. Since the temperature is likely to be the biggest variant it is often necessary to have accurate temperature control in connection with sound experiments. Organs are subject to frequent checking if the temperature of the room in which they are installed varies too greatly.

The baffle in addition to providing means of preventing interference between the wave fronts due to the front and rear surfaces of the cone also has a decided tuning effect when the baffle takes the form of a box of size bearing a not too large a ratio to the volume of air displaced by the front or rear surface of the cone.

I have found that reasonable constructional limits had some bearing in the matter, so that I had to restrict my ambition somewhat and make my various baffles so that I could move them about handily. If a baffle is built so that it encloses ten times as much air as the front surface of the cone does, the speaker will sound very much better than it would if the baffle box enclosed only half as much air. The more unyielding a box-baffle is, the deeper is the speaker pitch, and an increase in temperature of the enclosed air affects it the same way. A certain box-baffle may be too resonant. A layer of felt all around the inside will effect a cure, depending though on the thickness of the felt. Some one may ask: "Can you suggest a nearly perfect sound absorber?" Yes, an open window. If you arrange the rear of the box baffle so that it fits in the window frame you will obtain only the baffle-effect of the box. The other reflections from the rear surface never will interfere.

Sometimes a wall is used as a baffle but the open window is better.

Matched to Room Impedance

The writer constructed a tuned baffle box with the idea of modifying the output characteristic of a speaker cone so that it would suit the room in which it is played. In this particular case it was desired to obtain a controllable emphasis effect when organ selections were being played. The results were very realistic. The method consisted of fitting a perforated wooden box with a movable back that was pushed in when a higher pitch was desired and pulled out when the pitch was desired lower.

Now the reason for this required adjustability is that when a sounding body is in operation it emits waves that travel across the room, strike the corners, walls, other objects, etc. and result in cross-reflections that set up dead spots, and at other places these sound reflections add up to produce false sound impressions that create the illusion that the sound source is much

(Continued on next page)

(*Continued from preceding page*)

more powerful than it really is. These two principal opposite effects are called nodes and loops, and they constitute the main reason why some theatre speaker installations are not as good as they might be.

Commercially this trouble has to be met by careful placement of the speakers and proper location of reflecting surfaces in the theatre backstage as well as out in front.

Dynamic Used Outdoors

Certain outdoor enterprises also use a dynamic speaker in conjunction with a large reflecting baffle, to reproduce music. Here is a field for the exploitation of the tuned baffle, which can take the form of a horn.

Fig. 3 shows a combination of a baffle and a horn which has a secondary column that can be tuned (by admitting some water) to the desired pitch. This is a cse of changing resonance and is very effective where such a controllable feature is desired. It is often difficult to produce a speaker amplifying horn with period providing the desired degree of quality or illusion and the variable pitch baffle solves the trouble quickly and at a minimum of expense.

Sound source illusion, or so called "presence" in a speaker, is based on the number and amplitude of certain harmonics—certain dynamic speakers produce the illusion that the person talking is in front of the cone or at the cone, or away behind. Others give the impression also that the person speaking is talking down a barrel. All of these effects are due to the phenomenon of harmonics.

Baffle for Horn

Fig. 4 shows a horn that contains a baffle once used in a popular cabinet type phonograph and providing good and pure amplification of all acoustic frequencies. It consisted of an input source, a hole through which sound emitted from the sound box entered, a compartment that contained a parabolic sound mirror that reflected the impinging wave in two parts against two separate widely spaced mirrors, which in turn reflected again to a "collector" mirror whence the sound wave was emitted. The collector served as a "source." By this means sound-box resonances were dissipated and needle scratch was practically removed.

A horn of this type was seen installed as a sound-source at a large outdoor swimming pool in the metropolitan district. It was fed by a dynamic speaker of moderate size powered by

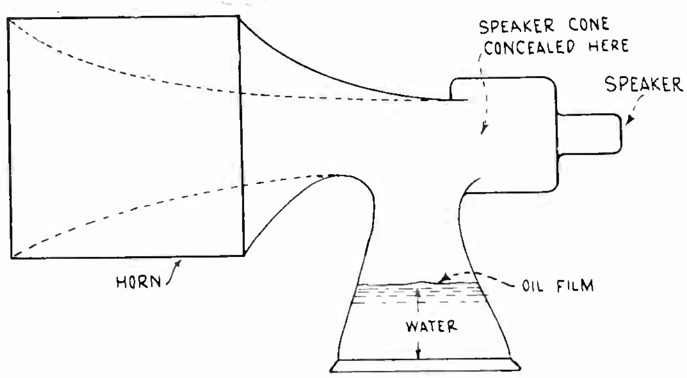

FIG. 3
A TUNED SPEAKER HORN.

a popular power amplifier power pack. In this case the horn was the whole story.

Ears Are Deceptive

We are prone to let our ears deceive us in the matter of volume output from the loudspeaker. In a previous article it was stated that our acoustic reactions were limited by our audibility range. It is also equally true that our idea of the quality of our speakers when under sufficient volume is mainly dependent on how well we hear certain harmonics. On this is generally based the desire for boom effects, directly due to the suppression of certain higher sound-frequencies and the over emphasis of frequencies below the 200 cycle region. It must be always remembered that the reproductive efficiency of a speaker taken as a whole under any given condition will not change, but be merely redistributed if changes in the voice coil transformer, or changes in the elasticity of the cone are made.

If a baffle containing a horn is not correctly designed the reflections resulting from such incorrect design will destroy the sound illusion effect, and incidentally produce a very detrimental reaction on the volume because of the lowered efficiency resulting. To show these effects well an analogy has to be made up and in this case happily it is possible to make a very direct comparison.

Waves Travel Through Slit

In a shallow pan of water we arrange a slit, made by locating two blocks so that there is water between them. Then if you dip your finger in the water so as to set up some waves, these waves will travel through the slit and will radiate away from the slit in such way that the slit seems a source. Now, if a convex non-absorbing surface be placed in the water at the right point an image of the slit will be formed on the surface of the water. Otherwise only a weak image will be formed, or no image at all. This is also true of the baffle-containing horn.

Distortion's Existence Proved

Now, if in addition to the original desired image by reflection you obtain another image close to the desired one you know that some distortion exists in your water analogy. So you investigate and find that water is reflected from the sides of the

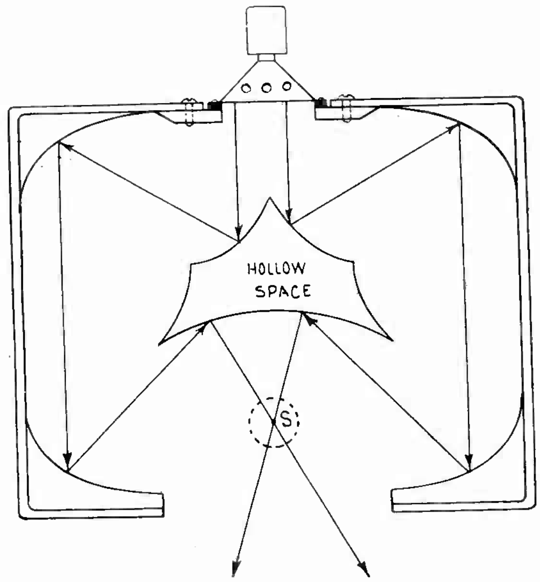

FIG. 4
A TYPE OF REFLECTION AMPLIFYING HORN FOR OUTDOOR USE.

pan right across the path taken by your desired image waves. Hang some cloth over the inside of these unwanted reflection sources, and the undesired interfering image disappears. You have only the desired image left.

So it is with loudspeaker horns and baffles, no matter what type. If sound analysis shows that some undesirable frequency exists, the correct location of a sound absorbing medium, such as velvet, felt or celotex, can be found and the trouble cured. This does not apply to excess AC hum. Sound attenuation is a matter of initial intensity and resonance. Its rate of decreasing intensity depends upon the absorbing constants of the materials which it strikes.

Have any of you ever tried to find out which notes from your loud speaker travelled the farthest? We are told that sound waves travel through air at a constant velocity but no specific mention is made about the influence of frequency one way or the other. So again I am going to ask some of our interested readers to try to determine any difference in intensity with distance, and let me know what they find. If the ear is assumed reasonably uniformly sensitive it can be assumed that higher frequency sounds can be heard farther away from the speaker than low frequency sounds. We note this effect when we tune our radio sets.

