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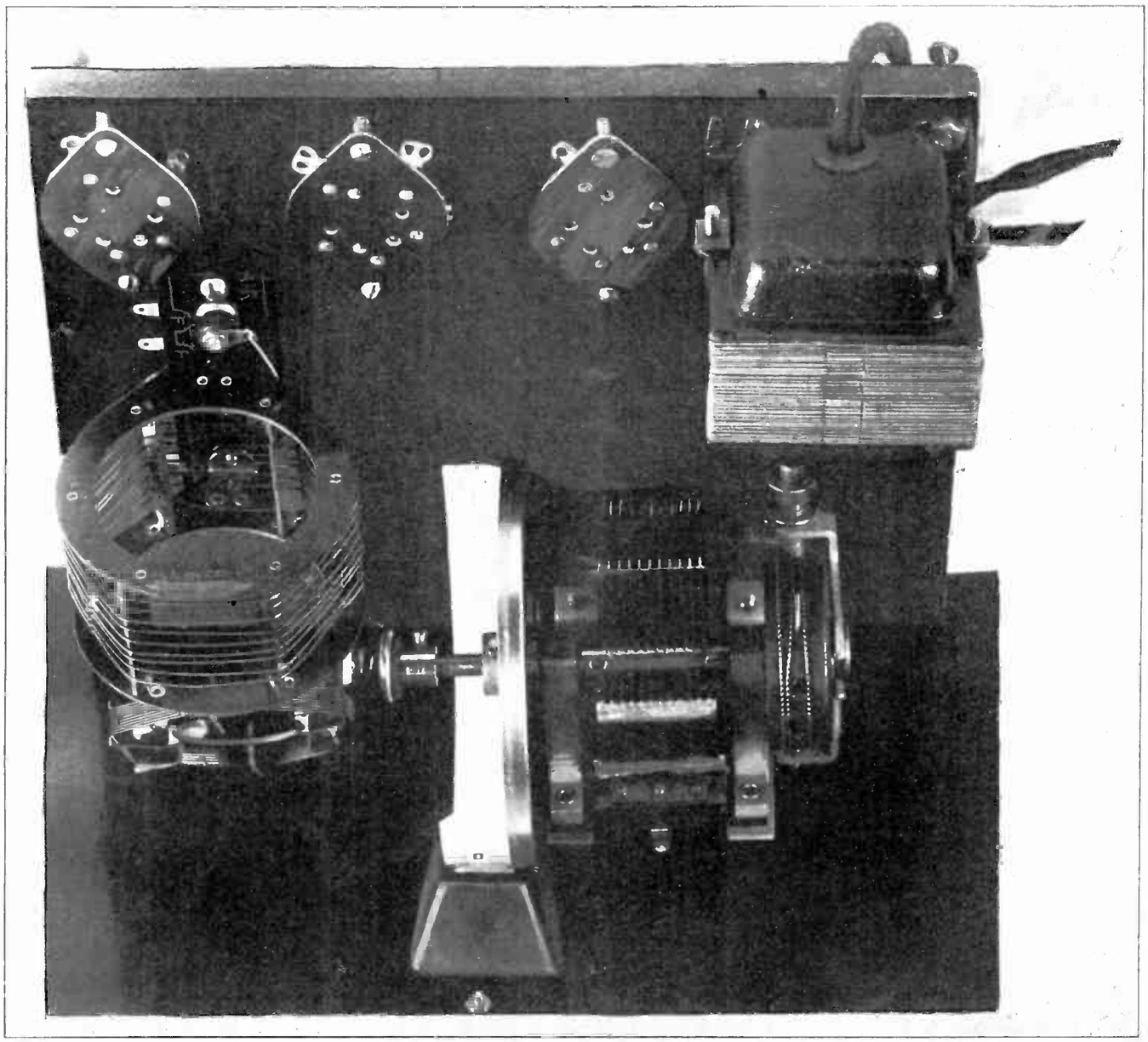

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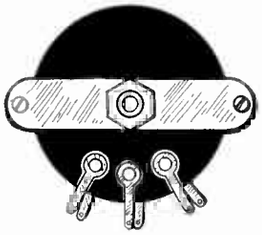
A Double Range Potentiometer



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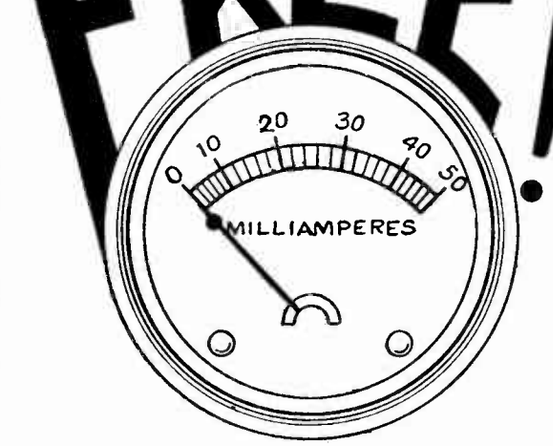

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Double Push-Pull AF

By Herbert E. Hayden

THE desirability of using push-pull in the output stage of a receiver or power amplifier is not an exclusive asset, since the same principle of aiding tone quality may be applied just as rationally to the preliminary audio stage. Fig. 1 shows a diagram of a two-stage power amplifier in which both stages are push-pull, an arrangement which undoubtedly will grow in popularity, just as last-stage push-pull came to be the reigning favorite.

The push-pull action consists of accepting a signal input and delivering it to the grids of two succeeding tubes, whereby the instantaneous voltages on these grids are exactly opposite in phase, that is, 180 degrees apart. The voltages are numerically equal, but their phases are opposite, so that if the signal voltage is 2 volts positive on one grid it is 2 volts negative on the other grid, a relative difference of 4 volts. Push-pull does not increase the volume, as compared with a single-sided circuit, but it does improve the quality, in that it empowers the push-pull stage to stand about four times as much gaff as the other, and cancels the even order of harmonics, particularly the second harmonic, which action reduces distortion and hum.

Matched Output for 245 Impedance

For a double push-pull circuit two coupling transformers and an output device are needed. The first coupling transformer, at left, is an input transformer, the second one, in the middle, is an interstage push-pull transformer, while the output device is a center-tapped choke coil. If the total inductance of this output coil is 30 henries across extreme terminals, then each half will be 15 henries, and that will provide a suitable impedance for the 245 output tubes.

The 280 rectifier will serve nicely, as the plate current drain of the audio amplifier will be about 75 milliamperes. Hence a tuner used in conjunction with this power amplifier, if drawing up to to 25 milliamperes, will bring the total drain to 100 milliamperes, which will be handled all right by the popular 245 power supply transformers on the market.

The input is made to P. and B. If a tuner is used the positive B voltage for the detector has to be taken into consideration. The dotted line at left, terminating in the designation "A", denotes an alternative of B voltage for the detector. For the leak-condenser type of detection the connection of "A" may be made to the center-tap of the 2.5-volt filament winding that serves the power tubes. Thus the amount of negative bias on the power tubes, 50 volts, is used reversely as a positive bias of 50 volts for the detector plate. This is the second secondary from the left. This voltage is brought out to a binding post, anyway. It is marked plus 50, but binding posts commonly have the designation plus 45, so although the post may read 45, the voltage will be 50.

For power detection the plate voltage should be higher, so the 180-volt binding post may be used. Connect "A" to that.

A phonograph pickup may be connected, one side to B, the other side to a 1 mfd. condenser which connects to P.

Color-Identified Leads

The diagram shows color designations. The power transformer is a Polo product, Cat. 245-PT. The primary has three outleads, because provision is made for optional use of a voltage regulator, such as the Clarostat or Amperite. The regulator is the little encircled resistor in one side of the primary and is connected to the red 82.5-volt tap. The other tap used is black. The third primary lead, green, is not used, and should be cut and taped at the end to prevent shorting. This holds true if the voltage regulator is included. If it is omitted then the red lead is ignored, except to be cut and taped at the end, and the AC input is made to black and green (100v primary).

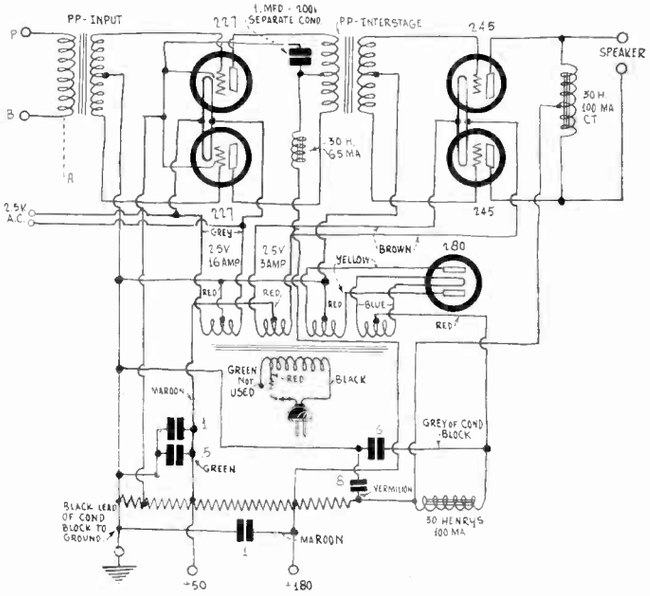


FIG. 1
DESIGN OF A DOUBLE PUSH-PULL TWO-STAGE AUDIO POWER AMPLIFIER.

The object of a voltage regulator is to maintain the voltage approximately the same, at the secondaries, despite line voltage changes.

All the leads of the Polo power transformer are color-identified, as shown. All center taps are red. The large, thick grey leads of the 2.5-volt, 16-ampere winding permit heating the tubes of the tuner, so two binding posts are used for bringing out this power source. As many as six such tubes, 227 or 224 may be heated in addition to the two 227s in the amplifier.

(*Concluded on next page*)

LIST OF PARTS

One push-pull input transformer.
One push-pull interstage transformer.
One shielded push-pull output impedance. (Polo, Cat. SH-D-CH).
One Polo 100 ma single shielded choke. (Polo, Cat. SH-S-CH).
One 30-henry 65-ma single unshielded choke. (Polo, Cat. US-S-CH).
One Polymet 1 mfd. 200-volt condenser bypass.
One Flechtheim condenser b11 block, 6, 8, 1, 10.5 mfd. (Cat. FL-6-8-B.)
One Multi-tap voltage divider, total 17,100 ohms, 20 taps.
Nine binding posts.
Two UY and three UX sockets.
One Clarostat line voltage regulator.
Two 227, two 245 and one 280 tubes.
Six-foot AC cable and male plug, with follow-through pendant switch.
One baseboard.

Action of Push-Pull L

By J. E.

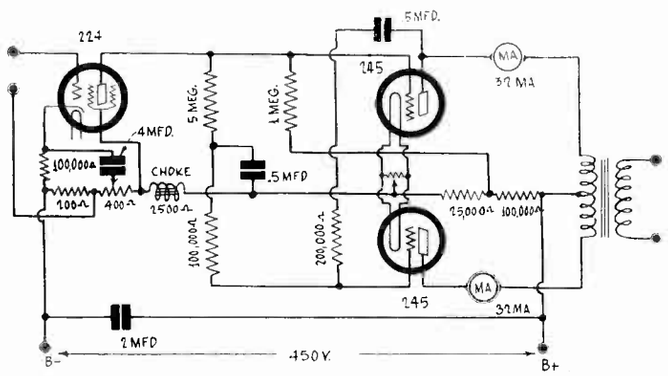


FIG. 1
THE CIRCUIT DIAGRAM OF THE NEW LOFTIN-WHITE PUSH-PULL AMPLIFIER. THE ARRANGEMENT IS BASED ON THE WELL-KNOWN PHASE REVERSER TUBE.

[*This is the first presentation to the readers of* RADIO WORLD *of the latest development of Messrs. Loftin and White in non-reactive amplifiers. This circuit is a push-pull resistance coupled amplifier utilizing the phase reverser tube for obtaining voltages which are equal in magnitude but in opposite phase on the two output tubes. Those who have the original Loftin-White amplifier can easily convert it to push-pull.*—EDITOR.]

THE quest for push-pull, resistance coupled amplifiers goes on, and there are many on the quest. It was to be expected that Messrs. Loftin and White should devise a push-pull arrangement to go with their famous non-reactive amplifier, and the expectation has materialized as reported by R. P. Clarkson in the May 10th "New York Sun Radio Section."

Only one method of connection between a single-sided amplified to a push-pull amplifier without transformers has so far been suggested, and that is the method of utilizing a tube for phase reversal. This method Messrs. Loftin and White have used in their new development, but instead of using a separate tube for phase reversal they have used one of the output tubes, which is in line with the utmost simplicity for which the Loftin-White circuits are noted.

The circuit arrangement and the design constants of this circuit are given in Fig. 1. The first tube is the usual 224 screen grid tube. As far as this tube goes there is essentially nothing different between the old single-sided Loftin-White and the push-pull arrangement. The only difference is that the hum bucking condenser in the push-pull circuit has a capacity of 4 mfd., while in the single-sided circuits it was .1 or 1 mfd.

The first deviation of consequence is the choke coil in the low voltage lead between the first tube and the push-pull amplifier. This coil should have a DC resistance of 2,500 ohms. The inductance of this coil helps to eliminate hum, and of course the resistance helps to put the proper plate voltage on the screen grid tube. It is stated that the inductance value of this coil is of relatively little importance just so long as the resistance is 2,500 ohms.

Power Savings

It is suggested by the designers of the circuit that the choke coil be the field winding of a loudspeaker. Many speakers have field windings which require approximately the current that will flow in the lead where this choke is connected and also they have a resistance of about 2,500 ohms. Therefore it seems a nearly ideal arrangement to put the field coil in that position. It saves the power that would otherwise be needed for maintaining the field in the speaker, which is considerable. It is saved because if the field coil were not placed in that position the same power would be dissipated in the 2,500-ohm resistor that would have to be placed there to keep the proper voltage on the plate of the screen grid tube.

The connection of the upper power tube is exactly as it is in the single-sided amplifier developed by the same engineers, except that the values of the resistors may vary slightly. However, there are other devices connected to this tube. First we have a .5 mfd. condenser connected to the plate. This condenser in turn is connected through a 200,000-ohm resistor to the grid of the lower power tube. The object of this link is to put a signal voltage on the grid of the lower tube which is as nearly 180 degrees out of phase with the signal voltage on the upper grid as can be. This is the well-known phase reverser, and it works because the upper tube reverses the phase.

There is also a 5,100,000 ohm resistance connected between the two grids. This resistance, as will be noted, is divided into one 5 megohm resistance and one .1 megohm resistance. A condenser of .5 mfd. capacity is connected between the junction of these resistors and the center-tap of the filaments of the two power tubes. The object of this is two-fold. First, it puts the same grid bias on the grids of both power tubes, which is one essential condition for successful operation of a push-pull amplifier. Second, it divides the signal voltage so that the lower tube gets the same as the upper. If this arrangement, or some equivalent arrangement, were not used, the signal voltage on the lower tube would be greater than that on the upper by a factor equal to the voltage amplification in the upper tube. This, of course, would defeat the push-pull arrangement entirely. The relative values of the various resistors used for this purpose are those furnished by Loftin and White. The correctness of the signal voltage division by the values given is assured by the painstaking work that these designers have done on the circuit.

Adjustment of Bias

It will be noticed that a milliammeter is connected in the plate circuit of each output tube. The object of these meters is to show when the grid bias on the tubes is correct. If the effective plate voltage on each tube is 250 volts the bias will be correct when each meter indicates 32 milliamperes. This assumes also that the tubes are normal. Should there be a difference between the milliampere readings this may be due to differences in the tubes or possibly to differences in the grid bias. While the bias is nominally the same on each tube there may be a slight difference, especially if there is any leakage through the .5 mfd. condenser connected to the plate of the upper output tube.

Since it is not easy to tell whether any such difference is due to the tubes or to the bias, a test is advisable, and the simplest test is to interchange the tubes. If the tubes are equal and the milliampere difference remains, the trouble is due to grid bias difference, but if the larger current stays with the same tube, one tube is better than the other. Equal tubes should then be selected because without equality of tubes the push-pull action will not be satisfactory. If the trouble is due to bias difference, better condensers should be inserted. Either of the .5 mfd. condensers might be defective.

No Loss of Signal Voltage

When a push-pull amplifier is built with an input transformer the voltage induced in the secondary of this transformer is divided equally between the two tubes. That is to say, the signal voltage each tube gets is only one-half of the total voltage across the secondary. When push-pull action is obtained by means of the phase inverter as used in this Loftin-White amplifier there is no corresponding loss of voltage. The entire signal voltage developed across the the resistance of the screen grid tube is impressed on the upper power tube, while the signal voltage for the lower power tube is taken from the amplified voltage in the upper tube. Thus something is really added. It is about the same as if another stage having an amplification of unity were added and the outputs of both the original and the added tube are added in the proper phase relation to double the output power and about quadruple the output capability of the circuit.

