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RADIO WORLD

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RADIO WORLD

The First and Only National Radio Weekly

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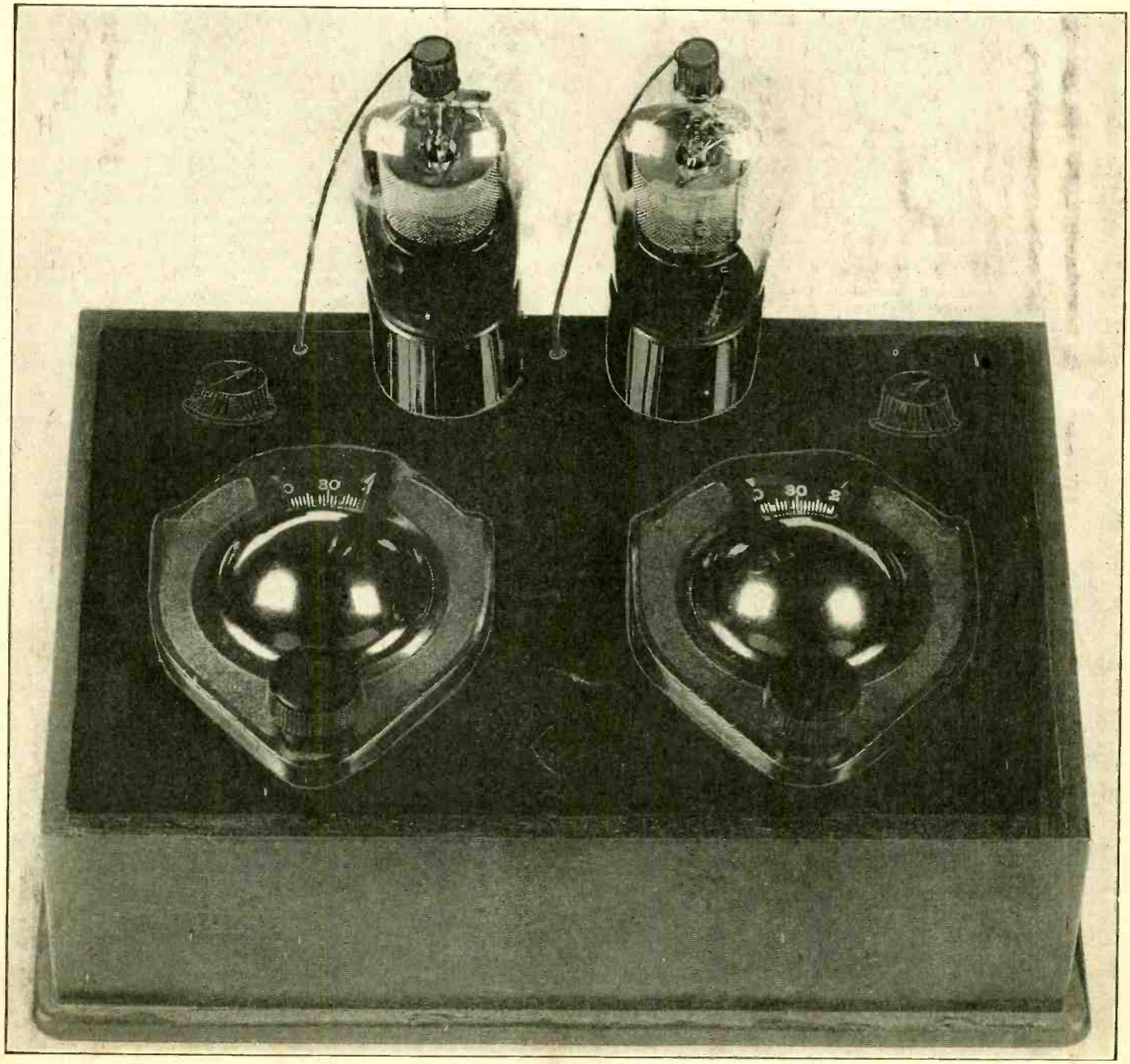

A short-wave adapter, using 235 and 224. See pages 6 and 7.

Parts for 2-Tube Adapter, 15 to 200M

One antenna coil, 50-turn secondary, three taps	$1.00
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Two .0002 mfd. midline junior tuning condensers	3.70
One block of three 0.1 mfd. in one case	.57
One .00025 mfd. grid condenser with clips	.20
One .00035 mfd. detector plate bypass condenser	.10
One 0.1 mfd. mica dielectric isolating condenser	.20
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Two .02 meg. (20,000 ohm) pigtail resistors	.40
One 0.25 meg. (250,000 ohm) pigtail resistor	.20
One .01 meg. resistor	.20
Two small vernier dials	2.00
Three binding posts	.27
One 5.5 x 8.25 inch top panel with two five-prong sockets affixed, and drilled for dials, switch and potentiometer	1.10
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One dozen 6-32 nickel plated brass machine screws, with nuts to match	.10
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A Sensitized Converter

Stage of Intermediate Frequency Built In

By Herman Bernard

WHEN short-wave or all-wave converters are used with a broadcast receiver, the sensitivity usually depends almost exclusively on the sensitivity of the receiver. One has the choice of an intermediate frequency, which may be any frequency within the range of frequencies to which the set itself will tune, say, 1,600 to 530 kc.

Nearly all tuned radio frequency receivers have uneven sensitivity in respect to frequency, therefore some frequency is chosen that affords relatively high sensitivity, but it should be one on which no broadcast reception is directly obtained. That is, if the set is very sensitive at 890 kc, that frequency could not well be used if there were a local station on 890 kc, or a semi-distant station that comes in loudly. It would come right through.

The selection of a low intermediate frequency assures freedom from trouble of this kind because of minimum separation of 50 kc between locals.

Changed Situation

The situation is widely changed when some intermediate frequency amplification is built into the converter. Fig. 1 shows the design of such a converter, using a single tuned circuit, the oscillator, for tuning in the desired stations, while the plate circuits of both the modulator and the intermediate stages are tuned to the intermediate frequency.

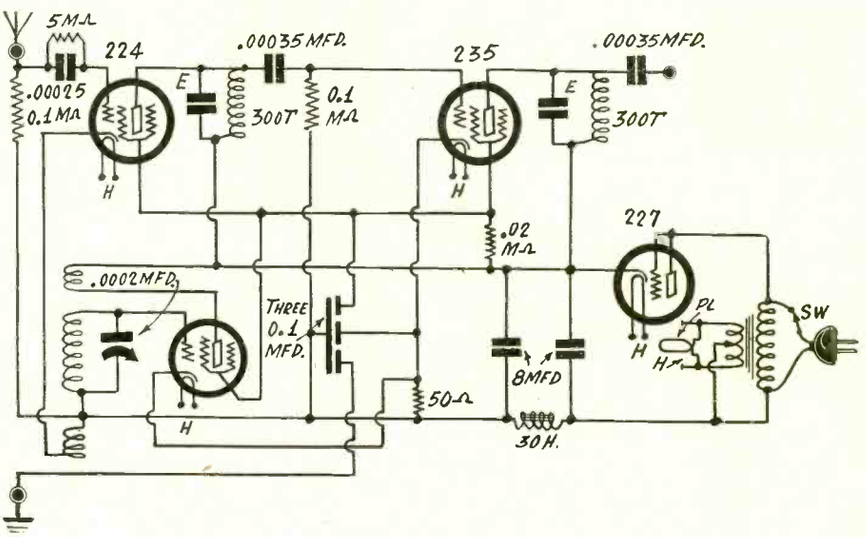


FIG. 1

The change in results consists of increased sensitivity and increased theoretical selectivity. The tube selection consists of a 235 variable mu used as oscillator and another as intermediate amplifier, the modulator a 224 and the rectifier a 227

The increased sensitivity is apparent, but the increased selectivity may seem to be a decrease in selectivity, due to the elevated amplitude. This condition is familiar to all radio constructors, since selectivity is usually estimated by the number of degrees on the dial taken up by a strong station. Such an estimate is erroneous, of course, because it does not take into consideration the amplitude. Hence weak stations seem to be tuned in more selectively than strong ones.

The reconciliation is often effected by stating that the apparent selectivity is increased or decreased. Therefore, in using the present system, the apparent selectivity may be increased by turning down the volume control of the receiver itself. In all

(*Continued on next page*)

LIST OF PARTS
for Fig. 1

Coils
- Four plug-in coils.
- Two 300-turn honeycomb coils.
- One 2.5 volt center-tapped filament transformer with AC cable and plug
- One 30 henry B supply choke coil.
- Two 20-100 mmfd. equalizers (E).