Acoustic Interference

The effect of interference on the reproductive quality of a cone speaker is always admitted but no one seems ready to commit himself as far as to decide whether the interference is helpful or otherwise. To determine this readily is easy if you have a cone that does not produce interfering waves but a glance at Fig. 6 of last week's issue April 26th, shows that this is anything but true.

But also a brief study and reflection (mental) will serve to show that in the case represented the interference in front of the cone is certainly helpful, while there is apparently none behind the cone at all—but if any of the waves behind the cone were to reach around to the front part—the resulting interference would be decidedly harmful—so we see that there are two kinds of interference—positive and negative, and we now know why interference helps because we can see that the individual vibrating parts of the cone are contributing wave fronts that add up to produce the greatly magnified wave front that stretches from one edge to another.

Four Stages of Audio

High-Power Installations Can Use Them Successfully

By Percy Warren

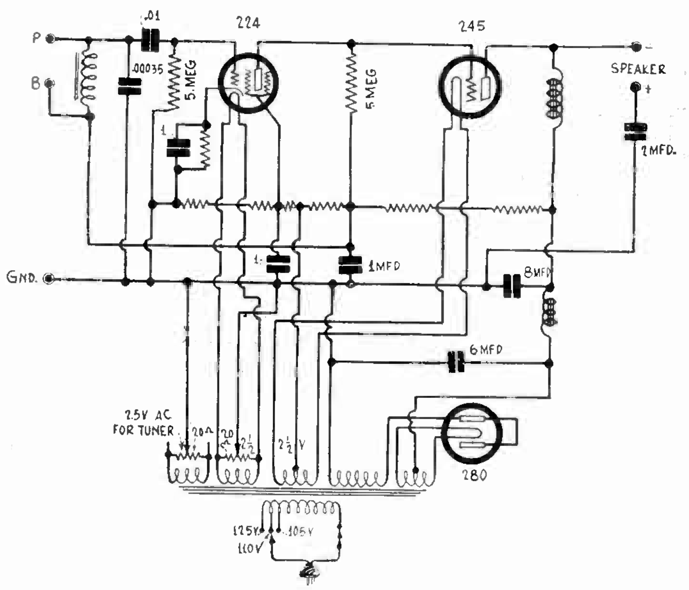

FIG. 1

A TWO-TUBE NON-REACTIVE AMPLIFIER THAT MAY BE USED IN CONJUNCTION WITH THE CIRCUIT IN FIG. 3 TO MAKE A FOUR-STAGE AUDIO AMPLIFIER.

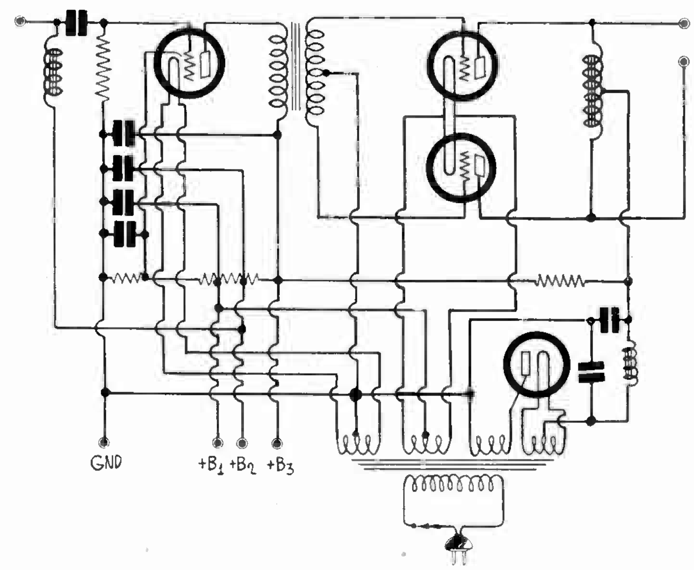

FIG. 2

THIS TWO-STAGE, PUSH-PULL AMPLIFIER MAY ALSO BE USED IN CONJUNCTION WITH THE CIRCUIT IN FIG. 3 TO FORM A FOUR-STAGE AUDIO AMPLIFIER.

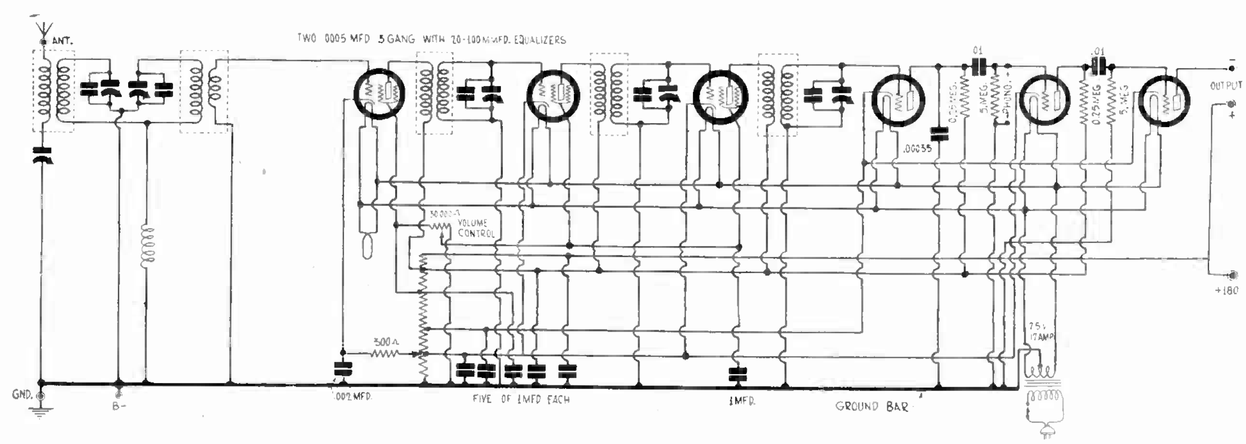

FIG. 3

A SIX-TUBE RADIO FREQUENCY AMPLIFIER AND TWO-STAGE AUDIO AMPLIFIER WHICH CAN BE USED WITH EITHER FIG. 1 OR FIG. 2 FOR HIGH VOLUME AND GREAT SENSITIVITY.

It might seem that the use of four stages of audio frequency amplification after a super-sensitive radio frequency amplifier of four stages is a step in the wrong direction, now that the trend is to do away with as many of the audio tubes as possible, replacing them with radio frequency tubes and power detection. Yet it is surprising how many radio amateurs "go in for" multi-stage audio frequency amplifiers. This practice is far from being obsolete for it is being done by many who can really tell a good receiver from a bad one, the quality of output being the basis of judgment.

We show in Fig. 3 the circuit diagram of a receiver which has been discussed in some detail in recent issues. This is a very sensitive and selective receiver, but as it stands the output volume is somewhat limited, since the last tube in the circuit is not a power tube but only a 227. While this tube is capable of delivering enough volume to suit many persons, it is not capable of delivering the volume demanded by the dynamic speaker addicts, who are in the great majority. These demand at least one 245 tube in the output stage, and preferably two of them in push-pull.

The circuit in Fig. 3 was really intended for additional audio amplification, and it has been operated with four stages with exceptionally fine results, both as to volume and quality. It has been operated satisfactorily both with the direct-coupled circuit depicted diagrammatically in Fig. 1 and with that shown in Fig. 2. Both of these circuits are arranged so that they can be connected to the output of the circuit in Fig. 3 with minimum change.

In Fig. 3 a lead from the plate is marked (—). This may be run directly to the upper input post of either Fig. 1 or Fig. 2. When this is done the last tube in the circuit represented by Fig. 3 gets its plate supply from the audio amplifier. To complete the plate circuit of this tube it is only necessary to connect the grounds of the two parts of the receiver. The circuit in Fig. 3 is provided with a post marked 180 volts. To this post the output of a power supply of suitable voltage should be connected, the ground of which supply should also be connected to the common ground.

In place of using an external B supply in addition to that built into the power amplifier, when the circuit in Fig. 2 is used this supply may be used, the B3 plus lead being the one intended for the plates of the tubes in the circuit in Fig. 3.

Note that the lower input post B, used only in Fig. 1, is not needed when making the connections as suggested.