Many might take exception to the arrangement shown in Fig. 1 on the ground that the condensers and the output transformer associated with the output tubes render the circuit reactive and in a measure defeat the advantages of the non-reactive system. Strictly speaking this objection is valid, but we must not be too fastidious about the matter. It is not an easy thing to couple a single-sided amplifier to a push-pull amplifier with any form of direct coupling,

Power Amplifier With

(*Concluded from preceding page*)

The subject of regulation is important, and this is taken care of in large part by the voltage regulator, but the power transformer itself has a regulation feature, and the object is to maintain the voltage fairly uniform, within the limits of the 280 tube regulation, despite divergence of current drains as more or fewer tubes are used in the tuner. This the large cross-section core of the power transformer assures with minimum core losses.

Of no less importance than regulation is filtration, which means the elimination of hum. The push-pull method operates at minimum hum, because with a full-wave rectifier the hum frequency that predominates is the second harmonic of the line freqency, so for 60-cycle line it is 120 cycles. Moreover, 120-cycle hum is easier to filter. Nevertheless large filtration capacity is used. This makes possible the elimination of hum with a single choke coil, 30 henries, 100 milliamperes rating. Across the rectifier output 6 mfd. is used, while at the output of the filter 8 mfd.

oftin-White Amplifier

Anderson

so when we make use of the only method yet discovered we must take it with its disadvantages as well as with its advantages.

What Disadvantages Are

One of the disadvantages of using the phase inverter tube is that the phase invertion is not complete nor is it the same for all frequencies. For the high audio frequencies, except the very highest, the phase change is so close to 180 degrees that for all practical purposes it may be said to be exactly 180 degrees. At the low frequencies, however, the deviation may be considerable. It is greater the smaller the condensers associated with the phase changer, and also the smaller the resistances in series with the condensers. Again, it is greater the lower the frequency. The problem of design is simply to choose these values so that the undesirable effect of the reaction is negligibly small for all essential frequencies. It might be pointed out that whereas the single-sided amplifier amplifies the direct voltages, the phase reverser is only effective on alternating. The lower the frequency the more nearly is the direct voltage condition approached, and when the frequency is zero the circuit in Fig. 1 is just the same as if the lower tube were not present, except for the effect of the plate current of that tube on the plate, screen and grid voltages.

Loss of Character

While the circuit loses its push-pull character as the frequency goes down, it will remain effectively push-pull for all frequencies that are likely to arise in broadcasting or in phonograph playing.

Even when the circuit in Fig. 1 is not exactly balanced, because of different tubes, different grid bias values, or improper phase shift by the reactive phase shift arrangement, the double circuit is never worse than the single-sided circuit, and as everybody knows, the single-sided Loftin-White is about as good from the quality point of view as it is practical to make a circuit. Therefore even if there is some unbalance for any of the reasons just stated, there is still a gain both in quality and volume. And there is also a gain in the volume capability, which is an advantage of first magnitude.

The inductance in the plate circuit of the upper tube also introduces an undesirable phase shift, but this too is quite negligible provided the transformer is so proportioned that the load on the tube is essentially a resistance.

A complete analysis of the phase shifts introduced by the condensers and the transformer would be extremely complex but qualitative considerations show that except at the low, possibly sub-audible, frequencies, there is not enough undesirable phase shift to make any essential difference.

Good Output Transformer Essential

Since the Loftin-White amplifier is capable of high quality, and also since the push-pull version of it is capable of still better quality, it is essential that the output transformer used be the best possible. It would be poor economy to build an amplifier of excelling quality and then spoil it all by putting in an output transformer designed to meet a given price rather than one designed to give the very best quality.

The voltage supply circuit is not shown in Fig. 1 because it does not differ from that used for the two tube circuit. The total voltage required is 450 volts, the same as that used in the two tube circuit. The current requirement, however, is approximately twice as great, since each 245 tube takes 32 milliamperes. But 64 milliamperes are well within the limits of the 280 rectifier tube which is used in the power supply.

If the filter choke in the power supply has been designed for a low current, the filtering effect will be slightly poorer when the extra load is put on it. However, this is offset by several factors in the circuit. First, we have a greater value of hum bucking condenser. Second, we have the extra choke coil in the supply to the screen grid tube, which is also effective in choking out hum in the supply to the power tubes. Third, we have the push-pull action which stabilizes the current pull from the power supply. In so far as the circuit is push-pull any hum which might be due to poor regulation of the power supply should be balanced out because when one tube demands less current the other demands more in exactly the same proportion.

This push-pull effect really prevents coupling between the two stages, but it does even more. It also balances out residual hum. This can easily be verified by putting unfiltered voltage on a push-pull stage and noting the hum and then taking out one tube and again noting the hum. It will be much greater when only one tube is active. The hum elimination really takes place in the output transformer, and may be explained in the following manner. When the B voltage increases, the hum increases the same on both tubes, and the plate current in each tube is increased in the same proportion. This increase is not transmitted to the secondary of the transformer because the change in one side of the primary is opposed to the change in the other. Exactly the same thing happens when the voltage decreases because of the hum. The push-pull amplifier eliminates even order harmonics and the hum behaves toward the circuit as an even harmonic.

Hum Balancer

In Fig. 1 is a center-tapped resistance across the filaments of the power tube. No value is given in the figure for this resistor. Values of 20 or 30 ohms are suitable. It is highly desirable that this resistor be accurately center-tapped because if it is not hum may creep into the signal notwithstanding the other precautions taken to eliminate it.

Many fans have had difficulty in connecting a Loftin-White amplifier to a detector or radio frequency amplifier. They say that it works very well in conjunction with a phonograph pick-up unit, but not so with a detector or radio frequency amplifier. Is the circuit intended only for phonograph playing or for use with a single tuner? The circuit is primarily an amplifier, although the first tube will not only amplify but it will also detect. The fact that the first tube will detect does not necessitate using the first tube as detector. Another audio amplifier may precede it, although this should never be necessary. But it may be desirable to put a detector tube ahead. And the question is how to make the connection.

There is no particular difficulty in connecting the amplifier to another tube, as it may be done in the same way as the connection is made between the screen grid tube and the power amplifier. How this is done may be seen by referring to the Loftin-White three-tube amplifier or to previous circuits published in RADIO WORLD. A simpler way, however, is to use an ordinary resistance coupler. A plate resistance of about .25 megohm, a stopping condenser of .01 mfd. and a grid leak of 5 megohms could be used.

Question of Quality

Does not this coupler affect adversely the quality of the amplifier? It does to some extent, just as any reactance does. But it affects it so little that no human ear could tell the difference, and it would have to be detected by means of more sensitive instruments. With a stopping condenser of .01 mfd. and a grid leak of 5 megohms the suppression of the amplification on the lowest audible frequency is so small as to be scarcely detectible.

While non-reactive coupling could also be used between the detector and the screen grid tube, this would require a much higher voltage at the source since that needed by the detector tube would have to be added. Any slight gain in the quality which might accrue from the omission of the stopping condenser would be more than offset by the complications in the circuit.

Adding Push-Pull to Two-Tube Set

A glance at the circuit diagram in Fig. 1 will show that it is a relatively simple matter to add the second tube to existing Loftin-White amplifiers. Many of the resistors have the same values. The hum-bucking condenser need only be changed if the hum becomes excessive when the change has been made. The grid resistor for the screen grid tube remains the same, as do the resistances to the right of the filament center-tap. The other resistors in the voltage divider should be cut in half if the same voltages are to obtain. The speaker field does not necessarily have to be placed where indicated as this may be a 2,500 ohm resistance. The usual value for the plate resistance is .5 megohm while in the push-pull circuit it is one megohm, but the single-sided amplifier has also been built with one megohm. The other resistors and condensers have to be added. Also a good push-pull output transformer should be used in place of the ordinary output transformer.

6,400 Milliwatts Output

is included. The capacities are obtained in a Flechtheim condenser block, which has a black common lead to go to ground and B minus: grey for 6 mfd., vermillion for 8 mfd., maroon for 1 mfd. (shown across 180 volts); maroon again for 1 mfd. shown in parallel with green .5 mfd. The other 1 mfd. condenser, used from the center tap of the interchange transformer's, primary to ground, in conjunction with a 30-henry audio choke to prevent feedback and motorboating, is a separate Polymet 1 mfd. condenser.

Such a power amplifier, using a first stage of 227s in push-pull and an output stage of 245s in push-pull, is one anybody should feel elated to possess, as it amplifies about 3,820 times, on the basis of 1-to-3½ transformer ratios, maximum undistorted power output of 6,400 milliwatts, or sufficient to give tone-pure output even for an auditorium accommodating 1,000 persons.

[Data on wiring and operation of this audio power amplifier will be published in subsequent issues.—Editor.]

Analysis of Dynamic Spea

By John C.

[*This article is the tenth of a series which began with the March 15th 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 dynamic and magnetic speakers. In the March 29th issue, "Hum Reduction in Dynamic Speakers" was discussed. Reverse wound coil 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 matter of the article in the April 19th issue was, "Why Dynamic Speakers Sound So Well." The effect of baffles, cone stiffness, and dampers was discussed. The issue of April 26 contained a discussion on "Dynamic Sound Waves," and dealt with complex sound pressures and even harmonies. In the May 3rd issue, "Non-Resonant Characteristics Unlike Ears" was discussed, showing that a flat speaker response curve is sought, whereas the ear is a tuned receiver. The issue of May 17th contained a brief discussion in "Shooting Trouble in Dynamics and Receivers," giving some obstinate sources of hum, and showing how effective remedies are applied.*—Editor.]

WHAT procedure should be followed to alter the pitch range of a dynamic speaker?

Beginning with the subject of altering pitch first, it is well to remind my readers that pitch modifications are grouped in two general classifications: No. 1, External, and No. 2, Internal.

The *External* ones include, altering the impedance of the primary of the voice coil transformer, substituting a push-pull dynamic input transformer, or two single phase transformers connected with primaries 180 deg. out of phase, and secondaries in addition paralleled, also altering the size of the baffle, making it larger for more depth and smaller for less, the placing of a layer of sound-absorbing material within the baffle, and the *method* of placing such material, and finally adjustably tuning the baffle by means of a piston-type rear cover.

Internal Effects Cited

The Internal ones include the variation of the magnetic field (slight pitch change only), altering the elasticity of the cone (insofar as standing wave radiation is concerned), and finally changing the damping by loosening or tightening the outer peripheral edge of the cone (where the usual flexible leather support is), either by pulling out radially from the axis of circumference or its artificial equivalent, painting this edge with a few coats of laquer, which upon drying shrinks the leather quite well.

Now some of these methods may be used in the home readily and others require a deal of technical experience and not a little patience.

A study of the foregoing methods will show quickly which one is most suitable (that is, easiest) to use to obtain the desired results, as some readers are not sufficiently well equipped with electrical measuring instruments, or electro-acoustical ones either, to go into the more detailed phases of the subject I will confine my remarks to the simplest tests that any amateur enthusiast can make, and probably will when he has the time an inclination to experiment.

I will begin with external methods first and with the baffle in particular.

What About Baffle Removal?

It was mentioned previously that the pitch of a speaker depended on the relative amounts of "air-column" on either side of the speaker cone, and that a certain ratio exists for a given pitch range for given size of speaker, but this does not prevent us from varying the size of the air-column in front or behind the cone surface, hence let us assume we want to lower the pitch range first (since most people enjoy listening to a downward pitch revision, deceptive though it may be).

Can it in the first place be assumed that because a speaker requires a baffle to enable it to possess a certain desirable pitch range in the first instance, that when the baffle is removed the pitch range goes with it? No more so than in the opposite case, i. e., when there is an enormous ratio between the front surface air-column volume and the rear surface air-column volume.

When the baffle is removed the result is that the rear cone is unloaded, and in consequence is very much less efficient than it was in the baffled state. (I suppose it's the reader's turn to become baffled now!) In a previous article I stated that if the distance around a baffled speaker was less than 4 inches the effectiveness of the baffle was seriously impaired, so you see the real effect of the baffle is to assist the speaker in the task of more faithfully reproducing as acoustical effects the audio frequencies impressed upon it, and the pitch range, an incidental and accompanying effect, is due to the resultant reaction that exists between the vibrating air column, excited by the recurring standing waves being continually formed on the cone, and the reflections occurring between the effective range of all parts of the baffle, therefore baffle effect, or loading, as it should rightly be called, affects the pitch by reason of its own period of vibration, rather than by the influence of the speaker's period of vibration.

So now with this much decided, let us suppose we have a 9" cone speaker (disregarding the cone material used), and the baffle (box type with rear side open) measures 12"x12"x15"—that is, 15 inches deep—and it is desired to lower the pitch say 2 octaves. This is a big drop, but it will do for explanatory reasons. Now suppose we make the box baffle 15 inches longer. Well, we do this and the results are discouraging; the speaker is deeper, all right, but it sounds tubby, like someone talking to you from the bottom of a barrel, so we must try something else. We increased the volume of the air-column from 2,160 cu. inches to 4,320 cu. inches, so now let us try another tack and make our box baffle 14"x14"x7", which is nearly equal to 4,320 cu. inches, and we find that we have the expected depth now and that the tone is devoid of the tubby effect, being rounded and "full," etc. The explanation is that long baffles involve rather high acoustical resistance effects. Hence excess absorption due to this resistance. Therefore if you want to make your speaker deeper by increasing the size of the baffled air-column behind the cone don't forget to keep the depth at least approximately similar to the square measure. If the baffle is now 14"x12"x14" deep and you want still lower pitch you will have to increase the depth, but *don't* make it *28 inches deep* or it will sound tubby again, and, too, the energy of radiation has a lot to do with baffle effects. Large speakers generally work best in large baffles, though when in a pinch sometimes it is necessary to put a small speaker in a baffle that is intended for a large speaker, the uninitiated ear might never detect the difference, but analysis of the output in the two cases would show some very real differences, and these would in all probability be apparent to the ear when the speakers are operated in direct comparison but not otherwise.

Not a Cinch to Select

So the selection of the right kind and size of baffle to aid in arriving at the desired quality of speaker reproduction is not exactly easy, but most certainly very interesting as a problem, to say nothing of being educational to a degree.

Most of you readers are doubtless aware that church organs after being installed are subject to countless necessary acoustical corrections in order to remove undesirable cross echoes and other false sound effects, all of which fall into the general classification of "baffle corrections," and in a certain New York cathedral it was found necessary to hang large rugs (absorption surfaces) at certain points opposite the organ pipe loft to counteract serious disturbances in sound distribution so as to enable listeners near the front of the church to hear the organ tones correctly, and so don't imagine that speaker reproductive quality adjustments are a simple matter, either.

While temperature change plays a big part in the almost constantly required retuning of a church organ, and excess humidity means that the air supplied for blowing the tubes must be dried and filtered, these troubles do not harass the small speaker owner to any serious extent, in the more northerly parts of the world, but in South America, for instance, if the weather is excessively moist for a sufficient length of time this combined with heat will affect paper cone speakers that are not water proofed.

No Thin Wood, No Dead Wood

If the enthusiast contemplates constructing his or her own baffle-box let me suggest that you refrain from using either too thin wood or a wood that is "dead." By wood that is "dead" I mean the kind that does not emit a semi-musical note when struck by the knuckle. I do advocate the use of knot-free white pine at least ⅞" thick for the construction of box type baffles that exceed 12"x12"x10" deep, because I have found it very satisfactory.

The resonance characteristics of baffle material also greatly influence the effectiveness of a given baffle, and as this characteristic is listed in tabular form as a velocity-of-sound-characteristic through a unit quantity of material, I will refer the reader here to some very good acoustical properties tables as compiled in a book called "A Hand Book of Physics," published by the Mechanical Rubber Co., Cleveland, Ohio.

To return to our subject again, when the voice-coil trans-

kers and Alteratio n of Pitch

Williams

former is connected to a source of variable frequency at constant voltage it is found that the impedance (the AC resistance) increases as the frequency increases, i. e., at zero frequency the "impedance" is $R = \frac{E}{1}$ or the transformer winding presents only resistance to the current flow so long as it remains steady or uniformly uni-directional, but directly the current supplied begins to alternate the picture is changed, and here's where the effect of varying voice transformer impedance comes in.

The voice transformer in the *unloaded state,* if examined while connected to the variable exciting source only would be found to obey the statements made above, but directly it is connected to the speaker voice coil this statement is no longer true.

The voice-coil operates in a uniform unidirectional magnetic field, and the turns of the voice-coil being more or less free to cut the lines of magnetic force perpendicularly to the direction of flow of said magnetic field set up emf's that continually tend to lag behind the impulses that are delivered from the voice-coil transformer secondary. Now as this lag is always present and is greater with a stiff cone than with an easily flexed one, and the magnitude of the reverse emf being less with the stiff cone than with the easily flexed cone.

Mechanical Resonance Influenced

So it is seen that the influence of mechanical resonance on the final result of any electrical adjustment is bound to be considerable and *must* be taken into consideration at the time that alterations in voice-coil transformer impedance are made. In order to raise the pitch range of a dynamic speaker by this impedance method it will be necessary to reduce the impedance, and perhaps in a given case it won't be necessary to reduce it very much, because after all as the principal idea is to increase the power delivered to the cone coil at the higher frequencies it is evident that this is what must be done.