Condensers
- One .0002 mfd. junior midline tuning condenser.
- One .00025 mfd. grid condenser with grid leak clips.
- One block of three 0.1 mfd. condensers in one case (black lead common, goes to converter B minus).
- Two .00035 mfd. fixed condensers.
- Two 8 mfd. electrolytic condensers with brackets.

Resistors
- Two 0.1 meg. (100,000 ohm) pigtail resistors.
- One 5.0 meg. tubular gridleak (not pigtail).
- One 0.01 meg. (10,000 ohm) pigtail resistor.
- One 50 ohm flexible biasing resistor.

Other Parts
- One front panel 7x10 inches.
- One subpanel with five UY sockets.
- One disc dial.
- One AC toggle switch.
- Three binding posts.
- One roll of slideback hookup wire.
- Three screen grid clips.
- Two feet of wire for connection to grid clips.
- One dozen nickel-plated brass 6/32 machine screws with one dozen nuts.
- One flathead 6/32 machine screws.
- Two 6/32 machine screws 2 inches long.
- Two 5/8 inch brass angles, nickel plated.
- Two threaded 5/8 inch bushings.

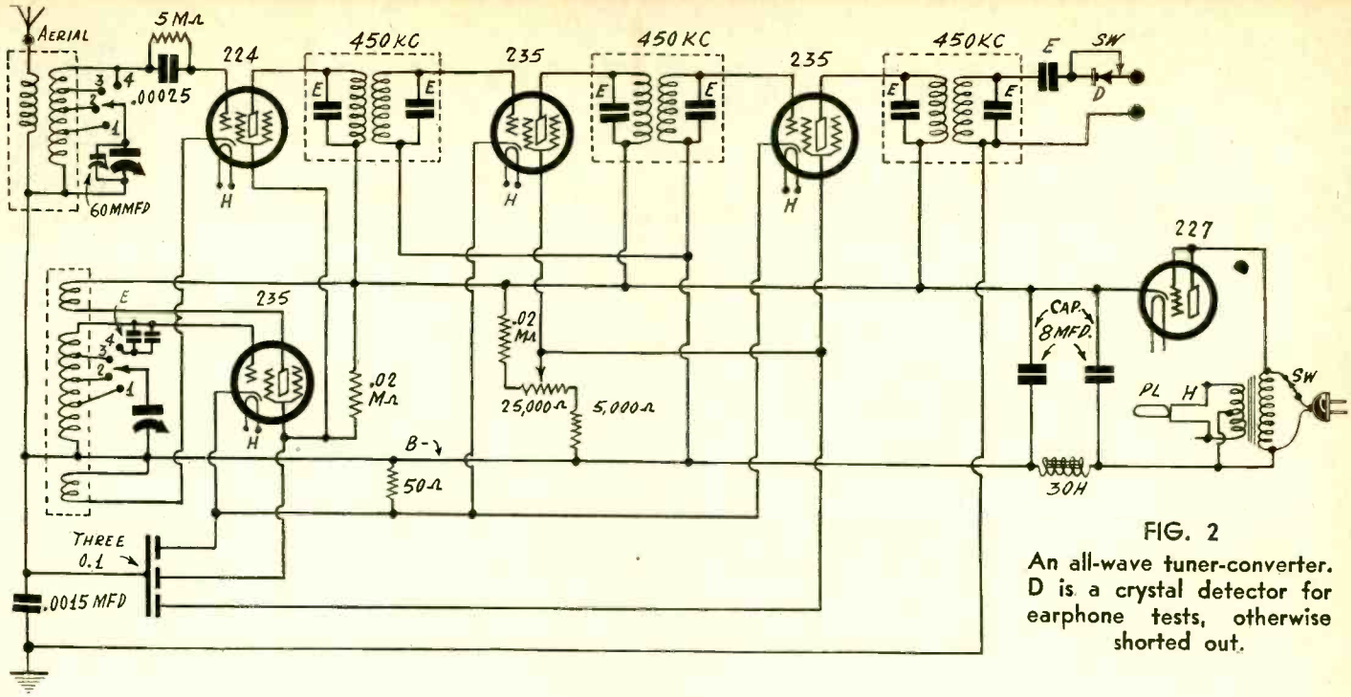


FIG. 2

An all-wave tuner-converter. D is a crystal detector for earphone tests, otherwise shorted out.

(*Continued from preceding page*)

other instances the volume control is used at full position, maximum response.

Another change has been effected—the establishment of a definite intermediate frequency. Since there is one intermediate stage built in, and since the rest of the stages (in the receiver) must be of the same frequency, the former choice of any intermediate frequency is severely narrowed down.

The equalizing condensers E across the 300-turn honeycomb coils in the modulator and intermediate plate circuits are adjustable, giving a range of about 150 kc, so that there is still opportunity to avoid a strong local by using this adjustment, and then the set must be tuned to the same frequency. This may be 790 kc to 640 kc. Therefore even if a set has various degrees of sensitivity, depending on the frequency, the inclusion of the converter's intermediate stage will enhance the amplification at the selected frequency and add that 40-fold gain that enables the use of a receiver that, of itself, may not be so very sensitive in this region.

A third consideration is the establishment for the first time in converters of the general advantage of logging. With any type of converter it is possible to log the stations tuned in, if the same intermediate frequency is used all the time, but it is not known in advance by the manufacturer or sponsor of the circuit what intermediate frequency will be used, so that the largest oscillator coil has to be wound for the lowest intermediate frequency to be sure that the lowest desired carrier frequency will be tuned in.

Let us see how this works out. Suppose that the intermediate frequency selected is the lowest one to which the receiver san be tuned, say, 530 kc. Suppose that an all-wave converter is desired. This will have to tune to bring a carrier of 550 kc. The largest coil, therefore, is wound with that object in view.

Effect of Intermediate Shift

Now suppose that, instead of using the lowest frequency for intermediate amplification, the converter owner uses the highest frequency to which his set responds, because of the greater sensitivity. He has, therefore, set his receiver dial at, let us say, 1,600 kc. The difference between the lowest and the highest frquency is 1,070 kc. Increase in the intermediate frequency decreases the response frequency, therefore the largest coil will not bring in the broadcast band, but either will not tune in the broadcast band, or, if it does so, will use the lower oscillator setting, instead of the favored higher frequency setting.

This complication is entirely avoided by having a built-in intermediate stage. It is then virtually impossible to tune in any stations with the converter unless the frequencies of the built-in intermediate and of the set are almost the same, and preferably of course, they should be identical. This can easily be arranged, because with the plates of the equalizers as far apart as possible the frequency of response in the intermediate stage, and at the modulator output, is around 790 kc, while when the plates are as close together as possible the frequency is about 150 kc lower.

There is also little if any likelihood of squealing resulting from added amplification at some low frequency, as compared with the virtually inevitable result of squealing if the built-in intermediate stage were tuned to a high broadcast frequency, requiring the set to be tuned to that frequency. Nearly all receivers subject to squealing or undue activity in the radio amplifier suffer this condition at the higher frequencies only.

There is, hence, much to commend the inclusion of a stage of intermediate frequency amplification.

In addition, the converter is grounded, which in some instances adds to the sensitivity, but in others will not change it any in either direction. Usually the result depends on whether the AC line is effectively grounded. If so grounded, then the addition of the ground facility helps little or none, because grounding is communicated to the converter through the filament transformer, one side of the primary of which is used for B minus of the converter, hence automatically would be grounded.

Moreover, no matter in which way the plug is connected to the convenience outlet, whether to pick up the high side or the grounded side to the B supply choke, the inclusion of a ground provision establishes ground infallibly. Therefore, despite seeming lack of difference in some installations, the ground should be included.

Radio Frequency Aspects

In fact, ground might be connected directly, instead of through a condenser as shown, because of the special treatment of the choke circuit of the B supply.

Notice that one side of the B supply choke is connected to one side of the primary of the filament transformer (either side), and that the choke interrupts the B minus lead to the converter. Therefore, instead of being in the positive leg of the rectifier, the choke is in the negative leg, and a direct connection of ground could not possibly cause a short circuit of the AC line, because in one case one side of the choke and ground would be common, hence the choke would be free of line effects, while in the other case the choke would be across the line. The only requirement is that the choke should present a suitable impedance to the line, at least as great an impedance as the primary of the transformer. Even a 5-henry choke would do that.

The placement of the choke in the negative leg requires that the electrolytic condenser cans connect to the choke at the points shown, while both anodes (caps) of the condensers go to the cathode, which is the positive lead. Therefore the subpanel should be of insulating material.

The input of the radio frequencies to the converter is made through a resistor in the antenna-ground circuit. The value is not critical. It is suggested that 0.1 meg. (100,000 ohms) be used, but values from 20,000 ohms up are suitable. Not much more than 100,000 ohms is recommended, however, because then the resistor begins to show considerable capacity effect, which would diminish the response at the higher frequencies, or detour the wave to ground.