Edith Thayer Hurt In Auto Accident

Mrs. Edward Butler, of Cochituate, Mass., was injured in an automobile accident in Connecticut. Mrs. Butler is known professionally as Edith Thayer, and plays as Jane McGrew in Hank Simmons' Show Boat over WABC of the Columbia Broadcasting System. She was reported out of danger but her doctor said she could not return to work until after the summer.

Miss Thayer's weekly performance was missed by admiring listeners, who have come to regard her as one of the outstanding lights of Show Boat. She plays ingenue and child parts with such entrancing personality that she makes big parts even out of small ones that occasionally fall to her lot. Her roles are usually prominent ones.

Monopoly Action Against Earl Off

Washington.

The Federal Trade Commission has dismissed its complaint alleging violation of the Clayton Anti-trust Act against the Charles Freshman Co., Inc., now known as the Earl Radio Corp., manufacturer of radio receiving sets. The complaint was based on the acquisition by the Charles Freshman Co., Inc., of a majority of the capital stock of Freed-Eiseman Radio Corp., which in effect would lessen competition between the two companies. No reason was given for the dismissal. A receiver was appointed in New York for the Earl company.

Flechtheim Adds to Condenser Line

A. M. Flechtheim & Co., Inc., of 136 Liberty St., New York City, have introduced a new type of high voltage filter condenser, known as type HV, rated for continuous operation at 800 volts DC (motor-generator) or 500 volts rms rectified AC. This makes it suitable for use with the 245 amplifier tubes, as in the Loftin-White power amplifier.

Type HV are non-inductively wound but uses no more foil material than does the usual type of inductively wound units. The DC resistance of the condenser is said to be over 600,000,000 ohms per microfarad and its power factor is less than 1 per cent. The breakdown voltage is around 2,500 volts DC.

Type HV are one-fifth the size of the ordinary type of condenser.

The Flechtheim Company also announced its type HS filter condenser, having a rating of 660 rms, 1000 v DC, and having the same general characteristics as type HV. Type HS can therefore be used for the 250 type tube amplifier.

LYNCH, ANNOUNCER, DIES

William S. Lynch, National Broadcasting Company announcer, died in a Brooklyn (N. Y.) hospital recently, following an appendicitis operation. He was twenty-three. His colleague, John B. Daniel, died the same way about a year ago.

A THOUGHT FOR THE WEEK

SHE'S straight from the South and acts as the more or less efficient maid for a family up in Westchester. When she heard Amos 'n' Andy over the radio for the first time—in fact, she never had heard a radio before—the little black girl almost doubled up with amazement as she listened to the language she knew so well and which seemed to flow on without having any source. Perhaps that's why she washed up the oyster shells that night and wanted to know if they were to be put away with the other dishes.

Forum

Why He Favors Magnetics

REFERRING to the debate you published on dynamic and magnetic speakers, it seems to me like a draw. Both gentlemen seemed to have overlooked the most important point, that dynamics are for high power and magnetics for low power. Now, some persons (especially real musicians, not jazz blowers) don't like high-power radio, because its so-called realism is synthetic, and they find that the really good magnetic can afford them more pleasure. Such persons don't like forceful music, nor big, deep, ear- worrying basses and bass drum voices.

So you see the dynamics is for one class and the magnetic for another class, and both are satisfied. It is useless to compare them. Their purposes are different and, by the way, the magnetic always referred to in such discussions is the standard commercial affair, which is very much of an atrocity.

You must make your own magnetic if you want a really good one. Of course, lots of persons don't know how to make one properly, and lots more would make a botch of it anyway. That is why there are so few good, musical-sounding magnetics. The best magnetic I ever made (and I've made scores) was the Keats model described in the New York "Sun" Radio Section over a year ago. No wonder the dynamic fans laugh at the dinky magnetic screechers offered for sale to-day by the carload! No wonder they boost the dynamic! But, boys, believe me, there are magnetics to be had that will do wonders on the right set, with only 135 volts, but you can't buy 'em in stores.

I recently went to hear a demonstration of dynamics by a highly reputable manufacturer of power-packs. The installation was most elaborate. Even the walls of the large show-room were covered entirely with Celotex. Not to mince words, I say flatly that the best of the dynamics (a $75.00 one) gave a performance that was absolutely ludicrous. So much for the highly equipped engineers that Mr. Morrison defends! Such is life when the experts are let loose!

HARRY VAN KIRK,
353 Union Ave.,
Elizabeth, N. J.

* * *

Says 75% Want DX

I AM for DX strong and I think 75 per cent. of the people are.

I disagree with Mr. Connaught in regard to multi-tube sets and at the same time wish to say that the set I have brings in DX regularly and as clear as a bell, and so loud that a stranger hearing it for the first time would think it was Chicago or New York.

Brought in two coast stations, KFI and KNX, without any aerial of any kind, loud enough to hear about 20 feet from the set.

I am using three 227, six 226 one 281 and one 210 in the best set I have ever had.

Let's have more debates.

ALAN LOCKLIN,
150 Brampton Road,
Syracuse, N. Y.

* * *

Reads Every Word

SOME readers have been handing in a few bouquets. May I also send in my bit? Personally I like the magazine as it is without any changes. I think a lot of a magazine to subscribe for it for a couple of years in advance, as I did for RADIO WORLD. I read everything in it.

GEO. H. LEGGETT, D.D.S.,
133 W. 123rd St., N. Y. City.

Five More Channels Allotted to Police

Washington.

In a general order (No. 85), amending a previous order, the Federal Radio Commission has made provisions for five additional short-wave channels for use by police radio services. The addition was made in order that demands of all cities could be met.

"Licenses for emergency police radio service will be authorized only for municipally controlled stations," the order reads. This does not mean that States, counties and other municipalities are debarred from the service because, it was explained at the legal division of the Commission, the legal definition of "municipal" covers these as well as incorporated cities.

The maximum power of stations to be used for police services is fixed at 500 watts.

No "Dry Holes" Now, in Radio Prospecting

One of the most interesting recent applications of radio science is in the field of geographical research. Recently the Federal Radio Commission has issued an order by majority vote definitely establishing a policy respecting the use of radio in oil explorations by qualified oil companies without requiring them to operate as public utilities.

Thus, radio will continue to be used in the location of oil deposits, hidden beneath surface rocks, by the all but miraculous methods evolved by engineers.

The geographical method uses radio in two ways. The first is to transmit radio signals in parallel with seismic or sound waves in the underground explorations at the place being prospected.

The underground seismic or sound waves are picked up by seismographs at various distances, and the radio signals by members of the exploring party. By comparing the elapsed times of transmission of the two waves it is possible to determine the nature of the substance beneath the earth's surface.

The above described method detects the presence of oil thousands of feet down, and the method is so exact that there have been no "dry holes" as was formerly the case when haphazard methods were used.

TELEVISION COURSE STARTS

In anticipation of an expected demand for educational service in television, the Engineering Extension Department of the Pennsylvania State College recently announced a new home study course in "The Elements of Television." It is intended for the amateur experimenter and the student beginner.

DC HI-Q DEMONSTRATED

To afford those residing in the midtown section of the Borough of Manhattan, New York City, an opportunity to hear and see the new 110-volt direct current model of the HiQ-30 in the evening, a demonstration studio has been opened at 427 West Fifty-first Street. Robert M. Miller is in charge.

NEW CORPORATIONS

Simco & Sommer, Inc., Passaic, N. J., radio supplies—Atty. Ola C. Cool, Newark, N. J.

Howe Radio Corporation, Utica—Atty. E. Hanagan, Utica, N. Y.

Livingston-Alvan, Johnson City, radios—Attys. Rath & Connerton, Johnson City, N. Y.

Idean Radio and Music Shop, Paterson, N. J.—Atty. Louis G. Bernstein, Paterson, N. J.

'Phone on Short Waves Set Some New Records

Successful long-distance radio telephone conversations are beginning to command the attention of the peoples of the world. The recent long-distance transmission record set up when a two-way conversation was held between Schenectady, N. Y., and Dunedin, New Zealand, was followed by the successful speed and remote radio control experiments between Marconi's yacht Electra, and various distant points.