Two Methods Outlined

There are two ways of doing the above; one by removing a few turns from the primary (if this can be done without its resulting in an excess magnetization current, and thus impairing the coupling), or a still better way (if there is room) is to *increase* the number of turns of the secondary winding, or failing this, remove the present secondary winding and substituting the *next size* finer wire. Wind this on to fill up the space formerly occupied by the previous winding. The plan to follow here is to count the turns of the old secondary winding as you remove it, and wind on about 50% more turns of the one size finer wire. I think this is usually possible; in any event there will always be at least enough room for 30% more turns and the pitch will be found raised when the altered transformer is connected to the speaker again.

The reason why the pitch is raised is because the added secondary turns have the effect of *increasing* the energy delivered to the cone coil at high frequencies, whereas the low frequency energy is not affected in the same degree by this alteration, i. e., the result attained is that the high audio frequencies are intensified very much more than the low ones and the net effect by this method is to tend to make the highes louder *by comparison* to the lows, than was the case previously.

This is of course a compromise, but since you have a given amount of energy (speaking in terms of the whole audio range, as a measure of this given amount) it is apparent that a revision in pitch range is merely a redistribution of the sound energy given off by the speaker. Where you formerly had a condition under which the greatest amount of sound energy was radiated nearer the low frequency end of the audible spectrum, now there is *more* sound output from the high frequency end, and it must be borne in mind that all this has been done to one speaker only, and also that only one experiment has been done at a time.

Two External Changes

I have not said anything about making *two* external changes, because I wanted each of the two methods to appear as distinct as possible in order that the aims and results of each might not be confused.

These are the principal external means of altering the pitch of a dynamic speaker, and the amateur enthusiast who enjoys experimenting can quite safely make changes of the type described above without permanently committing himself to the necessity of accepting the consequences of such alteration of characteristics; in other words, the speaker can be easily restored to its original operating form status quo, without any more trouble than by merely reversing the above process.

So now with the external means of altering pitch range disposed of we will try to consider the most accessible way to alter pitch by using internal methods of pitch alteration. There are a few ideas in this connection which I want to dispose of first, because questions are sure to arise in the mind of the reader, probably pre-conceived before we reached this stage of the discussion, and I am going to assume that I know what they are.

Internal Methods Explained

Some one will have thought, "Can I alter the pitch range of a speaker by changing the number of voice coil turns?" or perhaps this: "Can I change the pitch range by using a leaden voice coil tube?" The answer to both is no.

In the first case, since the inductance of a voice is of very low value, whether stationary or moving, and is only a small fraction of a henry, and the resistance is of the order of between 4 to 12 ohms, it is seen that the load imposed on the secondary of the voice-coil transformer is largely of a resistive nature, and since the impedance of the voice-coil transformer (as a whole) is so large by comparison, it will be easily seen that altering voice-coil turns results in a change of relatively insignificant importance, insofar as audible reproduction is concerned, and the lead voice coil form while increasing the mass of the speaker suspension is ineffective because that portion of the sounding body's radiating surface is not the least affected; i. e., one coil form edge is the same size as another, and sound wave radiation efficiency depends upon the degree of mechanical coupling between the sounding body and the surrounding air, as a previous experiment with the electric bell in vacuo plainly demonstrated.

Remorse of Small Avail

Internal means of *raising* the pitch of a speaker is likely to mean that once the deed is done it cannot be undone very easily, so the reader had better read slowly from here on. The pitch range of a *speaker* as we know by now, is due to the manner in which a cone is flexed, and is further due to the energy spent at a given frequency in setting up a given standing wave on the cone, against the flexural resistance of said cone.

Flexural resistance means the mechanical resistance offered to the advancing sound wave form as it moves radially outward from the voice-coil periphery (at the point where same is attached to the cone) and acoustical emphasis *is* dependent upon the degree of this resistance, hence the pitch range can be raised by stiffening the cone's principal sound radiating surface.

It is preferable to attain this additional mechanical stiffness at as small an increase of mass as possible, because additional mass here in any large amount will defeat the desired purpose of the pitch raising experiment that we are about to make, so with all necessary precautions in mind we obtain some clear (amyl acetate content) lacquer and carefully paint the rear surface of the cone, using a brush about one inch wide, and being careful to apply one coat of lacquer only.

Lacquer Helps

This coat of lacquer should be allowed to dry at least 24 hours, and at the expiration of this time the cone will be found to have gained considerable stiffness, at the cost of a relatively slight change of mass, and upon the speaker being reassembled it will be found that the "highs" are considerably better and that formerly "cloudy and fuzzy" *lows* are now distinct, and the voice sounds clear, and it also may easily seem that the speaker's (person speaking) voice is nearer to you, a harmonic phenomenon explained previously.

Another pitch raising scheme, perhaps not quite as effective, especially with fabric cones, is to shrink the edge of the cone where it is supported—namely at the outer periphery. This stiffens the outer edge, of course, leaving the major portion of the cone unchanged.

Some of these experiments produce pronounced results, depending on the type of speaker, whether dynamic or not, but they all give positive results, never negative.

Waterproofing usually raises the normal pitch range of a speaker cone, but this effect is always allowed for in the original design, but such a treated cone is not easily subject to pitch range modification and therefore baffle means, or transformer design modification is preferable.

This is the bulk of what I have to say to those readers who want to alter the pitch of their speakers, and I hope that this answers the queries of those readers who are interested in these experiments. If any one has further questions on the preceding I will answer them in a forthcoming article.

(*Continued next week*)

Resolved: Converters Excel

Affirmative —*By Charles Downing*

POPULAR interest in short-wave reception is increasing daily. Fans want to receive stations operating in far-away places, for there is a thrill in hearing a foreign announcer whose voice is unfamiliar even though it may also be unintelligible. This interest has brought out two types of short-wave receivers, the adapter and the straight receiver. Those about to launch on a short-wave reception venture want to know which type of receiver is more likely to get the distant stations with the loudest volume, the clearest quality, the least expense, and with the greatest reliability. Should they use an adapter or the superheterodyne type or should they get a short-wave receiver specially built and fully equipped?

There is one form of adapter that might be thrown out of the discussion at the start, and that is the one that plugs into the detector socket of the broadcast receiver. This is not of the superheterodyne type and when it is plugged in it simply converts the broadcast receiver into a short-wave receiver that does not work in most instances, and even when it does it works unsatisfactorily.

Super Type Adapter Best

The advantages of the superheterodyne type adapter are so many and so great that there can be little doubt about its superiority. Everybody who is interested in short-wave reception already has a good broadcast receiver, one capable of high quality, sensitivity, and selectivity. It is provided with a good loudspeaker and a good power supply. When the superheterodyne type adapter is used all this equipment is used as it is. Nothing is left idle while the short waves are being received, nothing is cut out of the circuit, all is retained.

Now if the selectivity of the broadcast receiver is good, that virtue is transferred to the short-wave receiver. If the sensitivity of the broadcast receiver is high, the short-wave receiver will be correspondingly sensitive. If the quality is good, the quality of the short-wave receiver will also be good. If the power supply is ample, it will also be ample when the adapter is added and the short-wave receiver will be well powered. If the loudspeaker in the broadcast receiver is high class, it will be equally good when it is used on the short-wave receiver.

Just as the broadcast superheterodyne is superior to the straight radio frequency amplifier so the superheterodyne type adapter is superior to the straight short-wave receiver. The superheterodyne is superior in selectivity, and for short-wave reception a high order of selectivity is essential. The superheterodyne receiver is also superior in respect to sensitivity, and to receive distant short-wave stations a high order of sensitivity is essential. Therefore in these two respects the adapter type of short-wave receiver is unquestionably superior.

It Costs Less

In point of cost the superheterodyne type adapter is in a class by itself. An adapter that will convert an existing broadcast receiver into a first class short-wave receiver is so small that no one will hesitate getting one as soon as he is convinced that results can be obtained with it. And when the overwhelmingly greater results are once realized no one will hesitate for a moment between the adapter type and the straight amplifier type. No one will be so foolish as to buy a completely new outfit for short-wave reception when infinitely better results can be obtained with a simple adapter that will utilize all the equipment already at hand. Perhaps the broadcast receiver cost $100. An adapter for this may cost from $5 to $25 depending on its construction. Thus for a small amount a short-wave receiver costing $125 may be obtained. Now, who would rather pay $125 for a short-wave receiver when one even better can be had for $25 or less? Only an extravagant man would do such a thing.

The question of cost, it is admitted, does not enter into the question of which type of short-wave receiver will give the best results. But we have already given incontrovertible reasons why the superheterodynes will give greater sensitivity and selectivity. We have not yet said anything about the relative ease with which the receivers can be operated. A short-wave receiver of the ordinary kind will not be selective enough without at least two tuners. These cannot be ganged because if that is attempted no signals will be obtained. And if they are not ganged it become virtually impossible to find the correct combination of settings that will bring in any given short-wave station. It is more difficult than to open a safe when the combination is unknown. The expert does not have the tumblers to go by, nor can he feel his way with sandpapered finger tips. He just has to try different combinations until he hits on the right one, but while he is searching the station desired might go off the air.

It is different with the superheterodyne adapter. There need be only one tuner, that of the oscillator. The circuit will be selective enough. And if there should be a second tuner, it will not be so critical that nothing can be received unless the tuner is set "on the dot." The extra tuner serves mainly to exclude broadcast signals from the circuit.

Negative —*By Edward C. Brock*

THERE is more traffic on short waves than on the broadcast waves, and nearly all international communication is carried on with short waves because these waves have greater carrying power. Concerning the reception of these waves the question has arisen whether it is better to use an adapter to go with the broadcast receiver or to build a specially designed short-wave set. Which should it be, a fully equipped short-wave set or an addition to the broadcast receiver?

Let us investigate the problem a little. Most communication on short waves is done by engineers and licensed amateurs who know the short waves thoroughly. What kind of receivers do they use? Do they use adapters? They do not. They are after results and consequently they use receivers specially designed for the short wave. These receivers are not elaborate but are of the simplest possible construction. And because they are simple they are efficient and they are also inexpensive. It is a well known dictum in radio that the simpler the set the more efficient it is for every piece of apparatus that is added increases the losses a little.

Experience of Designers

The experience of designers of short-wave adapters definitely point to the superiority of special short-wave receivers. Their great problem is to make an adapter that will work just as well as a short-wave receiver. All their efforts have been to attain the efficiency with adapters that already have been obtained with receivers. If the situation were reversed there would be some basis for argument but there is not. It is significant that all the efforts of these designers have been negative. Yet these men have no trouble at all designing a receiver for picking up short-wave signals from across the sea. So discouraging have been their efforts at designing short-wave adapters that all they do now when the subject comes up is to shake their heads and smile. They recognize the desirability of adapters for broadcast receivers but they doubt their practicability because so far their labors have not been rewarded with success.

When an adapter of two or three tubes are added to a broadcast receiver which already is capable of picking up every station in the country in the broadcast range it is natural to expect that as a short-wave reveiver it would be able to pick up all the short-wave stations that a little short-wave receiver having only two or three tubes can pick up. But does it? Far from it. A few faint signals from the more powerful local short-wave stations may be detected, but that is about all.

Many adapters have been designed and put on the market from time to time, and many of them have either been returned to the manufacturers or else put to other use, that is, they have been converted into straight short-wave receivers. Most of these, it is true, were of the type that used only one tube and plugged into the detector socket of the broadcast receiver, a type of adapter which is particularly unsuitable for short-wave reception, and is to be distinguished from the converter that uses the mixing principle.

Question of Cost

The question of cost should be no deterrent to building a short-wave receiver because the cost is not much greater than an adapter. One good short-wave tuner is needed. One or more will be needed for an adapter. About three tubes will be needed for the short-wave receiver. As many should be used in an adapter if any results at all are to be expected. Two audio frequency transformers are needed for the receiver, but these no longer cost a great deal, or they need not cost much since the best possible quality is not needed when receiving short waves. Chances are that all those who are interested in short wave reception already have enough parts with which to build the entire short-wave set. In such instances there is no question about cost at all for it is either a case of putting the old parts to good use or keeping them in the junk pile, no one would begrudge the few hours of time it takes to assemble the receiver.

There may be some extra cost in connection with supplying the plate and filament power, but this is so small that it is of no consequence. A 45 volt dry cell will take care of the plate voltage and a small filament transformer or the old storage battery the filament current. Even the cost of the power supply can be saved, for both the filament current and the plate voltage can be taken from the power supply in the broadcast receiver without in any degree sacrificing the efficiency of the short-wave receiver. It might be argued that this is a case of adaptation and that it would be just as well to make use of the entire broadcast receiver with only an adapter ahead of it. But there is a great deal of difference between taking the source of power from the broadcast receiver and using the broadcast receiver as a part of the signal amplifier. It makes little difference from where the plate and filament voltages are taken. If the power supply in the set is strong enough to operate the broadcast receiver, which may have as many as nine tubes, it will be ample to supply the three tubes in the short-wave receiver.

A Short-Wave Meter

By Capt. Peter V. O'Rourke

THE increasing interest in short-wave reception among radio fans has created a demand for methods for calibrating short-wave coils. For purposes of calibration wavemeters, oscillating frequency meters, and standard signals are available. Wavemeters and oscillating frequency meters may be purchased from instrument companies, and the standard signals can be picked up out of the air with suitable short-wave receivers, for standard frequency signals are transmitted periodically by the Bureau of Standards. However, the standard signals are not available at all times, nor are they available in all places with the receivers at hand. Moreover, many who like to calibrate coils and oscillators cannot make use of these standards because they are transmitted in code on continuous waves.

In order to have a ready means of calibrating, an inexpensive apparatus working on a simple principle is necessary. The signals used for standard must also be available at all times.

The simplest way of calibrating is to use the heterodyne method and to employ broadcast frequencies and their harmonics. The heterodyne method is as accurate as the frequencies of the broadcast stations used, and these are now more accurate than the needed accuracy in calibrating coils and oscillating frequency meters. Moreover, they are available at all hours of the day, every day, and at every place in the country.

Heterodyne Method

The heterodyne method consists of changing the frequency of a local oscillator until zero beat is produced between this frequency or one of its harmonics with the broadcast frequency selected as standard or one of its harmonics. Let f be the fundamental of the broadcast station selected as standard and let F be the fundamental of the local oscillator to be calibrated. Let m be any harmonic of f and n any harmonic of F. The only condition that is imposed on the values of m and n is that they be whole numbers, that is, that they be not fractional. Then zero beat is produced whenever nF=mf. Then if we know f, as we do as soon a we have selected it, and if we know the values of n and m we also know the value of F. As soon as the value of F has been determined we can set it against the oscillator dial setting corresponding to this frequency. If we do this for a large number of harmonics of f and F, or for a large number of values of n and m, we can get a calibration curve of the oscillator. Or we can also get a curve by making observations for a large number of values of f, that is, for a large number of known broadcast frequencies.

Now it is not always easy to tell what two harmonics are involved when the condition of zero beat is established. Hence we do not know definitely what the value of the unknown frequency is even though we know the value of the broadcast frequency f. To remove the ambiguity we have to resort to tricks or suitable guesses, being guided by the curve that is in the process of formation while the calibration is in progress.

Choice of Many Stations

Since we have many stations from which to choose, and since some of these have frequencies equal to the second harmonics of others, we have means of cross-checking. This will be explained later.

Also, since we are primarily interested only in the fundamental of the unknown frequency we can arbitrarily fix the value of n in the equation at unity. We can fix this because the squeals heard near the zero beat position when the fundamental is involved is much louder than when any of the higher harmonics of the unknown frequency is involved. Since we can confine ourselves to the case when n=1, our condition for zero beat becomes F=mf, in which m can be determined from the observations much more easily than when n also is unknown.

Set up an oscillator circuit like that shown in Fig. 1, in which the frequency determined by LC is to be determined for all settings of the condenser C. A broadcast receiver is necessary with which to detect the zero beat condition. In order to impress the oscillations on the broadcast receiver so as to produce the zero beat it is necessary to couple the two circuits, that is, the broadcast receiver and the oscillator. This can be done simply by means of condenser C3, a midget. Connect point A to the grid of one of the RF tubes in the broadcast receiver or to that of the detector. The object of making C3 a midget is to prevent too close coupling and hence too great an effect on the frequency of the circuit to which the oscillator is coupled. Use the smallest value of condenser that will give an audible squeal at either side of the zero beat position. When the oscillator is used subsequently the coupling condenser should be of the same value.

Tune the broadcast receiver to a station the frequency of which is known. Say the frequency is 660 kc. Now turn the oscillator condenser C from 100 on the dial, that is, maximum capacity, to zero and note the positions of all the zero beats that can be heard. Record them all, and note particularly their

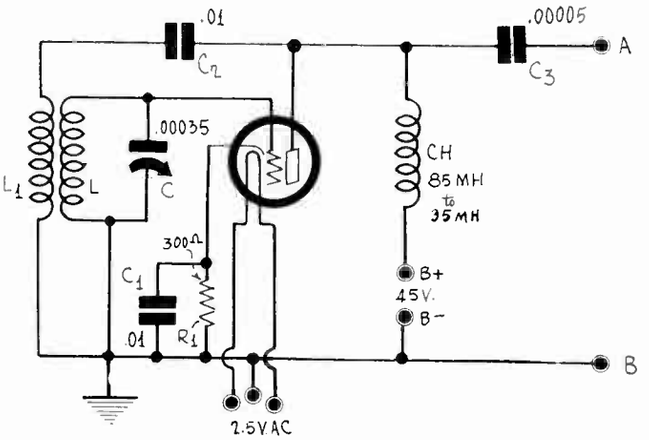


FIG. 1
THE CIRCUIT OF AN OSCILLATOR WHICH CAN BE USED EITHER AS AN AUXILIARY OSCILLATOR IN THE CALIBRATION OR THE OSCILLATOR TO BE CALIBRATED.

strength. The stronger the squeal on either side the lower is the corresponding value of m. It is not likely that the case of m=1 can be picked out unless the tuner LC tunes up to the fundamental of the broadcast frequency selected.