High Modulator Grid Leak O.K.

The same considerations apply to the grid leak in the intermediate stage, that is, the usual high values of the order of megohms should not be used, but the rule does not apply to the modulator grid leak, as this is in series with the line, not in parallel with it.

The connections are as follows:

Remove aerial from the receiver and connect it instead to the antenna post of the converter.

Connect the ground either to the converter or to the set, and run a wire between these two points.

Connect the output of the converter to the vacant antenna post of the receiver, or, if the set uses a screen grid tube as the first radio amplifier, remove the grid clip from this tube, put a grid clip on a wire lead, and connect the clip to the tube cap and the other end of the wire to the output post of the converter.

A Phonograph Amplifier

Two Audio Stages Needed

By Brunsten Brunn

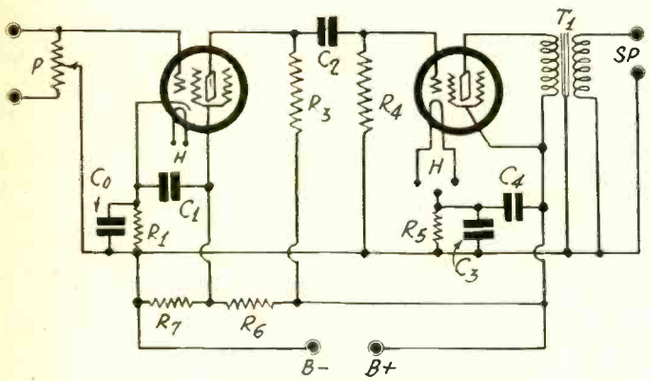


FIG. 1

A two-stage direct coupled amplifier suitable for amplification of phonograph signals when there is an inadequate amplification in the radio set for this purpose.

THERE has been a marked increase in the demand for phonograph amplifiers since the advent of the radio receiver with no audio amplification, or with only one stage of such amplification. This increase has been in the face of decreased interest in phonograph pick-up units. There is evidently much interest in electrical playing of phonographs or there would be no interest in special amplifiers.

It may be stated that with a pick-up unit of moderate sensitivity it is necessary to have two stages of audio frequency amplification. While one stage may give sufficient amplification to satisfy home requirements two are necessary when volume enough for a public hall is needed. In order to get enough volume for such places one or two power tubes must be used in the last stage, and such tubes ordinarily do not have enough amplification to meet the demand. Hence two stages are needed.

The amplifier may be either single sided or push-pull, the second giving considerably more and better output. If the very best quality is desired the coupling in the amplifier should be resistive as far as possible.

Single Sided Amplifier

In Fig. 1 is a single sided amplifier suitable for phonograph playing. It contains a screen grid amplifier and a pentode output tube. It is resistance-capacity coupled up to the output of the second tube, where a transformer is used to couple the speaker to the tube. This transformer may be the one that is built into the speaker, or it may be an extra matching transformer in case the transformer in the speaker is not suited to the output tube. Chances are that the speaker transformer will work out satisfactorily, for it has been built for a power tube and the pentode tube does not differ greatly from the older power tubes.

There is a potentiometer P in the grid circuit of the first tube, which is used for volume control. This is preferable to the shunt rheostat that is ordinarily supplied with a pick-up unit. The resistance of the potentiometer may be about 30,000 ohms, but it is not critical. The slider on the potentiometer is connected to ground in preference to the grid. This is the best way and is possible provided there is no ground on the pick-up unit.

The screen grid tube works into a 250,000 ohm resistance R3, which insures a high amplification. The stopping condenser C1 should not be smaller than 0.01 mfd. and should preferably be much larger. However, it is not advisable to use a larger value if this entails the sacrifice of the mica dielectric type. The grid leak R4 should be one or two megohms. If the value of C2 is 0.1 the value of R4 should be 2 megohms, and if the value of C2 is 0.02 the value of R4 should be 1 megohm. These combinations give about the same amplification on the low notes.

Cathode Potentials Raised

The cathode of the first tube is raised to a suitable potential with respect to the grid return by a 2,000 ohm grid bias resistor R1, which is shunted by a 2 mfd. condenser Co. A 0.1 mfd. condenser C1 is connected between the cathode and the screen to maintain the screen voltage constant with respect to the signal. The high resistance is necessary for bias because comparatively little current flows through it due to the high load resistance and the low screen voltage on the tube.

The bias for the power tube, a 247 pentode, is provided by R5, the value of which should be 418 ohms, or as near that value as practicable. This resistor makes the bias on the grid of that tube about 16.5 volts. The condenser C3 across this resistor should preferably be an 8 mfd. electrolytic but a 4 mfd. condenser will do fairly well. C4 need not be larger than 2 mfd.

The total voltage applied between B plus and B minus should be

(*Continued on next page*)

LIST OF PARTS

R1, R1—Two 20,000 ohm resistors.
R2—One 150 ohm resistor.
R3, R3—Two 250,000 ohm resistors.
R4, R4—Two 2 megohm resistors.
R5—One 200 ohm resistor.
R6—One 10,000 ohm resistor.
P—One 30,000 ohm potentiometer.
C—One 2 mfd. condenser.
C1, C1—Two 0.01 mfd. condensers.
Four UY sockets.
One push-pull input transformer.
One push-pull output transformer.

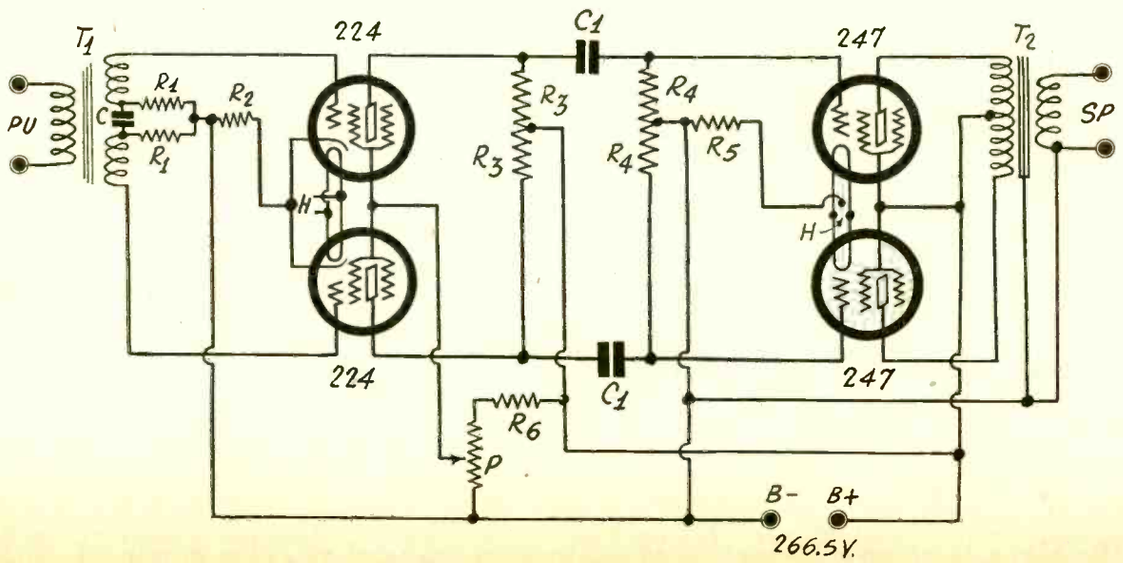


FIG. 2

A push-pull two-stage amplifier suitable for phonograph playing when large volume is desired.

A Two Tube AC Sh

All Voltages Obtained fr

By Henry

THE system of constructing a short-wave or an all-wave adapter, so that the voltages therefor will be obtained from an AC receiver (provided the receiver does not use 226 radio frequency tubes), is applicable also if a stage of tuned radio frequency amplification is used. The plate current will be only about 6 milliamperes, and the screen current will be less than 2 milliamperes, so there is no danger of overloading the rectifier of the receiver. Moreover, the radio frequency amplifying and detector tubes of the receiver may be removed, and as these are always two or more, the heater current and voltage for the adapter will be well within the limits of the receiver's power transformer. So there is no danger whatever of doing any harm to the set.