And now the latest, a radio-'phone bridge between Buenos Aires, Brazil, and Batavia, Dutch East Indies, via Berlin, a total air-line distance of 14,000 miles. These transmissions are made possible by short waves. The regularity with which this form of radio transmission may be used is the reason for the growth.

The Dutch Indian short-wave transmitter operating on 15.93 meters at Bandoeng, was picked up in Berlin, where its signal was amplified and retransmitted by the Nauen station on 14.98 meters to Buenos Aires. The return conversation was carried on 15.07 meters to Nauen, and from that point onward to Bandoeng on the same wave-length.

Also, another successful radio-'phone connection was established between Batavia and Rio Janeiro, via the Santa Cruz sending station, and the Taraqua receiving station.

Ship to shore and vice versa radio-'phone conversations are not lagging far behind, either, interest in this phase of the transmission art was successfully demonstrated some time ago between the Leviathan and American shore receiving and transmitting stations. Recently a successful two-way radio circuit was established between the Leviathan and some inland European stations. The success of these commercial experiments, it must be understood, is due to a great amount of technical preparation and study and countless unheralded previous experiments along the same line.

State Uses Station For Highway Safety

Boston, Mass.

A radio broadcasting studio has been opened by the Governor's committee on street and highway safety in its offices in the State House for the daily dissemination of bulletins on road conditions and safety subjects. It is believed that this is the first time in the history of radio that broadcasting has been used as a regular daily part of the routine work of a State or municipal department.

"The apparatus, which constitutes the first permanent installation of broadcasting equipment in the State House, links the committee's offices directly with the transmitting system of WBZ and WBZA, the Westinghouse stations, whose cooperation made the innovation possible," the official announcement stated.

The Recalcitrant Governor

HOW about an impressive thought for the week, for once? For instance:

In radio, as in other trades, some people take too many liberties, as in the case of a Governor threatening to erect a broadcast station without the approval of the proper authority. Acts like this may have some bearing on the trade by belittling the science. Let's hope that the coming visual science (television) will not be sneered at or degraded by an act so unbecoming.

It comes out in the wash!

FRANK DE MARCO

Literature Wanted

THE names and addresses of readers of RADIO WORLD who desire literature on parts and sets from radio manufacturers, jobbers, dealers and mail order houses are published in RADIO WORLD on request of the reader. The blank at bottom may be used, or a post card or letter will do instead.

RADIO WORLD,
145 West 45th St., N. Y. City.
I desire to receive radio literature.

Name ....

Address ....

City or town ....

State ....

F. R. Ogden, 3159 Downing, Denver, Colo.
S. S. Brown. P. O. Box 334, Newark, Ohio.
Richard G. Ball, Mount Vernon, Wash.
G. E. McClymonds, N. Y. C. Hotel, Painesville, Ohio.
H. C. Johnson, Flat Rock, N. C.
L. S. Selling, Bellevue Hospital, New York, N. Y.
S. W. Sayler, 10 So. 3rd St., Fernandina, Fla.
C. W. Cottrell, Radio Service, Eunice, La.
Paul Randall, 100 Post Ave., Battle Creek, Mich.
Jim McIntyre, 14 S. Caramillo, Colorado Springs, Colo.
Don Burkhardt, 3043 W. 3rd St., Dayton, Ohio.
H. E. Herdrich, 4750 Kenmore Ave., Chicago, Ill.
Wm. Henderleiter, 6223-37th Ave., Kenosha, Wis.
Howard Walden, P. O. Box 44, Dothan, Ala.
David S. Wells, 1112 Matthews, S.W., Atlanta, Ga.
F. L. McRee, 2424-22nd St., Lubbock, Texas.
O. V. Hullinger. 525 Preusser, San Angelo, Tex.
L. G. Febcil, 303 Hawkins Ave., N. Braddock, Pa.
Rob't. M. Patton, 438 Arnold Ave., Willow Grove, Pa.
F. A. Merrick, 534 Montclair Ave., Bethlehem, Pa.
N. & B. Silkbo. 16 Ward St., Paterson, N. J.
G. Delisle, 2135 Chambly St., Montreal, Canada
L. T. Baker, 698 St. Paul, Memphis, Tenn.
Edward Krug, P. O. Box 487, Nashotah, Wis.
John McEmmons, 100 Prospect St., Gloucester, Mass.
Edward H. Keeler, 320 Hurley St., Cambridge Mass.
Orival E. Borst, 607 N. C. St., Indianola, Iowa.
W. A. Bell, Rt. 2. Milton, Fla.
Mat Cryan, Jr., 625 Davis St., Kalamazoo, Mich.
Stephen Gumport, 130 West 86th St., New York, N. Y.
L. B. Walden, Box 397, Altavista, Va.
W. G. Reinhardt, 1280 Pine St., San Francisco, Calif.
R. B. Jolley. Box 323, Valdosta, Ga.
Lee R. Brock, 427 S. 8th St., Fredonia, Kans.
C. G. Porter, 1026 East 71st St., Seattle, Wash.
Don R. Williams, R. 6, Box 770, Phoenix, Ariz.
Joseph A. Eagan, 363 Monroe St., Brooklyn, N. Y.
C. A. Fraser, c. o. Taylor Instrument Cos., 95 Ames Str., Rochester, N. Y.
Wm. P. Cady, c. o. Taylor Instrument Cos., 95 Ames Str., Rochester, N. Y.
D. D. Jones, 11753 Camden Ave., Detroit, Mich.
Bob Graef, 3143 Durrell Ave., Cincinnati, Ohio.
Theodore C. Elder, R. D. 6, Butler, Pa.
J. E. Baker, Box 761, Sanford, Fla.
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RCA to Manufacture; $32,000,000 in Deal

The Radio Corporation of America has made arrangements to purchase from the General Electric Co. and the Westinghouse Electric & Manufacturing Co. the engineering and manufacturing facilities and plants heretofore used in the production of radio receivers, tubes and other equipment for the Radio Corporation.

RCA has asked its stockholders to approve an increase in its capital stock to compensate the sellers.

The stockholders are being asked to approve an increase in the authorized common stock from 7,500,000 to 15,000,000 shares. The Radio Corporation will issue of that amount to the General Electric and the Westinghouse companies a total of 6,580,375.1 shares, which is exactly equal to the number of common shares at present issued and outstanding. The General Electric will receive three-fifths and the Westinghouse two-fifths of these new shares.

The issue of these common shares includes reimbursement to the General Electric and Westinghouse companies for the $32,000,000, plus interest, on cash advances by them in connection with the Victor Talking Machine Company acquisition a year ago.

Ohio Air School Gains World's Eye

Columbus, Ohio.

The Ohio school of the air, operated by the State Department of Education, is attracting international attention, says the department. An educational representative of the Soviet Government will visit Columbus to study the methods of the school and a recent issue of a French educational journal contained an article on the use of radio and motion pictures for educational purposes in the American schools, pointing to the Ohio school, which has been in operation since January 7th, 1929, as a model system.

RCA Wants to Test On 30 Centimeters

Washington.

RCA Communications, Inc., has filed applications with the Federal Radio Commission for experimental operating licenses on extremely high frequencies, ranging up to one billion cycles per second, or down to wavelengths of 30 centimeters. Four applications were filed, three for modifications of previous experimental licenses and one for a new construction permit to operate on frequencies approaching the infra-red portion of the spectrum, with only one watt of power.

Lloyd A. Briggs, chief operating engineer of RCA, explains in a letter accompanying the applications that they are submitted "for the purpose of continuing the experimental operations incident to exploring the possibilities of the ultra-high frequencies which were under progress and authorized by the last previous licenses covering these stations." Three of the stations are located at Rocky Point, N. Y., and the fourth will be located at Weehawken, N. J.

