NOV. 8th 1930

SHORT-WAVE ISSUE

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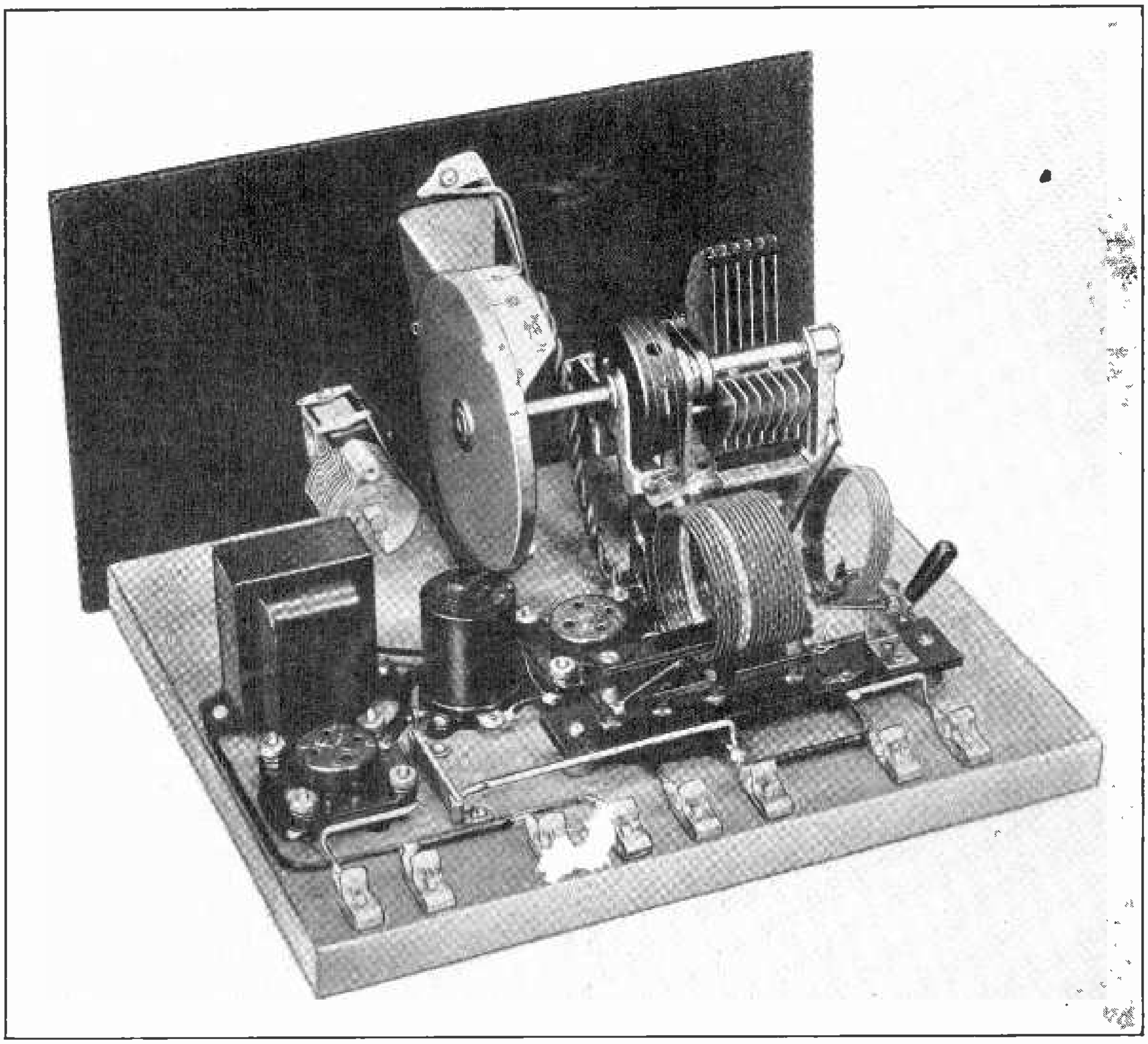

High Sensitivity Is Developed in the Hammarlund Hawk. See Article on Page 14.

Service Men's Guide Diagram of New Graybar

Early Experiments with Tubes

Short-Wave Adapters, Converters

LIST OF SHORT-WAVE STATIONS

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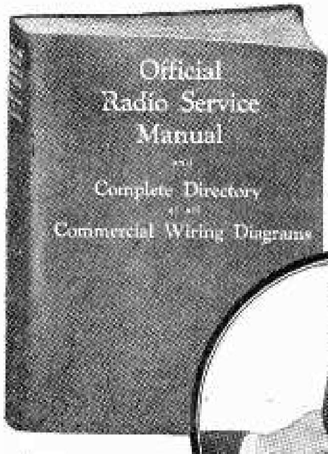

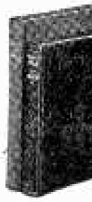

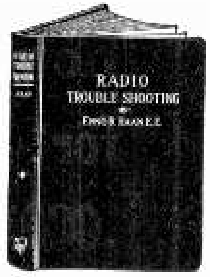

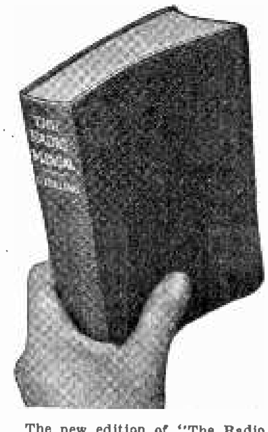

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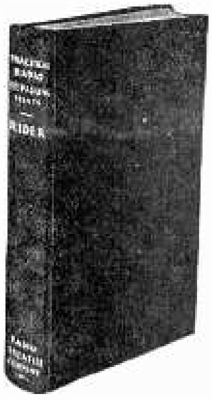

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Image inerference is discussed in detail and methods given by which it may be reduced.

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method which allows either the high or the low

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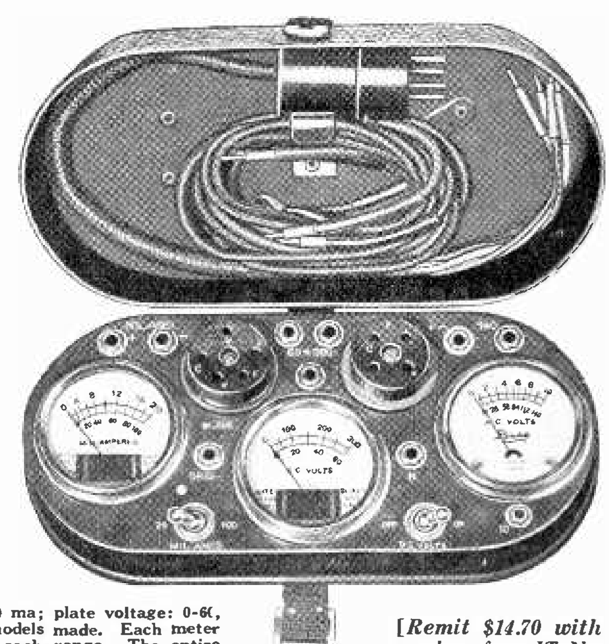

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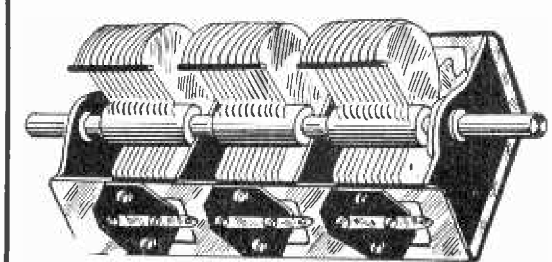

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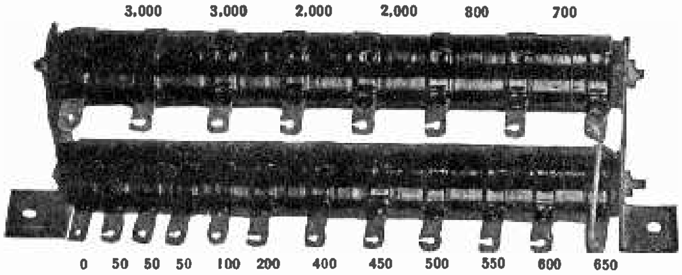

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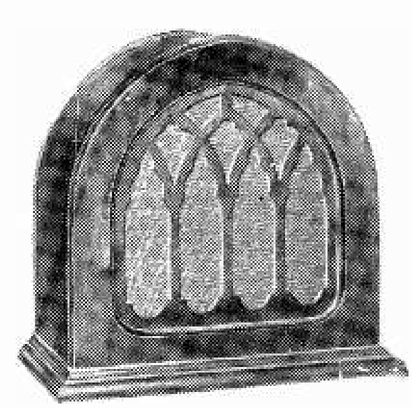

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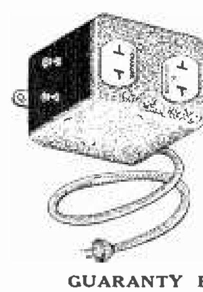

Connect relay's cable plug to 105-125 volt AC line. Connect B eliminator cable plug to relay socket so marked; connect trickle or other charger's plug to relay socket so marked; connect one side of A battery to binding post, other side to A set. Then turning on your set twins on B eliminator and turns off charger, turning off set turns on charger and turns off B eliminator.

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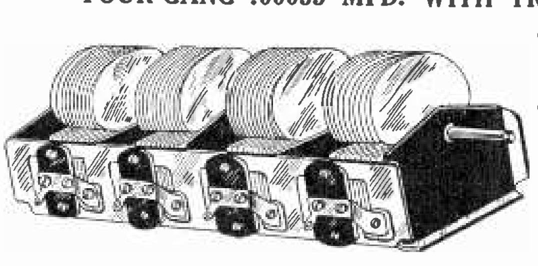

This condenser, each of four sections .00035 mfd., has aluminum plates that are removable and adjustable, also a ¼" diameter steel shaft that is removable. It is sturdy and is suitable for popular four-circuit screen grdi tuners. Trimming condensers are built in. The condenser may be mounted on its bottom or side. Total overall length, including shaft, 11⅞." Overall width, 4". The frame is steel Order Cat. 4-G @.................... $3.95

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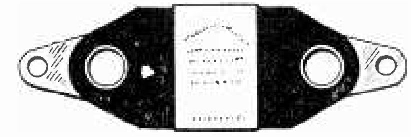

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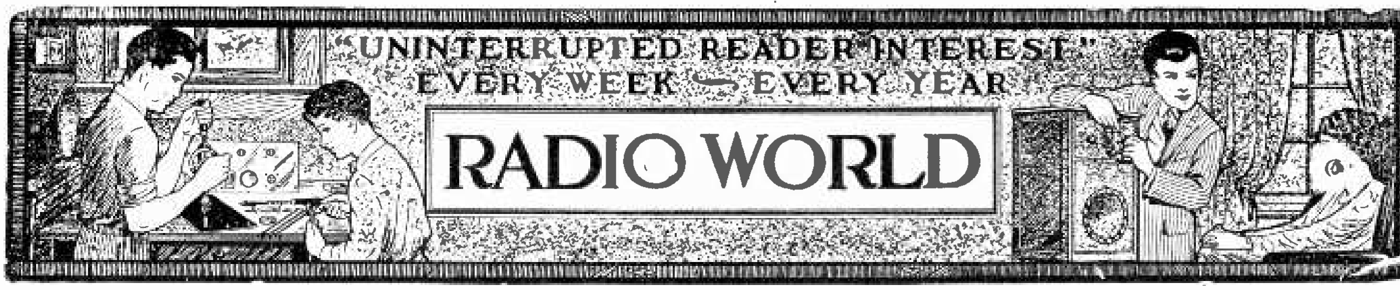

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Short-Wave Adapters, Converters and Receivers

By Herman Bernard

RESEARCH in short waves quickly develops the certainty that a different situation exists than when one is dealing with broadcast waves. Mathematically the only difference is one of frequency. Electrically, the differences are many, and sometimes complex.

The behavior of waves in the ether as well as in the receiver circuit is quite different on short waves, and the achievement of stability, accomplished in 1924 in broadcast receivers, has yet to be fully conquered in the short-wave field so that none who builds devices to bring in short waves will have to endure seemingly inexplicable periods of inoperation.

As a rule all forms of reception of short waves depend on some locally oscillating circuit. For instance, the simplest device to bring in short waves is an adapter, which plugs into the detector socket of a receiver, using none of the receiver's radio frequency amplification. The local oscillation here developed is in the sole tube, the detector, in the adapter. Figs. 1, 2, 3 and 4 show circuits suitable for such operation, each a little different, to accommodate a particular type of detector tube, the socket of which, in the receiver, is replaced by the plug of the adapter.

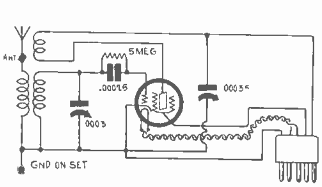

FIG. 1
A ONE-TUBE SHORT-WAVE ADAPTER, USING A 224 TUBE, TO PLUG INTO THE DETECTOR. THE TUBE HEATER, CATHODE, SCREEN AND PLATE LEADS ARE PICKED UP.

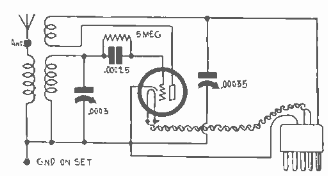

FIG. 2
THE SAME CIRCUIT AS IN FIG. 1, EXCEPT THAT A 227 TUBE IS USED. THE LEADS PICKED UP ARE TUBE HEATER, CATHODE AND PLATE. THE CIRCUIT CONSTANTS ARE THE SAME.

Operate on the Same Principle

All adapters operate on the same general principle of tuning in the short waves on the circuit built into the adapter, and into the socket of which adapter is inserted the receiver's detector tube that was replaced by the plug.

Inspection of the diagrams of these adapters will disclose that the grid connection to the receiver's detector socket (in the instance of screen grid tubes, the control grid connection) is not picked up, so that there is a new input entirely, that of the short wave received by the adapter, while the output is communicated to the plate post of the receiver's detector socket. Thus the audio frequencies are amplified by the audio channel of the receiver, permitting loudspeaker reproduction.

The adapter designs, therefore, are simply those of one-tube regenerative receivers, with plug-in arrangement.

A tuned grid oscillator is shown in Figs. 1, 2, 3 and 4. Other forms of supplying regeneration may be used instead, the only requirement being that there must be some adjustable part, either coil, condenser or resistor, so that feedback may be controlled. The circuit, while oscillatory in its nature, will not bring in signals, in most instances, unless the regeneration is controlled. The operating region for best sensitivity is just under the oscillation point. As the right condition varies with frequency, the necessity arises for a manual means of adjustment for this purpose.

Some Succeed, Some Fail

Many have had excellent success with short-wave adapters of the types illustrated, and with other types, but others have not been able to tune in a single station, much to their disgust.

Unless there is regeneration it is quite likely there will be no reception, and regeneration may be defeated by the unsuitability of the constants in the adapter to the particular receiver with which the adapter is used. An adapter is not universally useful, no more than a given size shoe will fit every foot, for as feet are different, so are detector plate circuits of receivers different, and adapter functioning depends considerably on plate circuits and voltages.

If a detector circuit has a resistive plate load, as would be true if the first stage of audio frequency amplification were resistance-coupled, the likelihood of failure to obtain regeneration is considerably greater than if transformer coupling were in the audio circuit. With resistance-coupled audio amplification the plate current is low, and if a screen grid tube is used as detector that current is extremely low, sometimes a fraction of a milliampere, and a minor fraction, at that.

Many commercial receivers and kit-sets of recent design will have a first stage of resistance-coupled audio and a push-pull transformer-coupled second audio stage. Hence, the greater the popularity of this type of audio, the greater the danger of not being able to use a short-wave adapter with the receiver.

Solutions Attempted

To overcome the difficulty, attempts may be made to match the adapter circuit to the other by adding more turns to the plate winding in the adapter, but here, too, a difficulty presents itself. The process of adding turns can be as useful only up to a certain point, after which still more turns simply spell still lesser probability of obtaining regeneration. For one thing, the inductance of this winding begins to assume proportions that, for the high frequencies involved, is very considerable, hence the winding begins to act as a choke coil, or a damper on oscillation. Also, when the two windings are viewed as the constituent parts of a transformer, increase in the number of tickler turns decreases the step-up ratio between plate and grid, and this ratio renders regeneration impossible.

Even if regeneration is obtained in a one-tube adapter used in most recent circuits, as the resistance push-pull transformer audio circuit, the audio gain not being nearly so high as it was in earlier receivers, the short-wave signal may not have much strength in the loudspeaker. The tendency in modern receivers for broadcast use is to have high-gain radio frequency amplifica-

(Continued on next page)

3-Tube Converters Can

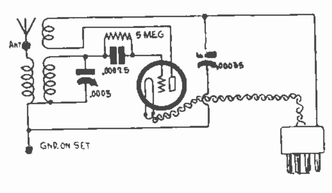

FIG. 3
WHEN A 226-TUBE IS USED THIS CIRCUIT APPLIES. THE SAME ARRANGEMENT WOULD BE USED FOR AN ADAPTER FOR BATTERY TYPE TUBES, EXCEPT THE 222 AND 232 SCREEN GRID TUBES.

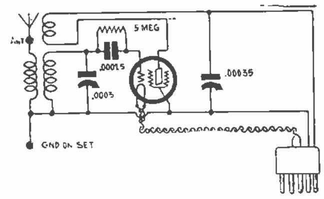

FIG. 4
WHEN A 222 OR 232 SCREEN GRID TUBE IS USED, THIS CIRCUIT APPLIES. IN ANY CASE THE ADAPTED CIRCUIT REQUIRES THE SAME KIND OF TUBE AS USED IN THE RECEIVER'S DETECTOR.

(*Continued from preceding page*)

tion and low-gain audio amplification, but the adapter does not use the radio channel at all.

This combination of situations, therefore, destroys the universality of the short-wave adapter. Nevertheless, in many instances good results will be obtained, if the audio circuit is right for the adapter used, or the adapter is properly proportioned for the detector output circuit introduced by the receiver.

Booster Battery May Help

Another limitation is the fact, also included in some of the foregoing considerations, that voltages must be taken as they are. When one plugs in for voltages one gets whatever voltages are there, and the only practical choice that would remain would be one of voltage reduction by the use of a series resistor. A parallel resistance connection, as from the lead going to the plate post of the detector socket, to ground, would short-circuit the voltage source for the receiver in the proportion of the parallel resistance to the resistance in that voltage source of the set itself.

The heater voltage can not be changed, except downward, although there would be hardly any need for this. The plate voltage is the main consideration, and if it could be raised perhaps regeneration could be obtained where under all other circumstances it failed. A booster battery would serve such a purpose.

Those experimentally inclined should try out some short-wave adapters, as virtually the same parts may be used for different hookups. If one adapter turns out well, due to nice agreement between the constants of the adapter and those of the used parts of the receiver, one may get perhaps his first taste of the alluring pastime of listening to short waves. Such reception provides a novelty and an experience that will cause the desire to listen to short-wave reception to grow, perhaps very suddenly, especially after one has tuned in a few European stations and

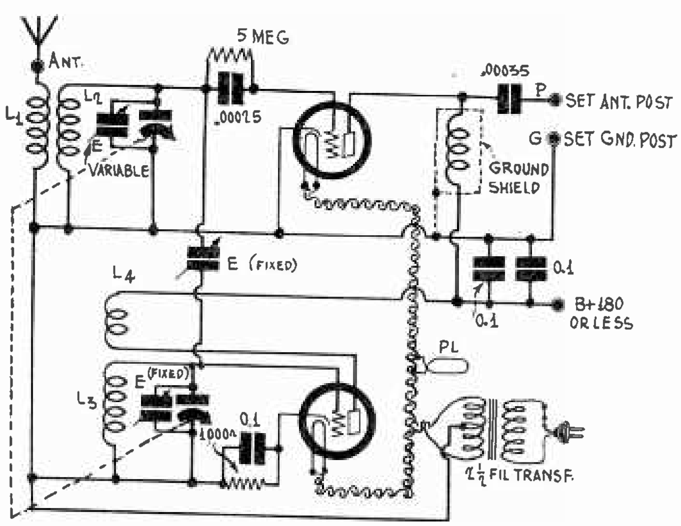

FIG. 5
DIAGRAM OF A TWO-TUBE CONVERTER, EACH CIRCUIT TUNED. WHILE THE TUBE HEATERS ARE SUPPLIED WITH AC, THE CONVERTER MAY BE USED ON ANY TYPE RECEIVER TO BRING IN SHORT WAVES.