Now tune in another known broadcast frequency and repeat the entire process, entering each reading in a table opposite the new broadcast frequency. Do this for as many frequencies as are available, and particularly try to select one that is exactly equal to twice that of another.

Interpreting the Tabular Data

Construct a graph with frequency in one direction and dial settings in the other. If the proper value of m is selected for calculating F from the known value of f, and the calculated data are entered in the graph, a regular curve should be obtained. If a point falls off the curve the error cannot be because of an error in f for that is known. Neither should it be because of an error in the dial setting, for it is assumed that the zero beat position has been ascertained accurately. Hence any error would be due to a wrong choice of m.

Now if the wrong value has been selected for m the point should be brought to the curve by selecting another whole number for m. Not many trials should be required because not many harmonics are involved. It is possible, however, to get a smooth curve which is all wrong if only one broadcast frequency is used. But any ambiguity of this sort should be cleared up by comparing the results of two broadcast frequencies one of which is the harmonic of the other. Suppose, for example, that one frequency is 660 and the other is 1,300 and that zero beats for these are obtained at the same dial setting. We might assume that we are dealing with the sixth harmonic of 660 kc, that is, 3,960 kc. If we are, we are dealing with the third harmonic of the 1,320 kc frequency. If the dial settings are not quite the same, in which case we might bring the point on the curve by multiplying 660 by either 5 or 7. The thing to remember is that we are dealing in exact multiples of known frequencies. Fractional multiples have no meaning, provided we are using only the fundamental of the oscillator frequency.

Harmonics of the oscillator frequency might enter to confuse the interpretation of the data obtained, but this can be checked by trying out only whole multiples of F. In other words, fractional multiples appear to enter, but these fractions are always made up of simple whole numbers both in the numerator and in the denominator. The complete formula for F is F=mf/n, in which both m and n must be such simple whole numbers as 2, 3, 4, etc. They may even be equal, in which case the same harmonics of both frequencies involved are beating. However, this case is no more likely to arise than that of beating of the two fundamentals, since the two must cover the same range and the two tuners will in general be quite different without any overlapping.

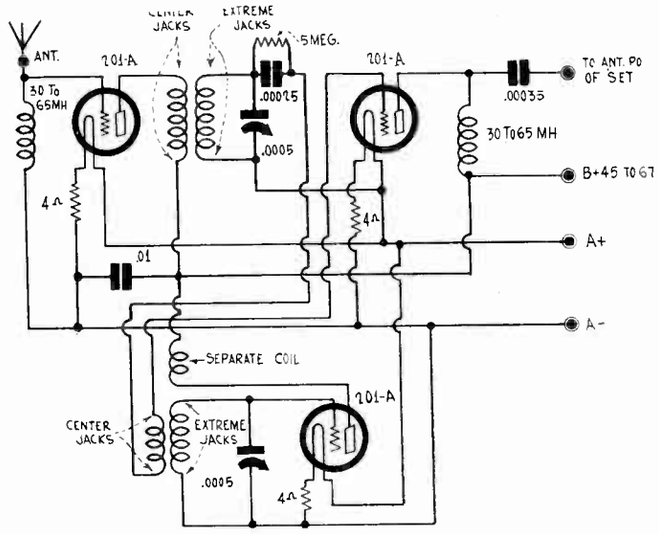
Beating of Upper Harmonics

Suppose we use the frequencies 1,500 and 600 kc and we find one dial setting at which a squeal is heard in both cases. The ratio of m to n, or vice versa, is then 2.5, and that is 5/2. Thus

(*Concluded on next pages*)

Coil Data for Battery and

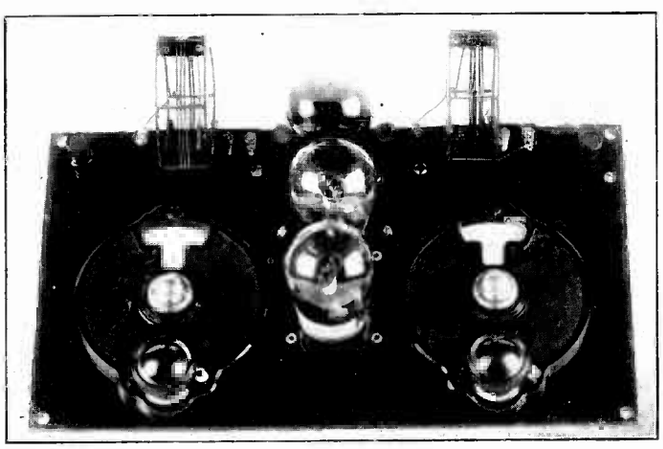
By H. B.



A SHORT-WAVE CONVERTER FOR BATTERY OPERATION. THE ONLY DIFFERENCES BETWEEN THIS AND THE TWICE-TUNED AC MODEL ARE THE OMISSION OF THE FILAMENT TRANSFORMER, FOR WHICH THE A PLUS AND A MINUS POSTS ARE SUBSTITUTED, THE USE OF THREE FOUR-PRONG SOCKETS FOR 201-A TUBES, AND THE INCLUSION OF FILAMENT RESISTORS. PERFORMANCE REMAINS UNCHANGED.

THE short-wave converters discussed for the past three weeks in these columns have been AC operated, containing their own filament transformer to heat the three 227 tubes used. While these converters are AC models, they work on any and all receivers, whether battery-operated, AC or composite, since the receiver is depended on for nothing but a B voltage for powering converter tubes. Nevertheless, if a person has a battery-operated receiver, or one of the composite type, with A battery and B eliminator, he can dispense with the filament transformer, and use three 201-A tubes in the converter. Also 201-A tubes are cheaper than the 227s. Besides, if a person lives on a farm, or elsewhere, without benefit of electricity in the home, the AC type would be of no use to him, but the battery type would be indeed. Hence a battery type converter is illustrated.

Fig. 1 shows the diagram to construct a converter that will operate just as well as the AC model. The filament supply is obtained from the storage battery, by connecting it properly to the A plus and A minus posts of the converter. Four resistors, of 4 ohms each, in the negative filament leg, drop the 6 volts of the storage battery to 5 volts required for the 201-A filaments. Three four-prong sockets are used (UX type). These differences, including the omission of the filament transformer, are the only ones distinguishing the battery model from the AC model.



THE TOP PANEL ARRANGEMENT IS THE SAME FOR AC OR BATTERY-OPERATED CONVERTER.

LIST OF PARTS

Two sets of short-wave coils, wound on air dielectric, three coils to a set, total of six coils.
Two .0005 mfd. Hammarlund de luxe straight frequency line tuning condensers.
Two radio frequency choke coils, 30 to 65 millihenrys (50 mh shielded type used in original model).
One .00035 mfd. fixed condenser.
One .00025 mfd. fixed grid condenser with clips.
One 5 meg. Lynch metalized grid leak, with mounting.
Three 4-ohm filament resistors with mountings.
One .01 mfd. fixed condenser.
One 7x14-inch drilled bakelite panel, with three UX sockets (4-spring) and coil receptacle built in.
One cabinet to fit.
Five binding posts.
Two National Velvet Vernier, type B, vernier dials.

15 to 95 Meters on Two Coils

Five coils are used. Two of these are choke coils of from 30 to 65 millihenries. Two others are plug-in coils. As there are two tuned circuits, two coils are needed for each frequency range. It is possible to cover from 15 to 95 meters, with .0005 mfd. straight frequency line condensers, using two different coils for each of two ranges covered, that is, a total of four plug-in coils, two of the same type being used at a time.

The fifth coil is for the plate circuit of the oscillator, to fit under the panel. This coil need not be changed as to physical position, hence it is desirable from the viewpoint of convenience to leave it fixed both mechanically and electrically.

The mechanical layout is a little different from what has been shown previously, but this is merely a matter of constructional design and has nothing to do with electrical constants or with performance. The converter is made a little handier to operate, that is all.

The input is made to the first choke coil, connected between antenna and ground. The ground lead is derived from the receiver, since it is assumed the filament circuit of the receiver is grounded. Also, B minus is connected in the receiver to one side of the filament, so there is no need to pick up any separate B minus lead. If in doubt, connect a voltmeter from ground post to B plus. A deflection or reading will prove ground is B minus. If some unusual receiver hookup omits contact of B minus from the ground post of the receiver, then special means must be provided for picking up B minus, but this is a most unusual case. This means would consist of making B minus and A minus identical in the receiver.

Polarity Inconsequential Here

The first coupling transformer in the tuning system is of the plug-in variety, being at left as you regard the top of the front panel with tuning knobs toward you. The primary, or small inside winding, is in the plate circuit of the first tube, and is brought out to the inside jacks of the plug-in receptable. No special polarity need be observed in connecting these two leads. One goes to plate, the other to B plus. For convenience use the coil lug nearest the plate of the nearest tube (which is used as oscillator). No particular polarity need be observed

Calibration of S

(*Concluded from page 9*)

the value of F in both cases is 3,000 kc since this is obtained either by multiplying 1,500 by 2 or 600 by 5.

It may be necessary to set up an auxiliary oscillator similar to that in Fig. 1 as an aid in stepping the frequencies down. The method of using this is as follows. Its tuning coil may be adjusted so that when the condenser is all used the circuit will beat with the highest available broadcast frequency, for example, 1,500 kc. Then the condenser on the auxiliary oscillator can be opened up until the beat is heard again. The frequency of the auxiliary oscillator is now 3,000 kc. The oscillator to be calibrated can be adjusted exactly to 3,000 kc by beating with this 3,000 kc frequency. Then the oscillator may be reset until

No Plugging In

Short—Wave Reception, 15 to 81 Meters, by Simply Turning Dial—Dynamic Tuner Solves Old Problem

By Herman Bernard

THERE are two main types of coils in use for short-wave work. These are the plug-in and the variometer types. The plug-in coils are familiar to all. Since a given tuning condenser is used, coverage of wide band of frequencies is accomplished by changing the coils. If the condenser is of relatively small maximum capacity, say, .00014 mfd., then three coils are used, and the range is usually approximately 15 to 133 meters. With .0005 mfd. about the same range is attainable with two coils.

The variometer type of inductance permits the alteration of the effective inductance in the circuit by turning a knob to prescribed points, as by switching from a front-panel knob. This accomplishes the inductance alteration without necessity of plugging in.

Dynamic Coils for Short Waves

A third type of coil will permit of a wide frequency range not only without plugging in, but also without any independent setting of the variometer. What the frequency range will be will depend on the number of turns on a fixed and a moving winding, their angle of displacement, the size of the diameters and the capacity of the tuning condenser, so that the system is effective on broadcast waves or may be used in a short-wave receiver, adapter or converter.

For short-wave use it is theoretically possible to tune from 15 to 81 meters. It is also possible to start higher in wavelength and end higher, or start lower and end lower, but 15 meters is low enough and 81 meters high enough for nearly all the stations that one would desire to tune in. Whatever range is used will depend on individual requirements. Where there are no special requirements, 15 to 81 meters will be found abundantly satisfactory.

It is suggested that with the dynamic short-wave coil a capacity of .0005 mfd. be used for tuning. This has the effect of enlarging the frequency band to be covered, because of the higher maximum capacity available, more than four times the common maximum in short-wave work. The detracting feature would be that the stations, already close enough together in dial position, are made still closer because of the confinement of .0005 mfd. to a dial space of 180 degrees otherwise allotted to .00014 mfd. But a vernial dial of sufficiently high reduction ratio will cure that, particularly if the dial is free from backlash and other lost motion.

Choice of Inductance Values

Therefore with .0005 mfd. selected the problem is to choose the inductance values properly. A word about how this is done.

The system of tuning contemplates the variation of the effective inductance at the same time that the capacity is changed in the tuned circuit. This is accomplished by using a long shaft on the condenser and having it engage also a moving coil that is in inductive relationship to a fixed segment of the secondary. So the tuned circuit consists of two windings, a fixed one and an adjustable one, in series. The same motion that turns the condenser rotor also turns the moving coil, so that, just as the capacity change is gradual with dial rotation, so is the change in effective inductance.

Let us take as an example two equal coils as the pair of windings. When they are connected in series aiding and closely coupled, dial setting 100 (see bottom illustration at right), the effective inductance of the two together, for maximum mutual, is four times what would be the inductance of either alone. Now, as the dial is turned the moving coil gradually recedes from position of maximum coupling to a right-angle position in respect to the fixed winding. This is usually assumed to be zero coupling, but in fact the moving coil is coupled as would be any fixed coil not in inductive relationship to the rest of the system. That is, the moving coil, at 90 degrees, is as effective as an exclusively conductively coupled winding of the same number of turns.

The inductive phase relationship has undergone a change from maximum positive to zero angle. The dial position now is 50 (middle photograph).

Avoidance of Zero Inductance

As the coil dial is turned some more in the same direction as heretofore, to engage less and less capacity, that is, rotated from 50 to 0, the moving coil that heretofore was in aiding phase starts a reverse phase, becoming a series opposing inductance. At parallel setting again, 0 on the dial (topmost illustration), the moving coil is bucking the fixed winding. The effective inductance of two equal bucking coils closely coupled inductively may be zero, but to avoid that condition the moving coil is position off-center in relation to the shaft, and thus the moving coil describes an eccentric circle. If the two coils, the fixed or static one, and the moving or dynamic one, are connected in series aiding at tightest coupling, and the opposite parallel coupling is cut down by displacement of the moving coil due to the eccentric circle description, then any proportion may be selected, this determined by the amount of displacement.

For instance, from a condition of four times the inductance of either constituting the effective inductance at maximum coupling for series aiding, the inductance range may be altered by the odd motion of the dynamic coil to an effective minimum of one-eighth that of either alone. Hence the inductance ratio is 32 to 1.

This is almost as great a ratio as exists between the smallest coil and the largest in the plug-in varieties, where three coils are used for covering 15 to 133 meters.

Equal Coils Not Imperative

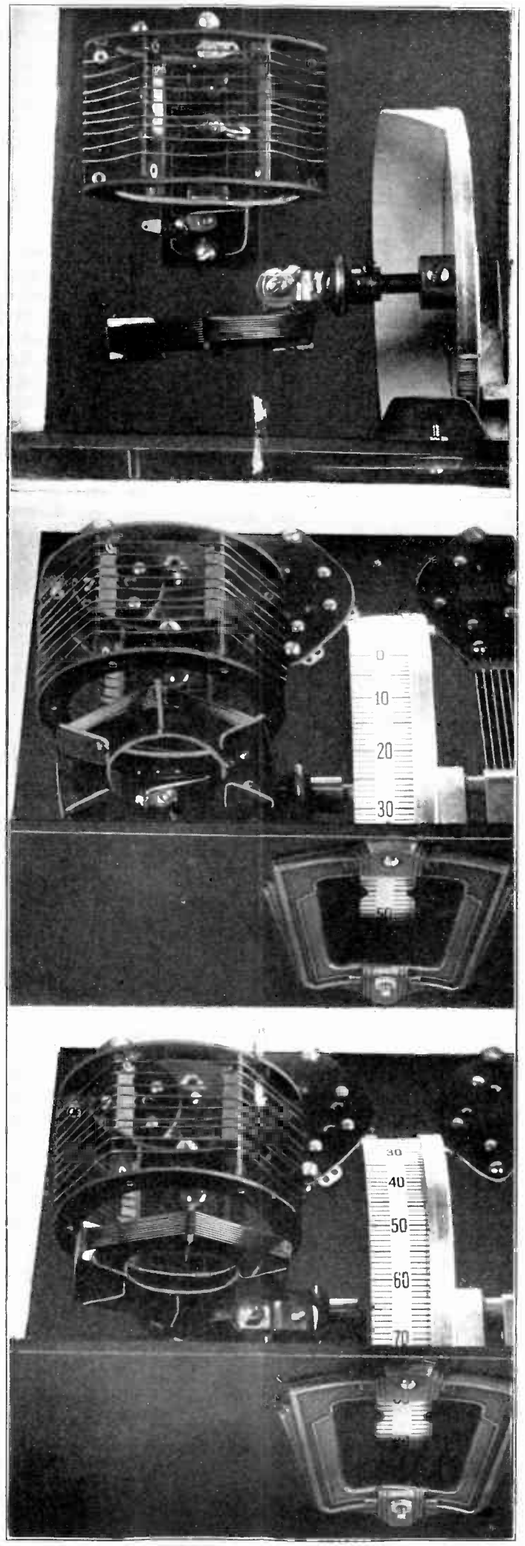
But the two coils need not be equal. Certain considerations lead one to assume that they ought not to be equal. One of these is the fact that the bucking coil introduces extra resistance in all positions of opposing series, and might stop oscillation in a circuit that has to oscillate to bring in signals. Therefore the design of the coils will depend on the frequency range as modified by conditions of required oscillation.