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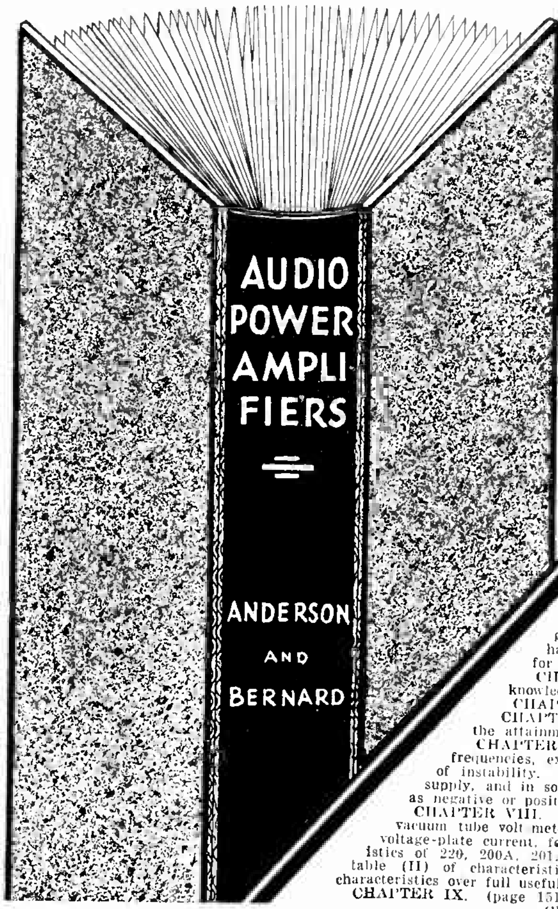

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By J. E. Anderson, M.A., and Herman Bernard, LL.B.

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IN radio receivers, separate audio amplifiers, talking movies, public address systems and the like, the power amplifier stands out as of predominating importance, therefore a full and authentic knowledge of these systems is imperative to every technician. "Audio Power Amplifiers" is the book that presents this subject thoroughly. The authors are:

J. E. Anderson, M.A., former instructor in physics, University of Wisconsin, former Western Electric engineer, and for the last three years technical editor of "Radio World."

Herman Bernard, LL.B., managing editor of "Radio World."

They have gathered together the far-flung branches of their chosen subject, treated them judiciously and authoritatively, and produced a volume that will clear up the mysteries that have perplexed many.

The book begins with an elementary exposition of the historical development and circuit constitution of audio amplifiers and sources of powering them. From this simple start it quickly proceeds to a well-considered exposition of circuit laws, including Ohm's laws and Kirchhoff's laws. The determination of resistance values to produce required voltages is carefully expounded. All types of power amplifiers are used as examples: AC, DC, battery operated and composite. But the book treats of AC power amplifiers most generously, due to the superior importance of such power amplifiers commercially.

"Audio Power Amplifiers" is for those who know something about radio. It is not for novices. But the engineers of manufacturers of radio receivers, power amplifiers, sound installations in theatres, public address systems and phonograph pickups will welcome this book. Engineers—even chief engineers—of the Bell Telephone Laboratories, Radio Corporation of America, Westinghouse Electric & Mfg. Co., Western Electric, Photophone, Vitaphone and the like needn't be afraid they won't learn something from this little book.

Details of Chapter Contents

CHAPTER I. (page 1) General Principles, analyzes the four types of power amplifiers, AC, DC, battery-operated and composite, illustrates them in functional blocks and schematic diagrams, and treats each branch in clear textual exposition.

CHAPTER II. (page 20) Circuit Laws, expounds and applies Ohm's laws and their special form known as Kirchhoff's Laws.

CHAPTER III. (page 35) Principles of Rectification, expounds the vacuum tube, both filament and gaseous types, electrolytic and contact rectifiers, and explains why and how they work. Full-wave and half-wave rectification are treated, with current flow and voltage derivation analysis. Regulation curves for the 280 tube are given. Voltage division, filtration and stabilization are fully illustrated and dissected.

CHAPTER IV. (page 62) Practical Voltage Adjustments, gives the experimental use of the theoretical knowledge previously imparted. Determination of resistance values is carefully revealed.

CHAPTER V. (page 72) Methods of Obtaining Grid Bias, enumerates, shows, and compares them.

CHAPTER VI. (page 90) Principles of Push-Pull Amplifier, defines the push-pull relationship, with keys to the attainment of desired electrical symmetry.

CHAPTER VII. (page 98) Oscillation in Audio Amplifiers, deals with motorboating and oscillation at higher audio frequencies, explaining why it is present, stating remedies and giving expressions for pre-determination of regions of instability. The trouble is definitely assigned to the feedback through common impedance of load reactors and B supply, and in some special instances to the load's relationship to the C bias derivation as well. The feedback is shown as negative or positive and the results stated.

CHAPTER VIII. (page 118) Characteristics of Tubes, tells how to run curves on tubes, how to build and how to use a vacuum tube volt meter, discusses hum in tubes with AC on the filament or heaters and presents families of curves, plate voltage-plate current, for 240, 220, 201A, 112A, 171A, 227 and 245, with load lines. Also, plate voltage-plate current characteristics of 220, 200A, 201A, 112A, 171A, 222, 240, 226, 227, 224, 245, 210, 250, full data on everything. There is a composite table (II) of characteristics of Rectifier and Voltage Regulator Tubes, and individual tables, giving grid voltage, plate current characteristics over full useful voltage ranges for the 220, 201A, 112A, 171A, 222, 240, 227, 245 and 224.

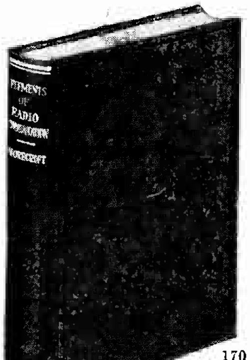
CHAPTER IX. (page 151 Reproduction of Recordings, states coupling methods and shows circuits for best connections.

CHAPTER X. (page 161) Power Detection, explains what it is, when it should be used, and how to use it. A rectifying detector, designed by one of the authors, is expounded also.

CHAPTER XI. (page 121) Practical Power Amplifier, gives AC circuits and shows the design of a sound reproduction system for theatres. A page is devoted to power amplifier symbols.

CHAPTER XII. (page 183) Measurements and Testing, discloses methods of qualitative and quantitative analysis of power amplifier performance. Order Cat. APAM.

"Elements of Radio Communication"



The latest book by Prof. John H. Morecroft, of the Engineering Department of Columbia University, and past president of the Institute of Radio Engineers, is his "Elements of Radio Communication." We regard this as the best elementary book to inform you authoritatively on the technical phases of radio in plain language, provided you have some foundation knowledge of radio. The book is a complete course on the elements of radio, containing much material never before published. It has 226 pages, 170 illustrations and a complete index. Cloth bound. Order Cat. M

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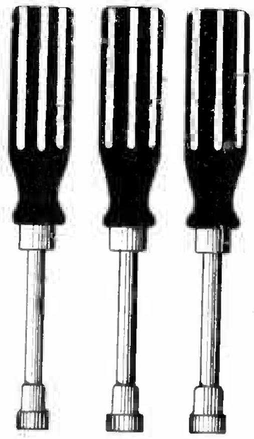

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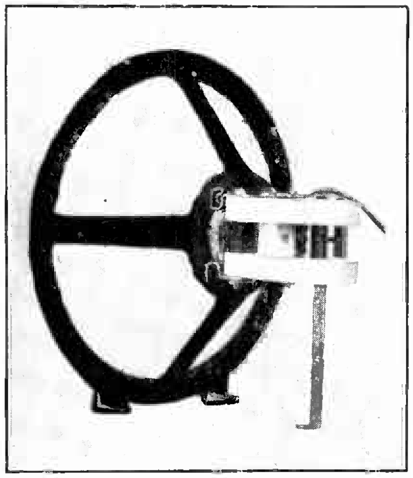

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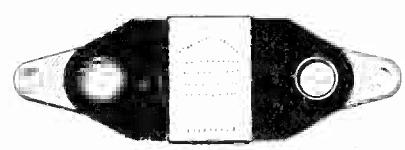

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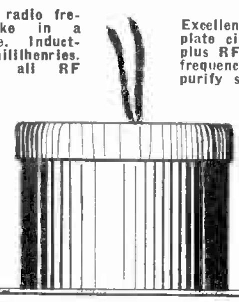