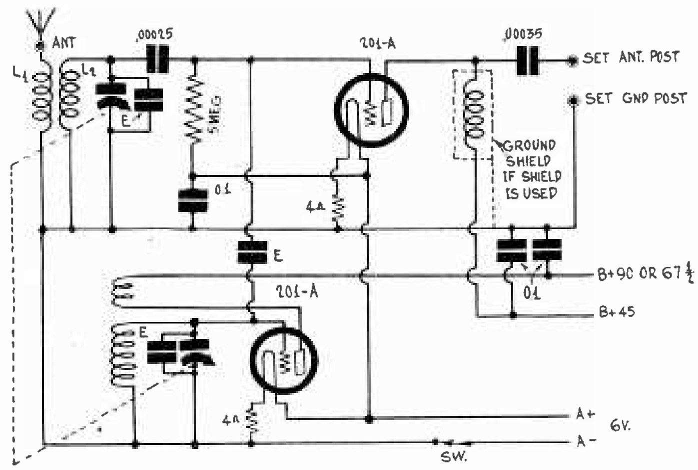

FIG. 6
A SHORT-WAVE CONVERTER, THE SAME AS SHOWN IN FIG. 5, EXCEPT THAT IT IS BATTERY-OPERATED. USE OF 201A TUBES AS ILLUSTRATED.

amazed not only members of his family but also himself! Short waves are receivable from all parts of the world. Broadcast waves are not.

One-tube adapters, therefore, may be regarded as experimental, because of the requirements that they impose.

Parts Required

The main parts required are a coil, a grid leak and grid condenser, a tuning condenser, a regeneration condenser, a socket, two binding posts, a front panel, a base panel, and a plug which may be the base knocked off an old tube. Remember that the grid lead in the plug is not used, and no connection is made to the grid post of the detector socket in the receiver. The plate post is brought out, also the two heater leads and possibly the cathode, as the adapters under consideration are for use with AC receivers. It is all right to bring out the cathode lead, as cathode in the adapter goes to ground or B minus, which are usually identical in receivers if leak-condenser detection is used in the receiver. If negative bias or power detection is used in the receiver, then the adapter circuit would short the receiver's detector biasing resistor to ground.

In some receivers cathodes, instead of B minus, are grounded, but this presents no objection, since if radio frequency amplifying tubes are concerned, they are not in the adapter circuit, although these tubes will remain lighted, and if an audio tube is concerned, the only difference is that B minus becomes grounded by the adapter connection, instead of cathode, so that the subpanel or chassis of the set, if of metal, is no longer grounded, but is at a bias potential.

Fig. 3 Also For Battery Operation

If the receiver's ground post is not B minus, but has a condenser connected from the post to the intended grounded point of the set, then there would no B voltage. In that instance it would be necessary to pick up B minus of the receiver, done usually by connection to the metal chassis of the set. Then the lead marked to "ground post of set" would not be taken literally, but would refer to connection to the metal chassis. However, by picking up the cathode lead, as diagrammed, this difficulty is avoided.

The coil data are given on page 10 and 11 in this issue.

Noting the diagrams, Figs. 1, 2 and 3, we see that the first is for a 224 screen grid tube, the second for a 227 tube and the third for a 226 tube, all for use, of course, with AC heating, except that Fig. 3 may be read as a design for battery-operated receivers using four-prong type tubes, except the 222 and 232 screen grid tubes. This double purpose of the diagram arises from the fact that, like the three-element battery type tubes, the 226 has no cathode.

For battery operation it would not be necessary to use twisted pair for the leads from the filament of the adapter socket to the corresponding points on the set's detector socket.

Converter Serves Purpose Much Better

A far better approach to universality is obtained by the use of a short-wave converter. Such a device has a local oscillator that beats with the desired short wave. By tuning the oscillator the beat is made between it and different short waves. The result is a constant beat frequency for any setting of the oscillator dial. By mixing the two frequencies in a modulator tube, the

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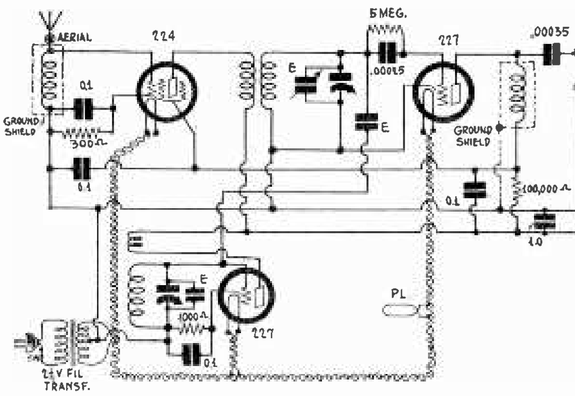

FIG. 7

A STAGE OF UNTUNED RADIO FREQUENCY AMPLIFICATION IS USED IN THIS THREE-TUBE CONVERTER. MODULATOR AND OSCILLATOR ARE TUNED. THE RADIO FREQUENCY AMPLIFIER IS A 224 TUBE. GROUND IS LEFT CONNECTED TO THE RECEIVER.

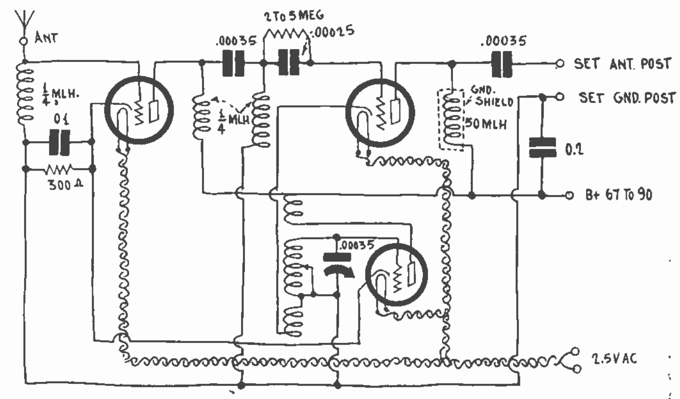

FIG. 8

SIMPLICITY IS GAINED, AND SELECTIVITY IS SUFFICIENT, IF ONLY THE OSCILLATOR IS TUNED IN A THREE-TUBE CONVERTER. THE TUBES ARE 227S.

output of this tube may be delivered to a broadcast receiver, at the antenna post thereof, and the frequency to which the broadcast receiver is permanently tuned would constitute an intermediate frequency. Thus you would have a Superheterodyne, with the converter as the mixer and the receiver as the intermediate amplifier, detector and audio amplifier.

Suppose a frequency of 30,000,000 cycles (10 meters) were desired. Then the broadcast receiver being tuned to 1,500,000 cycles (200 meters), it is desired to receive 30,000,000 cycles, so the oscillator would be tuned to 28,500,000 cycles or to 31,500,000 cycles. In either instance the difference would be the intermediate frequency, 1,500,000 cycles. As a 1,000 cycles are one kilocycle, these frequencies are usually stated as 30,000 kc., 28,500 kc. and 31,500 kc.

It is practical to tune the modulator as well as the oscillator, but it is not imperative on short waves, since the chief reliance for selectivity is on the intermediate frequency, or radio frequency amplifier of the receiver. The oscillator itself has no selectivity. It simply generates oscillations of different frequencies and thus enables establishment of an output equal in frequency to the intermediate frequency. It is the selectivity of the intermediate amplifier that makes the oscillator seem to be selective. While the selectivity is present, it just doesn't happen to be in the oscillator.

Choice of Intermediate Frequency

Any intermediate frequency may be chosen, within the limits of the broadcast receiver, but as most receivers are more sensitive at the higher frequency settings, it is suggested that 1,500 kc. or higher frequency be used, if the set tunes higher.

It is also convenient to use the same intermediate frequency all the time, for then the same dial settings of the converter will represent the same short waves, and logging them is practical. Any change in intermediate frequency changes the dial settings of the converter's oscillator for a given short wavelength.

Due to a late improvement in receivers, automatic value control, the fading experienced on short waves is greatly reduced, since the effect of such a control is to achieve a measure of constancy in the receiver's output despite differences at the input.

Also, the entire broadcast receiver is used, "as is," with all its radio frequency amplification, which in modern receivers is high. The performance depends as much on the receiver as on the converter.

In the instance of AC short-wave converters, it is necessary to use a separate heater transformer, for the 227 or 224 tubes draw 1.75 amperes each, and two or three tubes would impose a dangerous overload on the heater windings of power transformers in receivers. Also it is necessary to obtain at least one B voltage, and in this connection a solution lies in the inclusion of a separate B supply, which is expensive. Yet very inexpensive means of meeting the situation may be employed.

A Two-Tuned Circuit Converter

The short-wave converter is a really useful device, dependable and relatively trouble-free. It is assumed that the design has been made by one whose experience with such accessories as-

(Continued on next page)

LIST OF PARTS FOR FIG. 8

(Tubes AC heated)

One engraved 5 x 6½-inch panel
One walnut finish wooden cabinet to fit.
Three ¼-millihenry RF chokes.
One 50-millihenry shielded RF choke.
One block of three 0.1 mfd condensers.
One 5 meg. grid leak.
One .00025 mfd. grid condenser with clips.
Two .00035 mfd. fixed condensers.
One .00035 mfd. variable condenser. One dial.
One short-wave coil (15 to 82 meters).
Twisted pair for heater connection to filament transformer.
Three sockets. One 300-ohm flexible biasing resistor.
Four binding posts. One coil switch.

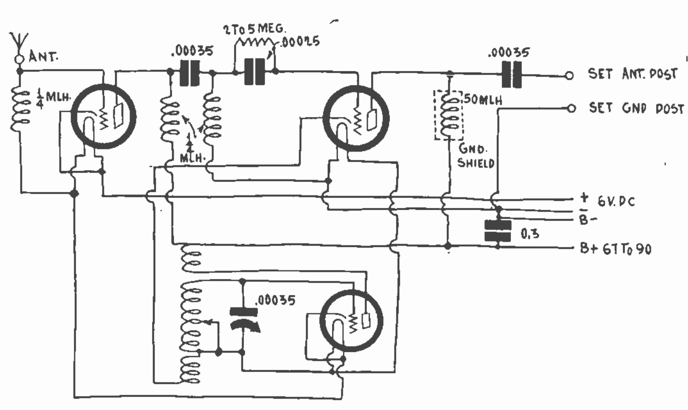

FIG. 9

THE THREE-TUBE CONVERTER, OSCILLATOR ALONE TUNED, IS SHOWN FOR BATTERY-OPERATED 227'S PARTS TO BUILD EITHER THE CIRCUIT IN FIG. 8 (LESS FILAMENT TRANSFORMER) OR FIG. 9 COST $5 OR LESS.

LIST OF PARTS FOR FIG. 9

(Tubes heated by 6-v. storage battery)

One engraved 5 x 6½-inch panel.
One walnut finish wooden cabinet to fit.
Three ¼-millihenry RF chokes.
One 50-millihenry shielded RF choke.
One block. of three 0.1 mfd. condenser (parallel-connected for 0.3 mfd).
One 5 meg. grid leak.
One .00025 mfd. grid condenser with clips.
Two .00035 mfd. fixed condensers.
One .00035 mfd. variable condenser. One dial.
One short-wave coil (15 to 82 meters).
Twisted pair for heater connection to 6-volt storage battery.
Three sockets. Four binding posts. One coil switch.

How to Get Short Waves

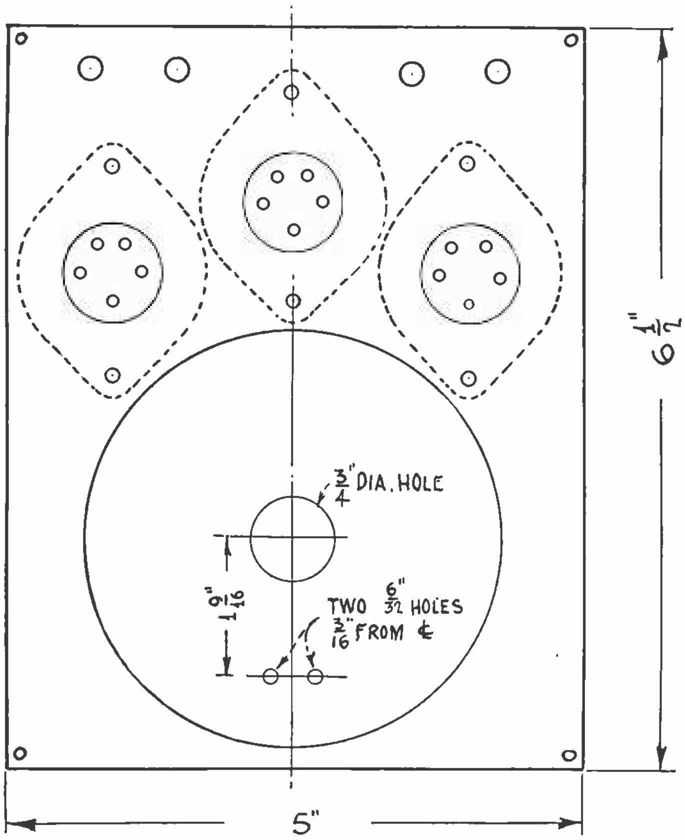

FIG. 10
DIMENSIONS FOR THE TOP PANEL OF THE CONVERTERS DIAGRAMMED IN FIGS. 8 AND 9. THE LARGE RING REPRESENTS A 4" DIAL. HEATER LEADS WILL EMERGE AT CABINET REAR. THE COIL SWITCH WILL BE AT CABINET FRONT.

sures his competency, and that the wiring is carefully duplicated. Deviations from recommended design may be all right in broadcast receivers, but since the problems encountered in short-wave work are much greater, it is doubtful whether any such changes should be introduced into converters, unless the builder himself is highly qualified in radio engineering knowledge in the short-wave field, or is willing to stake reception on his chances of instituting an improvement.

Fig. 5 shows a 2-tube converter, with a tuned modulator (upper tube) and a tuned oscillator, using 227 tubes. It is not necessary to use independent tuning controls, unless one desires to tune in above 120 meters, as when the short wavelength increases beyond that, it is not possible to satisfy the frequency requirements by single tuning control of ganged condensers, even with a relatively large trimmer manually operated, since the inductance requirements become diverse.

When the frequencies are higher, slight difference in capacities will account for large differences in frequency, and single control is all right. An exception exists, however, if the tuning condensers are of small maximum capacity, say, .0001 mfd. or .000125 mfd., and a large number of plug-in coils used, say, five or more for each tuned circuit, to cover from 15 to 200 meters.

Notice that in Fig. 5 it is necessary to pick up a B voltage of 180 volts or less.

The modulator and oscillator circuits are coupled by a small condenser, E, shown to lower left of the detector tube. The capacity is adjustable from 20 to 100 mmfd., but once set is left undisturbed. However, the condenser E, across the modulator grid coil, should be panel mounted, for variation. Its maximum capacity may be 50, 75 or 100 mmfd. It would be preferable in the oscillator grid circuit, except that it would introduce a confusing factor, altering the dial settings and rendering logging uncertain.

The coils are identical for the two tuned circuits of Fig. 5.

Fig. 6, diagramming the battery model of the same circuit shown in Fig. 5, includes only these changes: omission of the filament transformer, inclusion of the filament resistors, change in the grid return of the modulator, substitution of 201A tubes for 227 tubes and split-up of B voltages.

The amount of radio frequency amplification ahead of the modulator and the number of tuned circuits to use are problems to be decided.

It is possible to build a converter that consists only of a single tube, for instance, any one of the circuits shown in Figs. 1, 2 3 and 4. We have an oscillator, by establishing a sufficient degree of feedback and not molesting it, and also have a modulator, for the circuit is arranged in familiar fashion for detection.

By changing the output slightly and omitting the plug-in feature, we have a converter.

The antenna circuit receives all waves, and these of course include the short waves. Therefore, the frequency desired to be received is received without tuning. Then the oscillator is tuned, and as its condenser is rotated the frequency of oscillation changes, and the frequency response of the system changes. Since the intermediate frequency is fixed, we have all the necessary components: modulator, manually tuned oscillator and intermediate frequency.

With such a circuit the grid leak should be of lesser resistance value. Anything of the order of megohms likely will produce an audio note in the speaker, which may be varied slightly in pitch by turning the tuning condenser, but without receiving any short-wave stations. Leak values of 50,000 ohms or less should be used.

The possibility of receiving short-wave stations, when this critical circuit is properly adjusted, does exist, but its strongest attraction is theoretical, and practical results are next to worthless.

It can be established by any experimenter that some radio frequency amplification is advisable in a converter, for then the amplitude of the short-wave is raised to a sufficient level to enable a substantial input to the receiver. If this amplitude is too low, signals will be barely audible on the speaker, unless the receiver itself is overloaded to produce the desired volume. This overload consists usually of utilizing the volume control at its setting for maximum response which may cause the receiver itself, normally stable, to oscillate, due to the introduction of the converter. The oscillation, however, may be checked by the volume control in most of the modern circuits, but the setting of this control becomes extremely critical, and the required gradation in resistance is not present in the volume control itself. The one-tube converter therefore, is about on par with the one-tube adapter.

Another possibility of resorting to only one tube in a converter is to use a crystal for modulation. But this method, while better from the viewpoint of stability than the autodyne or combination oscillator-modulator tube, again provides such small sensitivity that no satisfactory results need be expected.

We come then to the converter that uses a stage of radio frequency amplification. Already we have found that the principal selectivity is derived from the intermediate amplifier which is in the receiver itself, and when only the oscillator is tuned the intermediate amplifier's selectivity is all the selectivity you can obtain. Yet this is sufficient. No more than one manually tuned circuit is necessary. Hence great simplification may be achieved without any really harmful sacrifice. For amplification alone, disregarding selectivity, we may as well use untuned stages. At least one RF stage is highly advisable, and no results of any consequence were achieved in any of the designs tested unless there was some radio frequency amplification ahead of the modulator.

Fig. 8 shows the circuit of a converter using an untuned stage of radio frequency amplification, a modulator and an oscillator. It is a circuit useful anywhere, if the location is supplied with alternating current electricity, and is useful with any receiver, whether battery-operated or not. The receiver's power source, tubes and the like do not enter into consideration so far as the converter is concerned, as the converter merely delivers to the receiver a frequency that the receiver can amplify.

The Four Connections

Four connections are made to the converter:

1. The aerial is removed from the antenna post of the receiver and is connected instead to the antenna post of the converter.

2. The ground post of the converter is connected by a wire lead to the ground post of the receiver. The ground is left connected to the ground post of the receiver.

3. The output of the modulator (marked "Set Ant. Post" on the diagram) is connected by a wire to the vacated antenna post of the receiver.

4. Positive B voltage is connected to the plus post of the converter. This voltage need be only high enough to insure oscillation, and may be from 45 volts to 90 volts.

If one has a screen grid receiver he may obtain this positive voltage from the screen of one of the radio frequency amplifier tubes in the set. The end of the wire from the converter's positive post may be bared for three-quarters of an inch, and looped so as to fit over the screen prong of a tube removed from a radio frequency socket. In the battery type tubes, 222 and 232, the screen lead is the left-hand rear one, as you regard the socket from the top, with filament springs toward you. In the five-prong tube, 224, the screen spring is the apex of an isosceles triangle of which the heater springs represent the points of the base angles.

(Continued on next page)

Coils for One-Tube Set

By William C. Johnson

[Herewith is the second and final instalment of an article dealing with a one-tube all-wave receiver.—Editor.]

THE data on the winding of the short-wave coils promised in last week's issue are given herewith. Note that there are five principal short-wave coil windings that cover more limited portions of the scale than do most of the commercially available coils, for the reason that this division results in the obtaining wider dial separation.

Heavy conductor for the set wiring and the coil windings results in a considerable reduction of radio frequency resistance. both for the coil and the set as a whole.

The inclusion of a general range broadcast coil, as well as the special sharply tuned limited range coils, will provide the builder of this small and highly effective set with a tuning system that will give the most in reception of stations per dollar spent, whether you look at it from the standpoint of utility or purely experimental interest.

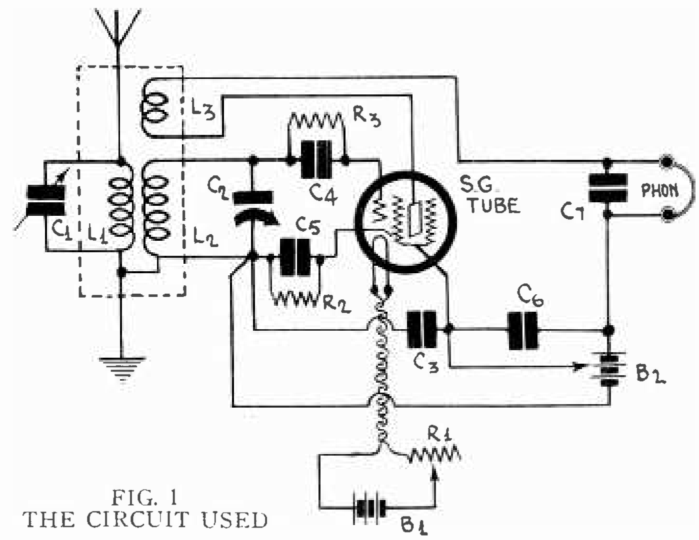

FIG. 1
THE CIRCUIT USED

Coils for the Circuit

Condenser C7 may be from .0015 to .0005 mfd., and C6 and C3 may be 0.1 mfd. each.