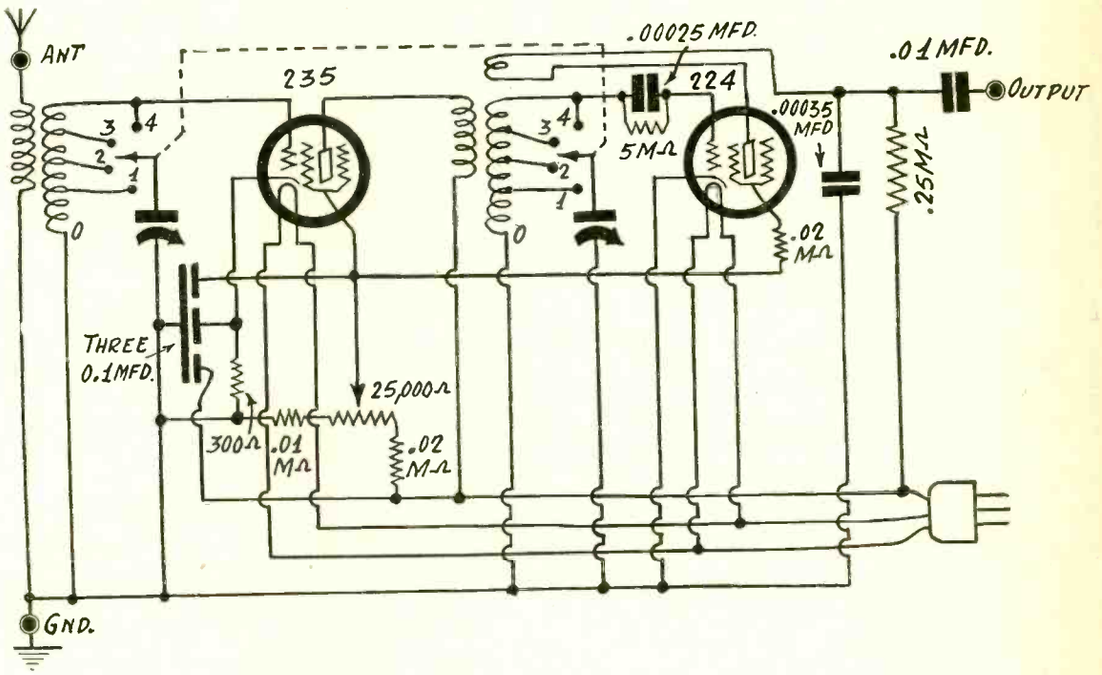


FIG. 1

A short-wave adapter, using two individually tuned circuits for a variable mu tube and a screen grid tube. The voltages are obtained by plugging into an AC receiver that uses heater type tubes.

This adapter, the SW-C, is not to be confused with the type that plugs into the detector socket, since that type relies on a plate load impedance for whatever plate voltage is delivered, and besides accounts for only a one-tube device. Also, in that case the detector load is not necessarily known, and the adapter lacks universality, as it may not oscillate. The present adapter positively will oscillate, since 100 volts or more are surely obtainable from the radio frequency plate circuit of any tube, and the plate load is right in the adapter.

Identical Secondaries

Unlike the circumstances presented where a short-wave converter is used, here two tuned circuits are resonant to the same frequency to bring in the carrier of that frequency. So the coils and their taps are identical. It is possible so to wind the coils, on 1.25 inch diameter tubing, about the diameter of a tube base, although of about twice the axial length of a tube base, to tune in the broadcast band as well. That complicates matters a little, and since the receiver itself attends to reception of the broadcast band, it is quite proper to confine the response of the adapter to the range from 15 to 200 meters (20 megacycles to 1,500 kilocycles).

Also, larger diameter tubing, 1.75 diameter, may be used, which makes for a better performing coil than does the smaller tube base variety. It is not quite practical to use the larger diameter and cover the broadcast band as well with the adapter, since there is no room in the selected cabinet for two coils requiring so much wire. The top panel is only 5.5x8.25 inches, while the inside depth of the cabinet is 2⅝ inches.

The wave band selection is done by means of a selector switch of the double pole four-point type, which has shaft insulated from everything. Any one position of the switch therefore accounts for indentical inductance selection for two circuits. By using secondaries wound to tune in up to 200 meters, taps may be provided so that progressively less than the total inductance will be used for bringing in the frequencies of three other bands.

Auto-Transformation

An analysis of the circuit will show that when the switch arm is moved so that the stator of the tuning condenser connects to less than the full inductance, there is a double transformation effect. The primary and the secondary themselves constitute a transformer, but the secondary under the circumstances outlined becomes an auto-transformer, of which the tuned part is the primary and the total winding (from point 0 to point 4) the secondary. Therefore the antenna voltage is stepped up in the ratio of the number of primary turns to secondary turns, when the total winding from (0) to (4) is used, with no other step-up, while when less than the total winding is used in the tuned circuit, say, from point (3) to point (0), the mutual step-up is less, in proportion to the number of turns not now in-

How to Construct a Good

(Continued from preceding page)

266.5 volts, allowing 16.5 volts for the grid bias and 250 volts for the plate and screen. Of course the value is not critical. The same voltage is applied to the plate of the first tube because this insures a high distortionless amplification. Notwithstanding this high applied plate voltage the screen voltage must be considerably lower than it would be in a radio frequency amplifier. The proper voltage is about 30 volts. This is obtained very nearly if R6 is 50,000 ohms and R7 is 7,000 ohms. In case the applied voltage is lower than 266.5 volts the various grid, screen and plate voltages will be pro-

ort-Wave Adapter
om Set—Two Tuned Circuits

B. Herman

LIST OF PARTS

Coils
- One antenna coil, 50-turn secondary, tapped at the 35th, 44th and 48th turns.
- One interstage coupling coil, three windings, 50-turn secondary tapped at the 35th, 44th and 48th turns.

Condensers
- Two .0002 mfd. midline junior tuning condensers.
- One block of three 0.1 mfd. in one case (black, common, goes to ground).
- One .00025 mfd. grid condenser with clips.
- One .00035 mfd. detector plate bypass condenser.
- One 0.1 mfd. mica dielectric isolating condenser.

Resistors
- One 300 ohm flexible biasing resistor.
- One 25,000 ohm potentiometer.
- Two .02 meg. (20,000 ohm) pigtail resistors.
- One 5,000 ohm resistor.
- One 0.25 meg. (250,000 ohm) pigtail resistor.

Other Parts
- Two small vernier dials.
- Three binding posts.
- One 5.5 x 8.25 inch top panel with two five-prong sockets affixed; panel and drilled for dials, switch and potentiometer.
- One walnut finish wooden cabinet to fit.
- Two 5/8-inch nickeled brass right angles and two 5/8-inch threaded bushings for coil mounting.
- One dozen 6/32 nickel plated brass machine screws, with nuts to match.
- One five-lead cable, with UY plug (two heater leads and plate lead used, other two not used).
- Two grid clips.
- One roll of slideback hookup wire.

cluded in the tuned winding, but there is an undisturbed gain because of auto-transformation.

Let us ascribe arbitrary values. Suppose the primary in the antenna-ground circuit has 12 turns, the total secondary has 84 turns, and tap (3) represents the midpoint of the secondary, or 42 turns from either point (4) or point (0). These values are assigned to simplify the computation.

If a voltage v is in the antenna primary, and there is unity coefficient of coupling, the voltage in the total secondary will be $7v$, due to the 1 to 7 ratio of the 12 turns and the 84 turns.

How to Wind the Coils

Now suppose that the switch pointer is moved to (3). Now the step-up ratio between primary and tuned secondary is only half as great as formerly, i.e., to 1-to-3.5. But there is a 1-to-2 step-up in the natural secondary itself, which secondary also has within it a tuned primary. So the resultant effect is not to decrease the step-up at all. The actual result is a gain because the resistance of the untuned part of the secondary is always an advantage, whereas when this part of the winding is in the tuned circuit the resistance is a detriment.

The interstage coil has a third or plate winding, used for producing regeneration, which is controlled by the potentiometer. The same adjustment that controls screen voltage on the detector affects the screen voltage on the radio frequency amplifier, but the detector screen voltage is retarded some 15 volts for readier stability and better detecting efficiency. No absolute values of the tickler turns and voltages may be prescribed without a foreknowledge of the condition of the tube to be used as detector, but if there is any over-keenness in the detector, resulting in squawking or inability properly to check oscillation, then the value of the limiting resistor in the detector screen circuit may be increased.

For general purposes, however, it will be found that any kind of wire on a 1.75 diameter will produce satisfactory results in regeneration, and permit control, if the number of turns is 20, and the separation between primary and secondary is 1/8 or 1/4 inch.

Where to Put Taps

Therefore, using 1.75 inch diameter bakelite tubing, the antenna primary may consist of 12 turns, 1/4 inch separation being allowed, then the secondary of 50 turns is wound, tapped at the 35th turn for tap (3); the 44th turn for tap (2), and the 48th turn for tap (1). The number of turns from (1) to (0) takes care of itself, as it consists of 2 turns, resulting from the last tap being the 48th on a 50-turn winding.