The way the moving coil changes its position in an off-center assembly is shown in the accompanying photographs. The top view illustrates a position of maximum opposing phase, dial at zero. Note how far the moving coil is from the fixed winding that is above it. This is caused by the off-center location on the shaft.

The middle view shows the moving coil about half way around, 50 on the dial. The dynamic winding is now like any other series-connected winding that is not in inductive relationship to the other.

Other Possibilities

In the bottom illustration that dial is set at about 85 and the moving coil is nearly all the way



United Tuning

Variometer Effect and Capacity Change United for Wide Frequency Range Without Plug-in Coils

in. Note how close the moving coil is to the fixed winding at this position of almost maximum series-aiding coupling, as contrasted with the position for maximum series-opposing connection in the topmost illustration.

Since two coils of equal industance, connected in series opposing, closely coupled inductively, that is, having a mutual inductance of maximum value, give an effective inductance of zero, the extra distance between moving and fixed windings for series opposing becomes obvious. We do not want zero inductance under any circumstances.

The same idea of a non-inductive condition is familiar to all in the examples of wire-wound resistors, with half the winding in one direction and half in the other direction, for the express purpose of making the resistor non-inductive.

It is not necessary, nor perhaps even desirable, to have both the moving coil and the fixed coil consist of the same number of turns on the same size diameter. Two equal coils were taken as illustrations simply for ease of explanation and reference.

Total avoidance of zero effective inductance may be obtained by having the moving coil actually central on the shaft, but of smaller individual inductance than is present in the fixed segment of the secondary. Or, the two methods may be combined, unequal inductance and off-center position. The inequality always should be such that the inherent inductance of the fixed winding is greater than that of the moving coil, if there is to be inequality at all.

Diagram Explained

Fig. 1 shows a circuit diagram to which the dynamic tuning system for short waves may be applied. It is that of a converter, which means that the short waves are accepted by the antenna circuit, delivered to the RF tube and then to the modulator, while the oscillator, the only tuned circuit, beats with the incoming frequency to produce an intermediate frequency. When the converter is connected to a broadcast receiver, the receiver's RF channel becomes the intermediate amplifier.

The entire broadcast receiver is used. Speaker reproduction of short-wave programs and code is attained by the superheterodyne principle.

It will be noticed that the RF stage and the modulator are untuned. Only the oscillator circuit is tuned. The selectivity depends wholly on the receiver's RF channel.

This single tuning system is not superior to one in which the modulator also is tuned, but it has possibilities. The single tuned system does bring in stations, plenty of them, and with good volume, considering that much volume on short-wage programs is not to be expected. Among the stations heard are broadcast stations on their harmonic frequencies, especially the third harmonics. The single tuned circuit idea is a good one, but is rich in harmonic reception.

Certainly the system is a simple one, in that selection is confined to one dial in a frequency range that renders selection hard enough, because short-wave stations "tune so sharply."

RF Stage Optional

The RF tube is not vital. It is possible to use only two tubes—the modulator and the oscillator—and obtain good results. It is somewhat better to use two tuned circuits.

The question of what selection to make, in view of the conflicting considerations. The compromise has not been settled in scientific circles, but is under close observation and test.

One system being tried out is that of ganging two condensers, using a trimmer across the oscillator condenser. This trimmer would be manually operated from the front panel.

It is expected that a report on the results obtained from various systems, together with recommendations for choice, will be available soon.

[*Read* RADIO WORLD *weekly and follow the developments on short-wave reception, including converters using one or two tuned circuits, and particularly the sensational dynamic tuning system for short waves, invented by Herman Bernard.*—EDITOR.]

Right or Wrong?

QUESTIONS

1.—If two power transformers of the same ratings are available they may be connected in parallel so as to double the output.

2.—The output volume of a receiving tube is the same as the volume capability of that tube.

3.—Most suppression of the high audio frequencies in a tuned circuit is due to the time constant lag and not to the fact that side frequencies differ from the carrier.

4.—If the rectifier in a dynamic speaker does not rectify completely, a good deal of hum is likely to develop.

5.—A long antenna will give better results on short waves with a converter than a short antenna.

ANSWERS

1.—Right. They may be so connected provided due attention is given to the phase of the voltages. For a given connection of the primaries it is possible to connect the secondaries so that a short circuit is formed. That is the wrong way. When the two secondaries are connected in parallel the voltage across them should be the same as that across either alone.

2.—Wrong. A tube has no output volume, but it has a volume capability. When the tube is put in the last stage of a receiver the volume capability of the receiver is the same as that of the tube, provided there is no danger of overloading ahead of the last tube.

3.—Wrong. Most of the high frequency suppression is due to the difference between the side-frequencies on the one hand and the carrier on the other. The effect of the time constant lag, or the transient, is negligible in all practical cases.

4.—Right. Much of the hum in dynamic loudspeakers can be traced to incomplete rectification. If the speaker has given good, humless service for some time and then gradually or suddenly develops hum, a defect in the rectifier should be suspected.

5.—Right. A long antenna picks up more signals, and if the object is to get distant stations regardless of selectivity, a long antenna is better than a short.

DE FOREST AND PURDUE OBTAIN VISION PERMIT

Washington.

Two licenses were issued by the Federal Radio Commission for the operation of television stations. One license went to the DeForest Radio Company, of Passaic, N. J., which is co-operating with its subsidiary, the Jenkins Television Company, while the other license was issued to Purdue University, Lafayette, Ind., which is co-operating with the Grigsby-Grunow Company, of Chicago, makers of Majestic receivers and tubes.

The DeForest Company applied for 20,000 watts, but was granted 5,000 watts. The frequency assignment will be one of the four in the continental band reserved for television.

Four-On-One Invention

The company set forth it desired the permit so it could expedite the development of television to a commercially practical degrees, thus hastening the day when televisors will be in the homes of the land.

For the Company, Allen B. DuMont, chief engineer, declared various television systems would be tested with a view to developing a practicable method of transmission and reception.

"Some of these systems are quite radical," he said. "One of them gives promise of ability to transmit pictures with much more detail on a much narrower wave band than required at present."

With this system he continued, it may be possible to crowd four stations on a wave band now used by two. He said the De Forest Company values its television patents at more than $2,000,000.

Cites Remarkable Progress

"Television is developing very rapidly," Mr. DuMont added. "Nobody can tell what will happen in the next six months. Remarkable progress has been made at the Jenkins station in the last two months."

Purdue's experimental television station will be limited to 1,500 watts for the present. The arrangement with the Grigsby-Grunow Company includes the use by the company of patents obtained as the result of developmental work by the college. Besides, the company has a television laboratory.

Two More Request Permits

Western Television Corporation, Chicago, Ill., requested a constructional permit for television radiation, at 1,000 watts, "any frequency."

John S. Boyd, Cincinnati, O., asked for an experimental television construction permit, 1,000 watts, 2,100 to 2,200 kc.

Air Survey Backed By Rockefeller, Jr.

Financed for its first year by John D. Rockefeller, Jr., and the Carnegie Corporation, the National Advisory Council on Radio in Education has formulated a preliminary report, soon to be released. The object of the council is to develop educational broadcasting. Levering Tyson, of Columbia University, is director.

Co-operation is being received from the committee appointed by Secretary of the Interior Wilbur, and from the trade.

Michigan Gets Police License

Washington.

A license to operate a short-wave station for crime detection, 5,000 watts daytime, 1,000 watts night time, on 1,662 kc, was granted to the State of Michigan by the Federal Radio Commission. This was not the frequency requested, but an assignment outside of the eight channels primarily reserved for police radio, being between a marine and a geophysical channel.

The issuance of the license relieves a tense situation. Gov. Fred C. Green, of Michigan, asserted that the State had absolute police power, therefore could erect and operate a short-wave police station without Federal license, and threatened to do so.

The Commission announced that the decision in the Michigan case came under a new policy regarding police radio for States, and that all other States were free to obtain such a license without a hearing. It was pointed out that the actual issuance of a license was necessary before operation would be legal.

$100,000 SUIT OVER GOLDBERG

"The Rise of the Goldbergs," a sustaining weekly feature sketch over WJZ and networks, has given rise to a law suit.

Mrs. Gertrude Berg, who plays Mrs. Goldberg in the humorous portrayal of the life of a Jewish family on New York's Lower East Side, was served with papers in a $100,000 suit begun by Mrs. Sophia Civoru.

Mrs. Civoru alleges she was to furnish ideas for radio sketches to Mrs. Berg under a partnership agreement. Mrs. Berg to write the continuity. A few sketches were produced under the agreement, plaintiff alleges.

The $100,000 is coming to her, says Mrs. Civoru, because of the use of her brainchild without recompense to her, in the WJZ broadcasts.

Aylesworth and Editor Clash on Advertising

Washington.

In a speech delivered here before the American Society of Newspaper Editors, Merlin H. Aylesworth, president of the National Broadcasting Company, said that sponsored programs on the air are not reducing the volume of newspaper advertising, and that, rather than being competitive, newspaper and radio broadcast advertising are inter-related.

Paul B. Williams, editor of the Utica (N. Y.) "Press," said newspapers are permitting themselves to be "used" by broadcasting interests, through program and publicity publication that is tantamount to advertising a competitor.

He said the United States Chamber of Commerce recently reported an 8 per cent. reduction in newspaper advertising space throughout the country in a year, yet, added Mr. Williams on his own account, radio advertising has shown a remarkable increase, estimated at 40 per cent. over this time last year.

DOUBLE CROSS IS U.S. CHARGE IN PATENT SUIT

Both sides of the controversy now started over the patents obtained by Percival D. Lowell and Francis W. Dunmore six years ago, for operation of radio receivers and speakers from alternating current, have given their contentions in the legal battle over ownership of the patents.

The Federal Government started suit in Brooklyn, N. Y., against the two men, asserting that the inventions were made while they were working for the Government, in 1922, and are Government property.

Success attended the two men's efforts, they applied for and received the patents, and rights thereunder were purchased by the Dubilier Condenser Corporation, one of the present defendants, and the Morkrum Company, another licensee, also defendant. The Government is suing for a court order to compel the transfer of the patent rights to it.

The patents are held to be highly valuable, because they refer to the B eliminator feature of modern AC receivers, whereby the alternating current is rectified and filtered, making the elimination of B batteries successful.

The two men were employed by the Bureau of Standards, Department of Commerce, and completed their experiments with apparatus and materials that were the property of the Government, besides receiving pay to work out the very inventions that emerged from their labors, is the Federal contention.

These facts of use of apparatus and material, and receipt of pay for the very work accomplished, constituted in legal effect payment for and predisposition of whatever patentable inventions might result, the Government contends.

The Dubilier Corporation relies heavily on a decision rendered in its favor in its suit against the Radio Corporation of America, in the Federal District Court in Delaware. The validity of the patents was sustained. Radio Corporation had made the contentions that the patents were dedicated to the public use.

The Department of Justice pointed out the difference between the effect on "first and second parties," the Government and the two men on the one hand, and "third parties" as R.C.A.. It is claimed that the Radio Corporation was a "third party," the legal phrase for an outsider, so far as the dispute was concerned, hence could not make available to itself the same legal defense or complaint that it could have done had it been an original party.

The court in the case of Dubilier vs. Radio Corporation of America, held that research employes of the Bureau of Standards make inventions while engaged as governmental employes but do not dedicate them to the public use, they become vested with the legal title to patents for such inventions when issued upon their application.

The court added that, if the United States, as employer, was entitled to assignment, such right, personal to the employer, was exercisable at its option only, and such rights or equities were no defense to infringement by a third party.

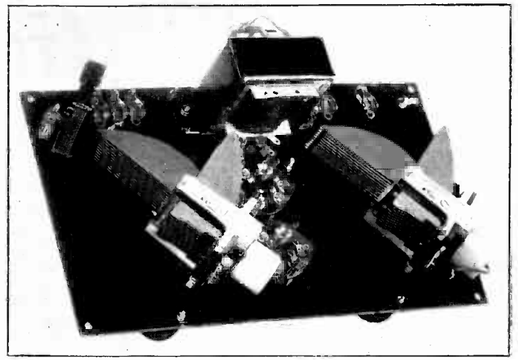
Lowell and Dunmore are defendants in the Brooklyn suit, while action against Dubilier was taken in Delaware and against the Morkrum Corporation in Maine.

AC Short-Wave Converters

Herman

as to the modulator secondary connections, either. These are represented by the lugs on the extreme outside jacks.

The oscillator coil is exactly like the other. The small inside winding is used as the pickup coil. No special precautions as to polarity need be taken about this one winding, either. The inside lugs of the coil receptacle are used. Note what the connection is. One side of the pickup coil goes to the grid of the modulator tube. The .00025 mfd. grid condenser is soldered to the stator lug of the modulator tuning condenser. So the free side of this grid condenser goes to the remaining unconnected side of the pickup coil. The 5 meg. leak is placed in the clips of the grid condenser. The tuning condenser in the modulator circuit goes across the extreme terminals of the left-hand coil receptacle. To maintain the same left and right positions whether working on the converter panel top or bottom, see that the in the upside-down position the receptacle for the plug-in coils are toward you.



THE BOTTOM ARRANGEMENT ALSO IS THE SAME, FOR AC OR DC, EXCEPT FOR THE FILAMENT TRANSFORMER.

Where Polarity Is of Extreme Importance

The polarity of the oscillator secondary, represented by the extreme jacks of the plug-in receptacle, must be correctly maintained. Oscillation may be denied you if the connection is wrongly made. It so happens the separate coil used for oscillation, connected in the oscillator plate circuit, is placed underneath the panel, so that it is in moderate inductive relationship to the secondary. Close coupling would defeat oscillation, even if the polarities were correct, because of the choking effect. So as the relationship is mutual, and the secondary can be changed of this winding is conductively attached to the copper supporting base of this separate coil, and the B plus binding post connects to this terminal, the polarities of the oscillator plate winding can not be changed. There is no need for changing it, as the relationship is mutual, and the secondary can be changed if it is necessary to reverse polarities.

It is possible to define exactly what the connections of the oscillator secondary should be, but as the circuit will oscillate one way, and probably will not oscillate at all the other way, the easiest way to do is to wire up one way, should oscillation fail, reverse the connections to the extreme jacks of the oscillator coil mount. This is done by removing both connections to the receptacle lugs at extreme positions, and putting these connections back in the opposite manner in which they were before.

To work the converter, disconnect antenna from your receiver and connect antenna instead to the antenna post of the converter. You may leave the ground lead on the receiver proper. Connect the output of the converter, usually represented by a blank post, to the antenna post of the receiver. A plus and A minus go to the respective terminals of the storage battery. The positive B voltage is obtained from the B battery block, or from a B eliminator. This voltage is not critical. Oscillation should be present even at 22½ volts, but at higher voltages the volume will be greater, without any excessive oscillation so long as the voltage is kept under 100 volts.

Coil Data

So far no directions have been given for winding the coils. It is utterly impossible to make the coils yourself exactly like the commercial coils used and illustrated, because dies to make special parts are necessary, and the construction of the form is beyond duplication without resort to this machinery. However, solid bakelite forms may be used, instead of the air dielectric that distinguishes the commercial products, and while the results will not be as good, you will get results. The data for winding substantially similar coils on this basis are as follows:

Coil No. 1—Primary, 2 turns of No. 24 silk covered wire. Secondary, wound ⅜" away, 3 turns of No. 16 enamel wire. Diameter, 2¾ inches. Axial length of tubing, 1 inch. (Wind two No. 1 coils.)

Coil No. 2—Primary, 3 turns of No. 24 silk covered wire. Secondary wound ⅜ inch away, 8 turns of No. 16 enamel wire. Diameter, 2¾ inches. Axial length of tubing, 1½ inches. (Wind two No. 2 coils.)

The secondaries should be space wound, that is, a space, equal at least to that of the wire used, should separate one turn from the next. The plate or pickup winding need not be so spaced, but may be.

These data, as to secondaries, conform to those of the commercial coils, but the primaries here stated have one turn fewer than the factory products, since the commercial coils may have their plate or pickup winding inside, instead of adjoining the secondary, hence the extra turn, because of smaller diameter.

Stagger the Prongs

Each coil, that is, primary and secondary combination on one tubing, is to be amounted on a bakelite strip, 2⅝ inches by 1 inch, and the terminals brought out to prongs that will fit into a receptacle of your own contrivance, which may consist of tip jacks built into the panel. To avoid the possibility of getting any given coil into the receptacle in two ways (thus putting the secondary in the primary circuit and etc. in one instance) stagger the prongs. The distances used in the commercial model coils are 1¼, 1, 2 and ½ inches. These dimensions account for the four terminals.

The same coil data apply to all converters discussed in the last three weeks, and includes the battery and AC types.

The condensers to tune these coils, if straight frequency line, may be .0005 mfd. capacity, thereby enabling tuning from 15 to 85 meters with only two coils. No .0005 mfd. condensers should be used unless straight frequency line. If other than SFL, use lesser capacity, say, .00015 mfd. condensers, and wind a third coil, consisting of primary, 8 turns, No. 24 silk, secondary, 19 turns, No. 16. (Wind two No. 3 coils.)