The inclusion of the .00035 mfd. filter tuner condenser (C1) in the circuit when short-wave reception is desired is not strictly necessary, but in the case of reception between 1,500 and 500 meters, with the regular broadcast coil, it is necessary, and works well too.

List of the Coils.

0 to 5 meters: Secondary, 3 turns of No. 12 B & S gauge bare copper wire, turns spaced ½ inch apart. Primary, 4 turns spaced 7/16 inch apart. Separation between primary and secondary, 7/16 inch.

3 to 10 meters: Secondary, 5 turns of No. 12 B & S guage bare copper wire, spaced about ⅜ inch; primary, 8 turns of No. 18 B & S gauge copper wire, spaced ⅜ inch. Separation between windings, 7/16 inch.

8 to 20 meters: Secondary, 8 turns of No. 12 B & S gauge bare copper wire, spaced ⅛ inch; primary, 10 turns of No. 16 B & S gauge copper wire, turns wound close. Separation between windings 7/16 inch.

15 to 90 meters: Secondary, 8 turns of No. 18 B & S gauge wire, turns spaced 1/16 inch; primary, 8 turns of No. 18 gauge wire, wound close. Separation between windings, ¼ inch.

70 to 199 meters: Secondary, 18 turns of No. 18 B & S gauge wire; primary, 10 turns of No. 18 gauge wire wound close. Separation between windings, ¼ inch.

Broadcast coil turns.

1,500 to 500 kilocycles: Secondary, 64 turns of No. 24 S. S. C.; primary, 30 turns of No. 26 S. C. C. Separation ¼ inch. This coil operates with the .00035 mfd. tuning filter condenser across the primary; .0005 mfd. across secondary.

Diameters to Use

All coil secondaries are 2½ inches in diameter, and all primaries are exactly 2 inches in external diameter, these two sizes of bakelite are easy to obtain. Air dielectric forms are available for the 2½ inch diameter the same as used in precision all-wave commercial coils.

It is recommended that wherever possible, and especially in the case of the short-wave coils, that bare copper wire be used, and if it is soft drawn, so much the better, as it will handle easily. To further facilitate matters, where the No. 12 gauge is used you can either carefully file a spiral groove, on the bakelite tubing, or if you have access to a lathe, merely use one of the standard thread-pitches, and you are all set.

It also may be necessary to cement the turns of some of the coils, in which case you are to use only pure collodion, and nothing else, and in the case of the first two short-wave coils the use of cement is really taboo.

The use of heavy conductor to wire up the radio frequency circuits is due to two things, one the necessity of keeping the surface resistance as low as possible, and the other because in the operation of short-wave receivers self-supporting wires are more likely to keep constant mutual capacity between the various RF circuits and parts and connecting leads.

Use of Heavy Wire

Nearly a hundred years ago it was found that very high frequency currents did not permeate the cross-section of a conductor but instead they tended to travel on the surface. Actually, careful measurement showed that these oscillatory currents flowed to a certain depth that depended on the frequency and also depended on the power that was dissipated. The range of frequency over which this effect was experimented with includes the present-day short-wave spectrum.

Therefore as in a receiving set there is generally no power to waste, especially in the RF end, it becomes important to save all the energy you can.

In the case of a short-wave set, due to the effect of surface resistance, the response below 20 meters is likely to get uncertain because of the relatively rapid increase of the frequency as you approach 10 meters or less. The effect is analagous to what happens when you try to make a pail hold more water than it will naturally. In other words the presence of excessive surface resistance produces a limited capacity effect and the excess induced charge merely leaks off and is wasted.

This same effect also occurs with broadcast coils, though not to such an observable extent, it being confined to the higher frequency end of the response range, in this case.

The general dimensions of a shield for this set are, 15 inches, by 9 inches deep, by 9 inches high, and the material is either 1/16th aluminum, or 1/32nd copper, so made that the top is removable.

This is a large shield but if smaller is used it will be found that the performance whether on long or short waves will be seriously impaired. Use of a shield is optional.

¼-Millihenry Choke Coils for Short Waves

(Continued from preceding page)

Simply slip this bared wire noose over the screen prong of the tube and replace the tube in the radio frequency socket. Then the screen voltage is communicated to the converter as the positive voltage, and for battery type tubes will be about 45 volts, while for the 224 tube it will be from 50 to 75 volts maximum, and in any instance is usually adjustable, since volume controls commonly govern the screen voltage. In some receivers the screen voltage of only one or two tubes is affected by the volume control, so you should select a socket that provides the desired control.

The wire noose is a makeshift, and it is better to use an adapter which consists of two wafers, punctured for the socket holes, with tiny phospher bronze contacts in the screen hole. A lug protrudes from the wafers between which it is sandwiched, and there is no danger of shorting to ground, as would be present were a set used with metal chassis, and the noose wire made contact with the subpanel or a grounded socket shield.

Thus with some ingenuity the B voltage may be obtained readily from a screen grid receiver, and that item of simplicity was one of the causes for selecting 227 tubes throughout for the converter shown in Fig. 8, since relatively low plate voltages then are sufficient.

There are only three unusual points in regard to this converter.

(Continued next week, November 15th issue.)

Coils for Sh

By Einar

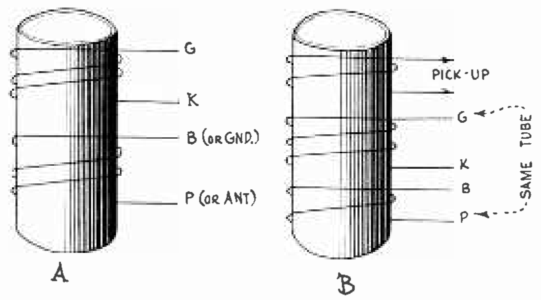

FIG. 1
THE DIRECTION OF WINDING, AND POINTS OF CONNECTION, FOR AN ANTENNA COIL OR INTERSTAGE COIL (A), AND FOR AN OSCILLATION COIL. COIL A REQUIRES ONLY A FOUR-PRONG BASE, BUT COIL B REQUIRES AT LEAST A FIVE-PRONG BASE.

COILS for short-wave converters can be made by winding a few turns on old tube bases from which the sealing wax has been removed or on forms of the same diameter specially made for short-wave coils. The number of turns to put on in any case depends on the size of the tuning condenser and on the diameter of the wire used for the tuned windings, or rather on the number of turns per inch.

Suppose we have a tuning condenser having a capacity range from 25 mmfd. minimum to 150 mmfd. maximum, these capacity limits including the distributed capacity of the coil and the tube. Then we have a capacity variation of 125 mmfd. Further, suppose that we use No. 22 double cotton covered wire for the tuned windings and that we wind the turns with only the separation imposed by the thickness of the insulation. This wire winds 29 turns to the inch on an average.

The diameter of a tube base is 1 and 11/32 inches. But the effective diameter of the coil is the distance between the centers of the wires on opposite sides of the coil. That is, to get the total effective diameter we have to add the diameter of the wire to the diameter of the form. Therefore the total effective diameter is 1.378 inches. It comes out slightly greater than that but the small fraction is dropped because of the fact that the insulation is somewhat compressed in winding.

Winding for Largest Coil

The so-called short-wave limit is 1,500 kc. (200 meters), the high frequency limit of the broadcast band. A short-wave set readily may reach this frequency. If the maximum capacity of the tuning condenser is 150 mmfd. we will need an inductance of 75 microhenries to tune down to 1,500 kc. This will be obtained with 12.9 turns of No. 22 DCC wire on the form specified.

Since there may be variations in any of the dimensions, such as those of the form, the insulation, the wire, and in the capacity of the condenser, and since all these may possibly be in the direction of making the coil too small, it is best to put on 15 turns of the specified wire (coil No. 3).

This refers to the tuned winding only. There will also be a primary if the coil is to be used as radio frequency transformer, a tickler if the coil is to be used as oscillator, and in some cases there should be a pick-up winding on the oscillator coil. If the RF transformer is to be used in the antenna circuit primary should have about 5 turns of any size wire from No. 22 to No. 30. There need be no separation between the windings although 1/8 or 1/4 inch is all right. This primary is also suitable if the coil is used after a tube like the 227, 112A, 230, 201A, 199 or any tube having an amplication constant of about 8. If the coil is to follow a screen gird tube, the primary should contain about 12 turns, and these turns be of any size wire, preferably No. 30 or smaller.

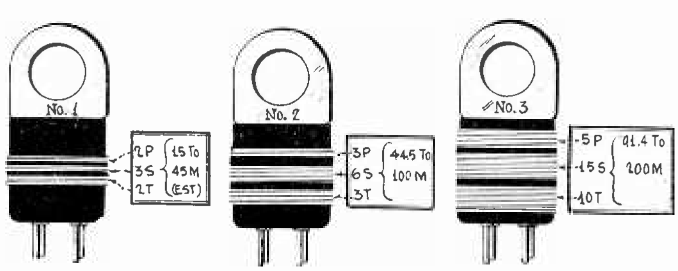

FIG. 2
THE THREE COILS REQUIRED FOR TUNING WITH A .00015 MFD. CONDENSER TO COVER FROM 15 TO 200 METERS, P REPRESENTS PRIMARY, S SECONDARY, AND T TICKLER. THREE WINDINGS ARE SHOWN ON ALL COILS, SINCE FOR TWO-WINDING COILS IT IS NECESSARY ONLY TO OMIT T. THREE-WINDING COILS REQUIRE A FIVE-PRONG OR A SIX-PRONG SOCKET BASE AND SOCKET, DEPENDING ON THE CIRCUIT. FINGER HANDLES MAY BE USED.

In case the radio frequency transformer follows a screen grid tube such as the 222, 232 or 224, the primary winding in the plate circuit should contain about 10 turns of some fine wire preferably smaller than No. 30.

The pick-up winding on the oscillator coil depends on the type of circuit in which it is used. If the pick-up is connected in the grid circuit of the modulator, in which there is already a circuit tuned to the carrier, four or five turns are sufficient, and these may consist of any size wire convenient to handle. A separation of one-fourth to one-half inch between the pick-up and the tuned winding is recommended whenever possible. If, on the other hand, the pick-up winding is in the screen circuit of a screen grid modulator tube, it may have twice the number of turns. Also, if it is in the cathode circuit of a modulator, the number of turns may be the same as if for a screen circuit.

The Middle Coil

The next largest coil in the short-wave set should tune to such a frequency that there is a small overlapping of the tuning ranges of the two. The 15-turn coil has an inductance of about 94.5 microhenries and therefore it will tune to 3.28 megacycles (91.4 meters) when the tuning condenser is set at 25 mmfd. Therefore, if we make the next coil such that it will tune to 3 megacycles (100 meters) when the condenser is set at 150 mmfd., there will be sufficient overlapping. This will require inductance of 18.8 microhenries, which will be given approximately by 5.5 turns of No. 22 DCC wire. Six turns will be all right.

It is well to point out that when coils are wound on tube bases it is not practical to use a whole number of turns. Due to the position of the prongs there will always be fractional turns. The fraction may be 1/4, 1/2, or 3/4 when the coil is wound on a four-prong (UX) base, and multiples of one-fifth when it is wound on a five-prong (UY) base. If it is convenient to make the number of turns greater by one-half turn or so than the number specified, no serious error is made.

Auxiliary Windings

For the tickler winding on the oscillator coil and the primary of the RF transformer which is to follow a screen grid tube, four turns will do, or four plus the fractional turn imposed by the position of the prongs. Fine wire may be used for either of these windings, that is, tickler or RF primary. If the coil is to follow a general purpose tube the turns may be reduced to three and a convenient fraction. If the primary is to be in the antenna circuit two turns of No. 22 wire will do, with or without a small separation between the windings.

The six-turn coil will tune to about 6.72 megacycles when the tuning condenser is set at 25 mmfd. This is equivalent to 44.5 meters. At least one more coil is therefore necessary to reach down to 15 meters. To calculate this coil is not practical, due to the large effect of small variable factors, but on the basis of ratios we obtain a coil of a little under 3 turns so that the smallest coil should contain this number in the tuned winding. The auxiliary windings should be reduced in the same proportion as near as is practical.

It must be remembered that these coils were derived on the assumption that the minimum capacity in the tuned circuit is 25 mmfd. It it quite possible that it will be less than this so that in each case the coil will tune to a higher frequency than was assumed. This means that the overlapping will be greater than assumed and also that the smallest coil will tune well above 20 megacycles (below 15 meters). The value of the minimum capacity in any case will depend much on the wiring and on the placement of the coils with reference to other conductors in the circuit, such as condenser plates and shielding.

While a reduction in the distributed capacity will increase the highest frequency of each coil, it will not widen the tuning range of any coil in the same proportion, because it will also increase the lowest frequency to which any coil will tune. This was provided for when all the coils were made a little larger than required by the assumed capacities.

Connecting the Leads

There is no standard method of connecting the coil leads to the prongs of the tube base. However, forms specially made for coils of this type usually are marked G. F. P. and B, and these designations may be followed. The prong marked G is

ort Waves

Andrews

the one that plugs into the grid receptacle of the socket, the one marked F the one that plugs into F minus, or the left filament receptable, the one marked P is the one that make contact with the plate spring in the socket and the one marked B the one that contacts with the usual F plus.

In some instances when these suggestions are followed the grid and plate wires are crossed in the set, which is not desirable. It would be better to connect the coil to the plug so that these two were reversed. In other cases the layout is such that it does not make any difference. The same general scheme is followed in respect to five-prong plugs, K being used for F and the two heater terminals for one of the auxiliary windings. Some coils require six terminals, and for these a special six-prong plug and socket are necessary.

Connection of Terminals

The proper method of connecting the leads of a radio frequency transformer or oscillator coil is shown in Fig. 1. "A" represents a radio frequency transformer, used either for antenna coupler or inter-tube coupler. The two windings are put on in the same direction. In the figure the direction is that of a right-handed screw, but it could just as well be that of a left-handed screw.

When the two windings are put on the same form, end for end, one extreme should go to the grid of the tube following and the other extreme should go to the plate of the tube preceding, or to the antenna. The interior end of the grid winding should go to the cathode, ground, or C minus, depending on the circuit in which it is used. The interior end of the plate should go to the positive of the B supply, or to ground in case the coil is used as antenna coupler. Thus the plate return and grid return connections adjoin.

Connection of Oscillator

The winding and connection of the leads of the oscillator coil are exactly the same as those of the radio frequency transformer, except that the two extreme terminals are connected to the same tube, as shown in "B."

"B" also shows the position of the pick-up winding with respect to the tuned winding. The pick-up and the plate windings should be on opposite sides of the resonant winding. There are two ways of connecting the pick-up winding no matter where it is connected in the circuit and one is as good as the other.

When the coils are wound on tube bases or similar forms a small hole should be drilled through the form for each lead, directly over the prong to which it is to be connected. The lead should be put through the hole and then down to the prong, where it should be soldered neatly. Before the holes are drilled they should be located very carefully over the proper prong on the form and also at the proper distance up.

Data on .0005 Mfd. Tuning

If a .0005 mfd. tuning condenser is used, the inductance required to tune to 1,500 kc is 22.54 microhenries, and this is given by 10.5 turns of No. 22 DCC wire on the tube base form. Primary would have 5 turns and the tickler 7 turns. This coil will tune down to 44.7 meters, assuming that the minimum capacity in the circuit is 25 mmfd. Another coil is needed to cover the entire short-wave band down to 15 meters. Computation of turns for this coil does not mean much because of the variables that must be expected. However, if 3 turns are put on for the tuned winding and 2 for the primary or tickler the range of this coil will be approximately correct.

The problem of determining the correct number of secondary turns for the smallest coil of the three-coil series, or the smaller coil of the two-coil series, may be solved experimentally by using a short-wave circuit with a stage of tuned radio frequency amplification and a tuned detector stage, a separate tuning condenser and dial for each circuit. There must be no gauging of condensers. Then with the next largest pair of identical coils plugged in, tune in a station at very near the lowest capacity setting of both condensers, representing approximately the highest frequency thus receivable. Then remove one coil, leave the other as it was, and do not disturb the dial setting. Wind the intended smaller coil and put it in the vacated coil socket, tuning only the condenser across this coil. If the new coil is correct the station will come in at nearly full capacity of the tuning condenser thus experimentally used. If the setting is much less than full capacity, reduce the inductance of the secondary. The other windings, primary and tickler, are not critical.

Special Forms

All the coils described are intended for plugging into tube sockets, but never put a coil in a socket wired in circuit for a tube, or vice versa.

The ordinary tube bases or special forms of similar structure are of bakelite which may contain considerable iron and other metallic particles. Hence when short-wave coils are wound on these forms the efficiency may not be as high as when the forms are made of special, low-loss material, although there will be plentiful reception. There are special materials available which use specially treated bakelite to reduce losses. One manufacturer designed a short-wave set around ordinary forms. Then he substituted low-loss forms and found that he had to design the tickler because the oscillation was too violent.

On the subject of distributed capacity, resort to space winding will result in smaller such capacity. A groove is cut in screw-thread fashion and the wire is wound in this groove. The separation between turns thus is increased, the capacity between turns decreased, and the thickness of insulation on the wire becomes of slight consequence. In fact, bare wire could be used. These refinements are available usually only in commercial coils.

Some coils forms made in the form of tube bases, but somewhat longer, have a diameter considerably less than regular tube bases. For example, one form has a diameter of 1.25 inches. When short-wave coils are wound on these forms more turns should be used than when the corresponding coils are wound on tube bases. When the forms are as large as 1.25 inches, one turn could well be added one more turn on the secondaries of the two smaller coils can be used and two or three turns more on the larger coils. Since the diameter and the number of turns enter into the formula in nearly the same manner it is safe to go on the assumption that the product of the turns and the diameter should be the same for the two different sizes of forms. Thus if the diameter is reduced by a certain amount the number of turns should be increased in the same proportion, or vice versa.

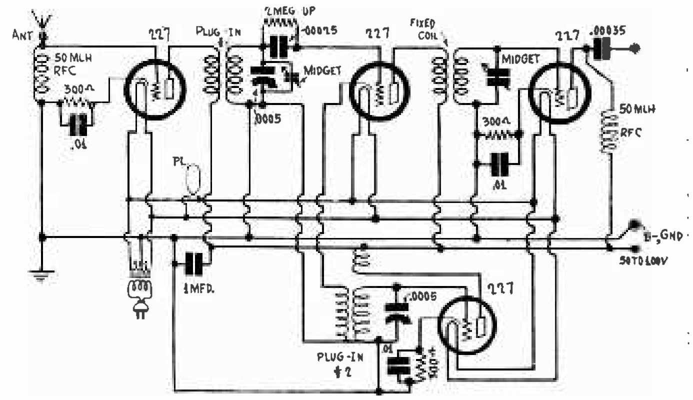

FIG. 3
ONLY TWO COILS ARE NECESSARY TO TUNE FROM 15 METERS TO 200 METERS IF THE TUNING CAPACITY IS .0005 MFD. THE WAVELENGTH COVERAGE OF EACH COIL IS IN TEXT. THE SMALLER IS ESTIMATED, BUT MAY NOT RESPOND EXACTLY TO THE STATED FREQUENCY RANGE STATED, WHICH IS TRUE ALSO OF COIL NO. 1 IN FIG. 2.

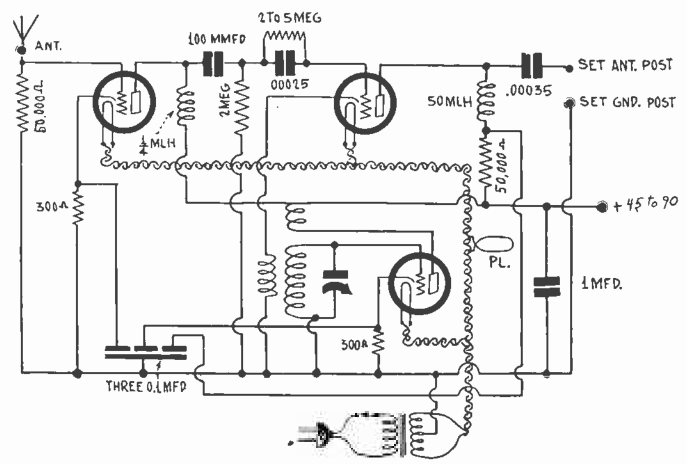

FIG. 4
THIS IS A DIAGRAM OF A SHORT-WAVE CONVERTER IN WHICH THE OSCILLATOR IS A THREE WINDING COIL. A FIVE PRONG BASE IS NEEDED SINCE TWO OF THE SIX TERMINALS MAY GO TO THE GROUNDED PRONG.