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Crosley 804 A.C.
Crosley, 40S, 41S, 42S, 82S screen grid
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Sonora B31 screen grid
Sonora A36 Sonora A40 Sonora A44
Kennedy royal 80 Kennedy model 10
Kennedy model 20 screen grid
Stewart-Warner 900 A.C.
Stewart-Warner 950 battery screen grid
Stewart-Warner 950 A.C. screen grid
Stewart-Warner 950 D.C. screen grid
Automatic Electric model B screen grid
Radiola 44 screen grid
Radiola 47 screen grid Radiola 66
Majestic 90
Majestic 9P6 power unit
Majestic 9P3 power unit
Stromberg-Carlson 641 screen grid
Stromberg-Carlson 642 screen grid
Stromberg-Carlson 846 screen grid
Edison R1, R2 and C2
Edison R1, R2 and C2 (25 cycles)
Edison R4, R5 and C4
Parts list for Edison R4, R5 and C4
Edison C1
American Bosch 54 D.C. screen grid
Victor R32 and RE45
Grebe SK 4 A.C. screen grid (early model)
Grebe SK 4 A.C. screen grid (late model)
Grebe SK 4 D.C. screen grid
Grebe 428 DeLuxe console
Traveler A.C. power pack
Erla 224 A.C. screen grid
Silver-Marshall 30B screen grid
Silver-Marshall 30C screen grid
Silver-Marshall 30D screen grid
Silver-Marshall 30E screen grid
Eveready 1, 2, and 3 Eveready series 30
Eveready series 40
Eveready series 50 screen grid
Steinite 40, 50 and 102 Steinite 50 power unit
All American Mohawk 96 screen grid (60 cycle)
All American Mohawk 90 (25 cycle)
All American Mohawk 90 (60 cycle)
All American Mohawk 70, 73 and 75
Gulbransor Model C (early model)
Gulbranson Model C (late model)
Bremer-Tully 7-70 and 7-71
Bremer-Tully 81 and 82
Earl 21, 22 Earl 31, 32 Earl 41, 42
Philco 65 screen grid Philco 76 screen grid Philco 87
Philco 95 screen grid
Peerless Electrostatic series, screen grid
Fada 20 and 20Z Fada 22 battery
Fada 25 and 252 screen grid
Fada 25 and 25Z screen grid with M250 and M250Z Electric units
Fada 35 and 35Z screen grid Fada 75 and 77 screen grid
Brunswick 5 NC8 Radio Chassis Schematic
Brunswick 5 NC8 Audio Chassis Schematic
Brunswick 5 NC8 and 3 NC8 Audio Chassis Schematic
Brunswick 5 NC8 cabinet wiring
Brunswick 3 NC8 Radio Chassis Schematic
Brunswick 3 NC8 cabinet wiring
Brunswick S14, S21, S31, S81, S82 screen grid Radio Chassis Schematic
Brunswick S14, S21, S31, S81, S82 screen grid Radio Chassis Actual
Brunswick S14, S21, S81, S82 Audio Chassis Schematic (25 cycle)
Brunswick S14, S21, S81, S82 Audio Chassis Schematic (60 cycle)
Brunswick S14, S21, S81, S82 Audio Chassis Actual (25 cycle)
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Brunswick 3 KR8 Radio Chassis
Brunswick 3 KR8 Audio Chassis Schematic
Brunswick 3 KR8 Audio Chassis Actual
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Brunswick 5 NO Socket Power Actual
Brunswick 3 KRO and 3 KR6 Radio Chassis
Brunswick 3 KRO and 3 KR6 Socket Power
Brunswick 5KR, 5KRO, 2KRO Socket Power
Brunswick 5KR, 5KRO, 3KRO, 2KRO, 5KR6 Socket Power
Brunswick 5KR, 5KRO, 2KRO, 5KR6 Radio Chassis
Amrad Bel-Canto series
Sparton 89, Sparton 89A, Sparton 49
Sparton ensemble
Sparton 931, 301 D.C., Sparton 931 A.C.
Sparton 110 A.C., Sparton 301 A.C.

Here is an opportunity to obtain these hard-to-get wiring diagrams of modern radio receivers. The sheets are punched with three standard holes for loose-leaf binding. Each diagram is on a separate page. As you will see by glancing through the above list, these diagrams include the popular receivers of the day. Electrical constants are indicated on the majority of the diagrams and in many cases the actual chassis layouts are shown with color coding.

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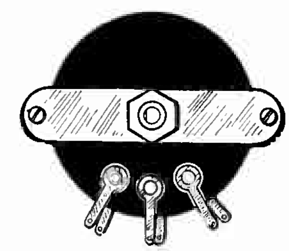

AN instrument containing two electrically independent potentiometers with their sliders mounted to the same shaft. Both are turned when one is turned. It is made by Centralab and has the smooth motion for which variable resistors and potentiometers of this make are known. One unit, next the control knob, has a resistance of 200,000 ohms, and the other, at the rear, has a resistance of 10,000 ohms.

They may be used either as high resistance rheostats (from center to one side) or as potentiometers, singly or together. This makes the instrument exceptionally flexible and applicable to a large variety of uses.

It has been designed for a volume control for which it may be used to vary the plate voltage, the grid voltage, the screen grid voltage, or the signal voltage, or two combinations thereof. For example, the 10,000 ohm section may be used as a potentiometer in the antenna circuit to control the signal input voltage and the 200,000 ohm section may be used at the same time for controlling the audio signal voltage before it is impressed on the first audio amplifier tube. Or the low resistance may be used to control the signal input voltage and the high resistance for controlling a screen grid voltage, or vice versa.

The unit is provided with six soldering lugs for making connections to the instrument either as variable resistance or as potentiometer.

Single hole mounting with quarter inch shaft. The two units are held together firmly by metal clamps and bolts.

The resistance elements and the sliders are inclosed in dust-proof bakelite cases.

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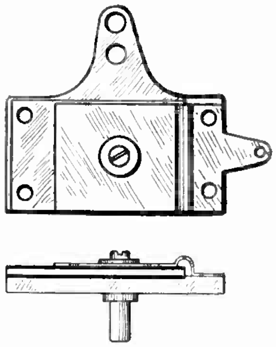
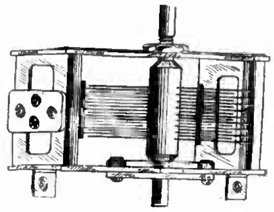


CAT. EQ-100 AT 35c

The most precise and rugged equalizing condenser made, with 20 mmfd. minimum and 100 mmfd. maximum, for equalizing the capacity where gang condensers are used that are not provided with built-in trimmers. Turning the screw alters the position of the moving plate, hence the capacity. Cross-section reveals special threaded brass bushing into which screw turns, hence you can not strip the thread. Useful in all circuits where trimming capacity of 100 mmfd. or less is specified. Maximum capacity stamped on

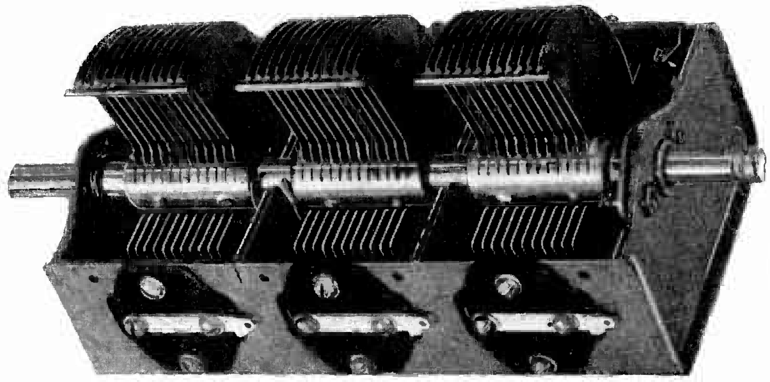
SINGLE .00035



CAT. KH-3 AT 85c

A single .00035 mfd. condenser with nonremovable shaft, having shaft extension front and back, hence useful for ganging with drum dial or any other dial. Shaft is ¼ inch diameter, and its length may be extended ⅝ inch by use of Cat. XS-4. Brackets built in enable direct sub-panel mounting, or may be plied off easily. Front panel mounting is practical by removing two small screws and replacing with two 3/34 screws ¾ inch long. Condenser made by Scovill Mfg. Co.

THREE-GANG SCOVILL .0005 MFD.