Oscillator Plate Coil

The plate winding for the oscillator, a separate coil, consists of 10 turns of wire on 2¾ inch diameter. This wire may be of any type insulation, and of any thickness, from No. 18 to No. 24. It need not be space wound. (Wind one such coil.)

Commercial panels have receptacle jacks built in. If commercial coils are used, the plug-in part is used in the receptacle jacks. The separate receptacle is not used, and the adjustable coil is removed from this separate receptacle, and used as the oscillator plate winding, without any extension bushings. The adjustable coil from the other receptacle is not used.

As stated, there are no adjustable coils in the converter design now under consideration.

hort-Wave Meter

it beats again with the auxiliary. Now the frequency of the oscillator under calibration is 6,000 kc. Without altering the adjustment of the oscillator under test, the auxiliary may be readjusted until it beats again with the second harmonic of the 6,000 kc. We have now established a 12,000 kc frequency. This may be held constant while the oscillator under test is adjusted to 12,000 or 24,000 kc.

This is one of the methods used for stepping up a known frequency to higher known frequencies. This has the advantage that only the fundamental and the second harmonics of the two oscillators are used. But it has the disadvantage that the auxiliary oscillator has to be set up and changed. The changing is relatively simple if a set of plug-in coils is used.

U. S. SUES RCA AND ALLIES AS PATENT TRUST

Washington.

The Federal Government has instituted an anti-trust suit in the Federal court at Wilmington, Del., to test the legality of the arrangements existing among the Radio Corporation of America, General Electric, Westinghouse Electric & Manufacturing, American Telephone and Telegraph, Western Electric, RCA Photophone, RCA Radiotron, RCA Victor, General Motors Radio Corporation, and General Motors Corporation. The suit followed strong demands from the Senate and other quarters.

A Department of Justice statement follows:

"It is announced at the Department of Justice that there is today a suit under the Sherman act in the District Court at Wilmington, Del., to test the legality of arrangements existing between Radio Corporation, General Electric, Westinghouse, American Telephone and Telegraph and six other corporations.

Increase in Patent Agreements

"The patent arrangements originally made between several of the defendants have been steadily increased in number and enlarged in scope until the defendants now practically have control of the radio business and its development. The control has been brought about by a novel method of cross-licensing patents.

"The suit is concerned chiefly with the legality of these patent arrangements. The petition filed alleges that the defendants, most of whom are competitors, by issuing patent licenses to one another have created a patent combination or pool through which they exercise joint control over the radio industry and that competition among them has ceased, and that no outsider can obtain a license except on terms jointly prescribed by the chief defendants.

"The petition also alleges that the proposed reorganization recently submitted to stockholders of Radio Corporation would have the effect of perpetuating the control already obtained by the defendants.

Considerate Words for Defendants

"The defendants, on the other hand, have earnestly contended that they are doing nothing more than they are authorized to do under the patent laws.

"The situation is an intricate one and it is desirable that these vexed questions be settled in the courts."

Welcome, Says Young

Owen D. Young, chairman of the executive committee of the Radio Corporation of America, said:

"The Radio Corporation of America welcomes the suit of the Government of the United States to test the validity of its organization, which has now existed for more than ten years, and in every step of which the Government has been advised."

NEW BOARD SECRETARY

Washington.

James W. Baldwin, of Indiana, chief clerk and administrative assistant at the Department of Justice, has been appointed secretary of the Federal Radio Commission, succeeding Carl H. Butman, resigned.

Duo Control of Volume Favored

The single volume control heretofore employed in radio sets is rapidly being replaced by the duo volume control or double variable resistor controlling two critical circuits at a time, according to Charles Golenpaul of the Clarostat Mfg. Co., Brooklyn, N. Y.

When only one volume control is employed, according to him, imperfect results are obtained. If the single volume control is placed in the RF amplifier circuit, as is usually the case, it is difficult to reduce the volume to the desired degree on powerful signals. For this reason, many sets in the past have been equipped with the so-called soft and loud switch, or again the local-distant switch, which usually eliminates one stage of RF amplification.

The present practice is to employ a duo or double volume control unit, with one variable resistor placed in the antenna circuit or shunted between antenna and ground, usually with a tapered or logarithmic winding of high resistance, and the other placed in the screen grid RF circuit, both resistances being adjusted in perfect step with a single knob, he added.

CHILDREN FEEL EASY AT MIKE

Children with experience in the theatre or on motion picture lots do not make the best natural material for radio plays, according to C. L. Menser, who produces and directs the "Penrod" sketches broadcast by the National Broadcasting Company.

Menser, when he selected the "Penrod" cast, heard as many non-professional youngsters as children who had had actual dramatic experience. Though his cast includes several professional children, many of the youngsters heard in the program have never been on the air before.

"Children are natural mimics and actors," Menser said. "It is not difficult to teach them the rudiments of radio playing in a few rehearsals. If they have not learned the tricks and affectations that seem to be part of every professional child's equipment it is much easier to teach them microphone technique. The naturalness that a child can give to its line readings is little short of remarkable and if the youngsters do not come to the studios with the preconceived ideas that they are actors and not ordinary human beings, the director's job is made much easier.

"Children, unlike adults, can take direction while the broadcast is in progress. They will respond instantly to a gesture or a grimace of the director and many times he can lift an otherwise dull scene by going through some pantomine in view of the young actors at the microphone," Menser declared.

"The unbearable 'child actor' of story and anecdote isn't a product of radio. The conceit and affectations that so often make professional children unbearable—and the youngsters are not to blame for this as much as their parents—seem to come from direct contact with an audience. In the studio they hear no applause nor do people crowd around them telling them they are wonderful and marvelous and precious. The child radio actor has a better chance of getting experience at an early age without being spoiled, than has the child of the legitimate stage or in motion pictures."

HIGHEST NOTES DON'T REGISTER AFTER ONE'S 40

In the early days of radio it was a common practice for the manufacturer to rely upon the ear as the sole judge of the tone quality of his product. The ear, however, is limited in its ability to judge tonal values accurately. The radio set of today is subject to many scientific measurements which determine, with a high degree of accuracy, how faithfully it will respond to all the tones of the musical scale.

It is frequently noted, said E. W. Butler, sales engineer of E. T. Cunningham, Inc., radio tube company, that a group of listeners will have a decidedly different opinion as to the itnensity of the low and high notes reproduced by receivers, a fact which is largely due to the difference in the hearing ability of the individual.

After Forty

For example, to some persons a low tone of fixed intensity will sound very much louder than to others, and the same is true of tones in the middle and higher register. In other words, a person may be hard of hearing on tones in various parts of the scale.

It has been demonstrated that as persons pass the age of 35 or 40, it is difficult for them to hear tones in the range above 3,500 cycles which corresponds to the last few notes on the upper end of the piano scale.

Since a radio set is intended to reproduce as faithfully as possible the program presented in the broadcasting studio, it is necessary to measure carefully with laboratory equipment the intensity of the sound waves corresponding to various tones, as compared with the proportionate intensity of that same tone in the broadcast.

When It Sounds Natural

If the receiver gives faithful reproduction, the program will sound natural to the listener because the same variations and defects in his hearing would be present whether he heard the program at home or in the studio.

WHAM Wave Fight Due to Crosstalk

Washington.

Bethuel M. Webster, Jr., and Paul M. Segal, counsel for WHAM, owned by the Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y., appeared before Justice William Hitz, of the Supreme Court of the District of Columbia, in connection with the plea for a permanent restraining order against the Federal Radio Commission to prevent it from changing the channel assignment of WHAM.

They asked the court to declare invalid the acts of the Commission on the ground that they were not in accordance with the radio law.

WHAM is now operating on 1,150 kc, while the Commission wanted to put it on the 1,160 kc channel. Mr. Segal pointed out that KTNT, at Muscatine, Iowa, using 5,000 watts power, was to be shifted to the same frequency, 1,160 kc, during daylight hours in Muscatine, with the result, he contended, that interference would result to the service of WHAM.

PERMIT ASKED FOR SENDING OF RADIO TALKIES

Washington.

Synchronization of voice with television broadcasting, which would constitute "talking movies by radio," is planned by the Short Wave & Television Laboratory, Inc., of Boston, the Federal Radio Commission was told by representatives of that corporation.

At a hearing, Prof. M. Segal, former assistant general counsel of the Commission, now attorney for the company, explained that the corporation already operates an experimental television station in Boston. It now seeks assignment on a channel in the broadcast band which would be used simultaneously with the television channel in the short-wave band, and make available to the public the "radio talkies," Mr. Segal explained.

The hearing was on the application of the company for one-half time assignment on the 1,370-kilocycle channel with 100 watts night power and 250 watts day.

Hollis S. Baird, chief engineer of the company and inventor of its television apparatus, A. M. Morgan, president and a radio amateur, and Butler F. Perry, treasurer, testified in support of the application.

Says Sound is Necessary

In outlining to the Commission the project of the company, Mr. Segal explained that the broadcast assignment it seeks is now "vacant." He said his client's station now is broadcasting television on the channel of 2,180 kilocycles with 500 watts. But, he declared, reception of television without the accompaniment of music or voice is "purely a novelty," and that there is no sustained interest unless the voice also is received.

The company, continued Mr. Segal, has outlined a project whereby both sound and vision would be transmitted at the same time, by means of a "sound track" on the film for visual transmission, in the same manner that the "talkies" are now presented in motion picture theatres.

"This would encourage television, and television is in need of considerable encouragement," he told the Commission.

Could Enjoy Sound Alone

Mr. Segal, according to "The United States Daily," explained that the broadcasting of voice programs which would be rendered would be of the same high character now afforded listeners. Consequently, he explained, a listener would be enabled to tune in on the broadcast programs without consideration to the television transmission. On the other hand, those possessing televisors would receive the "talkies" by radio.

Mr. Morgan explained that the company is preparing to enter into the commercial television manufacturing field. It also is engaged in the manufacture of types of television apparatus, short-wave receiving sets, and similar radio materials, he declared. The company has adequate financial backing, he testified, and since December, 1928, has expended approximately $100,000 in radio research.

A scanning device for television, and special type coils for short-wave reception were explained to the Commission by Mr. Baird, who invented them. He declared they were superior to those in common use today.

France Favors American Sets

Washington.

Shipments of American radio apparatus to France during 1929 were more than three times as great as in 1928, according to electrical equipment division of the Department of Commerce. The total value of equipment exported was $201,065, as compared with $62,603 for the preceding year.

Receiving set components and loudspeakers were the largest item in this class of material, amounting to approximately $54,700 each. Receiving set accessories valued at $41,769 and complete receiving sets worth $23,250 were also shipped to that country, it was stated.

It was pointed out until recently American receiving sets were little used in France, although known there by reputation. During the past two years, however, certain sets have been introduced through the persistent attempts on the part of the manufacturers, and the results indicate they have been received with good favor and an expanding market is presenting itself.

It is reported a great many French listeners are now tuning in on American broadcasts. The American stations which are the most popular and which are readily heard in France, especially when broadcast on short waves, are located in Pittsburgh, Chicago and New York.

WEAF PEPS UP TRANSMITTER

WEAF, one of the outstanding stations of the United States, transmitter located at Bellmore, L. I., having had difficulty in penetrating satisfactorily to some parts of the New York City area, is about to improve its transmitter and introduce 100 per cent. modulation, so that the voice of WEAF will ring strong and clear all over the semi-dead spot areas of the metropolitan district. The penetration at distances will be enhanced, likewise.

A permit for remodeling the transmitter was granted to the National Broadcasting Company by the Federal Radio Commission. The permit calls for the replacement of much of the present equipment of the station with improved apparatus, but does not provide for any increase in power. The present power is 50,000 watts.

The permit was granted after the application had been under consideration for several days.

The replacement work is about to be begun. Engineers estimate, however, that it will not be completed until the end of the summer, as the usual WEAF broadcasting service is not to be interrupted during alterations.

The modern apparatus with which the present WEAF equipment will be replaced is designed to improve the quality of the broadcasting. With its installation listeners will get the deepest bass notes of vocalists and instrumentalists and the clear tones of the higher notes, as well as overtones, as never before, engineers predict.

New Corporations

Aetna Radio Corp. Atty., A. L. Rubenstein, 645 East Tremont Ave.

Mercury Radio and Television Research Service Corp. Atty., M. K. J. Macklis, 423 Utica Ave., Brooklyn, N. Y.

Steven's Radio Stores. Atty., I. Schleider, 152 West 42nd St., New York, N. Y.

CONTEMPT OF COURT LAID TO BOARD BY WGBS

Washington.

For the first time in radio history a Federal court is considering contempt of court preceedings against the Federal Radio Commission, with the Court of Appeals of the District of Columbia having before it a petition seeking such legal redress.

The petition, filed by the General Broadcasting System, Inc., operating WGBS, in New York City, seeks to have the court order the Commission to set aside a license granted to WICC, a Connecticut station, to operate on the channel to which the court has assigned the New York station. Moreover, the petitions seks to have the court issue a rule upon the Commission "to show cause why an attachment should not issue for contempt of court in violating the order of this court dated April 26, 1930."

The Commission filed three separate answers to the petition. Separate pleadings were filed because the action complained of was effected by a three-two vote of the Commission, with Chairman Charles McK. Saltzman and Vice-Chairman E. O. Sykes, dissenting. The latter two filed answers in opposition to the vote of the Commission's majority.

Contumacious Action Charged

The WGBS petition, filed by B. M. Webster, Jr., and Paul M. Segal, attorneys, alleges that the Commission assigned WICC, at Hartford, Conn., to the 600 kilocycle channel, after the Court of Appeals had issued a stay order instructing that WGBS utilize this channel during the pendency of its litigation before it. The Commission had ordered that WGBS, effective May 1, return to its previous assignment on 1,180 kilocycles because of cross talk interference with the operation of other New York stations while operating on the 600-kilocycle channel.

The station, however, obtained the stay order from the court. The Commission, by majority vote, the petition pointed out, caused to be issued to WICC, a license on 600 kilocycles, effective May 1st, despite the court order, and despite the fact that the license was not actually "signed, sealed and delivered" to the station when the stay order was issued.

Reply is Deferential

"Pursuant to said contumacious action of appellees," the petition states, "WICC is now in operation on appellant's frequency of 600 kilocycles. Bridgeport is situated approximately 50 miles from appellant's station and the service thereof is completely destroyed by said operation."

In the reply it is contended, says "The United States Daily," that the Commission issued a license authorizing WICC to operate on 600 kilocycles "prior to the time its attention was called to the issuance of said order."

"This Commission," the answer states, "is not contemptuous of this or any order of this honorable court, but endeavors at all times to carry out its mandates as rendered.

In identical answers, Gen. Saltzman and Vice-Chairman Sykes stated they thought the Commission should have not actually delivered to WICC the license to operate on 600 kilocycles.

Excess Power Use Is Under U. S. Inquiry

Washington.

A campaign against broadcasting stations which are using more than their authorized power and thus causing interference with other stations, is being started by the Federal Radio Commission as a result of numerous complaints, Commissioner Harold A. Lafount stated orally.

"A very careful check is to be made to see that stations do not use more than their authorized power," he said, "not because we object to the laying down of a better signal strength, but because of the interference with other stations on the same channels, and because the carefully worked out scientific allocations, designed to give maximum public service, thus are thrown out of kilter."

Census Question Not a Tax Joker

The radio question in the 1930 census was not asked for taxing radio receivers, said Major Herbert H. Frost, chairman of the Merchandising Committee of the Radio Manufacturers Association.

"The radio question was inserted in the 1930 census at the direct request of the Radio Manufacturers Association," Major Frost said, "and the Association is unalterably opposed to any tax on radio. Our sole purpose is to obtain information concerning the markets for radio products."

42 Stations Have Licenses Held Up

Washington.

The Federal Radio Commission extended for the regular 90-day period the licenses of all broadcasting stations "in good standing."

As a disciplinary measure, the Commission issued 30-day licenses to 18 stations for infractions of regulations.

Forty-two stations failed to file renewal applications, and consequently have not been granted the routine extension.

Set Tax Bill Wins In South Carolina

Columbia, South Carolina.

The bill to tax radio sets was passed by the State Legislature. The tax is from 50 cents to $2.50 per set, depending on the cost of the set.

The imposition of this levy would constitute South Carolina the first State in the Union to tax radio sets. Such taxes are common in Europe.

A THOUGHT FOR THE WEEK

WHY shouldn't this coming summer season be all right for radio? For instance, arrangements have been made to give more baseball scores and news of sporting events this summer than have ever been put on the air since radio started to change about everything that can be changed. That's the way to keep the men interested in radio—and, after all, the men still support the household even if madame does most of the spending.

Forum

The Doctor Diagnoses Kahn's Case

ONCE upon a time I was prompted to sit down and write the very same kind of a letter as Mr. Kahn did to the *Forum*. I was suffering from "radio fatigue." Just as I was about to start the letter, on came a symphony orchestra with a composition of Liszt. I got up and tuned in a jazz station that was broadcasting phonograph records in order to get my feelings more in harmony with my thoughts, when the fool announcer put on the "1812 Overture." It seemed like pure cussedness on the part of the station, just as I was trying to get into my most roiled mood against jazz music.