Short-Wave Stati
and How to T

By Adam

TUNING for short-wave stations is like fishing. It requires skill, patience, and a good outfit. The equipment for tuning in short-wave stations consists of a good converter or short-wave set and a list of short-wave stations. As part of the set a slow motion dial without any backlash is a great help in coaxing in the elusive remote stations.

The list of short-wave stations is helpful mainly by reference to stations already received. Some short-wave stations are so strong that they will come in without any special nursing while others are most elusive. Take, for example W2XAD in Schenectady, N. Y. It can be picked up without trouble in most parts of the United States. It works on a wavelength of 19.56 meters, Now the list of short-wave stations shows that F8BZ, Agen, France, works on 19.5 meters, which is just one shade under Schenectady station on the dial, and it also shows that the Danish station at Lyngby works on 19.6, which is even closer on the dial than the French station, but in the opposite direction.

Another General Electric at Schenectady works on 21.96 meters, which has for neighbors in the spectrum of W6XN, Oakland, Calif., and VPD, Fiji Islands, working on 23.35 and 20.7 meters, respectively. Both are long shots from the Eastern parts of the United States and a chart of stations is a helping hand.

Preparing a Calibration Chart

After a few strong stations have been located on the dials great help in locating distant stations may be obtained from a calibration chart constructed from the stations of known frequency or wavelength. A line, or curve, drawn through the known points will also contain, at least approximately, the distant stations so that when it is desired to tune for a given station it is only necessary to consult the chart and obtain the dial readings. While the station may not be received on the dot, it should at least be found within one division of the dial. The advantage of having to explore only one division on each dial over 100 of them will be appreciated by every one.

Most of the short-wave stations are code, which may be unintelligible to many short-wave fans. But there are many voice stations throughout the world, enough to make fishing for them interesting. Even some of these may be quite unintelligible because they will carry announcements and speeches in strange languages. The thrill of receiving them will be none the less exhilerating. Indeed, it may be enhanced by the strangeness. These particular stations will be of little aid in constructing the chart since the announcement of the wavelength will not be understood. Those who understand code have an advantage in this respect for announcements of stations are made in a universal code language.

Careful Tuning Essential

Extreme care in tuning for the short-wave stations is essential, for on a division on the dial it may be strong and on 0.1 of a division it may be entirely gone. Such fine tuning is not possible without a very good dial or without condensers which turn without any lost motion. Sometimes when there is backlash in the dial or in the condenser a station may be heard in passing a certain point. Returning for it, it is no longer there. It is again heard a few divisions away. It is next to impossible to stop on the desired spot when there is considerable backlash. This objectionable play may be between the condenser and the rest of the set, so that in mounting the tuning condensers care should be taken that everything is reasonably rigid.

When to Listen

This does not mean that the tuning condensers should be hard

Right or Wrong?

Questions

(1)—If a screen grid tube is used as a grid bias detector working into a high resistance with a fixed voltage in the plate circuit, the best detecting point can be found by varying either the grid bias or the screen voltage.

(2)—It is not safe to connect two 280 tubes in parallel to boost the rectified current because the tubes may be slightly different and if they are one of the tubes will take all the load.

(3)—It is the horizontal portion of an antenna that is effective in picking up signals. The vertical portions serve no other purpose than to connect the horizontal antenna to the receiver, and for that reason it is called the lead-in.

(4)—When a grid leak and a condenser are used for detection with a 200A tube the grid return should be made to the positive end of the filament.

(5)—If both the primary and the secondary of a radio coupling transformer are tuned the selectivity of the coupler is less than if only one of the windings is tuned.

(6)—The only advantage silver plating on copper wire has over plain copper in radio frequency coils is that it looks better and does not corrode.

(7)—When power detection is used the best value of grid bias resistance is 20,000 ohms.

(8)—Two equal inductance coils connected in parallel without any coupling between them form an inductance one-half the value of either coil. In this respect the inductances combine in the same manner as resistance.

(9)—The distortion introduced into the signal by the cutting of sidebands can be compensated for in the audio amplifier by amplifying the higher audio notes more than the low.

Answers

(1)—Right. The best detecting efficiency occurs near the point where the curvature of the grid voltage, plate current characteristic is greatest, and the characteristic can be shifted with respect to the axis of ordinates by varying the screen voltage, keeping the plate and grid voltages constant or the operating point can be shifted by varying the grid bias, keeping the other two voltages constant. Therefore the operating point and the point of highest detecting efficiency can be brought together by varying either the screen voltage or the grid bias.

(2)—Wrong. It is quite safe to operate two 280 tubes in parallel. The tubes will divide the load between them even when their characteristics differ. If they are exactly equal each tube will take one half of the load.

(3)—Wrong. It is the vertical portion of the antenna that is most effective in picking up radio waves. The higher this is the more effective is the antenna. The horizontal portion adds a little to the effective height of the antenna and it also makes the antenna a little directional.

(4)—Wrong. This tube takes a negative return of the grid. Damping, wherever it may occur, tends to level out the response High vacuum tubes take a positive return.

(5)—Right. The interaction between the two coils is such that there are two points of maximum intensity with a decided dip where the single resonance should come in. Both the volume and selectivity are lower. As the coupling between the two tuned circuits decreases, the two maxima merge and the selectivity and the volume increase. But the coupling must be very loose if there is to be a single maximum and if this maximum is to show an increase in the selectivity.

(6)—Right. While silver is a better conductor than copper its conductivity is only a small percentage higher. No appreciable advantage would accrue even if the coil were wound with solid silver wire. Then the silver plating is so thin that the silver does not add to the conductivity of the coils to any measurable degree.

(7)—Wrong. The value of the bias resistor depends on the type of load in the plate circuit as well as on the applied plate voltage. In one circuit 20,000 ohms may give best results while in another 15,000 or even 10,000 ohms may give better results. Even higher bias resistance than 20,000 ohms have been used advantageously.

(8)—Right. An inductance can be treated as an impedance or a pure resistance and two inductances in parallel without mutual inductances between them combine in exactly the same manner as resistances.

(9)—Right. Since the only distortion introduced by the tuner is a reduction in the higher audio frequencies in comparison with the low, if the audio frequency amplifier is designed so that it amplifies the highs more than the low in the proper proportion, equalization can be effected.

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Tolworthy

to turn, for if they are, exact tuning becomes difficult and long distance stations still more elusive.

When is the best time to listen for short-wave stations? Any time during the 24 hours of the day, for short waves may travel half around the world and every hour of the day is represented around the world simultaneously. When it is noon in New York, it is midnight somewhere in China and Japan. When it is noon in London, it is midnight in Hawaii and other Pacific Ocean islands. While you are at breakfast, somebody else in another part of the world is listening to the evening's entertainment; while you are eating dinner, somebody else is listening to eye-openers on radio. So the time to listen is when you have a chance.

The time to listen for a particular station is another matter. Entertainment is usually broadcast in the afternoon and evening. local time. If a distant station is the "mark" the receiver must be tuned at a time when the station is on the air, and that may be early or later, depending on the distance between the transmitter and the receiver and the direction.

If one wants to listen to Western European stations in the Eastern part of the United States it is necessary to allow for a time difference of about 5 hours, remembering that any given hour in Western Europe occurs 5 hours before the same hour occurs in the East. If one wants to listen to South American stations it is only necessary to allow two or three hours in the same direction. It might help to remember that the meridian of Chicago passes through the West coast of South America, so that those living in the Central West need not allow for any time difference when listening for stations west of the Andes.

How to Listen

While more stations may be heard and identified with headphones, any station that cannot be heard with a loudspeaker should not be counted as received. It is just as easy electrically to bring in a station on the loudspeaker as on the headphones, and much more easy from the point of view of comfort.

It must be realized that to the uninitiated the short waves are most erratic. At one time the signals from a remote station may be very strong while at another time they cannot be heard at all, or they may be subject to fading. When a given station fades, periodically or permanently, the thing to do is to try another wave band and try for stations in that band. Possibly the station you were just listening to will be there to greet you on the other wavelength, for radio engineers now understand some of the vagaries of radio waves. They did not change ot suit you but because they knew about the fading.

List of Short Wave Stations

Meters kc Call Location

12.2—24,550—FZA—Madagascar.
13.4—22,350—FZT—Madagascar.
14.0—21,400—LSH—Buenos Aires.
14.5—20,650—PMB—Bandoeng, Java.
14.6—20,500—DIV—Nauen, Germany.
14.83—20,200—DGW—Nauen, Germany.
15.02—19,950—DIH—Nauen, Germany.
15.03—19,925—LSG—Buenos Aires.
15.04—19,900—DIH—Nauen, Germany.
15.1—19,830—SPU—Rio de Janeiro.
15.29—19,600—DFA—Nauen, Germany.
15.4—19,450—FZV—Madagascar.
15.42—19,425—FW3—Paris.
15.43—19,400—ZTM—St. Assise, France.
15.43—19,400—FW3—St. Assise, France.
15.5—19,325— .... —Nancy, France.
15.55—19,260— .... St. Assise, France.
15.68—19,100—PCO—Kootwijk, Holland.
15.74—19,025—PLE—Bandoeng, Java.
15.9—18,850—XDA—Mexico City, Mexico.
15.94—18.790—PLE—Bandoeng, Java.
16.01—18,700—GBJ—Rugby, England.
16.11—18,600—GBU—Rugby, England.
16.12—18,575—PDM—Kootwijk, Holland.
16.3—18,400—PCK—Kootwijk, Holland.
16.38—18,300—GBS—Rugby, England.
16.4—18,250—FZS—Saigon, Indo-China.
16.5—18,150—CGA—Drummondville, Canada.
16.54—18,100—GBW—Rugby, England.
16.57—18,075—GBK—Bodmin, England.
16.60—18,050—PCS—Kootwijk, Holland.
16.7—17,950—FZU—Madagascar.
16.8—17,850—PLF—Bandoeng, Java.
16.82—17,800—PCV—Kootwijk, Holland.
16.88—17,750—PHI—Amsterdam, Holland.
16.88—17,750—PHO—Huizen, Holland.
16.88—17,750—PLG—Bandoeng, Java.
16.9—17,725—HS1PJ—Bangkok, Siam.
17.0—17,625—PLE—Bandoeng, Java.
17.20—17,425—AGC—Nauen, Germany.
17.7—16,925—PLF—Bandoeng, Java.
18.07—16.600—PCL—Kootwijk, Holland.
18.3—16,375—G2GN—S. S. Olympic.
18.56—16,125—GBX—Rugby, England.
18.75—15,975— .... —Saigon, Indo-China.
19.5—15,350—F8BZ—Agen, France.
19.56—15,325—W2XAD—Schenectady, N. Y.
19.6—15,300— .... —Lyngby, Denmark.
19.63—15.250—W2XE—New York, N. Y.
20.0—14,975—LSJ—Monte Grande, Argentina.
20.3—14,750—FZU—Madagascar.
20.7—14,475—VPD—Suva, Fiji Islands.
21.96—13,650—W2XO—Schenectady, N. Y.
23.35—12,850—W6XN—Oakland, Calif.
24.4—12,275—FW4—St. Assise, France.
24.4—12,275—FZT—Madagascar.
24.4—12,275—KITR—Manila, P. I.
24.9—12,050—NAA—Arlington, Va.
25.0—11.975— .... —Oporto, Portugal.
25.34—11,825—W2XE—New York, N. Y.

Meters kc Call Location

25.4—11,800—W8XK—East Pittsburgh, Pa.
25.5—11,750—CJRX—Winnipeg, Canada.
25.53—11,740—G5SW—Chelmsford, England.
25.65—11,675—KIO—M. Kaukuko, Oahu, Hawaii
26.2—11,450—KIXR—Manila, P. I.
26.22—11,425—DHC—Nauen, Germany.
26.22—11.425—PHA—Nauen, Germany.
28.5—10,500—VK2ME—Sydney, Australia.
28.5—10,500—VK2FC—Sydney, Australia.
28.69—10,425—DGH—Nauen, Germany.
28.8—10,400—PLR—Bandoeng, Java.
29.5—10,150—ARI—Hongkong, China.
29.7—10,010—EAR110—Madrid.
30.0—9,996—LGN—Bergen, Norway.
30.5—9,825—FZT—Madagascar.
30.6—9,800—GBW—Rugby, England.
30.7—9,750—EAM—Madrid.
30.8—9,725—NRH—Heredia, Costa Rica.
30.9—9,700—LS—Monte Grande, Argentina.
30.9—9,700—DFF—Nauen, Germany.
31.0—9,650—SAD—Stockholm, Sweden.
31.1—9,625—7LO—Nairobi, Br. East Africa.
31.19—9,605—HJQ—Oslo, Norway.
31.2—9,600—FW3—Paris.
31.28—9,580—VK2FC—Sydney, Australia.
31.28—9.580—W3XAU—Philadelphia, Pa.
31.3—9,575—BZW—Zuzin, Germany.
31.3—9,575—VPD—Suva, Fiji Islands.
31.3—9,575— .... —Manila, P. I.
31.38—9,550— .... —Koenigswusterhausen, Germany.
31.38—8,550— .... —Zeezen, Germany.
31.4—9,540—PCJ—Eindhoven, Holland.
31.4—9,540—7LO—Nairohi, Br. East Africa.
31.48—9.520—W2XAF—Schenectady, N. Y.
31.5—9,510—FL—Paris (Eiffel Tower).
31.5—9,510—3LO—Melbourne, Australia.
31.56—9,500—VK3ME—Melbourne, Australia.
31.6—9,480—EH9XD—Zurich, Switzerland.
31.6—9.480—OXQ—Lyngby, Denmark.
31.65—9,470— .... —Paris (experimental).
31.8—9,425— .... —Posen, Poland.
31.8—9.425—XDA—Mexico City, Mexico.
31.88—9.405— .... —Koenigswusterhausen, Germany
31.9—9,400—CM2MK—Havana, Cuba.
32.0—9,360—CJA—Drummondville, Canada.
32.0—9,360—EH9XD—Zurich, Switzerland.
32.0—9,360—PHI—Amsterdam, Holland.
32.0—9.360—90C—Bern, Switzerland.
32.05—9,350—2PL—Sydney, Australia.
32.8—9,130—SUS—Cairo, Egypt.
33.0—9.075— .... —Paris (Radio Vitus).
33.17—9.030—CFH—Halifax, Canada.
33.64—8.900—LPI—Monte Grande, Argentina.
33.8—8.860—NAZ—Managua, Nicaragua.
34.64—8.650—W8XAG—Dayton, Ohio.
34.69—8.640—W2XV—Long Island City, N. Y.
34.8—8.610—FZV—Madagascar.
34.86—8.600—KWT—Palo Alto, Calif.
35.0—8.500—HKCJ—Manizales, Colombia.
35.0—8,500—RA97—Khaborovsk, Siberia.

Meters kc Call Location

35.0—8,500—VER—Ottawa, Canada.
35.5—8,440—WSBN—S. S. Leviathan.
36.0—8,320—G2AA—Rugby, England.
36.0—8,320—3KAA—Leningrad, Russia.
37.0—8,100—EATH—Vienna, Austria.
37.0—8,100— .... —Paris (Radio Vitus).
37.0—8,100—HS4PJ—Bangkok, Siam.
37.0—8,100—W6XF—Los Angeles, Calif.
37.36—8,020—NAA—Arlington, Va.
38.0—7,875—F8BZ—Agen, France.
38.98—7,700—IDX—Rome.
39.1—7,660—FZT—Madagascar.
40.2—7,450—YR—Lyon, France.
40.5—7,400— .... —Eberswalde, Germany.
41.0—7,300—CGL—Winnipeg, Canada.
41.45—7,225—DOA—Doberitz, Germany.
41.5—7,220—HB9D—Zurich, Switzerland.
41.7—7,175—VK6AG—Perth, Australia.
43.0—7,960—EAK—Madrid.
43.5—6,880— .... —Rome.
43.6—6,870—ANH—Kothen, Germany.
43.86—6.825—VRY—Georgetown, Br. Guinea.
47.5—6,300—VE9AP—Drummondville. Canada.
48.00—6,240—HKC—Bogota, Colombia.
48.00—6,240— .... —Manila, P. I.
38.3—6,200—LON—Buenos Aires.
48.5—6.175—HKT—Bogota, Colombia.
49.0—6,110— .... —Paris (Eiffel Tower).
49.0—6,110—ARI—Hongkong, China.
49.02—6,105—W2XE—New York, N. Y.
49.18—6,100—W3XAL—New York, N. Y.
49.36—6,075—W9XAA—Chicago, Ill.
49.4—6,060—UOR2—Vienna, Austria.
49.46—6.055— .... —Motala, Sweden.
49.5—6,050—W3XAU—Philadelphia. Pa.
49.5—6.050—W8XAL—Cincinnati, Ohio.
49.83—6.010—W9XF—Chicago. Ill.
49.9—6.000—W2XAL—New York. N. Y.
49.9—6,000— .... —Motala, Sweden.
49.95—5,995—HRB—Tegucigalpa. Honduras.
50.0—5,990—GAJ—Karlsborg, Sweden.
50.0—5,990—RFN—Moscow, Russia.
50.0—5,990—WHP—Harrisburg, Pa.
50.0—5,990—ZL3CZ—Christchurch, N. Z.
52.5—5.700—VE9CL—Winnipeg, Canada.
55.0—5,445— .... —Rugles, France.
58.0—5.160— .... —Prague, Checoslovakia.
59.5—5,030—FZU—Madagascar.
62.5—4.790—W8XK—East Pittsburgh, Pa.
67.76—4,420—DOA—Doberitz, Germany.
70.0—4.275—OHK2—Vienna, Austria.
70.0—4,275—RA97—Khaborovsk, Siberia.
70.1—4,270—RFM—Russia.
74.72—4.000—NAA—Arlington. Va.
82.9—3.610—DOA—Doberitz, Germany.
84.25—3.550—D7RL—Copenhagen.
98.9—3.000— .... —Motala, Sweden.
104—2.880— .... —Mailand.
107—2,800—W2XCR—Jersey City, N. J.
139.5—2,145—W2XCAW—Schenectady, N. Y.
142.5—2,100—W3XK—Washington, D. C.

The Hammarlund Hawk

By Lewis W. Martin

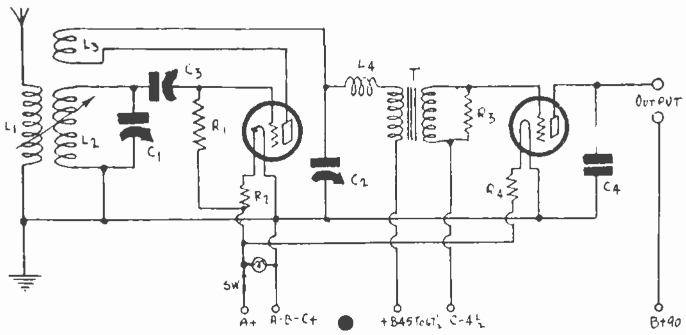


FIG. 1
THE HAMMARLUND HAWK, A "DETECTOR AND ONE-STEP" FOR RECEIVING SHORT WAVES. AN ADJUSTABLE PRIMARY, PARALLEL PLATE FEEDBACK AND A FINE CONDENSER-COIL COMBINATION ARE FEATURES.

THE consistency with which short-wave stations in both foreign and extremely distant domestic points may be heard is one of the great delights of this form of reception, especially so when a receiver of simple design can be used.

In broadcasting, elaborate transmitters and receivers must be used for best results. In short-wave work, simplicity reigns. No banks of tubes, multiple selector and amplification systems need be used. A simple, well-designed receiver will afford results that will truly embarrass its broadcast companion. And by simplicity, we not only mean few tubes, but only one major tuning control. Especially is this true with the advent of the new 2-volt 230 tube. Thus simplicity and efficiency are merged with economy.

Since only 60 milliamperes of current are drawn, the receiver can be operated at an unusually low cost. This is ideal for short-wave work, where we like to tune in stations hours at a time, because of the tingling thrill of picking up one distant station after the other, especially when the air is so replete with them.

Such a receiver, using a circuit keenly engineered by Hammarlund, is shown in Fig. 1.