One of the finest, strongest and best gang condensers ever made is this three-gang unit, each section of full .0005 mfd. capacity, with a modified straight frequency line characteristic. The net weight of this condenser is 3¾ lbs. Cat. SC-3G—5 **at $4.80.**

HERE is a three-gang condenser of most superior design and workmanship, with an accuracy of at least 99¾ per cent. at any setting — rugged beyond anything you've ever seen. Solid brass plates perfectly aligned and protected to the fullest extent against any displacement except the rotation for tuning. It has both side and bottom mounting facilities. Shaft is ⅜ inch diameter and extends at front and back, so two of these three-gangs may be used with a single drum dial for single tuning control. For use of this condenser with any dial of ¼" diameter bore, use Cat. XS-8, one for each three-gang. Tension adjusters shown at right, other side of shaft.

SALIENT FEATURES OF THE CONDENSER

(1)—Three equal sections of .0005 mfd. capacity each.
(2)—Modified straight line frequency shape of plates, so-called midline.
(3)—Sturdy steel frame with rigid steel shields between adjacent sections. These shields minimize electric coupling between sections.
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(5)—Both the rotor and the stator plates are accurately spaced and the rotor plates are accurately centered between stator plates.
(6)—Two spring stoppers prevent jarring when the plates are brought into full mesh.
(7)—The rotor turns as desired, the tension being adjustable by set-screw at end.
(8)—The shaft is of steel and is ⅜ inch in diameter.
(9)—Each set of stator plates is mounted with two screws at each side of insulators, which in turn are mounted with two screws to the frame. Thus the stator plates cannot turn sidewise with respect to the rotor plates. This insures permanence of capacity and prevents any possible short circuit.
(10)—Each stator section is provided with two soldering lugs so that connection can be made to either side.
(11)—The thick brass plates and the generous proportions of the frame insure low resistance.
(12)—Provision made for independent attachment of a trimmer to each section.
(13)—The steel frame is sprayed to match the brass plates.
(14)—The condenser, made by America's largest condenser manufacturer, is one of the best and sturdiest ever made, assuredly a precise instrument.

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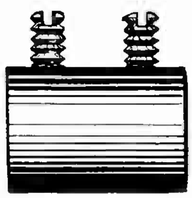
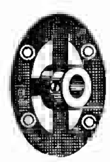


CAT. RL-3 AT 12c

For coupling two ¼ inch diameter shafts, either coil shaft and condenser shaft, or two condenser shafts, a coupling link is used. This may be of the rigid type, all metal, where the linked units are not to be insulated.

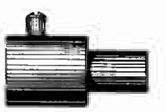
The rigid link, Cat. RL-3, has two set-screws, one to engage each shaft, and is particularly serviceable where a grounded metal chassis is used, as the returns then need no insulation.



CAT. FL-4 at 30c

Flexible insulated coupler for uniting coil or condenser shafts of ¼ inch diameter. Provides option of insulated circuits

EXTENSION SHAFTS, TWO SIZES



CAT. XS-4 AT 10c

Here is a handy aid to salvaging condensers and coils that have ¼" diameter shafts not long enough for your purpose. Fits on ¼" shaft and provides ⅝" extension, still at ¼". Hence both the extension shaft and the bore or opening are ¼" diameter. Order Cat. XS-4.

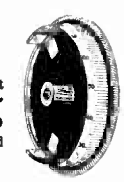
For condensers with ⅜" diameter shaft, to accommodate to dials that take ¼" shaft, order Cat. XS-8 at 15c.

.00035 TWO-GANG

A two-gang condenser, like the single type, KHS-3, but consisting of two sections on one frame, is Cat. KHD-3, also made by Scovill. The same mounting facilities are provided. There is a shield between the respective sections. The tuning characteristic is modified straight frequency line. Order Cat. KHD-3 at $1.70.

DRUM DIAL

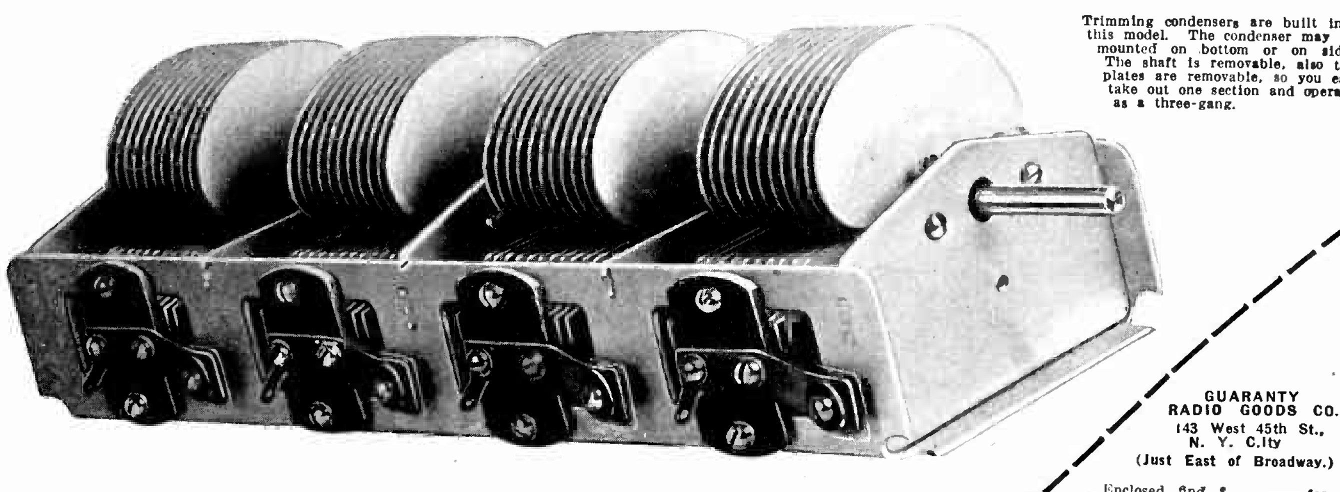
CAT DD-0-100 @ $1.50



A suitable drum dial of direct drive type is obtainable for ¼" shafts or ⅜" shafts, and with 0-100 scales. An escutcheon is furnished with each dial.

FOUR-GANG .00035 MFD. WITH TRIMMERS BUILT IN

Trimming condensers are built into this model. The condenser may be mounted on bottom or on side. The shaft is removable, also the plates are removable, so you can take out one section and operate as a three-gang.



Four-gang .00035 mfd. with trimmers built in. Shaft and rotor blades removable. Steel frame and shaft, aluminum plates. Adjustable tension at rear. Overall length, 11 inches. Weight, 3½ lbs. Cat. SPL-4G-3 @ $3.95.

SHORT WAVES

Tuning condensers for short waves, especially suitable for mixer circuits and short-wave adapters. These condensers are .00015 mfd. (150 microfarads) in capacity. They are suitable for use with any plug-in coils. Order Cat. SW-S-150 @ $1.50. To provide regeneration from plate to grid return, for circuits calling for this, use .00025 mfd. Order Cat. SW-S-250 @ $1.50.

A four-gang condenser of good, sturdy construction and reliable performance fits into the most popular tuning requirement of the day. It serves its purpose well with the most popular screen grid designs, which call for four tuned stages, including the detector input.

Ordinarily a good condenser of this type costs, at the best discount you can contrive to get, about twice as much as is charged for the one illustrated and even then the trimming condensers are not included. The question then arises, has quality been sacrificed to meet a price? As a reply, read the twenty-six points of advantage. The first consideration was to build quality into the condenser. The accuracy is 99¼%.