I wonder if he is not aware of the concerts of the General Electric Symphony, under Damrosch? The Rochester Symphony Orchestra on the Columbia Chain; likewise the Montreal Symphony. The Minneapolis Symphony gave twenty-one concerts this winter over WCCO. Almost every afternoon the hotel orchestras of New York City broadcast over the Columbia Chain and this music is well over 80 per cent classic—that is, not jazz!

The quest for variety has driven program directors to use everything in sight, not only from works composed in the last 200 years, but they have even gone back to mediæval times and dug up old songs and religious cantos, some we would never have had the privilige of hearing if it were not for this aforementioned quest.

I play xylophone solos over the radio now and then and I want to tell you it is impossible to think of any number, jazz or classic, in any age that has not been used not only once, but time and again. Arranging an original program is well night impossible and can be done only with material that has never before been used.

Can it be possible that he missed out on all the concerts by the Chicago Symphony Orchestra? Then there are the concerts under the direction of Roxy of the Roxy Theatre. Where was he during the Atwater Kent programs, which featured nothing else but the better music and the best artists?

It is true that there is a great deal more jazz than the heavy music, but that is as it should be, for most of the time, youth likes to dance, and it is dance music that is played. However, taken throughout the day, I find that I get a well-balanced diet of music, so much so that I can turn off the radio and leave it alone until Amos 'n' Andy come along to lighten up my cares.

After realizing all these things I folded up the type-writer and never wrote the letter. Mr. Kahn has radio fatigue, and since jazz is more irritating than other forms of music, it is just like a sore thumb, which he seems to bump oftener only because it hurts every time he bumps it, and jazz gets the blame.

If he wants any better programs than we have today he will simply have to get busy and write some better music or think up something entirely new and original. Personally I am awfully glad that I am not the program director for some big whooptydoo station that has to set the pace for the others, by reason of its big name. The dinky station can put on just as original a program as the biggest, though of course it might not be so elaborate or highly touted. So don't knock 'em—join 'em.

VERNE V. GUNSOLLEY,
116 So. 4th St., Minneapolis, Minn.

Reception Predicts Weather

THE article by M. U. Wallach in the April 19th issue was indeed interesting, and gives me the satisfaction of knowing that others besides the writer are interested in weather conditions and radio reception.

Here we have circled the country via the dial every night for four years, keeping a log of weather conditions and of every station tuned in.

We know what the weather will be 24 to 48 hours in advance of the local Weather Bureau, by the volume of a station's broadcast, and can tell the direction the wind will be 24 to 36 hours in advance of the change.

The best DX reception comes in advance of a falling barometer and usually lasts until the barometer reaches the lowest point.

Our most severe storms of static appear in April and September, sometimes lasting a week in succession.

The best results of continuous DX reception came in July and August, 1929, when the Pacific Coast stations were heard 28 nights in each month.

Please let us hear more on the DX subject, from North, South, East and West.

D. T., Topeka, Kans.

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 .....

Francis Quinn, 2577 East 63rd St., Cleveland, Ohio.
J. R. Shannon, New Albany, Miss.
Sillar City Radio Lab., Box 422, Silar City, N. C.
C. H. Metzger, 3220 Elmley Ave., Baltimore, Md.
Max W. Bennet, 310 E. Market St., Columbia City, Ind.
Richard H. Goddard, 122 Nursery Ave., Woonsocket, R. I.
M. D. Collins, 125 Elm St., Elgin, Ill.
E. Kreusch, 176 Chadduck, Buffalo, New York.
Juan Cuevas, s/c. Sta. Clara & Esperanza, Cienfuegos, Cuba.
Pioneer Broadcasting Co., Wilmington, Del.—Corp. Trust Co. of America.
Duraum Radio Corp.—Atty. D. Spielman, 457 Schenectady Ave., Brooklyn, N. Y.
Radio Maintenace Corp., wireless telegraph instruments—Atty. S. V. Ryan, Albany, N. Y.
Argentine Brunswick Radio Corp., Wilmington, Del.—Corp. Trust Co. of America.
General Mfg. Corp. of N. J., Atlantic City, electrical, radio, and aircraft equipment—Atty. Morris Wesler, Atlantic City, N. J.
Abby Electric Corp., wireless telegraphy—Atty. J. M. Grossmann, 115 Broadway, New York.
Allied Telephone Utilities Co., Wilmington, Del., telephone, telegraph—Corp. Trust Co. of America.
Reeber's Radio Salon, Corona, Queens, New York—Attys. Giaimo & Nicolisi, Corona, New York, N. Y.
Broadney & Co., radio equipment—Atty. M. Levy, 66 Court St., Brooklyn, N. Y.
Brazilian Brunswick Radio Corp., Wilmington, Del.—Corporation Trust Co. of America.
Custom Radio Equipment Laboratories—Atty. H. J. Zweibel, 225 West 42nd St., New York, N. Y.
Fred Dillion, 1224 Horn Ave., W. Hollywood, Calif.
Cheong Ping, care Messrs. Hughes & Hough Ltd., Bank of Canton Building, Hongkong, China.
G. C. Muzquiz, 2107 Main St., Houston, Texas.
D. G. Kimball, Troutdale, Maine.
M. Giacaletto, Mark, Box 87, Illinois.
Wm. L. Norton, 4336-12th, N. E., Seattle, Wash.
Dale Langley, 306 So. California St., Monrovia, Calif.
S. A. Dalton, Sweeny, Texas.
Leon Jones, 4th Oak St., Greenwood, Mo.
Rob. S. Silva, 4013 Sunset Blvd., Hollywood, Calif.
L. R. Nease, Shattuc, Ills.
Robert C. Zindel, 113 Alexander St., Wausau, Wisc.
Geo. Morrison, 379 Mountain Road, Union City, N. J.

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COMPLETE PARTS for Amertran 3 stage, 250 Push-pull Amplifier, including RCA tubes. Sell or swap for Cine-Kodak outfit. Schwalbe, 1185 Anderson Av., Bronx, N. Y.

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BARGAINS in first-class, highest grade merchandise. B-B-L phonograph pick-up, theatre type, suitable for home, with vol. control, $6.57; phono-link pick-up with vol. control and adapter, $3.50; steel cabinet for HB Compact, $3.00; four-gang .00035 mfd. with trimmers built in, $1.95; .00025 mfd. Dubilier grid condenser with clips, 18c. P. Cohen, Room 1214, at 143 West 45th Street, N. Y. City.

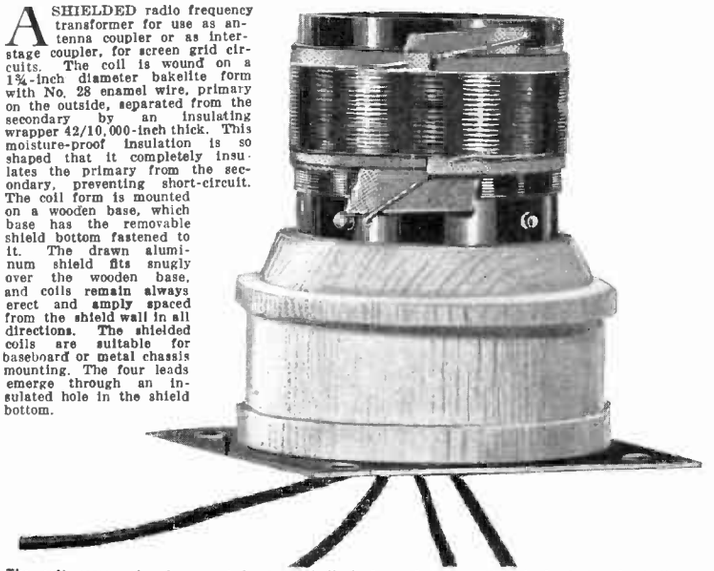
THE ELECTRIC WORD, by Paul Schubert.

A narrative of the rise of radio from the discovery of Hertzian waves and the first practical use of them by Marconi, in 1900, to its present-day position of eminence. This book will be of great interest, not only to the great army of persons concerned in one way or another with radio work, but also to the layman whose immediate interest in radio is confined to his own set, and who will be fascinated by this story of an interplay of science, business, politics, and diplomacy that is without parallel in history. Price $2.50.

RADIO WORLD, 145 W. 45th St., New York City

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.

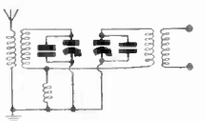


The coil comes already mounted on a shellacked wooden base, which is fastened at the factory to the shield bottom. Series A coil is illustrated.

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.



BP-6 is the coil at bottom.

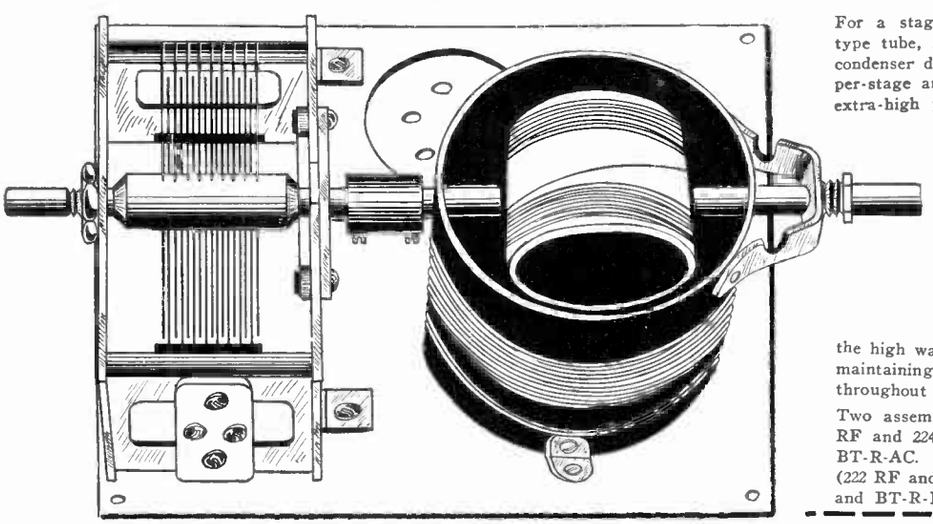
EXTREME accuracy in winding and spacing is essential for coils used in gang tuning. These coils are specially suited for gang condensers, because the inductances of all are identical for the stated size condenser. The coils are matched by a radio frequency oscillator. The color scheme is as follows: 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.) Bluo is for grid and yellow 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.

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.

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 cricuits. 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. Five needed for Bernard's circuit. 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).

Screen Grid Coil Co., 143 West 45th Street, New York (Just East of Broadway):

Enclosed please find $..... (Canadian must be express or P. O. Money Order), for which send me prepaid the following:

☐ A-40-80-S, each	$2.25	☐ B-SH-3, each	$1.00
☐ Matched set of four A-40-80-S	10.00	☐ Matched set of four B-SH-3	4.00
☐ A-40-70-S, each	2.25	☐ B-SH-5, each	1.00
☐ Matched set of four A-40-70-S	10.00	☐ Matched set of four B-SH-5	4.00
☐ BT-L-AC and BT-R-AC, assembled, with condenser, link, socket and base, per pair			6.00
☐ BT-L-DC and BT-R-DC, assembled, with condenser, link, socket, base, per pair			6.00
☐ C-6-CT-5, .0005 mfd. shielded coil for six-circuit tuner			each $2.25
☐ C-6-CT-3, .00035 mfd. shielded coil for six-circuit tuner			each $2.25
☐ BP-6			.25
☐ EQ-100, equalizer of 20-100 mfd. capacity, made by Hammarlund			.35

(Note: All coils come with shields, except BP-6 and BT-L.)

NAME..... ADDRESS.....

CITY..... STATE.....

☐ If ordering C.O.D. put cross here. Post office fee will be added to prices quoted.

Balkite Push-Pull Receiver

The Balkite A-5 Neutrodyne, one of the most sensitive commercial receivers ever developed; 8 tubes, including 280 rectifier. Wholly AC operated, 105-120 v. 50-60 cycles; in a table model cabinet, genuine walnut, made by Berkey & Gay.

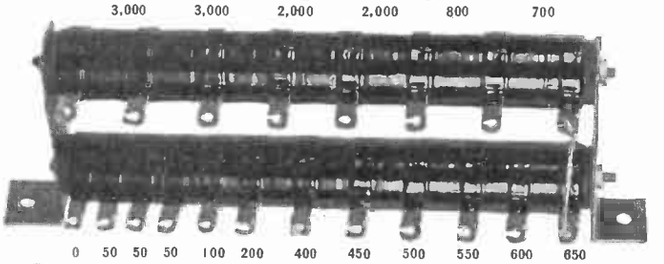
Three stages of tuned RF, neutralized, so there's no squealing; easy tuning; operation on short piece of wire indoors perfectly satisfactory; no repeat tuning points; no hum; phonograph pickup jack built in; excellent tone quality; good selectivity. Two posts are accessible for connecting the field coil of a DC dynamic speaker.

The parts of which this receiver is made are all ace-high and the wiring is done with extreme expertness, by Gilfillan. The power supply is exceptionally fine, the set being worked at 50% less than the rated capacity of the power transformer and chokes, assuring long life. There is no hum, as filtration is remarkably good.

The illuminated drum dial, at center, reads 0-100 at left, and at right has a blank space in which to write call letters. The little knob at left is the volume control, and the one at right is the AC switch. Each RF stage is filtered and bypassed individually, and the RF coils, tuning condenser and power transformer are separately and totally shielded. The lead from antenna binding post to antenna winding of the first coil is of shielded wire that is grounded. Also, the receiver as a whole is totally shielded, with metal chassis and metal undercover, so there is no stray pickup. Cat. BAL-A5, list price $135; net price.....

$44.00

New Multi-Tap Voltage Divider



The resistance values between the twenty taps of the new Multi-Tap Voltage Divider are given above. The total is 17,100 ohms and affords nineteen different voltages.

The Multi-Tap Voltage Divider is useful in all circuits, including push-pull and single-sided ones, in which the current rating of 100 milliamperes is not seriously exceeded and the maximum voltage is not more than 400 volts. Higher voltages may be used at lesser drain.

The expertness of design and construction will be appreciated by those whose knowledge teaches them to appreciate parts finely made.

When the Multi-Tap Voltage Divider is placed across the filtered output of a B supply which serves a receiver, the voltages are in proportion to the current flowing through the various resistances. By making connection of grid returns to ground, the lower voltages may be used for negative bias by connecting filament center, or, in 227 and 224 tubes, cathode to a higher voltage.

If push-pull is used, the current in the biasing section is almost doubled, so the midtap of the power tubes' filament winding would go to a lug about half way down on the lower bank.

Order Cat., MTVD, list price $6.50, net price.....

$3.90

R-245 Set and Tube Tester

With the R-245 Tube and Set Tester you plug the cable into a vacated socket of a receiver, putting the removed tube in the tester, and using the receiver's power for making these tests: Plate current, on 0-20 or 0-100 ma. scale, changed by throwing a built-in switch; 0-60, 0-300 v. DC, changed by moving one of the tipped cables to another jack; filament or heater voltage (AC or DC), up to 10 volts, or any other AC voltage source, measured independently, up to 140 volts, including AC line voltage. Also screen grid voltage and screen grid current may be read by following connections specified in the new 8-page instruction sheet.

Each meter may be used independently. The two test leads, one red, the other black, with tip jack terminals, enable quick connection to meters for independent use.

With this outfit you can shoot trouble in receivers and test circuits using the following tubes: 201A, 200A, UX199, UX120, 210, 171, 171A, 112, 112A, 245, 224, 222, 226, 227, and pentodes.

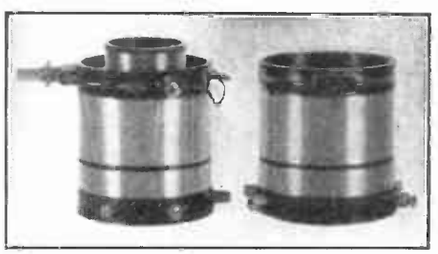
When the R-245 is plugged into the vacated socket of a set and the removed tube is placed in the proper socket of the Tester, the receiver's power supplies all the voltages and currents. You see the vital tests made right before your eyes, all three meters registering immediately, all three reading at the same time.

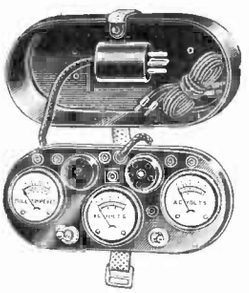
Here are some of the questions answered by the Tester when plugged into the receiver:

What is the filament or heater voltage (no matter if DC or AC)? What is the plate voltage at the plate itself? What is the plate current drawn by the tube? Is the tube in good condition or does it require replacement? What is the grid bias voltage? What is the cathode voltage? What is the screen grid voltage? Besides, when meters are used independently, you can answer these questions: What is the screen grid current? What is the line voltage (no mater if AC or DC)? Is the circuit continuous or is it open? What is the total plate current drawn in the receiver? What are the respective B voltages at the B batteries or voltage divider?

Order Cat. R-245. List price, $20; net price..... **$11.40**

Silver-Plated Coils

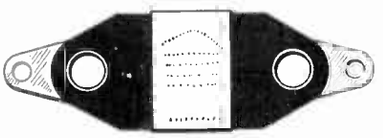




Wound with non-insulated wire plated with genuine silver, on grooved forms, these coils afford high efficiency because of the low resistance that silver has to radio frequencies. The grooves in the moulded bakelite forms insure accurate space winding, thus reducing the distributed capacity, and keep the number of turns and separation constant. Hence the secondary reactances are identical and ideal for gang tuning.