Uses An Adjustable Primary

In the detector circuit L1 is a variable primary, adjustable with a special friction contact arm. In this way optimum coupling throughout the entire frequency spectrum is assured. Tuning the secondary L2 is a .000125 mfd. variable condenser of special design. This condenser uses non-corrosive midline shaped brass plates 1/32" thick which are double-spaced. With a full floating rotor mounted in adjustable cone bearings, positive and permanent capacities and absence of any plate vibration are assured.

A specially developed insulation, Parmica, which most closely approximates the efficiency of dry air, is used as the insulating medium in this condenser, accordingly reducing the dielectric losses to less than 10% of the losses in an ordinary short-wave tuning condenser. Further double wiping contact eliminates objectionable inductive reactance of the conventional pigtail.

The detector is a regenerative, using the condenser parallel-feed method. Accordingly, the tickler, L3, is a fixed one, a .0001 mfd. midget variable condenser tuning the plate. With this method, the tuning is very smooth, and gradual over the entire scale. There are no dead spots or tuning dips.

The coils are space-wound over thin, rigid delectric, developed five years ago. They have Parmica bases and are accurately designed to assure full band coverage.

Four Coils, 14 to 105 Meters

In the standard set, four plug-in coils are provided, these covering 14 to 105 meters with .000125 mfd. These coils, known as 20, 30, 40 and 80 meter coils, differ in the number of turns and size of wire used. The variable primary, however, is a part of the base, and is accordingly the same for all wavelengths.

The coils, with the exception of the 80-meter coil, are wound with No. 16 double silk covered wire, on a 2-inch diameter, and wound 11 turns to the inch. On the 80 meter coil No. 18 double silk covered wire is used, also wound on a 2" diameter, but with 17 turns to the inch. Between the tickler and secondary there is a one-turn space.

To isolate the plate circuit and thus afford better reproduction, a radio frequency choke, L4, is used. This choke has an exceptionally low distributed capacity, only 3 mmfds., this being afforded by its patented helical winding. In short-wave work it is imperative that the distributed capacity be minimum, so that the capacity will not short part of the signal.

To provide steady grid control a special grid condenser having a variable capacity of from 20 to 100 mmfd. is used, in conjunction with a 3 megohm grid leak, R1.

One Stage of Audio

In the audio channel is a special low-ratio audio transformer, this feeding into a 230 type tube. This circuit also is well bypassed.

As to the filament control of the receiver, if a pair of 1½-volt dry batteries are used, the resistance value of each of the filament resistors, R2 and R4, should be 15 ohms. If a 6-volt storage battery is used, the resistances should each have a value of 65 ohms. If a single 2-volt battery is used, as Eveready's breathing cell, no resistances are required.

After connecting the antenna, ground and phones, insert the tubes and turn on the switch. The primary coil attached to the hinge should be so placed that it is vertical. Now insert any coil and turn the knob on the regeneration condenser so that the rotor plates are completely meshed. Then slowly turn the knob which controls the variable tuning condenser. As this knob is rotated you should hear a series of whistles, disclosing the presence of stations.

How to Clear Up Reception

To clear up reception, turn the regeneration knob (midget condenser) until only the signal itself remains. Adjustment of the variable primary will serve to increase or decrease the intensity of the signal. The primary need be set but once for each coil.

As to the control of the grid condenser, after the station has been tuned in at any frequency, the set screw should be turned to the right or left, with a Bakelite rod or dowel stick. This can be done before or after setting the primary.

The shield plate in front of the variable tuning condenser prevents any body capacity. The special placement of the parts also helps to prevent this annoyance.

This receiver, when built in strict accordance with the instructions, diagram and specified parts, will afford ample volume on distant stations. Those desiring loudspeaker reception may add another stage of audio amplification in the standard manner, using a low ratio transformer, or connect the output to the phonograph input of a broadcast receiver, being careful, however, not to apply B voltage "twice," once from the short-wave set's supply to the audio tube, again from the broadcast set's detector plate voltage source.

An added precaution is to shunt the B batteries with a fixed condenser, ascertaining before you connect it that it does not leak.

The B bias battery should receive similar treatment, though the capacity need not be high. A condenser is insurance against coupling when the battery grows old.

Usually A— B— and C+ are connected together, and their junction is grounded, which is correct practice in this case also.

To avoid excessive RF pick up, the battery leads should be kept short, and they and the battery may be kept in an insulated metallic box.

LIST OF PARTS

C1—One Hammarlund 125 mmfd. short wave condenser, type MWL-25
C2—One Hammarlund 100 mmfd. midget condenser, type MC-23
C3—One Hammarlund 20-100 mmfd. condenser, type EC-80
L1, L2, L3—One Hammarlund LWT-4 short wave coil set consisting of LWT-B base, with adjustable primary, and one each LWT-20, LWT-30, LWT-40 and one LWT-80 coils, to cover from 15 to 105 meters.
L4—One Hammarlund radio frequency choke, type RFC-85
T—One Hammarlund 4 to 1 audio transformer, type HL-15
R1—One 3 megohm grid leak
R2, R4—Two filament resistors, 15 ohms
R3—One 100,000 ohm resistor
C4—One .001 mfd. fixed mica condenser
One Hammarlund drum dial and knob, type SDW-1
One Bakelite panel, 7x12x3/16 in.
One plywood baseboard, 11¼x10x⅞ in.
One aluminum condenser shield, 4x5x1/32 in.
Two four-prong cushion sockets
One filament switch
One set of Fahnestock clips
Wood screws, hookup wire, solder, grid-leak mounting and clips

The Graybar 770

By J. E. Anderson

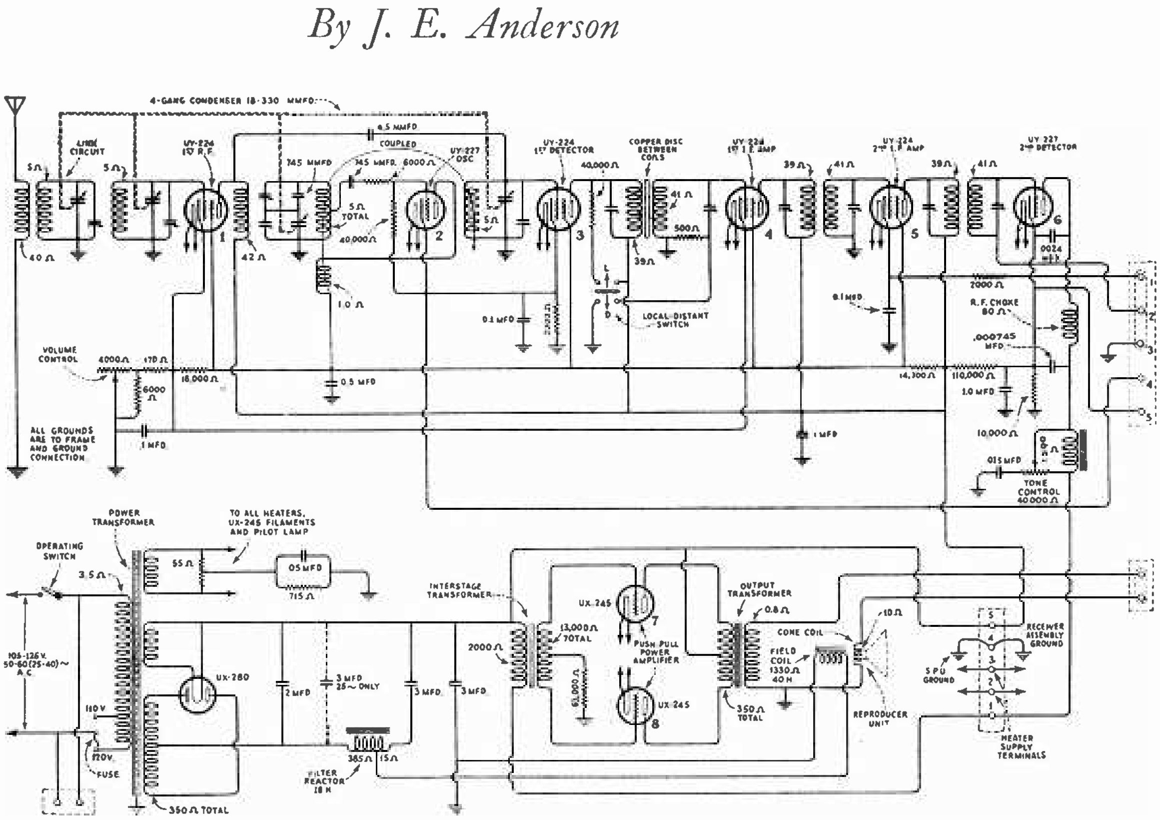


FIG. 1
The complete circuit diagram of the Graybar Model 770 Super-Heterodyne receiver, a circuit that incorporates many unusual features of design. One of these is the filter in the B supply is put in the negative side of the line and another is the "local-distant" switch.

SERVICE MEN'S GUIDE

THE Graybar 770 model Super-Heterodyne contains several unusual features. One of them is the manner of returning the center of the heater winding to ground. Across the transformer is a 55 ohm, center-tapped resistance and between the tap and ground is a 715 ohm resistance shunted by a .05 mfd. condenser. This winding serves all the heater tubes in the receiver as well as a pilot lamp. Thus if there is any current between the heaters and the cathodes the heaters are made positive with respect to ground by the amount of drop in the 715 ohm resistance. Since most of the cathodes themselves are lifted in potential by the bias resistor, the 715 ohm resistance tends to raise the heaters to the same potential as the cathodes.

Another unusual feature is the "local-distant" switch, which is so arranged that when it is set at "local" a 40,000 ohm resistance is cut across the primary of the first intermediate frequency transformer and a 500 ohm resistance is in series with the first intermediate frequency tuned circuit. When the switch is set at "distant" the 40,000 ohm resistance is opened and the 500 ohm resistance is short-circuited. The changes are made in the primary and the secondary of the same transformer so as not to upset the matching of the circuits.

A unique tone control is incorporated in this receiver. In series with the lead from the plate of the detector to the primary of the first audio transformer is an audio choke coil. From the junction between the transformer and the choke is a 40,000 ohm potentiometer in series with a .025 mfd. condenser, which is grounded. The plate side of the choke is connected to the slider of the potentiometer. When the slider is set at one end, near the condenser, the high notes are shunted to ground while the lows pass through the choke to the transformer and thence to the amplifier. When the slider is set at the other end of the resistance all the notes are permitted to pass to the amplifier because the choke is short-circuited and the 40,000 ohm resistance prevents any shunting to ground. This tone control operates without reducing the sensitivity when no reduction is desired, a fault found in many tone controls.

No automatic volume control is incorporated in the circuit, but there is an effective manual control, which operates on the grid bias of the RF amplifier tube and the first intermediate tube.

Still another unusual feature is the arrangement of the filter. The chokes are put in the negative side of the line instead of in the positive side, and the field coil acts as one of the filter chokes. One side of the field coil is grounded.

While there is no apparent provision for a pick-up unit for phonograph reproduction, there is a terminal strip at the right of the diagram, Fig. 1, to which the grid return of the detector is connected, at point (2). If one terminal of the pick-up unit is connected to (2) and the other to (5) the detector tube will act as an amplifier, without grid bias, for the phonograph signals.

There are three tuned circuits at radio frequency in addition to the oscillator circuit. Two of these are between the antenna and the first tube and these are coupled very loosely. The third tuned circuit is in the grid of the first detector, a 224 tube. The plate of the first tube and the grid of the detector are coupled by means of a 4.5 mmfd. condenser, a radio frequency choke being used to feed the plate of the first tube.

All the tuning condensers are ganged, including that of the oscillator. Trimmers are used to line up the condensers, and a special arrangement is used to put the oscillator in line. In series with the oscillator tuning condenser is a 745 mmfd. fixed condenser, and a trimmer condenser is connected across each of these. Only about half of the voltage across the oscillator grid coil is impressed on the grid of the oscillator through a 745 mmfd. condenser and 6,000 ohm resistor. A grid leak of 40,000 ohms is used for the oscillator. This arrangement of coupling is to insure moderate oscillation and freedom from harmonics.

Loose coupling and sharp tuning in the RF level are depended on for the suppression of frequencies which might cause image interference. Tuning of both the primaries and the secondaries in the intermediate frequency channel, and suitable coupling between the circuits, are used to get the band pass effect in the intermediate level.

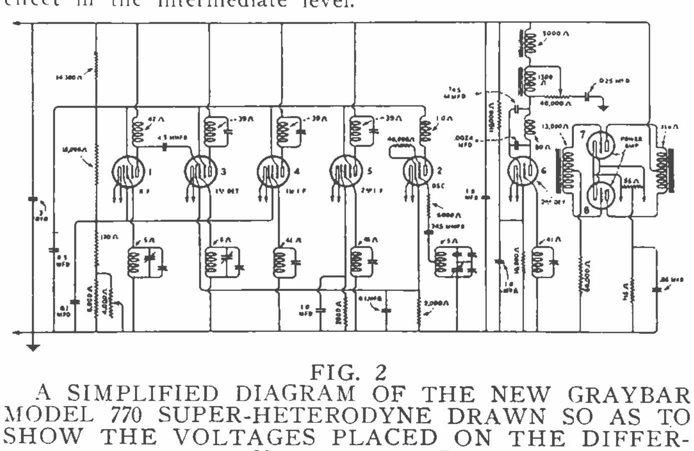
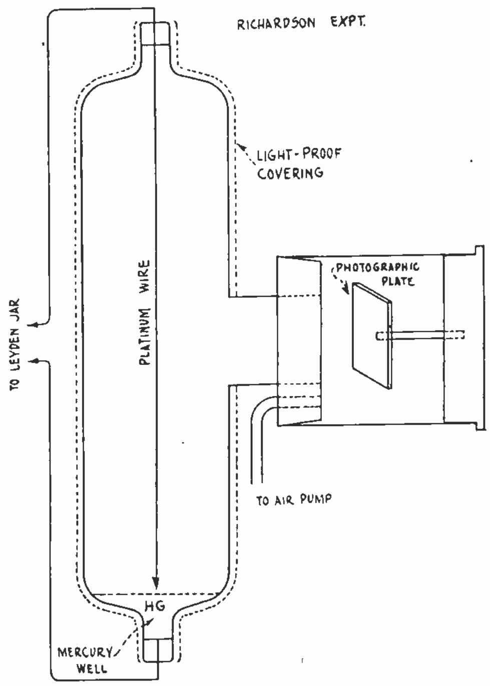


FIG. 2
A SIMPLIFIED DIAGRAM OF THE NEW GRAYBAR MODEL 770 SUPER-HETERODYNE DRAWN SO AS TO SHOW THE VOLTAGES PLACED ON THE DIFFERENT ELEMENTS.

The Early History of

By John C.



[This article is the fifth of a series dealing with the historic aspect of radio transmission and reception art. The first article appeared in the October 11th issue, and presented a condensed resume of important scientific steps that culminated with the successful commercial experiments of Guglielmo Marconi, 1899-1901. The second article appeared in the October 18th issue and consisted of a brief review of the early telegraphic systems, including data on the first photo-electric work and short-wave transmissions with concave and parabolic mirrors, also early stages in the development of the beam transmission system. Progress was traced from the sixteenth century to the eighteenth century. The October 25th installment, traced the development of the Leyden jar, from whence the first oscillatory currents were obtained, and also told of the concentration of short-wave radiations by lenses, as well as by reflection. The fourth installment, last week, dealt with the subject of interference in short-wave transmission and with the experiments of Dr. Preston that established the identity between luminous and electromagnetic radiation, a prediction of Dr. James Clerk Maxwell made nearly a hundred years previously.—EDITOR.]

THE progress of radio transmission would have been delayed if the work being done on the determination of the velocity of light had been stopped. So the experiments of Dr. Jean Leon Foucault (1819-1896) are important.

The history of the measurement of the velocity of visual light is one of broken continuity, insofar as its relationship to radio is concerned, due to the lapse in radio development between the sixteenth and latter part of the eighteenth century, though during this time studies of astronomical bodies had provoked interest of scientists who concentrated on the nature of the radiations of the heavenly bodies. Thus, bit by bit, the science structure of spectroscopy was built up, of which the velocity of the visual radiations became a part, and finally led to the work which we are about to get acquainted with.

Since the time of Galileo the speed of light had been subject to an upward revision, at a time rate that coincided with the improvements in the apparatus and methods by and with which it was measured, but the successive revisions became less and less as time went on, and when in the years 1886-1889 it was proposed to make another determination, a theoretical value for the constant was predicted that was not much greater than the latest commonly accepted figure of Prof. Michelson, which in round numbers is 186,000 miles per second.

How Experiment Was Made

The experiment of Foucault was made with an arrangement of five front-surfaced silvered mirrors, of concave contour, a rotating mirror, and a multiple micrometer slit, together with the necessary optical means of observing the expected displacement of the beam measured by the multiple slit (see illustration).

A source of parallel white light in the form of a narrow beam falls on the first concave mirror whence it is reflected to the face of the rotating mirror, and from there it goes through the system of reflections to the last mirror, and from there it is reflected back again along a different path, though by the same system of mirrors, to the multiple slit, where the image is formed at the focus of the object lens of the optical system shown.

It is readily seen that there are two paths for the light beam which terminate at the multiple slit, though the two paths are of unequal length, and therefore it is reasoned that if light takes a measurable time to traverse the set path, then the time of travel for the two paths should be different, and this should be manifested by a shift of the image that appears on the multiple micrometer slit.

Rotating Mirror a Valuable Adjunct

The trouble is that there is so little difference between the lengths of the two light paths that the two images overlap completely, making what appears to be a single image, a difficulty that has to be surmounted if the experiment is to be a success, and here is how it is done.

The rotating mirror of Fig. 1 has four front-surface silvered faces so assembled that they rotate about a common axis, driven by a small controllable speed motor. The function of this mirror is to break up the continuously reflected light beam into periodic intervals or parts of the parent image, and to let them be reflected at a rate that may be adjusted, by altering the speed of rotation of the mirror without otherwise altering the shape or size of the original image.

So as the speed of the mirror is slowly increased, the image that you see begins to blur and upon still further increasing the speed of rotation the degree of blurring increases, but after the speed of the mirror further increases the two images are seen to resolve into separate lines of light, and an optimum speed of rotation for the mirror is found that provides the maximum resolution of the two images, after which they are seen to merge again. The formula by means of which the speed of light is obtained is as follows:

$$V = \frac{8 \pi N L R}{D}, \text{ where,}$$

V = the Velocity of Light.
N = speed of the rotating mirror.
L = the path length from the first mirror to the last and return.
R = distance from the multiple micrometric slit to the face of the rotating mirror.
D = The observed displacement of the image on the micrometric slit.

The preliminary preparation necessary usually consumes several weeks, but the final observation is only a matter of a few minutes, and Foucault obtained a value for the velocity of light of 298,000 kilometers per second, or 190,234.16 miles per second.

The Michelson Interferometer experiment of more recent date, an idea of which may be gleaned from the second illustration, provided the value for the constant which we use now, although as recently as ten years ago Prof. Michelson made a new determination of the constant, the value of which may be found if you will consult "The Physical Review" for 1920, and even this value has been re-checked in the past two years.

Study of Radiation Let to the Vacuum Tube

A study of the phenomena connected with the subject of radiation yielded a fund of information utterly diverse.

One of the first to give us the idea of radiation at a distance was Sir John Tyndall, who in a lecture delivered in March, 1863, at Cambridge University, England, said that radiation through the earth's atmosphere was regarded as a form of molecular motion, and on that account received the name of radiant heat, and if the frequency was such that the eye could see the result, its name became radiant light.

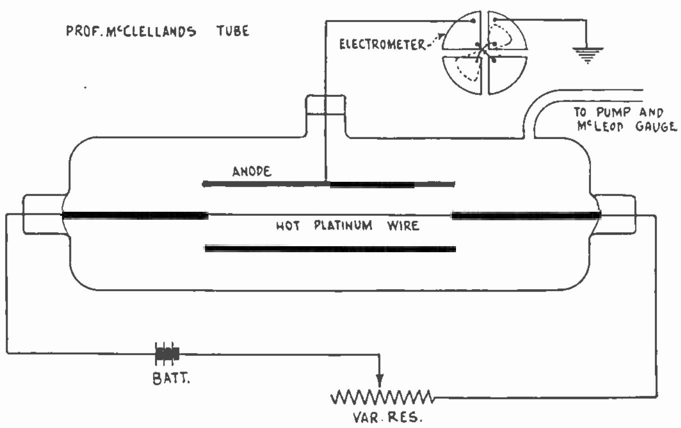
During the course of the lecture Dr. Tyndall demonstrated the principle of the topic of his lecture by means of an experiment which has since become classic.

It is referred to as the Tyndall vapor condensation experiment, and shows the way in which the heat energy of a chosen radiation of the visual spectrum evaporates water vapor. The apparatus consists of a glass cylinder, which contains water vapor only, attached thereto is a pump by means of which the cylinder's internal pressure may be altered.