The interstage coil duplicates the other, except for the addition of the 20-turn tickler. All the wire is No. 28 enamel, except that the tickler may be even finer wire, silk or cotton covered, if desired.

These data are for .0002 mfd. tuning condensers.

If no oscillations are productible, reverse the connections to the tickler coil.

The first tube, a 235 variable mu tube, takes a negatively biased grid return, provided by the 300 ohm resistor, which will afford normally a 1 to 1.5 volt bias. The detector, a 224, takes a zero bias grid return, because of the use of the leak-condenser type of detection. This means the grid return goes to grounded B minus.

In connecting the adapter, all that is necessary is to remove aerial from the broadcast set and connect it instead to the adapter's antenna post, connect the ground post of the adapter to the ground post of the set, leaving the ground connected either at set or adapter, and put the five-prong plug into a radio frequency socket of the receiver.

It his been suggested that all tubes except the audio and rectifier tubes be removed from the set. The connection of output of adapter to the set is made by removing the first audio tube from the set and connecting the bared looped end of the output lead from the coverter to the grid prong of the removed tube, which tube then is replaced in the first audio socket.

If one wants to listen in on earphones, this may be done by connecting phones between the adapter output post and the ground post of the adapter. Then it is not necessary to connect the output anywhere else. However, for speaker operation the connection to the first audio tube as outlined is necessary.

Phonographer Amplifier

portionately lower without any change in the circuit constants. The first tube (left) may be either a 224 or a 235 screen grid tube. Since the volume is controlled by means of a signal variation a 224 will not cause any distortion due to excessive bias.

In Fig. 2 is a push-pull two stage amplifier utilizing screen grid tubes in the first stage and 247 pentodes in the second stage. The amplifier is coupled to the pick-up unit by means of a push-pull input transformer and to the speaker by means of a push-pull output transformer. The coupling between the stages is resistance-capacity. The values of parts are given in the list on page 5.

Current List Prices On Receiving Tubes

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

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

* *This is comparable to the* 235.

Short-Wave Time-Table

A time table of principal short-wave transmissions will be published in the Special Short-Wave Number of RADIO WORLD, dated July 11th. No matter in what time zone you reside, you can tell what important stations are on the air the world over. Be certain to get a copy of this special number.

Push-Pull Detection

NoVoltage Difference at Output

By J. E. Anderson

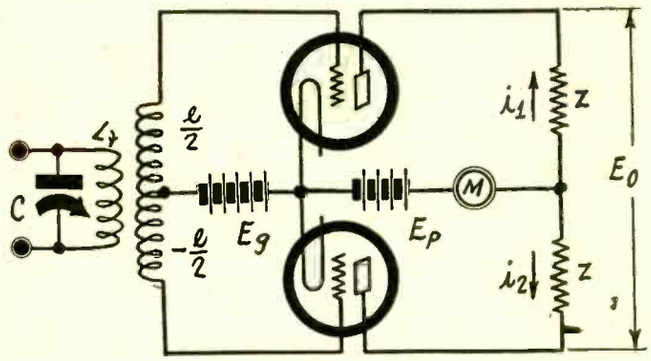


FIG. 1

A circuit in which the grids of two detector tubes are connected in push-pull with respect to the source of signal voltage. No push-pull connection is possible with respect to the detected component of the plate current.

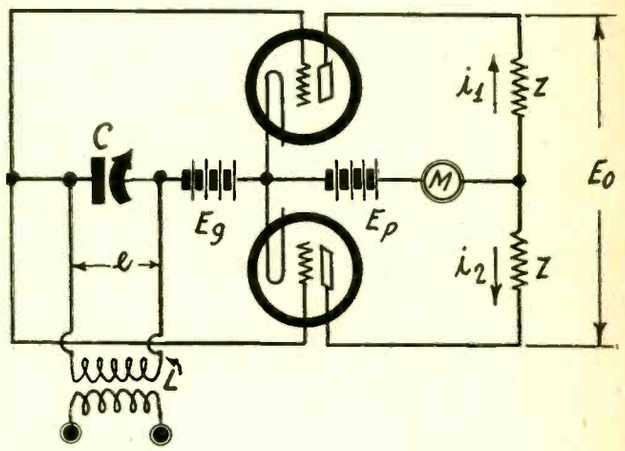


FIG. 2

In this circuit the same signal voltage is impresse on the two tubes. No detected signal voltage will be im ed on a push-pull output transformer.

WHY does not push-pull detection work? Many detectors purporting to be push-pull have been described but in every case they have worked, if at all, in spite of the connection and not because of it. In no case were they push-pull detectors. The theory of detection is against the possibility of push-pull. Let us attempt to show why it is futile to look for push-pull detection with amplifier tubes.

The detected component of the output of a tube is the rectified portion of the plate current. It is mainly the second harmonic of the output but the higher even harmonics add some to the rectified current. We can consider the problem either from a d.c. or an a.c. point of view, but it is preferable to consider a.c. The increase in the d.c. component of the plate current is then proportional to the detected component and also proportional to the audio frequency amplitude in case the a.c. is modulated.

In order to have push-pull detection we must connect the plate circuits of the two tubes in push-pull, just as they are connected in push-pull amplification. If we can find the value of the voltage Eo in either Fig. 1 or Fig. 2 we have the voltage across the load of the tube, the voltage we seek.

AC Input

Let an alternating current of radio frequency flow in the circuit LC in Fig. 1 and let the condenser C be adjusted so that the circuit is resonant. Then a strong alternating voltage will be induced in the secondary of the transformer. Let this voltage be e. The secondary is center-tapped and the coil connected to the tubes so that each tube gets half the voltage. Since the voltage is in the same direction in the whole coil at any instant the two half voltages are impressed on the two tubes in opposite directions. In the upper tube the alternating voltage $e/2$ is added to the permanent bias Eg and in the lower tube it is subtracted therefrom. Hence the lower $e/2$ is written with a negative sign. This is the way the input voltages are arranged on the input side of every push-pull circuit.

Now the output current i_1 is proportional to the square of the total grid voltage, or it is proportional to $(Eg + e2)^2$, provided the value of Eg is such that the tube will detect well. The plate current i_2 in the lower tube is also proportional to the total voltage, that is, to $(Eg—e/2)^2$.

The current in each case is composed of three terms. One which is the square of the bias voltage Eg. This is the same for both tubes and is the current obtained when no signal is impressed, or when e is zero. A second term which is the product of Eg and e. This is the same in magnitude for the two tubes but differ in direction. This is the term that is of interest in an amplifier. The third term is $(e/2)^2$. It is the same in both tubes both as to magnitude and direction and it shows up as an increment in Eg^2. It is the sole term that is of interest in detection. If the tube is properly biased for detection Eg^2 is small and $(e/2)^2$ is large for large values of e. The third term contains the audio component if the input current is modulated and the audio signal is only a variation in the magnitude of this term.

It will be noticed that the detection component flows in the same direction as the current due to the steady bias and that it does not depend at all on the direction of the radio frequency signal voltage. If a milliammeter M is connected in series with the plate battery this meter will read the sum of the third terms from the two tubes as well as the sum of the first terms from the two tubes. The second terms will not contribute anything to the meter reading because the currents are opposite and cancel out. But the third terms will add up and the increase in the meter reading due to the signal voltage will be twice $(e/2)^2$.

The two impedances Z in the plate circuits are supposed to be exactly equal. They must be in a push-pull circuit. They will cause equal drops so that if a voltmeter is connected between the two plates, or across the two Z impedances, there will be no reading. There will be a difference due to the two middle terms of the current but this difference will not register on a d.c. instrument. It will be a radio frequency voltage.

The first and the third terms will cause equal drops and therefore they will not register, either, for the meter is connected between two points of equal potential in respect to these currents. Therefore Eo is zero as far as the detected component is concerned. That is, if Z, Z are the two halves of the primary of a push-pull output transformer there will not be any input to the transformer at audio frequency, for if there is no audio frequency voltage across its primary terminals there is no input. In order to get the benefit of the detection in the tubes it would be necessary to connect a transformer or a coupling resistance in the position of the milliammeter M. Then we would get the sum of the detection effects in the two tubes.

The two arrows in the plate circuits of Fig. 1 show the direction of flow of the steady and the detected components of the currents.

Connecting Grids in Parallel

Thus we find that when we connect the two grids in push-pull and divide the signal equally between the tubes we do not get any detected voltage across a push-pull transformer connected in the usual fashion in the plate circuits. There is another way of connecting the grids of the tubes with respect to the voltage, and that is in parallel as indicated in Fig. 2. Here the same voltage e is impressed on the two tubes in series with the common grid bias. What happens in the plate circuits of the two tubes? Let us see.