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☐ Cat. SC-3 G-5 @ $4.80
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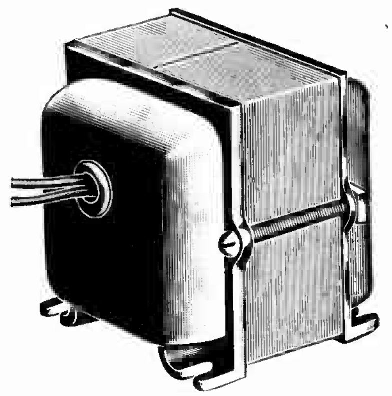


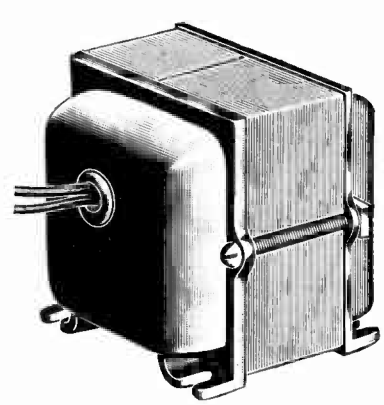
Shielded single choke, 200 ohms D.C. resistance, non-saturable at 100 milliamperes, with two black outleads, each 6 inches long. For filtration of B supplies. Inductance, 30 henrys.
Cat. SH-S-CH, price $5.00

The shielded single choke will pass 100 ma. One will suffice if the current is 100 ma. or less. for filtration of B supplies, provided the capacity at the filter output is 8 mfd. or more. Use two such shielded chokes if less than 8 mfd. is used at the filter output, Also, the shielded single choke may be used as in the power tube circuit for an output filter. In this connection use at least 2 mfd. for the capacity section of the filtered speaker output. Order Cat. SH-S-CH © $5.00

The shielded double choke may be used for filtration where the B current is 60 ma. or less, with relatively small filter capacities, no less than 4 mfd. at the output, however. This choke consists of one winding, center-tapped. Its use is especially recommended for 171, 171A, 245 or 210 push-pull output. Connect the black leads (extremes of windings) to plates of the push-pull tubes, red center tap to B plus, and the speaker many be connected directly to plates without any direct current, but only signal current, flowing through the speaker. This system is applicablo only to push-pull. Order Cat. SH-D-CH © $6.00

In the same type of case a 20-volt secondary filament transformer, for 110 volts, 50-133 cycle, may be obtained for use in conjunction with dry rectifiers, such as Kuprox, Westinghouse, Benwood-Linze and Elkon, in dynamic speakers or A battery eliminators. Not made for 25 or 40 cycles. Order Cat. SH-F-20 © $2.50

245 Power Transformer for use with 280 rectifier, to deliver 300 volts D.C. at 100 milliamperes, slightly higher voltage at lower drain, and supply filament voltages.
Cat. 245-PT price $8.50



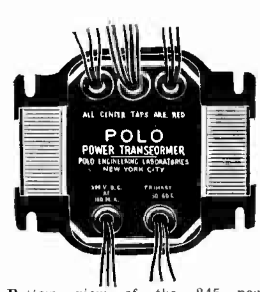
Twenty-volt filament transformer, 110 v. 50-133 cycle input, for use in conjunction with dry rectifiers. It will pass 2.25 amperes.

In a different type case, square, of cadmium plated steel with four mounting screws built in, size 4½ inches wide by 3¾ inches high by 4 inches front to back, a 50-60 cycle filament transformer is obtainable with the same windings as the 245 power transformer, except that the high voltage secondary is omitted. Order Cat. 245-FIL, © $4.50
For 40 cycles order Cat. 245-FIL-40 © 7.00
For 25 cycles order Cat. 245-FIL-25 © 8.50

[Any of the above three in the same case as the 245 power transformer, © $1.00 extra. Add PTC after the Cat. number.]

A single choke, unshielded, 65 ma rating, 30 henrys inductance, for B filtration or single output filter of speaker, is our Cat. US-S-CH © $1.25

The Polo 245 power transformer is expertly designed and constructed, wire, silicon grade A steel core and air gap large enough to stand the full rated load. The primary is for 110v A.C., 50-60 cycles, tapped for 82.5 volts in case a voltage regulator, such as a Clarostat or Amperite, is used. The black primary lead is common. If no voltage regulator is used, connect black lead to one side of the A.C. line, green lead to the other side of the line, and ignore red lead, except to tape the end. For use with a voltage regulator (82.5-volt primary) use red lead and ignore the green except to tape the end. The secondaries are: high voltage for 280 plates, with red center tap to ground; 2.5 volts, 3 amperes, red center tap to C plus, for 245 output, single or pushpull; 5 volts, 2 amperes, red center tap, as positive B lead, for filament of 280 tube; 2.5 volts, 16 amperes, red center tap to ground, for 224, 227 and pentode tubes, up to nine heater type tubes. Hence there are five windings.



Bottom view of the 245 power transformer. All leads are plainly marked on the nameplate, including the top row.

A special filament transformer, 110 v., 50-60 cycles, with two secondaries, one of 2.5 v. 3 amp. for 245s, single or push-pull, other 2.5 v. 12 amperes for 224, 227, etc., both secondaries center-tapped. Shielded case. Cat. F-2.5-D @ $3.75

The conservative rating of the Polo 245 power transformer insures superb results even at maximum rated draw, working up to twelve tubes, including rectifier, without saturation, or overheating due to any other cause. This ability to stand the gaff requires adequate size wire, core and air gap, all of which are carefully provided. At less than maximum draw the voltages will be slightly greater, including the filament voltages, hence the 16 ampere winding will give 2.25 volts at maximum draw, which is an entirely satisfactory operating voltage, increasing to 2.5 volts maximum as fewer than a total of nine RF, detector and preliminary audio tubes are used.

The avoidance of excessive heat aids in the efficient operation of the transformer and in the maintenance of good regulation, for excessive heat increases the resistance of the windings.

The transformer is equipped with four slotted mounting feet and a nameplate with all leads identified. It is one of the very finest instruments on the radio market.

Highest Capacity of Filament Secondary

SPECIAL pains were taken in the design and manufacture of the Polo 245 power transformer to meet the needs of experimenters. For instance, excellent regulation was provided, to effect minimum change of voltage with given change in current used. Also, the 2.5 volt winding for RF, detector and preliminary audio tubes, was specially designed for high current, to stand 16 amperes, the highest capacity of any 245 power transformer on the market. Hence you have the option of using nine heater type tubes. The shielded case is crinkle brown finished steel, and the assembly is perfectly light, preventing mechanical vibration.

The power transformer weighs 11½ lbs., is 7 inches high, 4⅞ inches wide, and 4¼" front to back, overall.

Elevating washers may be used at the mounting feet to clear the outleads, or holes may be drilled in a chassis to pass these leads, and the transformer mounted flush.

Advice in Use of Chokes and Condensers in Filter

With the 245 power transformer either one or two single chokes should be used, or a shielded double choke, depending on the current drain and the capacity of filter condensers used. Where the capacity at the output is 8mfd. or more for a drain of 65 to 100 ma., a single choke will suffice (Cat. SH-S-CH), but where smaller output capacity than 8 mfd. is used on such drain, two such chokes should be used in series. Next to the rectifier, in either instance, use a 1 or 2 mfd., 550 A.C. working voltage rating condenser (D.C. rating, 1,000 volts). You may use your choice of capacity at the midsection.

If the drain is to be 65 milliamperes or less, the double choke, Cat. SH-D-CH, may be used for filtration, instead of two single shielded chokes.

The Polo 245 power transformer may be obtained for 25 cycles or 40 cycles on special order, as these are not stocked regularly, and remittance must accompany order. The same guaranty attaches to them as to all other Polo apparatus—money back if not satisfied after trial of five days. In these the primary and secondary voltages and taps are the same, only the case is deeper (front to back) because of larger core and wire for lower frequency.
For 40 cycles order Cat. 245-PT-40 .... @ $9.50
For 25 cycles order Cat. 245-PT-25 .... @ $12.50

[Note: The filter for 40 cycles should consist of two shielded single chokes, Cat. SH-S-CH, with 2 mfd. next to the rectifier and 4 mfd. minimum at the joint of the two chokes and at the end of the filter. For 25 cycles the same holds true, except that the output capacity at end of chokes should be 8 mfd. minimum.]

We Make Special Transformers to Order

Polo Engineering Laboratories, 143 West 45th St., New York, N. Y.

Enclosed please find $———— for which ship at once:

☐ Cat. 245-PT @...$8.50	☐ Cat. 245-FIL @..$4.50
☐ Cat. 245-PT-40 @ 9.50	☐ Cat. 245-FIL-40 @ 7.00
☐ Cat. 245-PT-25 @ 12.00	☐ Cat. 245-FIL-25 @ 8.50
☐ Cat. SH-S-CH @ 5.00	☐ Cat. SH-F-20 @. 2.50
☐ Cat. SH-D-CH- @ 6.00	☐ Cat. UN-S-CH @. 1.25
☐ F-2.5-D @ 3.75	

Note: Canadian remittance must be by post office or express money order.

☐ If C.O.D. shipment is desired, put cross here. No C.O.D. on 25 and 40 cycle apparatus. For these full remittance must accompany order. The 25 and 40 cycle apparatus bears the 50-60-cycle label, but you will get actually what you order.

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