Under normal conditions of pressure the cylinder appears clear, but if a small quantity of dust be admitted to the bottom of the cylinder, and the pressure is reduced, a cloud of vapor fills the cylinder, and may be dispersed again under the condition of reduced pressure by passing a beam of white light through the cylinder, which proves that the electrostatic charges that were responsible for the condensation of the minute drops of

the Vacuum Tube

Williams



water on the dust particles were all dissipated by the ionization effect of the white light. Subsequent experiments made during the course of the same lecture showed that the ionization was in reality due to the ultra-violet components, a truth illustrated forcefully when the iron-electric arc was substituted as the source of radiation.

The Vacuum Tubs Begins

The first attempt to obtain the registration of an effect due to the radiation from a straight wire in a vacuum is due to Dr. Oswald W. Richardson, of Cambridge University, a diagram of whose apparatus appears herewith. This is referred to as Richardson's first experiment, while in the subsequent illustration is the second experiment.

But it is the first that we are interested in now.

A glass envelope 20 centimeters high and six centimeters internal diameter is fitted at its center with a side chamber whose interior is exposed to that of the large glass cylinder in which a straight platinum wire is suspended. The wire's end just dips into a well of mercury at the bottom. The external circuit of the platinum wire and the mercury well is completed by leads that go to a Leyden jar oscillatory circuit, comprising a spark-gap and an induction coil, operated by batteries.

Within the side chamber, so attached that the two vessels may be evacuated, is a suitable support that holds a sensitive photographic plate. The dotted line around the tube denotes a light-proof covering to exclude all external unwanted radiations. The side chamber is also light-proofed.

Thus the attempt was made to register the presence of radio-active rays emanating from the surface of the platinum wire, which carried alternating currents, the high tension electrical driving system being kept in continuous operation while the pressure within the tube was reduced.

After an exposure of some 20 hours the plate was removed and developed, but the most careful inspection showed no tangible results. The experiment was repeated, this time with the plate close to the wire, and the plate showed an image of the wire, with thin axially radiating streamers, which were densely packed at the edge of the solid image, but grew rapidly faint and separated at a short distance from the axis. This proved to be only an induction effect, and not what was sought.

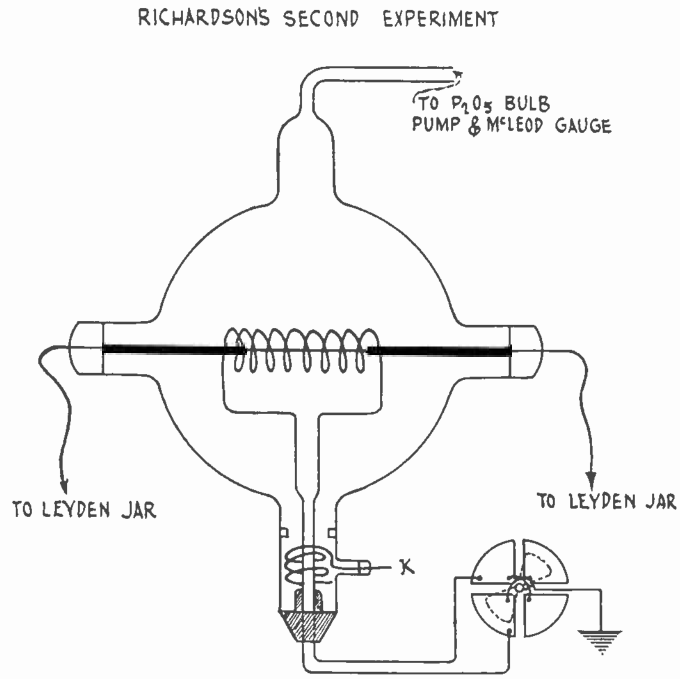
It was known, though, that as almost the whole of a high frequency alternating current flows along the surface of the conductor, if the ions are in motion, they must travel at considerably higher velocity, due to their concentration, and if means could be provided whereby they could be stopped suddenly it was deemed possible that even Roentgen rays would be the logical outcome. This shows that the idea of radiation in a vacuum was well established, and also the various scientists had more than a hazy conception of what they were after.

The Second Experiment

Richardson's second experiment was decidedly more fruitful. The aim this time was to detect the presence of ionized air, or an ionized layer close to the surface of a conductor carrying alternating current.

An illustration herewith shows the different form of tube used, and also shows a very different arrangement of tube electrodes.

The horizontally axial wire is of platinum, and is relatively thin with respect to the rest of the assembly. B is a kind of secondary coil in which a charge is to be induced that will result in the electrometer being affected. K is an electrometer-discharger, for bringing the needle to zero, when desired. The ground connection is for the tin-foil guard-ring, a device that is used to drain any spurious charge from the inner surface of the glass



tube. The appendix at the top of the tube leads to the P_2O_5 bulb, exhaust pump and McLeod gauge. This time, with the platinum wire excited, and the pressure within the tube reduced to 2 millimeters, the electrometer indicated the presence of a positive charge which increased as the pressure dropped, and finally was constant at the end of a period of several hours exhaustion of the tube.

An increase of excitation of the platinum wire increased the indicated value of the charge, and from this and other observations the ground-work had been laid for the next step, which was in the form of a tube experiment, due to Dr. J. A. McClelland. He had proven that the radiations from hot platinum were negative charges, and further that they were subject to deflection by a magnetic field, and also were deflected when they were passed between two parallel-charged plates, whether in vacuo or not, and also that the air in the vicinity of the stream became conducting.

Third Attempt More Successful

This third attempt to detect a sensible radiation from the surface of hot platinum, known as the McClelland experiment, appears as a modification of the previous two cases, with the notable exception that the platinum wire is very short, and it is heated by direct current, instead of the Leyden jar system as used formerly. In fact, an ordinary wet battery of four cells was used, the voltage being six and the current 10 amperes, a decided reversal of the former case, where high frequency heating was resorted to.

The result of the greatest importance here was that the observed discharge current as measured by the electrometer was greater than in the two other cases, and there was no necessity for the elaborate precautions against leakage with a tube of this type.

A NEW CONDENSER BY HAMMARLUND, OF THE "BATTLESHIP" TYPE OF CONSTRUCTION, IS AVAILABLE IN THREE AND FOUR GANGS.

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. Those not answered in these columns are answered by mail.

RADIO UNIVERSITY

The Flow of AC

IN MANY push-pull amplifiers you have shown the speaker connected from one plate to the other in the push-pull stage, and you have also shown primaries of transformers connected in the same way. How is it possible for any signal getting into the speaker or the primary when there is no outlet for the current?—A. F. W.

The plate current from the two tubes supplied through a center tapped choke or two chokes is practically constant, but the two tubes alternate in drawing the current. Both the chokes tend to hold the current through them constant. Hence when one plate is higher in potential than the other the current flows through the load, which may be the speaker or the primary, from the tube of high potential to that of low. As the two plates alternate in potential the current through the load also alternates.

* * *

Response of Loudspeakers

IS IT a fact that most loudspeakers are more efficient on the high audio frequencies than on the low? If so, does not the speaker compensate for the suppression of the high frequencies by excessive selectivity?—W. K. F.

It is a fact that many speakers are more effective on high frequencies than on low, but only up to a certain frequency. Above this frequency, which may lie anywhere between 5,000 and 10,000 cycles, there is a very sharp cut-off. In most instances the speaker cut-off is in the range where the tuner also cuts off. Hence instead of compensating, the two act together, in most instances, to suppress the high frequencies. The tuner, however, tends to compensate for the inefficiency of the speaker on the very low frequencies.

* * *

Hum in Converters

I HAVE built a shortwave converter with 224 and 227 tubes. It works, but there is a very loud hum, especially when I listen in with the headphones. What is the cause of the hum and what can be done to remedy it?—M. M. S.

It may be that the heaters are not balanced. A serious source of hum in circuits of this type is oscillation or strong regeneration in the receiver with which the converter is used. Oscillation tends to bring out any hum that may be in the set. Another possibility is that the modulator tube in the converter oscillates feebly but not strongly enough to prevent detection.

* * *

Choke-Transformer Coupler

IN THE November 1st issue you published a power amplifier in which you used an interstage push-pull transformer for coupling the two push-pull stages. Would it not be possible to use an ordinary push-pull input transformer and a couple of audio frequency chokes? If this is possible I should like to do it because this type of coupler will cost much less.—C. W. F.

This is quite feasible. For the interstage coupler use a transformer just like the one specified for input in Fig. 1, page 5, November 1st issue, and connect the primary from the plate of one 227 to the plate of the other. Also use two Polo 30-henry chokes, connecting them in series with the junction to the plate voltage source and the other two leads to the plates of the 227 tubes. No stopping condensers are needed in series with the primary of the push-pull transformer.

* * *

Powering Short-Wave Adapter

WHICH is the better arrangement for a short-wave converter, building the filament and plate power supply in it or providing binding posts for an external source of power?—J. A. E.

Obviously, it is better to build the power supply in it because then it is handy and always available. However, if you have a good power supply, or part of one such as a filament transformer, and do not want to buy another for the converter alone, then it is all right to use an external source. Electrically there is little difference between the two methods.

* * *

Pointers On Tone Controls

MOST radio manufacturers now incorporated tone controls in their receivers. In most instances the control consists of a variable resistor in series with a fixed condenser, the two being connected across the secondary of a transformer in the audio amplifier. Different capacities and resistances are used. Will you kindly discuss the advantages of using different capacities and resistances?—P. W. A.

If a small fixed condensor is used the range of the tone control is small because even when the resistance is set at zero the medium notes will not be reduced much. If the condenser is large, on the other hand, the range is wide because when the resistance is set at zero even the notes in the middle register are greatly cut down, leaving only the bass. When the resistance is all in, all notes are amplified without much attenuation. If the resistance is small, when set at maximum, all notes are reduced so that it is advantageous to use a high value variable resistance. The choice, then, is between a large or a small condenser in series with it.

* * *

Wire for Short-Wave Coils

WHAT size wire is best for short-wave coils? I have seen some coils specified with No. 14 wire and others with wire as small as No. 26. Is there any rule to go by in selecting the wire?—J. C. W.

As a rule, the heavier the wire the better the coil, provided that the turns are properly spaced. It is customary to increase the size of wire as the frequency to be covered by the coil increases. There are two considerations that enter in the choice. First comes the fact that the effective resistance of a coil becomes lower the heavier the wire and due to the skin effect it is desirable to provide a large conducting surface for the coils to be used for high frequencies. Second, it is practical to use heavier wire for the smaller coils because there is space for it. or the higher inductance coils, finer wire must be used if the required inductance is to be obtained on the available form. If the heavy wire turns are crowded eddy current losses may spoil the efficiency of the coil.

* * *

Adapter Failure

WHY is it that most adapters which have been offered for sale fail to work? They are wired in the same manner as ordinary short-wave sets and most of them work well. —G. E. H.

The failure of the adapters to work is usually due to the condition of their use. They are designed to work by plugging into the detector socket of a set. But no two sets are alike and therefore the adapter may be plugged into a circuit where it has no chance to work at all. One thing that may be wrong is filament voltage. Another is the plate voltage. Still another is the by-passing in the plate circuit of the receiver. If an adapter is designed to work with a given receiver there is no reason why it should not work well as long as it is used with that receiver, but there is no good reason why it should work well with any other receiver having a different circuit.

* * *

Antenna for Short Waves

WHY IS IT that for the reception of short waves comparatively short antennas are used? Would it not be better to use antennas since they gather up more energy from the waves?—G. M.

It is true that the signal voltage generated in a long antenna is greater than that generated in a short one, but that alone does not determine the current flowing in the antenna at the receiver, nor the voltage at the point the first grid is connected. Resonance effects take place. A short antenna may be much more effective under certain conditions.

* * *

Feed Back in Short-Wave Converter

IS IT possible to induce oscillation in a short-wave converter in which the oscillator is coupled to the modulator through the screen grid, that is, oscillation in the modulator tube? If so, in what manner does it take place and what precautions should be taken to prevent it?—C. F. W.

It is possible because the capacity between the control grid and the screen grid is comparatively high. One method, of course, to prevent it is too loosen the coupling between the oscillator coil and the screen circuit. Another way is to put a resistance in the screen circuit, without by-passing it. This is equivalent to loosening the coupling. Still another way is to reduce the plate, screen and grid voltages on the modulator tube. And still another is to change the phase of the voltage fed back by reversing the leads in the pick-up coil.

* * *

Oscillator Modulator in Short-Wave Converter

I HAVE built a Super-Heterodyne type converter for short waves and it does not work just right. While I have received many distant stations on it, at times it misbehaves and I cannot get anything more than hisses. When I set the oscillator on a low value of the condenser and then turn the RF condenser I notice a series of hisses. At ever point the hiss is loud. What causes this noise and why does it happen on so many places on the dial?—S. E. S.

This indicates that the modulator is oscillating and the hiss occurs when the frequency generated is such that it is equal to the frequency of the oscillator or when one of the harmonics of

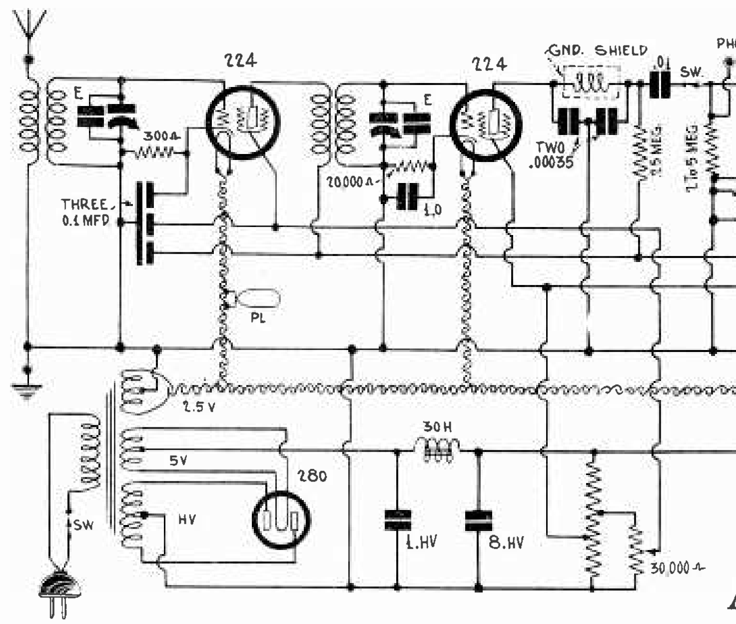


FIG. 861 SCHEMATIC OF A MIDGET RECEIVER WITH A SELF CONTAINED A, B AND C SUPPLY VOLTAGE SOURCE. A PHONOGRAPH PICK-UP CONNECTION IS PROVIDED, AND A BAND FILTER SYSTEM IN THE R.F. OUTPUT PLATE LEAD PROVIDES AMPLE SELECTIVITY.

one is equal to a harmonic of the other. Apparently, when the modulator is oscillating the regular oscillator is not, for if both circuits were oscillating there would be a heterodyne squeal where a hiss occurs.

* * *

Short-Wave Converter on Metal Sub-Panel

IS IT practical to build a short-wave converter on a metal sub-panel or chassis similar to those used for broadcast receivers—L. A. H.

It is practical provided that the tuning coils are not too close to the metal. If the plug-in, tube base type of coil form is used it may be sufficient to put the coils on baseboard type sockets which would lift the coils an inch or so from the metal.

* * *

Input Coupler in Short-Wave Sets

WHEN an untuned stage of radio frequency amplification is used in a short wave receiver I have noted that it does not make much difference whether I use a large or a small coupling resistance or a large or small coupling coil. What is the reason for this? I should think that the higher the resistance or impedance the louder should the signals be.—J. K.

The reason for the small change in the signal intensity is that the impedance of the antenna is small in comparison with the ordinary resistances or impedances used. The change does not become rapid until the coupling impedance is equal to or smaller than the impedance of the antenna.

* * *

Regulation of Rectifiers

WHICH gives the higher voltage in a rectifier-filter for the same voltage input, the condenser input or the choke input to the filter? About how much is the difference?—L. C. D.

The condenser input gives the higher voltage. The amount of the difference depends on the capacity of the first filter condenser or on the inductance of the choke next the rectifier. Two 281 tubes in a full wave rectifier with 700 volts per plate at 100 milliamperes gives a voltage of 770 volts with condenser input and 525 volts with choke input. The difference between the circuits in question is a 4 mfd. condensed across the line next to the rectifier tubes. A half-wave rectifier with the same tube and the same filter gives a voltage of 670 volts at 100 milliamperes, the 4 mfd. condenser being used.

* * *

Special Virtue in 30-Henry Chokes

I HAVE noticed that in nearly all cases where audio frequency or filter chokes are used, 30 henry chokes are recommended. Is there any special virtue in this inductance? Why cannot 100 henry chokes be used as well, or 50, or 25, or even 10 henry chokes?—W. W. S.

There is no special virtue in 30 henry chokes. Their use is only one of those cases where habit has decreed 30 henries. The specification does not really mean much because the same coil may have an inductance of 100 henries under one condition and less than 300 under other conditions. The inductance varies with the current flowing through it. The rule is that choke should have as high inductance as practicable. It is certainly better to have 100 henries than 10 henries, but in some cases it may be entirely impractical to use 100 henries. The coil would be bulky and expensive and a lower value coil might serve well enough.

* * *

All Electric Midget Set

WILL you kindly publish a diagram of a midget receiver all electric set with two tuned R.F. stages, 2 resistance coupled stages, with provision for cutting in a phonograph record pick-up.—W. E. G.

See Fig. 861 at top of page, which is an excellent circuit.

Doubts New Tubes Are Needed

A RADIO man called at our home, offering to test the tubes free. After doing so, he informed us that we needed a new set of tubes. Our reception is good, however, and we feel he is not telling the truth. How can we be sur tehat his test was bona fide?—A. J. M.

Why not invite him to call some evening and tune in a distant station, listening to it five minutes or so to note the average reception. Then have him insert new tubes for a comparative test. You can also have each tube exchanged for a new tube, one at a time, and you can easily note which tubes really do require renewal.

* * *

A Shocking Speaker

WHEN anyone touches the base of our loud speaker, a severe shock is felt. Does this mean a defect somewhere?—J. K. L.

Yes, presumably the speaker connections are making contact with the base or frame of the speaker at some point. Try reversing the connections of the speaker at the plug. If this does not help matters, have your dealer repair the speaker. If your power tube is larger than the 112A type, the set should have an output filter or output transformer to protect its fine wire windings from the actual plate current. With the filter in place, no shock could be felt even though the speaker winding was grounded to the base.

NINE JOIN NEW CHAIN PROJECT ON WEST COAST

Washington.

A new radio chain is in the process of formation on the Pacific Coast, it was disclosed in a letter to Federal Radio Commissioner Harold A. Lafount from F. C. Dahlquist, of Seattle, organizer of the new network. Nine stations have already aligned themselves with the chain, including a station operated by the Warner Bros. motion picture interests in Hollywood. In his letter Mr. Dahlquist wrote:

"Our main studio will be located in Los Angeles, which is without question of a doubt today the greatest entertainment center of the world and where we are assured of a greater variety of outstanding talent than in any other city in America.

Year's Work

"I have been working on this project for about a year and have just succeeded in completing all of the details. I have always felt that there was an opportunity on the Pacific Coast for a third network, one that would embrace the smaller communities not now served by chain broadcast as well as the larger centers.

"I think you will agree with me that high class and desirable network programs will greatly add to the service that the majority of the stations I have mentioned will give their listeners. They are all most enthusiastic over the possibility.

"I know that you will be interested in knowing who my associates are in this undertaking. I have been particularly fortunate in being able to interest some of the best known and substantial business men on the Pacific Coast in the undertaking.

Cites Backers

"They include such men as L. L. Davis, chairman of the board of the American Public Service Company; William E. Vogelback, president of the American Engineering and Management Corporation; Edward W. Heller, a prominent San Francisco financier; Kenneth Humphreys, executive of the Boeing Airplane Company of Seattle; Hebert Ihrig, prominent merchant of Seattle; George Comstock, general manager of the Neon Products Co., Washington, and Gen. W. Bjornstad, San Francisco financier, who I think needs no introduction to official Washington.

"No stock has been offered to the public and it is not the plan of the organization to offer any as the financing is entirely subscribed by my associates. The company is to be known as the Pacific Broadcasting Company. The financing is more than ample and I can assure you of the quality of our programs and production and that our policies will be strictly in accord with the high ideals you have expressed.