The plates are connected in push-pull and we have the same impedances Z, which may be the halves of a push-pull transformer. As before the plate current in either tube is proportional to the square of the total grid voltage, assuming that the steady bias is high enough for efficient detection. Each tube gets the same grid voltage $Eg+e$. The two plate currents are now exactly equal and there is not even a voltage drop across Z, Z for the second term in the square of $Eg+e$. Hence we get no voltage across the impedances Z, Z or across a push-pull transformer connected in the usual way to the tubes. The meter M in Fig. 2 gives the increase in the plate current due to the signal just as it did in Fig. 1 and therefore if we wish to make use of the detecting efficiency of the tubes it is necessary that we connect the load in the position of M. There is little or no advantage in connecting as in Fig. 2, making Z, Z zero, for the effect is only that of putting two equal tubes in parallel both in the grid and the plate circuits. There may be a slight advantage in connecting as in Fig. 1 but it is not enough to justify the use of two tubes. In neither case is push-pull detection possible.

Application of Kirchhoff's Laws

Expansion of Ohm's Findings Explained

By J. A. Dowie

Chief Instructor, Natural Radio Institute

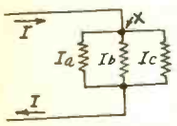


FIG. 1

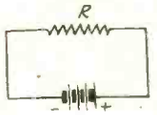


FIG. 2

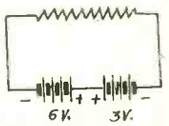


FIG. 3

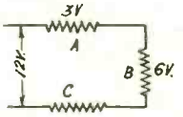


FIG. 4

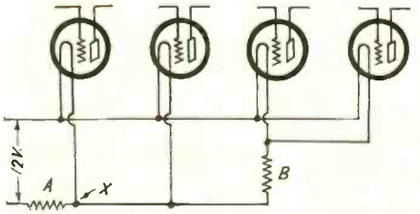


FIG. 5

TWO laws which have been deduced from Ohm's Law and called Kirchhoff's Laws are very important to a radio service man when dealing with problems pertaining to the flow of electric currents in a circuit or network of conductors.

Kirchhoff's *first* law states that at any point in a circuit there is as much current flowing away from the point as there is flowing to it. In other words, electricity does not accumulate at any point in an electric circuit, since just as much current arrives at the point per second as leaves. For example, the series-parallel circuit shown in Fig. 1, the current I flowing to point (×) must exactly equal the sum of the currents $I_{(a)}$, $I_{(b)}$ and $I_{(c)}$ which are flowing away from the point (×). In other words, $I = I_a + I_b + I_c$.

Kirchhoff's *second* law is as obvious as the first, but more difficult to state as clearly, unless you first thoroughly understand the meaning of the term IR drop, which will be explained here.

When one substance is charged positively and another substance is charged negatively, there is said to be a difference of potential between them. When a battery is connected in a closed circuit as shown in Fig. 2, there is a flow of current through the resistor R and there will be a drop in potential across the resistor which will be equal to the product of the current times the resistance of the resistor. For example, if .5 ampere of current flows through a resistance of 10 ohms, the "IR drop" would be .5 times 10, or 5 volts.

Furthermore the "IR drop," though expressed in volts, differs in meaning from the so-termed "electromotive force," the latter designating the voltage applied to a circuit by a generator, battery, etc.

Now suppose we had two batteries, one rated at 6 volts and the other rated at 3 volts, and they were connected together as shown in Fig. 3 so that they would buck each other, then the available voltage which may be utilized in the circuit from these batteries would be 6 minus 3 or 3 volts. Therefore, the 3 volt battery may be considered as a negative voltage opposing the 6 volts positive applied electromotive force. A resistor in a circuit producing an IR drop of 3 volts would result in the same available voltage 6 minus 3 or 3 volts.

On this is based Kirchhoff's second law, namely, that the sum of several "IR" drops around any one path of an electric circuit equals the sum of the electromotive force impressed on that same path.

Thus the sum of the IR drops in the resistors (A), (B) and (C) of Fig. 4 must be equal to the applied electromotive force of 12 volts.

Now let us apply Kirchhoff's law to a practical radio problem.

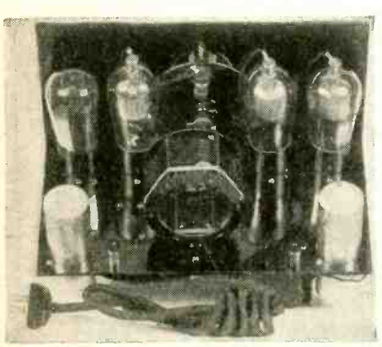
Suppose we wished to design a portable audio amplifying unit using two 112A tubes and two 245 tubes, and for simplicity fixed resistors are to be used in filament leads for cutting down the required voltage for each tube. In this example, we are going to use a 12 volt car battery for the filament supply. If the resistors A and B are connected as shown in Fig. 5 what resistance rating in ohms will be necessary for each resistor.

We know that the filaments of the 112A tubes require 5 volts, and the filaments of the 245 tubes require 2.5 volts. Therefore, the resistor A must cut down the 12 volts to 5 volts for the 112A tubes. In other words, there must be an IR drop of 7 volts (12—5) through resistor A. We must also have an IR drop of 2.5 volts (—2.5) through resistor B, so as not to affect the voltage across the two 112A tubes. This is a good example of Kirchhoff's second law because it can be seen that in this latter case that the sum of the IR drops through the resistor A and B and the 245 tubes totals 12 volts, or is equal to the applied e.m.f. of 12 volts. According to Ohm's Law the current flowing through the circuit consisting of resistors A and B and the combined resistance of the 245 tube filaments is identically the same at every point in the circuit. The 245 tube draws a filament current of 1.5 amperes, two 245 tubes would draw 3 amperes, which would be the total current that flows through the resistor B. To find the value of the resistor B which has an IR drop of 2.5 volts we use the regular Ohm's law formula:

$$R = E/I = 2.5/3 = .83 \text{ ohm.}$$

A single 112A tube draws a filament current of .25 of an ampere, two 112A tubes .5 of an ampere.

Kirchhoff's first law states that the current flowing from a point, such as × in Fig. 5, must be exactly equal to the current flowing to that point. Therefore, since all the filament current flows from point × the same amount of current must flow to it, and consequently to complete the circuit this total current must have previously flowed through the resistor A. In this case, the total current flowing through resistor A and also away from point × would be equal to 3 amperes (1.5 + 1.5) flowing through resistor B to the 245 tubes plus .50 of an ampere (.25 + .25). With the above data it is an easy matter to use Ohm's Law to determine the necessary resistor for A as $R = E/I = 7/3.5 = 2$ ohms.



Polo's Converter in New Assembly

An improved layout of parts, and a new cabinet design to match the lines of the modernistic dial used, are announced by Polo Engineering Laboratories, 125 West 45th Street, New York City, for their all-wave converter, the DX-4. The arrangement of parts is more compact, yet is such as to afford greater room between individual parts.

The views of the rear of the chassis and the front of the cabinet are illustrated herewith.

The circuit design is that of a stage of untuned radio frequency amplification, a tuned oscillator, and untuned modulator and a rectifier, as the converter supplies all its own power.

An optional circuit, the DX-4-VM, comprising the same layout as the other, but omitting the untuned radio frequency stage, and substituting instead a built-in stage of intermediate amplification, is offered. The principal difference is that with the DX-4 model any intermediate frequency within the range of the receiver with which the converter is worked may be used, whereas in the second-mentioned model, the DX-4-VM, the intermediate stage compels choice of an intermediate frequency somewhere within 790 kc. and 640 kc.

Besides, Polo has in preparation an all-wave midget receiver using a switch at front panel to change bands.

Measurement of KH Layer

Bureau of Standards Develops Recorder

THE Bureau of Standards of the Department of Commerce carries on a series of studies of the height of the Kennelly-Heaviside layer. The height of this layer above the earth's surface varies from 40 to 400 miles and is the principal factor determining the distance of transmission of radio waves on different high frequencies.

The study of this height is the most powerful means available of studying the vagaries of radio transmission.

Considerable work has been done on the measurement of layer heights by the echo (or reflection or group retardation) method. With this method a very brief and sharp radio-frequency impulse (of a few ten-thousandths second duration) is transmitted 30 times per second from a transmitter to a receiver about 10 miles away.