The radio frequency transformer may be perpendicularly or horizontally mounted, and has braced holes for that purpose. It has a center-tapped primary, so that it may be used as antenna coil with half or all the primary in circuit, or as interstage coupler, with all the primary on a screen grid plate circuit, or half the primary for any other type tubes, including pentodes. The three-circuit tuner has a center-tapped primary, also. This tuner is of the single hole panel mount, but may be mounted on a chassis, if preferred, by using the braced holes. Pair consists of RF transformer and three-circuit tuner, both for .0005 mfd. only. Order Cat., G-RF-3CT, list price $5.00; net price..... **$2.48**

Fixed Condensers

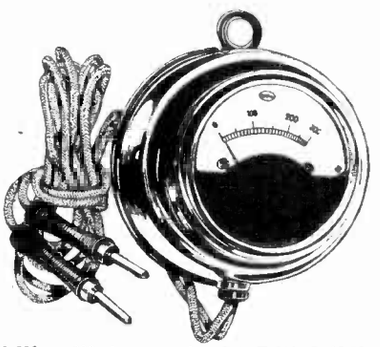


Dubilier Micon fixed condensers, type 642, are available at following capacities and prices:

.0001 mfd.	10c	.006	20c
.00025 mfd.	10c	.00025 with clips.	20c
.0003 mfd.	10c	All are guaranteed	
.00035 mfd.	15c	electrically perfect and	
.001	17c	money back if not	
.0015	17c	satisfied within five	
.002	18c	days.	

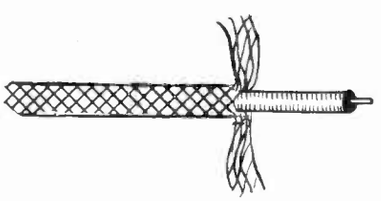
Order Cat. MICON .0001 etc. at prices stated.

High-Voltage Meters



0-300 v., 200 ohms per volt. Cat. F-300 @ $2.59
0-500 v., 233 o.p.v. Cat. F-500 @..... 3.73
0-600 v., AC and DC (same meter reads both); 100 ohms p.v. Order Cat. M-600 @ 4.95

Shielded Lead-in Wire



No 18 solid wire, surrounded by a solid rubber insulation covering, and above that a covering of braided copper mesh wire, which braid is to be grounded, to prevent stray pick-up. This wire is exceptionally good for antenna lead-in, to avoid pick-up of man-made static, such as from electrical machines. Also used to advantage in the wiring of receivers, as from antenna post of set to antenna coil, or for plate leads, or any leads, if long. This method of wiring a set improves selectivity and reduces hum. This wire is now appearing on the general market for the first time although long used in the best grade of commercial receivers. Order Cat. SH-LW. List price 9c per ft.; net price per foot **5c**

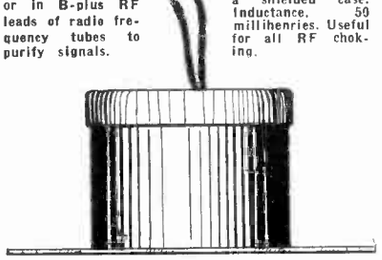
Double Drum Dial

Hammarlund double drum dial, each section individually tunable. Order Cat. H-DDD. List price $8.00; net price **$3.00**

Shielded RF Choke

Excellent in detector plate circuit or in B-plus RF leads of radio frequency tubes to purify signals.

An efficient radio frequency choke in a shielded case. Inductance, 50 millihenries. Useful for all RF choking.



In some instances one outlead is connected to case, so use this lead for B-plus or for ground, otherwise ground the case additionally. Order Cat. SH-RFC. List price, $1.00; net price **50c**

Guaranty Radio Goods Co., 143 West 45th St., New York, N. Y.
(Just East of Broadway)

Enclosed please find $..... (Canadian must be express or post office money order, for which please ship:

- ☐ BAL-AS @. $44.00
- ☐ MTVD @ ... 3.90
- ☐ G-RF-3CT @ 2.48
- ☐ R-245 @..... 11.40
- ☐ Ft. of SH-LW @.....5c p. f.
- ☐ H-DDD @... $3.00
- ☐ SH-RFC @... 50c
- ☐ M-600 @.... $4.95
- ☐ F-300 @..... $2.59
- ☐ F-500 @..... 3.73
- ☐ MICON.... @ ....
- ☐ MICON.... @ ....
- ☐ If C.O.D. shipment is desired put cross here.

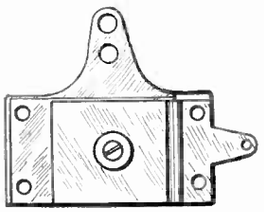
Your Name .....

Address .....

City..... State.....

Accurate Tuning Condensers and Accessories

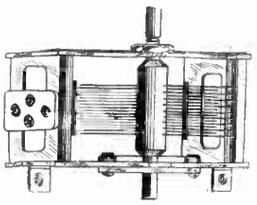
EQUALIZER



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

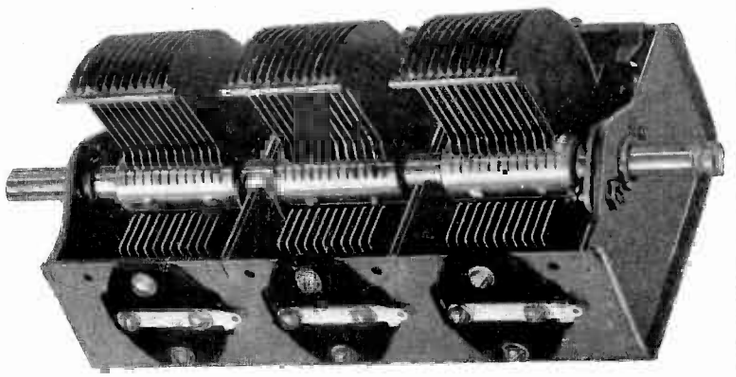
SINGLE .00035



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 ⅜ inch by use of Cat. XS-4. Brackets built in enable direct subpanel 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 3¼ 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 exeept 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

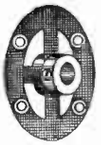
(1)—Three equal sections of .0005 mfd. capacity each.
(2)—Modified straight line frequency shape of plates, so-called midline.
(3)—Sturdy steel frame with rigid steel shields between adjacent sections. These shields minimize electric coupling between sections.
(4)—The frame and the rotor are electrically connected at the two bearings and again with two sturdy springs, thus insuring positive, low resistance contact at all times.
(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.

RIGID AND FLEXIBLE LINKS

CAT. RL-3 AT 12c

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.

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.



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 ⅜" 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

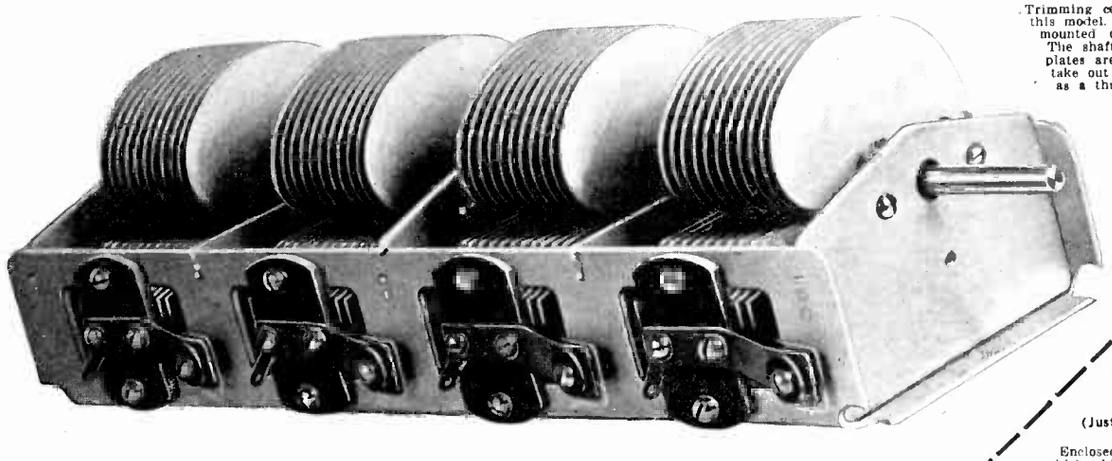
A two-gang condenser, like the single type, KHS-3, but consisting of two sections on one frame, is Cat. KHD-3, also made by Scovill. The same mounting facilities are provided. There is a shield between the respective sections. The tuning characteristic is modified straight frequency line. Order Cat.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

GUARANTY
RADIO GOODS CO.,
143 West 45th St.,
N. Y. City
(Just East of Broadway.)

Enclosed find $.....for which ship designated parts:

.....

Street Address.....

City..... State.....

the following merchandise as advertised:

- ☐ Cat. XS-4 @ 10c
- ☐ Cat. KH-3 @ 85c
- ☐ Cat. XS-8 @ 15c
- ☐ Cat. KHD-3 @ $1.70
- ☐ Cat. RL-3 @ 12c
- ☐ Cat. DD-0-100 @ $1.50
- ☐ Cat. EQ-100 @ 35c
- ☐ Cat. SC-3 G-5 @ $4.80
- ☐ Cat. SPL-4 G-3 @ $3.95
- ☐ Cat. FL-4 @ 30c
- ☐ Cat. SW-S-150
- ☐ Cat. SW-S-250

ALL PRICES ARE NET

Headquarters for Outstanding Books—FREE!

"AUDIO POWER AMPLIFIERS"—Anderson and Bernard

"Audio Power Amplifiers" is the first and only book on this important subject. 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."

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.

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.—CHAPTER II. (page 20) Circuit Laws, expounds and applies Ohm's laws and those 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, full-wave and half-wave rectification, current flow and voltage derivation. Regulation curves for the 280 tube are given.—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.—CHAPTER VI. (page 90) Principles of Push-Pull Amplifier.—CHAPTER VII. (page 98) Oscillation in Audio Amplifiers, motorboating and oscillation at higher audio frequencies.—CHAPTER VIII. (page 118) Characteristics of Tubes, tells how to run curves on tubes, how to build and how to use a vacuum tube voltmeter, 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.—CHAPTER XI. (page 121) Practical Power Amplifier, give 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.**

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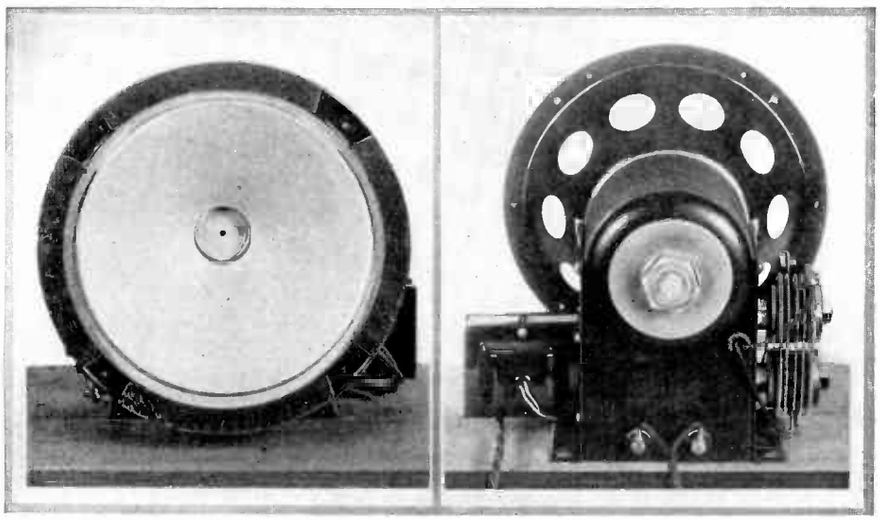

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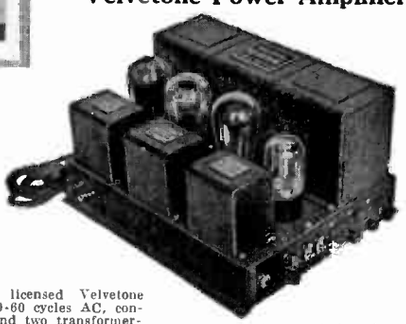

The National Company's wired and licensed Velvetone push-pull power amplifier, for 110 v. 50-60 cycles AC, consisting of B supply for 280 rectifier, and two transformer-coupled audio stages, the first 227, the second 245s in push-pull, with output transformer built in. Supplies all B voltages for an AC or any other tuner, also 2.5 v. heater voltage for 227 and screen grid RF, detector and preliminary audio tubes, and is especially suitable for the MB-29 tuner. Order Cat. PPPA, list price $97.50; net price **$56.52**

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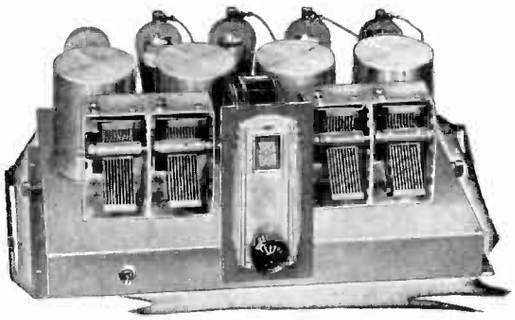

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Kuprox B eliminator, Model 316, 220 volts DC, utilizing 280 tube, for 110 v. AC, 50-60 cycles, to deliver positive voltages of 45, 90, 135 and 180 and negative voltage of 40 for biasing 171 or 171A, also delivers 4 volts negative for other receiver tubes.

One knob on the terminal panel controls the actual voltage on the 45-volt tap and another knob controls the voltage on the 180-volt tap.

The terminal panel contains in addition to the two knobs seven binding posts for B minus, which is connected to the case, for the four positive and the two negative voltages.

It is provided with a standard plug and an 80-inch connecting cord.

The overall dimensions are: width 5⅛ inches; length, 13 inches; height, 8¼ inches. Order Cat. KO-B, list price $35, net price **$13.16**

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Cigar-cigarette stand, with imitation microphone pedestal, into which is built a lighter. Press button at top and light up. 10-ft AC cable and plug. Works on AC or DC, 110 v. Order Cat. MIK-L-S, list price $2.75; net price..... **$1.49**

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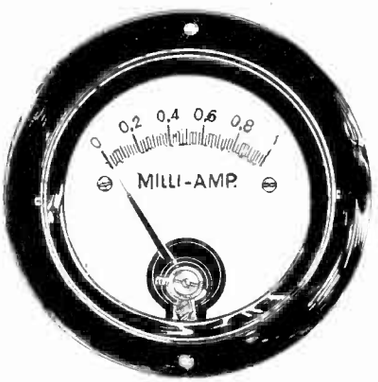

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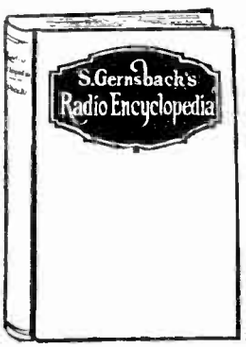

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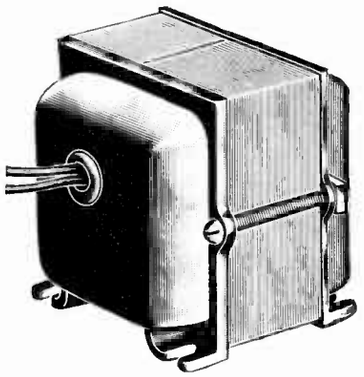
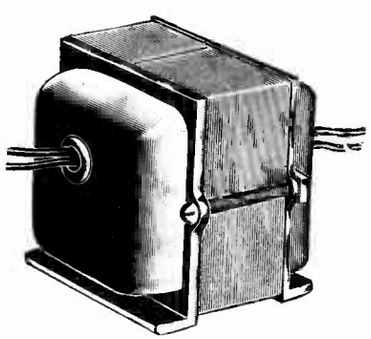


Shielded single choke, 200 ohms D.C. resistance, non-saturable at 100 milliamperes, with two black outleads, each 6 inches long. For filtration of B supplies. Inductance, 30 henrys.
Cat. SH-S-CH, price.....$5.00

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 may be connected directly to plates without any direct current, but only signal current, flowing through the speaker. This system is applicable 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



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
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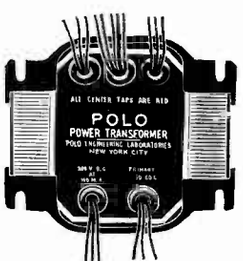
[Any of the above three in the same case as the 215 power transformer, © $1.00 extra. Add PTC after the Cat. number.]

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

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

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. 6 ft. AC cable, with plug. Order 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 tight, 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 condenser used. Where the capacity at the output is 8 mfd. 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-PT-40 @ 9.50
☐ Cat. 245-PT-25 @ 12.00
☐ Cat. SH-S-CH @ 5.00
☐ Cat. SH-D-CH- @ 6.00
☐ F-2.5-D @ 3.75
☐ Cat. 245-FIL @...$4.50
☐ Cat. 245-FIL-40 @ 7.00
☐ Cat. 245-FIL-25 @ 8.50
☐ Cat. SH-F-20 @. 2.50
☐ Cat. UN-S-CH @. 1.25

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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