Expects News to Be Pleasing

"I need not tell you the struggle that most of the independent stations experience in attempting to build programs of sufficient quality to compete with the network stations and that in most cases, about all that many of them could do was to use phonograph records, which no doubt serve the purpose but cannot in any sense compete with original talent.

For this reason I do not believe that I am presuming too much when I believe that you will be pleasd to learn that a greater number of Pacific coast stations will be assured of finer quality programs."

Colleges Sell Time on Air

Washington.

Due to lack of funds to carry on, college broadcasting stations which are supposed to be operated for the dissemination of cultural programs, are turning to advertising to help pay their expenses, according to Armstrong Perry, of the National Advisory Committee on Education by Radio.

In some instances, suspended activity by college stations has been revived by appealing to Chambers of Commerce to buy time on the air.

A successful instance, Mr. Armstrong declared, is that found at the Colorado State Teachers' College, financed by corporate interests and which now broadcasts programs which have enjoyed a highly favorable reception.

By means of its commercial support this college is able to continue to render valuable cultural service, such as the broadcasting of its teacher-training facilities, college life, athletics, class-room teaching, and similar activities, as well as an educational program of a high order.

CURB ON POWER CALLED DODGE

Washington.

Orestes H. Caldwell, former Federal Radio Commissioner, in testifying before the Radio Commission in behalf of WGN, Chicago, which has applied for permission to use 50,000 watts, said that in restricting the use of high power to one-half of the forty cleared channels the Federal Radio Commission is operating "directly in opposition to the public interest and contrary to the consensus of all expert and engineering opinion."

"I am paying my own expenses and testifying on my own independent views based on my experience and knowledge of radio running back through twenty-five years," he declared.

"If the Federal Radio Commission continues in its present indefensible policy of limiting power on clear channels and thus restricting and hobbling the usefulness of the radio wavelengths for the fullest service to the largest public, I charge that the Commission is overlooking its sworn duty, is guilty of a most outrageous impairment of the nation's radio facilities and is mutilating and injuring this great public service which the taxpayers are paying it $800,000 a year to administer."

Limiting power is against the public interest in three ways, Mr. Caldwell testified, as follows:

"By depriving millions of American citizens who live on farms and in small towns of the clear, satisfactory radio signals to which they are entitled.

"By requiring millions of other citizens to spend money unnecessarily on the purchase of expensive radio sets to bring in the weak signals of distant low-power stations.

"By imposing needless burdens of costly hearings on the broadcasting stations and the radio art generally, to present in solemn review simple engineering facts accepted by all authorities years ago."

WOC-WHO TEST CONFIRMED AS GREAT SUCCESS

The synchronization of WOC and WHO has been hailed as a great success, but some readers have expressed their doubts. So a report was obtained from Western Electric Company, and here it is:

"The first example of synchronization has been successfully operated between WOC, at Davenport, Ia., and WHO at Des Moines. These two stations, approximately 190 miles apart, found it necessary to share the same wavelength and their broadcasting periods. As a result, when WOC was on the air the radio listeners in Des Moines were compelled to stand by or else reach out on the ether for other stations. This same situation was true in Davenport when the Des Moines station was broadcasting.

Conference Called

"To adjust this difficulty engineers of the Western Electric Company and the Bell Telephone Laboratories were called into conference with the executives of the Central Broadcasting Company, owner of the two stations. A broadcast receiver was installed at Marenga, Ia., a town midway between the two cities. With this set the signals sent out by the stations were received with about equal intensity and the received signal transmitted to the monitoring station over a telephone line.

"Super-sensitive crystal oscillators of an entirely new design were installed at both stations to hold the two transmitters on the identical wave. A telephone line between WOC and WHO carries the program from the studio of one to the studio of the other as in ordinary broadcasting. A telephone line also runs to the monitoring receiver midway between the two. Thus, if there is an interference due to clashing waves, it is audible to the operator at the control who makes the necessary adjustments, remedying the difficulty.

Better Service

"Results of listening tests and field strength measurements indicate that very much better service is being given to radio listeners in nearly all of the zones served by either station. This improvement is due to the fact that both transmitters operate a large number of hours during the day, while before one station was required to be silent during the operation of the other. This is borne out by thousands of letters received to this effect from radio enthusiasts throughout the entire district."

Chicago Stations Have Lion's Share

Washington.

The Chicago area gets better broadcasting service than any other place in the world, according to Chairman Charles McK. Saltzman, of the Federal Radio Commission, yet it is regarded as "radio's sore spot."

Many of the finest stations in America cluster around Chicago and the district has more radio stations than the radio law calls for on the basis of equal distribution of radio facilities according to population and area. Other states in the Fourth Zone, which includes Chicago and is represented by Gen. Saltzman, lack facilities, and their rights under the law must be reconciled with those of the Chicago situation.

OSCILLATING CRYSTAL KEEPS PRECISE TIME

The piezo-electric quartz crystal and the vacuum tube amplifier have made it possible to add to the science of horology, or time keeping, an accuracy previously beyond the scope of the imagination.

The earth used to be the prime standard of time, it being assumed that it kept on rotating from century to century with the same speed, and uniformly all the time. This assumption was made in the face of evidence that it was not true simply because there was no better standard available.

Oscillator Clock

But now that may be changed by the piezo-electric oscillator clock described by W. A. Marrison, of the Bell Telephone Laboratories, in a report to the National Academy of Sciences.

The rate of Mr. Marrison's clock is controlled by a quarty crystal ground to vibrate at a frequency of 100,000 cycles per second. The crystal is kept under constant temperature to a high degree, as well as to other constant operating conditions, so that there is no variation in the rate of vibration.

Geared Crystal

The crystal is geared to a synchronous motor by means of electrical heterodyne circuits and the clock mechanism is driven by the synchronous motor. A clock keeping sun time is operated on a frequency of 366 cycles per second and another clock keeping sidereal time is operated on a frequency of 366 minus 0.000701,865 cycles per second. Two clocks so operated would keep correct time for 3,000 years without deviating more than a fraction of a second.

New Station for Short-Wave Testing

Los Angeles.

KHJ, Los Angeles, dedicated a 300-watt short-wave transmitter to the frequency calibration of amateur radio stations throughout the United States and the Orient.

Radio amateurs are required by the Federal Radio Commission to operate within certain frequency bands. The equipment necessary to the accurate checking of frequencies is very costly. Therefore it is necessary for short-wave operators to be able to check or calibrate their instruments with the carrier wave of some short-wave station whose frequency is accurate.

The American Radio Relay League has designated three short-wave stations to act more or less as yardsticks for this measuring and checking process. W6XK is to be one of them. Its frequency standard has been calibrated by the Bureau of Standards, Washington, D. C., to an accuracy better than one-hundredth of one per cent.

Harold G. Peery, chief engineer of KHJ, said: "The only other stations rendering this same service to amateurs are W1XP, Massachusetts Institute of Technology, and W9XAM, Elgin Watch Company, Elgin, Illinois.

"W6XK will send on three bands: the 80-meter band, or 3,500 kc to 4,000 kc; the 40-meter band, or 7,000 kc to 7,300 kc; and the 20-meter band, or 14,000 kc to 144,000 kc."

Political Pull Charged by WBOU

Washington, D. C.

The Court of Appeals of the District of Columbia has received a novel case in which it is charged that political influence was exerted, which resulted in the recent order of the Federal Radio Commission transferring WWVA from Wheeling, West Va., to Charleston, West Va. The petitioner who seeks to have the order vacated is WBOU, stating that interference with its program would be the result of the order. WBOU uses 250 watts, while WWVA uses 5,000.

The court has granted a stay order deferring the removal of WWVA until a technical report of the conditions likely to produce interference is submitted.

NEBRASKA ASKS HIGHER POWER

A large part of Nebraska is now denied adequate radio service because of the time limitations of KFAB on the air and its power of 5,000 watts, Dietrich Dirks, station manager, told the Federal Radio Commission at a recent session.

"It is not an infrequent occurrence that because of its time division, KFAB is unable to broadcast events of national importance and educational and entertainment features of value," continued Mr. Dirks. "It is often necessary to sign off before a program is completed.

"Because of KFAB's division of time and its consequent inability to supply a constant, dependable service, many listeners in the sparsely settled areas of Nebraska and adjoining States get no regular, satisfactory service from any source.

"Because of its time limitation, KFAB is unable to cooperate to an adequate extent with the local and State law enforcement departments. It is unable to follow its policy of releasing material requested by the law enforcement officers immediately upon receipt. It is often unable to broadcast emergency warnings of approaching storms at a time when such broadcasting is absolutely vital.

"If KFAB were given full time, as is made obvious by the aforementioned facts, it would be able to build a schedule of programs and services in answer to the needs of its service areas as no other station could. The policy of the KFAB Broadcasting Company would continue to be one of progressiveness in the adoption of technical and engineering improvements. Without doubt, if KFAB is given an opportunity to increase its facilities to full time, to increase its power to 25,000 watts, its consistent, dependable and vital service will be unsurpassed by any other station."

Literature Wanted

Harry Crouse, 154 W. Barkley St., Uniontown, Pa.
W. M. Deane, Box 194, Pasadena, Texas.
Joseph Greig, Gen. Del., Gary, Ind.
H. D. Smith, 323 E. Lake Drive, Atlanta, Ga.
F. H. Wilson, Box 23, Kaleva, Mich.
Dale Slack, 303 S. Elm, Wellington, Kans.
Ralph Paeth, 308-6 Ave., S. W., Cedar Rapids, Iowa.
J. Robert Chandler, Arcade Box 1004, Los Angeles, Calif.
E. W. Borschell, 2244-23 St., Santa Monica, Calif.
Joe Shoo Hoo, Mai Tong Low, 337 Massachusetts Ave., Boston, Mass.
George Och, 805 S. Bouldin St., Baltimore, Md.

FARM NEWS ON SHORT WAVES PROVES VALUE

Washington.

Possibilities of establishing market news services for farmers throughout the country by means of short waves are indicated by the experiments conducted in California during the past year, said Com-missioner Harold A. Lafount of the Federal Radio Commission. For a year, he added, the California Department of Agriculture, in cooperation with the Federal Department of Agriculture, has been disseminating information for farmers and it has provided "an effective means of communication between strategic points within the State, supplementing and strengthening the broadcasting over the general brodcasting stations."

Scope Outlined

The following statement by Federal-State Marketing News Service shows the variety of material which is communicated to farmers by this service:

"In giving farmers a correct picture of current market conditions speedily and in an authentic way, there is presented by radio timely information, including the following facts: Volume by grade in the consuming markets; market activity; the origin of supplies; condition of the commodities as they arrive; how the various products are meeting market preferences; weather conditions in the various markets and at shipping points; supplies in transit from other areas; stocks on hand; prices being offered, both in producing sections and in the terminal markets; a condition of the crop; number of cars ordered; availability of harvest help; and other pertinent and necessary information.

"The daily market reports on important perishables such as are produced in California and which are furnished through our present system, show carlot shipments made each day from producing sections, destinations, diversions, arrivals, and supplies on the markets, the quality and condition of receipts and prices paid in terminal markets and at points of origin."

Speaks of Network

G. H. Hecks, Director of Agriculture for California, describes the use of short waves as follows:

"In the assembling of this information and in its speediest dissemination, a network of short-wave stations complete a most vital link in the entire chain of the machine.

"Of the five frequencies allocated to this service and now available for our use, the 10,010 kilocycle channel is not being used in this State, because this channel is best suited for distance of 1,000 miles or more for daylight contact. The 4,244 and 3,250 kilocycle channels are suited best for night communication. The 8,810 kilocycle channel is used between our San Francisco, Los Angeles and Brawley stations. The 5,365 kilocycle channel is used between the Sacramento, San Francisco, Modesto, Fresno, Salinas, Los Angeles and Santa Maria stations.

Sees Advantages

"We believe the radio has advantages over any of the other communication systems from the standpoint of flexibility, speed and accuracy. Flexibility from the standpoint that we can cut out or place into the system different stations practically at will."

Save Money on Tubes!

Get a Guarantee Just the Same!

QUALITY tubes at enormously reduced prices enable you to save money and obtain full satisfaction. **Any tube will be replaced on request within thirty days of its sale!**

These tubes are made by a manufacturer of national reputation and are not "distress merchandise." No tube is shipped until it is carefully checked on a Readrite No. 9 Radio Test Kit. Orders filled in 24 hours.

Type	*List Price*	*Your Cost*	*Type*	*List Price*	*Your Cost*	*Type*	*List Price*	*Your Cost*
☐ 201A	$1.25	49c	☐ WD-12	$3.00	59c	☐ 245	$2.00	59c
☐ 226	1.75	49c	☐ 200A	4.00	59c	☐ 280	1.90	59c
☐ 199-UX	2.50	59c	☐ 171A	2.25	59c	☐ 224	3.30	59c
☐ 199-UV	2.75	59c	☐ 171AC	2.25	59c	☐ 222	4.50	59c
☐ 120	3.00	59c	☐ 112A	2.25	59c	☐ 281	7.25	95c
☐ WD-11	3.00	59c	☐ 227	2.20	59c	☐ 210	9.00	95c

☐ 250, List $11.00, your cost, **95c.**

[Remit with order for tubes and we pay postage]

DIRECT RADIO CO.

Room 504, at 1562 Broadway, New York, N. Y.

(Between 46th and 47th Streets)

Short Waves! for $4.87

All parts for a 3-tube short-wave converter to be worked with a broadcast receiver to bring in short waves.

AC Model, Cat. SUP-3A, including cabinet, 5x6½" panel, dial, tuning condenser, coil, coil switch, binding posts, sockets, resistor, chokes, bypass condenser, etc., for Fig. 8 circuit of Herman Bernard's article, page 7 this week (less three 227 tubes, less filament supply) $4.87

Battery Model, Cat. SUP-3B, Fig. 9 of Bernard's article, all parts, (less three 227 tubes) $4.87

Supertone Products Corporation

Dept. W, 216 Wallabout Street

Brooklyn, N. Y.

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OFFICIAL SERVICE STATION

for all Radio World circuits, including Diamond of the Air, HB 44, HB 33, HB Compact, short-wave adapters and converters, etc. *Indorsed by Radio World.* We carry replacement parts in stock. All prices very reasonable.

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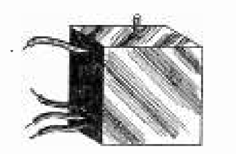
Three 0.1 mfd. in One Case



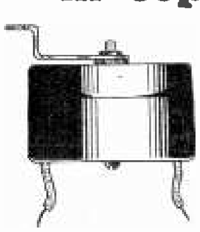
Cat. SUP-31

Three Supertone non-inductive fixed condensers of 0.1 mfd. each, encased in aluminum and provided with a 6/32 mounting screw, built in. The black lead is common to the three condensers, the three red leads are the other sides of the respective capacities. Size, 1½" square by ⅞" wide. Order Cat. SUP-31, list price, $1.00; net price, 57c.

GUARANTY RADIO GOODS CO.

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

RF Choke in Copper Shield



A 50-millihenry radio frequency choke coil, in a copper shield, with mounting screw and bracket attached. This choke is excellent for the plate lead of a detector, placed in series with the plate and the load impedance, for keeping RF out of the audio channel, broadcast receivers. Also excellent for RF plate lead, between the end of the plate load and B plus, and for screen grid leads, between screen rgid and B plus, for thorough filtering and stabilizing. This choke will pass 25 ma. In all cases ground the shield. Order Cat. SH-RFC. List price, $1.00; your price.... **57c**

For short waves, an unshielded RF choke, 10 millihenrys, with mounting bracket. Order Cat. SW-CH, list price 80c; your price.... **47c**

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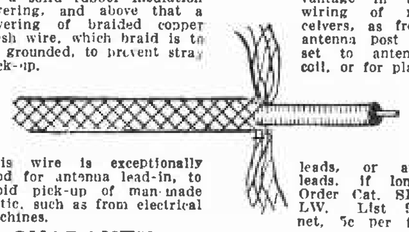
SHIELDED LEAD-IN WIRE

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. Order Cat. SH-LW. List 9c, net, 5c per ft.

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Reliable PRODUCTS

AC POWER TRANSFORMERS

FOR 4-226, 1 or 2-227, 2-171A, 1-280 TUBES. 600 Volt secondary, for high voltage. ALL SECONDARIES CENTER TAPPED. 50 WATT RATING. Ideal replacement for every type AC set, using similar combinations of tubes. For 110 volt, 60 cycle A.C. **$3.75**

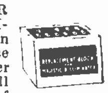
For 3-224, 2-227, 2-245, 1-280, or 5-227, 2-245, 1-280 tubes, or any similar combination of 2½ volt tubes. 600 volt secondary. All secondaries center tapped. 75 WATT RATING. For 110 volt, 60 cycle A.C............ **$4.75**

For 5 or 6-224 (or 227), 2-281, 2-250 tubes. 1200 volt secondary. ALL SECONDARY WINDINGS CENTER TAPPED CAPACITY; 135 WATTS. For all auditorium amplifiers, receiver Power Packs, and short wave transmitters. For 110 volt, 60 cycle A. C...................... **$5.95**

2½ VOLT AC FILAMENT TRANS.

Two windings, both center tapped. One gives 2½ volts at 12 amps., and the other gives 2½ volts at 3 amps. Ideal for 8-227 or 224 tubes and 2-245 tubes. For 110 volt, 60 cycle A.C. **$2.25**

REPLACEMENT COND. BLOCKS



We can supply a condenser block FOR ANY POWER PACK OR "B" ELIMINATOR. We list below the types in popular demand. Note that any of these blocks can be used for circuits other than that for which it is designed. All these blocks are the exact duplicate of the original, considering electrical specifications, physical size, placement of terminals, etc. GUARANTEED ONE YEAR!

For Majestic "B" Eliminators $2.95
For Majestic Master "B" Eliminators.......... 3.95
For Atwater Kent Model 37.................... 5.45
(Contains 2 chokes)
For Majestic 171 Sets 5.88
For Majestic 245 Sets 5.88
For Majestic 250 Sets 5.88

STANDARD BLOCKS

Contains all suitable sections, and GUARANTEED ONE YEAR.

For 171 Tube Sets............................ $5.95
For 245 Tube Sets............................ 4.95
For 250 Tube Sets............................ 5.95

ELECTROLYTIC CONDENSERS

Absolutely dry-mounts in any position. GUARANTEED NEVER TO BLOW OUT! Occupy surprisingly small space. 500 volt D.C. peak rating. (Use two of each type required for 250 tube power packs—1,000 volt rating thereby obtained.)

Mfd.	Anodes	Diam.	Length	
1	1	¾"	2⅛".........	27c
2	1	1"	2⅛".........	44c
4	1	1½"	2⅛".........	84c
8	1	1⅜"	4½".........	$1.24
16	2	3"	4¼".........	2.12
24	3	3"	4¼".........	2.75
32	4	3"	4¼".........	3.74

WEBSTER POWER AMP.—"B" SUPPLY

Ideal phonograph, radio tuner or microphone amplifier. Uses 2-226, 2-210 and 1-281 tube. Furnishes 45, 67, 90, and 135 volt "B" current for tuner, to which it is coupled. Also furnishes 110 volts D. C. Speaker field current. Illustration only shows four tubes—five are used. For 110 volts, 60 cycles, A.C.

Reg. $75.00........................ **$19.10**

MISCELLANEOUS ITEMS

30 Henry Chokes 95c
Victor Push Pull Input-Output (in one case..$2.50
Shielded Audio Transformers.................. 97c
R.C.A. Magnetic Speaker Chassis............. 3.75
A.C. Synchronous Phono Motor................ 4.45
Pacent Phonograph Pick-up 4.95

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"A B C OF TELEVISION" by Yates—A comprehensive book on the subject that is attracting attention of radioists and scientists all over the world. $3.00, postpaid. Radio World, 145 West 45th St., N. Y. City.

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Earn $22 to $30 a week while learning Electric and Acetylene Welding in all branches and $10 to $14 a day after short period of training. This is the best and fastest growing trade in America. Big demand for trained men. Learn this big pay trade in the finest equipped shops in America. Union card when finished. Act now! Write Mr. Flint, Superintendent of Shop.

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EXPERIENCED RADIO SERVICE MAN wants position. Write Thomas E. Martin, Keota, Iowa.

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ALL merchandise listed is BRAND NEW and is shipped in the original, factory sealed cartons and carries the same guarantee of ABSOLUTE SATISFACTION! Due to the demand for this seasonable merchandise actually exceeding the available supply, ACT IMMEDIATELY! (We reserve the right to return remittances, as soon as the supply of any one item is exhausted.) In most instances, our SALE PRICES ARE LOWER THAN THE ACTUAL MANUFACTURERS' COST! Join the ever swelling ranks of our 100% SATISFIED CUSTOMERS—WE HAVE YET TO RECEIVE OUR FIRST COMPLAINT.

Stewart-Warner Magnetic Chassis

New 1930 Self-Baffled Dynamic Type. Do not confuse with earlier and cheaper models. An ultra-sensitive, loud speaker. Produced by one of radio's greatest companies. Extremely sensitive, tremendous volume without distortion or rattling. Reproduces with absolute fidelity. Speaker uses a power action unit avoiding chattering even under unusual volume. Oversize magnet. We guarantee satisfaction. Cone diameter 9 in. In factory sealed carton. Shipping weight 6 lbs.
List Price $10.00.
YOUR PRICE.................. $2.75

R.C.A. Filter Condenser and Output Choke No. 8346

This unit has 7 condensers and an output choke. Condenser values include four 0.5-mfs. capacities and three 2-mfs. capacities—total 8-mfs. Used in Radiola No. 60. Size 6 x 4 x 3 inches. Shipping weight 5 lbs. List Price $16.50.
YOUR SPECIAL PRICE.. $5.75

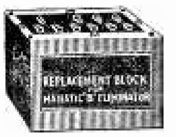
R.C.A. Filter Cond. No. 8289

This condenser unit of 6 condensers includes two 1.0-mfs., two 3.5-mfs., a 2-mf. and a 3-mf. condenser—total capacity 14-mfs. Used in Radiola No. 17 and Radiola No. 50. Size 6 x 4 x 3 inches. Shipping weight 4½ lbs. List Price $19.20.
YOUR SPECIAL PRICE........ $5.75

Loftin-White Direct Coupled 2-Stage Power Amplifier

A very fine phonograph or radio tuner amplifier. Gives auditorium volume! Uses one 224, one 245, one 280 tubes. 6¾x8½x9 inches. Self-contained power supply — for 110 volt, 60 cycle, A.C. Shipping weight 20 lbs.
List Price $35.00.
YOUR PRICE................ $16.50

Replacement Power-Pack Condenser Blocks



Exact duplicate, physical size, placement of connection terminals, and electrical specifications of original blocks. For Majestic 171 type receivers.. $5.85

Shipping weight, all types, 7 lbs.

For Majestic 250 type receivers.. $5.85

For Majestic 245 type receivers.. $5.85

For Majestic "B" Eliminators.. $2.90

The above can be used with any similar power packs — fully guaranteed for ONE YEAR! (All other types can be supplied. Write for prices.)

245 A.C. Power Transformer

For five 224 (or five 227), two 245, one 280 A.C. tubes, OR ANY COMBINATIONS OF 2½-VOLT TUBES. All secondary windings CENTER TAPPED. 600-VOLT HIGH VOLTAGE SECONDARY. 75 WATT CAPACITY. Size 5¼x4¼x3½ inches. For 110 volt, 60 cycle, A.C. Shipping weight 12 lbs.
List Price $15.00.
YOUR SPECIAL PRICE........ $4.45

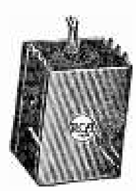
600 Volt Condenser Sections

Impregnated in pitch. Flexible lead terminals.
.5 mfd......25c 2. mfd......40c
1. mfd......30c 4. mfd......60c

Utah Dynamic A.C. Power Speaker—Model 33A

110-volt, 60-cycle A.C. light socket supply for field excitation using Westinghouse dry rectifier. 9 in. high, 9½ in. wide, 7½ in. deep. Speaker comes packed in wooden crate. Weight 19 lbs. It is one of the most powerful as well as best reproducers in the market. 9-inch cone.
List Price $50.00.
YOUR SPECIAL PRICE........ $7.50

R.C.A. Double Filter Chokes
(No. 8336)



This heavy-duty, extremely strong, double filter choke can be used for all types of filter circuits, experimental work, power amplifiers, receivers, eliminators, power packs, converted sets, etc. Known as R. C. A. replacement part for all Radiola models, particularly Nos. 33, 17 and 18. Each choke D.C. resistance, 500 ohms. Connected in parallel, these double filter chokes have a rating of 30 Henries at 160 Mills; connected in series, 60 Henries at 80 Mills. Fully shielded in heavy metal case with special insulating compound. Size 5¼ x 3¾ x 2⅞. Shipping weight 6 lbs.
List Price $10.05.
YOUR SPECIAL PRICE........ 95c

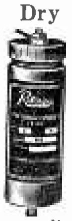
2½ Volt A.C. Fil. Transformer

Two windings, both center tapped. One "lights" six 227 or six 224 2½-volt tubes, and the other lights two 245 tubes (not used with Webster amplifier). Total: 14 amps. For 110 volt, 60 cycle, A.C. Size 4¼x2⅝x3¼ inches. Shipping weight 6 lbs.
List Price $10.00.
YOUR SPECIAL PRICE........ $2.75

1½-2½-5 V. A.C. Transformer

Lights five 226, two 227 (or 224) and two 171 A.C. tubes. Permits conversion of battery sets to A.C. operation, using Raytheon type "B" eliminator. For 110 volts, 60 cycles, A.C. Shipping weight 5 lbs.
YOUR SPECIAL PRICE........ $3.95

Dry Electrolytic Condensers



Mount in any position! Guaranteed never to blow out! Remarkably compact and very inexpensive, permitting generous use of filtering systems. The greater the mfd. capacity employed, the less A.C. hum remains. 500 volt peak rating. Ideal for all 171A - 245 power packs—use two of each capacity desired for 250 power packs (1,000 volt peak thereby assured).

Mfd.	Numb. Anodes	Diameter	Length	YOUR PRICE
1	1	¾ in.	2⅛ in.	28c
2	1	1 in.	2⅛ in.	45c
4	1	1½ in.	2⅛ in.	85c
8	1	1⅜ in.	4½ in.	$1.25
16	2	3 in.	4¼ in.	2.12
24	3	3 in.	4¼ in.	2.75
32	4	3 in.	4¼ in.	3.75

Peerless 15" 110 Volt D.C. Concert Dynamic Speaker

The largest and most powerful dynamic speaker made! Gives tremendous volume—deep and sonorous, as well as fully vibrant over entire musical register. Contains push-pull output transformer (adapts speaker to any receiver output!) and two D.C. field coils, one 800 ohms and the other 4,000 ohms. Ideal for use with Webster amplifier listed below. Shipping weight 25 lbs.
List Price $75.00.
YOUR SPECIAL PRICE...... $16.95

R.C.A. 600 Volt Replacement Condenser Block (No. 8333)

For Radiolas 18, 33 and 51. Over a half a million of these different types of Radiola receivers are on the market. Every serviceman needs these blocks, but they can of course be used for other purposes, such as experimental or converting battery sets for power. Size 3¾ x 2¾ x 3½ inches. Shipping weight 4 lbs. List Price $7.40.
YOUR SPECIAL PRICE........ $1.45

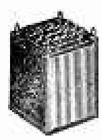
Freed-Eisemann Block

Contains 1—4 mfd.; 2—.1 mfd.; 2—1 mfd.; 1—.5 mfd.; 1—2 mfd. 5¼ x 3½ x 2½ inches. Flexible leads. Shipping weight 6 lbs. YOUR PRICE...... $1.95

Webster Push-Pull Power Amplifier and "B" Supply

Uses two 226, two 210 and one 281 tubes! Super powerful PUSH - PULL amplifier. GIVES AUDITORIUM VOLUME! Also furnishes 110 volt D.C. speaker field voltage (A.C. speakers can also be used!) and 45, 67, 90, 135 volts "B" current. FOR USE AS PHONOGRAPH, SPEECH AND RADIO TUNER AMPLIFIER! 16 in. long, 10½ in. wide, 6¾ in. high. Use 2½-volt A.C. filament transformer shown at left to supply "A" current to tubes in tuner, to which it will be coupled. FULLY GUARANTEED! For 110 volt, 60 cycle, A.C. Shipping weight 40 lbs. List Price $100.00.
YOUR SPECIAL PRICE....... $20.25

250 Push-Pull A.C. Power Transformers

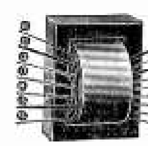


Ideal for use in short wave transmitters, public address amplifier systems, super-power amplifiers, A.C. receiver power packs, etc. EMPLOYS HIGHEST GRADE MATERIALS AND LABOR — FULLY GUARANTEED! Has FOUR CENTER TAPPED secondary windings: 2½ volts, 8.75 amps.—7½ volts, 2½ amps.—7½ volts, 2½ amps.—1200 volts; designed for two 281, two 250 and five to six 2½-volt A.C. tubes (224's or 227's) or 226 tubes if a suitable resistance is used. FULLY SHIELDED! Soldering lug terminals. CAPACITY: 135 WATTS. Size 6¼x4¾x4¾ inches. For 110 volt, 60 cycle, A.C. Shipping wgt. 18 lbs. List Price $20.00.
YOUR SPECIAL PRICE........ $5.65

R.C.A. Loud Speaker 103

A beautiful speaker in appearance. Superb in its ability to reproduce music and speech most faithfully. The frame and pedestal are mounted to resemble hand-carved oak, while the beautiful tapestry medallion conceals the mechanism and completes the decorative design of the instrument. Magnetic unit. Corrugated cone. Height 15 in., width 13½ in., depth 6¾ in. In factory sealed carton. Shipping weight 14 lbs. List Price $22.50.
YOUR SPECIAL PRICE........ $5.20

Earl Power Transformer

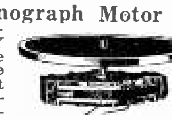


Make money revamping the old battery set. This power transformer used in Earl Model 22 receiver supplies "A," "B" and "C" potentials for: two '27's (or screen - grid '24's), three '26's, two '71A's and one '80 rectifier; total current output of high-voltage winding at maximum output (about 200 volts) is 80 ma. High-voltage secondary, filament winding for '27's, and for '71A's are center-tapped. May be used in any number of combinations. Suitable resistors, a couple of 4-mf. filter condensers, two 30-henry chokes and by-pass condensers complete fine power pack. Size 3¾ x 3 x 2¾ inches. 16 long leads and full wiring directions. Shipping weight 5 lbs. List Price $7.50.
YOUR SPECIAL PRICE........ $1.75

Victor Push-Pull Input-Output Unit

Housed in one metal case. For 171A, 245, 250 tubes. Electrostatically shielded — impregnated in dielectric sealing compound. Output matches moving coil on all dynamic speakers. Solder lug terminals. TREMENDOUS VALUE! Shipping weight 6 lbs.
YOUR PRICE.................. $2.50

A.C. Phonograph Motor



SYNCHRONOUS—revolves EXACTLY 80 turns per minute despite any voltage variations. Most compact made—only 1¾ in. thick—mounts in any limited space. For 110 volt, 60 cycle, A.C. Complete with turntable. Shipping wgt. 10 lbs. List Price $15.00.
YOUR SPECIAL PRICE........ $4.45

Pacent "Phonovox" Pick-up

One of the best and most powerful electric phonograph pick - ups made. Balanced tone arm. unusually sensitive.
Shipping weight 7 lbs.
YOUR PRICE.................. $4.85

A-B-C Eliminators

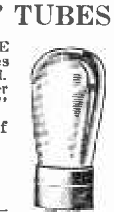
B-C Unit

Dispenses with all batteries—no new tubes required. "A" unit (bone-dry) furnishes 6 volts at 2½ amperes; "B-C" unit furnishes 180 volts "B" (and all lower plate voltages) and up to 40 volts "C"—requires 280 rectifier tube. For all push-pull amp. receivers, or any type battery set. Shipping weight 12 lbs.
"A" UNIT.................. $11.45
"B-C" UNIT, with 280 tube. Shipping weight 12 lbs....... $10.75

GUARANTEED (6 MONTHS) "REXTRON" TUBES

Sold on a 6 month FREE REPLACEMENT GUARANTEE BASIS, IF THEY PROVE UNSATISFACTORY! All tubes are carefully meter-tested before shipment, and carefully packed. Do not confuse these HIGH QUALITY TUBES with any other "low priced" tubes—"Low Price" tubes are usually "seconds."

Choice of	Choice of	Choice of	Choice of
226	201A-112A	224	222
227	200A-199UX	245	210
171A	199UV-120	280	250
			281
$1.00 each	$1.00 each	$1.00 each	$2.95 each



WE ARE A WHOLESALE HOUSE AND CANNOT ACCEPT ORDERS FOR LESS THAN $3.00. If C. O. D. shipment is desired, please remit 20% remittance, which must accompany all orders; balance on delivery.
If the full cash amount accompanies the order, you may deduct 2% discount. Send money order—check—U. S. stamps (any denominations).

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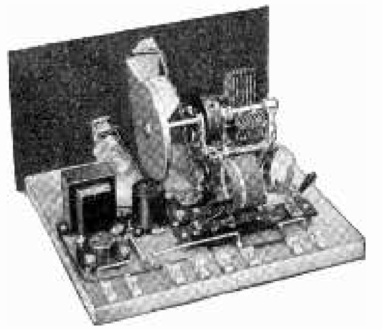
Should you wish goods shipped by parcel post, be sure to include sufficient extra remittance for same. Any excess will be refunded.

We have no catalog—order from this page; you will find special offers from time to time in this magazine. Prompt shipments will be made.



A SHORT-WAVE SET YOU'LL BRAG ABOUT—

Boy, The Hawk *does* bring 'em in! Two tubes—regenerative detector and one audio stage. Easily constructed from the Hammarlund kit, containing all parts, as illustrated.

It includes the famous Hammarlund Drum Dial, the new Hammarlund wide-space short-wave "Midline" Condenser and the improved Hammarlund Space-Wound Plug-in Coils. Covers the range of 15 to 105 meters. Extra coils available for higher wave bands.

The New

HAMMARLUND

Wide-Spaced

SHORT-WAVE

CONDENSER

Heavy, widely-spaced plates for strength. Less chance for accumulation of dust causing capacity changes in close tuning.

"Parmica" insulation, which closely matches the ideal dielectric efficiency of dry air. Current loss greatly reduced; sensitivity and selectivity much improved.

A real short-wave condenser in the three most desirable sizes: 150, 125 and 100 mmf.

Write Dept. RW10 for Details of Hammarlund Short-Wave Equipment.

HAMMARLUND MFG. CO.

424-438 W. 33rd Street, New York

For Better Radio
Hammarlund
PRECISION
PRODUCTS

Slightly Used Amer-tran Transformers

We have on hand some Amer-tran audio transformers, both first stage de luxe and push-pull input No. 151, which have been used by us only in experimental work. They are slightly used, therefore, but are in first-class condition. Five-day money-back guarantee. There is not a mark or scratch on the case or anywhere else except on the terminal lugs. These lugs have a trace of solder on them, showing where we removed the connection made to the test circuit, and this solder trace is the only difference between our stock and brand-new merchandise. We have even put the transformers back in their original boxes.

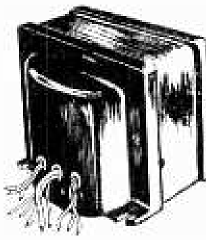
First stage de luxe, list (when new) $8.00;
slightly used @ $3.90
Push-pull input, list (when new) $12.00;
slightly used @ $5.90

RELIABLE RADIO COMPANY
5-DAY MONEY BACK GUARANTEE!
Room 504, at 1562 Broadway, N. Y. City
(Between 46th and 47th Streets)

"RADIO TROUBLE SHOOTING," E. R. Haan. 328 pages, 300 illustrations, $3. Guaranty Radio Goods Co., 143 W. 45th St., New York.

POLO PRECISION POWER EQUIPMENT

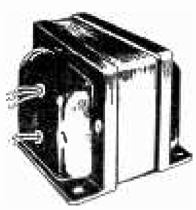
245 POWER TRANSFORMER



Cat. 245-PT
Price, $9.50

THE 245 power transformer is for use with a 280 rectifier tube, to deliver 300 volts DC at 100 milliamperes slightly higher voltage at lower drain, from 105-125-volt AC line (marked 110 v.), 50-60 cycles. The primary is tapped at 82½ volts in case a voltage regulator (Clarostat or Amperite) is used. The black primary lead is common. If no voltage regulator is used the other primary lead is the green one. If regulator is used, the red and black form the circuit. The secondary voltages are all center tapped: 672 volts AC for 280 plates, 2½ v. 3 amps. for 245 output single of push-pull 5 v. 2 amps. for 280 filament; 2½ volts 16 amps. for up to eight 224 or 227 tubes. Center taps are red and all leads are identified on name plate. Laminations are hidden except at bottom. Eight-inch leads emerge from the sides, but if preferred may be taken off through the bottom of the transformer by pushing them through the rubber grommets. Shipping weight, 12 lbs. Overall size: 5" extreme width x 4½" high. Order Cat. 245-PT (12 lbs.) @....$9.50

245 B SUPPLY CHOKE



Cat. 245-CH
Price, $4.25

100 ma choke coil for B filtration in 245 circuits; 200 ohms DC resistance, inductance 30 henrys. A continuous winding tapped in two places, giving three sections and four outleads, and permitting a "choke input" to filter. By this method rectifier tube life and filter condenser life are lengthened yet filtration is splendid. The black lead goes to the rectifier filament center, the red, green and yellow leads are next in order. Capacities suggested: black, none; red, 1 mfd.; green, 8 mfd.; yellow, 8 mfd. In shielded polished aluminum case. Shipping weight, 4 lbs. Order Cat. 245-CH @ $4.00.

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105-120 v., 50-60 cycles, with two secondaries, one of 2½ v., 3 amp. for 245s, single or push-pull, other 2½ v. 12 amperes for up to six 224, 227, etc., both secondaries center-tapped. Shielded case, polished aluminum; same as 245-CH illustrated. 6 ft. AC cable, with plug. Shipping weight, 4 lbs. Order Cat. SP-FLT (4 lbs.) @ $4.25

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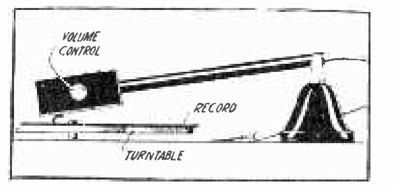

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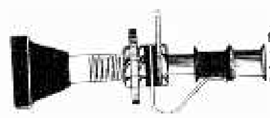

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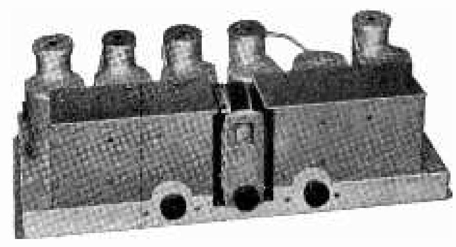

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NATIONAL VELVETONE Push-Pull Power Amplifier, using one 227, two 245's and one 280; two stages of transformer coupling, with output transformer; heater voltage for five extra tubes; plate voltage for tuner. A matched unit for the MB-30 or MB-29-A. Phonograph jack built in. Velvetone comes completely wired. Licensed by RCA. Order Cat. PPPA, list price $97.50, less tubes; net price..............................$57.33

HAMMARLUND HI-Q-31—The latest development in custom-set building, a 9-tube circuit, using a 3-stage band-pass filter pre-selector, three stages of 224 RF, 224 power detector, 227 first audio, two 245's for push-pull output, and a voltage regulator tube. Chassis is 23⅝x12¾". Order Cat. AC-31-R, list price of complete parts, $159.80, less tubes; net price..............................$91.06

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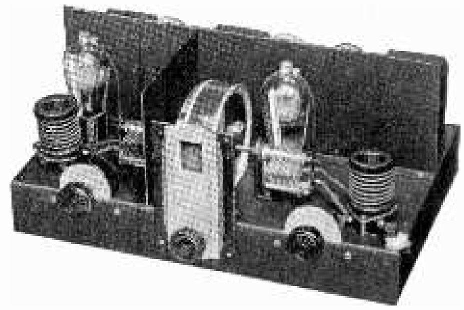
HI-Q-31 TUNER FOR BATTERY OPERATION (less audio)—Order Cat. BAT-31-T, list price $102.95, less tubes; net price..............................$58.69

Short Waves



NATIONAL 5-TUBE THRILL BOX—A remarkably sensitive short-wave outfit, noted for reception of foreign stations. Uses 224 RF, 224 detector, 227 first audio, 227 push-pull second audio. A separate A and B supply is required. See below. Standard set of four pairs of coils included (21.2 to 2.61 megacycles). Humless operation, even on earphones. Single tuning control. No grunting, no backlash, no hand capacity. Order Cat. AC-SW-5, list price, less tubes, less B supply, $79.50; net price $46.74

NATIONAL SW POWER UNIT—Furnishes heater voltage and B voltage for the AC Thrill Box. Uses 280 rectifier. Comes in wired form only. Licensed under RCA patents. Order Cat. 5880, list price, less tube, $34.50; net price..............................$20.28

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