Single or Multiple Pulses

If the waves travel only along the ground a single pulse is obtained at the receiving station each thirtieth of a second. If, however, a part of the waves travel upward and the Kennelly-Heaviside layer reflects or refracts them back to the receiver, two or more pulses are received instead of one. The sky-wave pulses are retarded behind the ground-wave pulse because they have traveled a longer path. The amount of this retardation is usually from a few ten-thousandts of a second to a few thousandths of a second. At the receiving station the pulses are photographed on the moving film of an oscillograph, and the time retardation of the delayed pulses thus measured. From the time retardation and the known velocity of propagation in free space the effective height of the reflecting or refracting layer is determined.

Beginning June 1, the bureau started issuing a weekly bulletin giving KHL heights. This information is broadcast by radio telegraphy from the Arlington naval radio station, as a part of the Ursigram bulletins of cosmic data compiled by Science Service and distributed by that organization in mimeographed form to interested scientists.

Development of Apparatus

Apparatus for this work has not been highly developed previously. For satisfactory work the transmitter should send out a strong pulse lasting a ten-thousandth second, and the receiving equipment, including the oscillograph, should be capable of receiving this without distortion or widening of the pulse.

The Bureau of Standards has been developing such apparatus. This includes the development of a transmitter with suitable pulse-making equipment, special receiving sets and amplifiers. A continuous automatic recorder of Kennelly-Heaviside heights has also been devised, and will permit the issuing of daily bulletins of the height, if found desirable. It is expected that papers will be published during the present year describing the apparatus.

Short-Wave Club

ARE you interested in short waves? Receivers, transmitters, converters, station lists, trouble shooting, logging, circuits, calibration, coil winding—what not? If so become a member of Radio World's Short-Wave Club, which you can do simply by filling in and mailing attached coupon. As many names and addresses as practical will be published in this department, so that short-wave fans can correspond with one another. Also letters of general interest on short-wave work will be published. Besides, manufacturers of short wave apparatus will let you know the latest commercial developments. Included under the scope of this department is television, which is spurting forward nicely. Fill out the coupon and mail at once.

If you prefer, send in your enrolment on a separate sheet or postal card.

Short-Wave Editor, Radio World, 145 West 45th Street, New York, N. Y. Please enroll me as a member of Radio World's Short-Wave Club. This does not commit me to any obligation whatever.

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Lindbergh and Wife "Cram" Code for Flight

Two radio sets will be carried on Colonel Charles A. Lindbergh's Lockheed Sirius airplane when Colonel and Mrs. Lindbergh take off for their flight to the Orient.

One set is a regulation type such as that used on the planes of the Pan-American Airways flying daily over the network of airways in Central and South America. This set can be used on wavelengths from 34 to 90 meters and has a range of 2,700 miles by day and 6,000 miles by night. The other set is an emergency transmitter mounted in the tail of the plane and specially constructed in a manner so that it is virtually accident proof. Tests of this set have shown that it may be submerged under water for many hours without damage. A nine foot drop to a concrete floor left it functioning perfectly. It weighs only 40 pounds.

The range of the emergency set is 400 miles by day and about 3,000 miles by night and the transmitter will operate on a wavelength of 35 meters. Its range is sufficient to keep the fliers in touch with aid at almost every point of the trip in case an emergency should arise. This set will be housed in the plane with a collapsible boat equipped with oars, sails, and compressed rations.

Both Colonel Lindbergh and his wife are proficient in sending and receiving the international code. Lindbergh knew how to send and receive previously but has been brushing up preparatory to this trip. His wife has been studying diligently both in the air and by means of a buzzer at home until she is now as proficient as her husband. She can send and receive at the rate of 17 words a minute.

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F. Hernandez, 545 So. 20th St., Newark, N. J.
Thomas Chlosta, 69 Shepherd St., Willimansett, Mass.
Jack Stanton (W8DJM), 130 High St. Dayton, Ohio.
W. H. Carr, 402 N. 16th St., Kansas City, Kans.
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Arnold M. Peiffer, 950 Addison St., Chicago, Ill.
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John K. Lobur, 213 Morris Ave., Newark, N. J.
Jack Schoenhaut, 127 Bay 37th St., Brooklyn, N. Y.

Kilocycle-Meter Conversion Table

The conversion table printed on the opposite page is highly accurate, because worked out by the factor 299,820. Most tables are based on the factor 300,000, which is erroneous to 6 parts in 100,000.

The table is entirely reversible, for instance, 10 meters equal 29,982 kc., or 29,982 meters equal 10 kc. Any quantities not included in the table may be read by shifting the decimal point. If moved to the right for frequency the point is moved to the left for wavelength, and vice versa. The shift is therefore in opposite directions.

The factor 299,820 is based on the velocity of a radio wave, which is equal to the velocity of light, or 299,820,000 meters per second. By dropping the three ciphers (dividing by 1,000), the factor 299,820 is used, and the answer reads in kilocycles.

Wavelength in meters is equal to velocity divided by frequency. Frequency in cycles is equal to the velocity divided by the wavelength.

Table, Kilocycle to Meters, or Meters to Kilocycles

[See Explanation on Opposite Page]

kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc
10	29, 982	1, 010	296. 9	2, 010	149. 2	3, 010	99. 61	4, 010	74. 77	5, 010	59. 84	6, 010	49. 89	7, 010	42. 77	8, 010	37. 43	9, 010	33. 28
20	14, 991	1, 020	293. 9	2, 020	148. 4	3, 020	99. 28	4, 020	74. 58	5, 020	59. 73	6, 020	49. 80	7, 020	42. 71	8, 020	37. 38	9, 020	33. 24
30	9, 994	1, 030	291. 1	2, 030	147. 7	3, 030	98. 95	4, 030	74. 40	5, 030	59. 61	6, 030	49. 72	7, 030	42. 65	8, 030	37. 34	9, 030	33. 20
40	7, 496	1, 040	288. 3	2, 040	147. 0	3, 040	98. 62	4, 040	74. 21	5, 040	59. 49	6, 040	49. 64	7, 040	42. 59	8, 040	37. 29	9, 040	33. 17
50	5, 996	1, 050	285. 5	2, 050	146. 3	3, 050	98. 30	4, 050	74. 03	5, 050	59. 37	6, 050	49. 56	7, 050	42. 53	8, 050	37. 24	9, 050	33. 13
60	4, 997	1, 060	282. 8	2, 060	145. 5	3, 060	97. 98	4, 060	73. 85	5, 060	59. 25	6, 060	49. 48	7, 060	42. 47	8, 060	37. 20	9, 060	33. 09
70	4, 283	1, 070	280. 2	2, 070	144. 8	3, 070	97. 66	4, 070	73. 67	5, 070	59. 13	6, 070	49. 39	7, 070	42. 41	8, 070	37. 15	9, 070	33. 06
80	3, 748	1, 080	277. 6	2, 080	144. 1	3, 080	97. 34	4, 080	73. 49	5, 080	59. 02	6, 080	49. 31	7, 080	42. 35	8, 080	37. 11	9, 080	33. 02
90	3, 331	1, 090	275. 1	2, 090	143. 5	3, 090	97. 03	4, 090	73. 31	5, 090	58. 90	6, 090	49. 23	7, 090	42. 29	8, 090	37. 06	9, 090	32. 98
100	2, 998	1, 100	272. 6	2, 100	142. 8	3, 100	96. 72	4, 100	73. 13	5, 100	58. 79	6, 100	49. 15	7, 100	42. 23	8, 100	37. 01	9, 100	32. 95
110	2, 726	1, 110	270. 1	2, 110	142. 1	3, 110	96. 41	4, 110	72. 95	5, 110	58. 67	6, 110	49. 07	7, 110	42. 17	8, 110	36. 97	9, 110	32. 91
120	2, 499	1, 120	267. 7	2, 120	141. 4	3, 120	96. 10	4, 120	72. 77	5, 120	58. 56	6, 120	48. 99	7, 120	42. 11	8, 120	36. 92	9, 120	32. 88
130	2, 306	1, 130	265. 3	2, 130	140. 8	3, 130	95. 79	4, 130	72. 60	5, 130	58. 44	6, 130	48. 91	7, 130	42. 05	8, 130	36. 88	9, 130	32. 84
140	2, 142	1, 140	263. 0	2, 140	140. 1	3, 140	95. 48	4, 140	72. 42	5, 140	58. 33	6, 140	48. 83	7, 140	41. 99	8, 140	36. 83	9, 140	32. 80
150	1, 999	1, 150	260. 7	2, 150	139. 5	3, 150	95. 18	4, 150	72. 25	5, 150	58. 22	6, 150	48. 75	7, 150	41. 93	8, 150	36. 79	9, 150	32. 77
160	1, 874	1, 160	258. 5	2, 160	138. 8	3, 160	94. 88	4, 160	72. 07	5, 160	58. 10	6, 160	48. 67	7, 160	41. 87	8, 160	36. 74	9, 160	32. 73
170	1, 764	1, 170	256. 3	2, 170	138. 1	3, 170	94. 58	4, 170	71. 90	5, 170	57. 99	6, 170	48. 59	7, 170	41. 82	8, 170	36. 70	9, 170	32. 70
180	1, 666	1, 180	254. 1	2, 180	137. 5	3, 180	94. 28	4, 180	71. 73	5, 180	57. 88	6, 180	48. 51	7, 180	41. 76	8, 180	36. 65	9, 180	32. 66
190	1, 578	1, 190	252. 0	2, 190	136. 9	3, 190	93. 99	4, 190	71. 56	5, 190	57. 77	6, 190	48. 44	7, 190	41. 70	8, 190	36. 61	9, 190	32. 62
200	1, 499	1, 200	249. 9	2, 200	136. 3	3, 200	93. 69	4, 200	71. 39	5, 200	57. 66	6, 200	48. 36	7, 200	41. 64	8, 200	36. 56	9, 200	32. 59
210	1, 428	1, 210	247. 8	2, 210	135. 7	3, 210	93. 40	4, 210	71. 22	5, 210	57. 55	6, 210	48. 28	7, 210	41. 58	8, 210	36. 52	9, 210	32. 55
220	1, 363	1, 220	245. 8	2, 220	135. 1	3, 220	93. 11	4, 220	71. 05	5, 220	57. 44	6, 220	48. 20	7, 220	41. 53	8, 220	36. 47	9, 220	32. 52
230	1, 304	1, 230	243. 8	2, 230	134. 4	3, 230	92. 82	4, 230	70. 88	5, 230	57. 33	6, 230	48. 13	7, 230	41. 47	8, 230	36. 43	9, 230	32. 48
240	1, 249	1, 240	241. 8	2, 240	133. 8	3, 240	92. 54	4, 240	70. 71	5, 240	57. 22	6, 240	48. 05	7, 240	41. 41	8, 240	36. 39	9, 240	32. 45
250	1, 199	1, 250	239. 9	2, 250	133. 3	3, 250	92. 25	4, 250	70. 55	5, 250	57. 11	6, 250	47. 97	7, 250	41. 35	8, 250	36. 34	9, 250	32. 41
260	1, 153	1, 260	238. 0	2, 260	132. 7	3, 260	91. 97	4, 260	70. 38	5, 260	57. 00	6, 260	47. 89	7, 260	41. 30	8, 260	36. 30	9, 260	32. 38
270	1, 110	1, 270	236. 1	2, 270	132. 1	3, 270	91. 69	4, 270	70. 22	5, 270	56. 89	6, 270	47. 82	7, 270	41. 24	8, 270	36. 25	9, 270	32. 34
280	1, 071	1, 280	234. 2	2, 280	131. 5	3, 280	91. 41	4, 280	70. 05	5, 280	56. 78	6, 280	47. 74	7, 280	41. 18	8, 280	36. 21	9, 280	32. 31
290	1, 034	1, 290	232. 4	2, 290	130. 9	3, 290	91. 13	4, 290	69. 89	5, 290	56. 68	6, 290	47. 67	7, 290	41. 13	8, 290	36. 17	9, 290	32. 27
300	999. 4	1, 300	230. 6	2, 300	130. 4	3, 300	90. 86	4, 300	69. 73	5, 300	56. 57	6, 300	47. 59	7, 300	41. 07	8, 300	36. 12	9, 300	32. 24
310	967. 2	1, 310	228. 9	2, 310	129. 8	3, 310	90. 58	4, 310	69. 56	5, 310	56. 46	6, 310	47. 52	7, 310	41. 02	8, 310	36. 08	9, 310	32. 20
320	936. 9	1, 320	227. 1	2, 320	129. 2	3, 320	90. 31	4, 320	69. 40	5, 320	56. 36	6, 320	47. 44	7, 320	40. 96	8, 320	36. 04	9, 320	32. 17
330	908. 6	1, 330	225. 4	2, 330	128. 7	3, 330	90. 04	4, 330	69. 24	5, 330	56. 25	6, 330	47. 36	7, 330	40. 90	8, 330	35. 99	9, 330	32. 14
340	881. 8	1, 340	223. 7	2, 340	128. 1	3, 340	89. 77	4, 340	69. 08	5, 340	56. 15	6, 340	47. 29	7, 340	40. 85	8, 340	35. 95	9, 340	32. 10
350	856. 6	1, 350	222. 1	2, 350	127. 6	3, 350	89. 50	4, 350	68. 92	5, 350	56. 04	6, 350	47. 22	7, 350	40. 79	8, 350	35. 91	9, 350	32. 07
360	832. 8	1, 360	220. 4	2, 360	127. 0	3, 360	89. 23	4, 360	68. 77	5, 360	55. 94	6, 360	47. 14	7, 360	40. 74	8, 360	35. 86	9, 360	32. 03
370	810. 3	1, 370	218. 8	2, 370	126. 5	3, 370	88. 97	4, 370	68. 61	5, 370	55. 83	6, 370	47. 07	7, 370	40. 68	8, 370	35. 82	9, 370	32. 00
380	789. 0	1, 380	217. 3	2, 380	126. 0	3, 380	88. 70	4, 380	68. 45	5, 380	55. 73	6, 380	46. 99	7, 380	40. 63	8, 380	35. 78	9, 380	31 96
390	768. 8	1, 390	215. 7	2, 390	125. 4	3, 390	88. 44	4, 390	68. 30	5, 390	55. 63	6, 390	46. 92	7, 390	40. 57	8, 390	35. 74	9, 390	31. 93
400	749. 6	1, 400	214. 2	2, 400	124. 9	3, 400	88. 18	4, 400	68. 14	5, 400	55. 52	6, 400	46. 85	7, 400	40. 52	8, 400	35. 69	9, 400	31. 90
410	731. 3	1, 410	212. 6	2, 410	124. 4	3, 410	87. 92	4, 410	67. 99	5, 410	55. 42	6, 410	46. 77	7, 410	40. 46	8, 410	35. 65	9, 410	31. 86
420	713. 9	1, 420	211. 1	2, 420	123. 9	3, 420	87. 67	4, 420	67. 83	5, 420	55. 32	6, 420	46. 70	7, 420	40. 41	8, 420	35. 61	9, 420	31. 83
430	697. 3	1, 430	209. 7	2, 430	123. 4	3, 430	87. 41	4, 430	67. 68	5, 430	55. 22	6, 430	46. 63	7, 430	40. 35	8, 430	35. 57	9, 430	31. 79
440	681. 4	1, 440	208. 2	2, 440	122. 9	3, 440	87. 16	4, 440	67. 53	5, 440	55. 11	6, 440	46. 56	7, 440	40. 30	8, 440	35. 52	9, 440	31. 76
450	666. 3	1, 450	206. 8	2, 450	122. 4	3, 450	86. 90	4, 450	67. 38	5, 450	55. 01	6, 450	46. 48	7, 450	40. 24	8, 450	35. 48	9, 450	31. 73
460	651. 8	1, 460	205. 4	2, 460	121. 9	3, 460	86. 65	4, 460	67. 22	5, 460	54. 91	6, 460	46. 41	7, 460	40. 19	8, 460	35. 44	9, 460	31. 69
470	637. 9	1, 470	204. 0	2, 470	121. 4	3, 470	86. 40	4, 470	67. 07	5, 470	54. 81	6, 470	46. 34	7, 470	40. 14	8, 470	35. 40	9, 470	31. 66
480	624. 6	1, 480	202. 6	2, 480	120. 9	3, 480	86. 16	4, 480	66. 92	5, 480	54. 71	6, 480	46. 27	7, 480	40. 08	8, 480	35. 36	9, 480	31. 63
490	611. 9	1, 490	201. 2	2, 490	120. 4	3, 490	85. 91	4, 490	66. 78	5, 490	54. 61	6, 490	46. 20	7, 490	40. 03	8, 490	35. 31	9, 490	31. 59
500	599. 6	1, 500	199. 9	2, 500	119. 9	3, 500	85. 66	4, 500	66. 63	5, 500	54. 51	6, 500	46. 13	7, 500	39. 98	8, 500	35. 27	9, 500	31. 56
510	587. 9	1, 510	198. 6	2, 510	119. 5	3, 510	85. 42	4, 510	66. 48	5, 510	54. 41	6, 510	46. 06	7, 510	39. 92	8, 510	35. 23	9, 510	31. 53
520	576. 6	1, 520	197. 2	2, 520	119. 0	3, 520	85. 18	4, 520	66. 33	5, 520	54. 32	6, 520	45. 98	7, 520	39. 87	8, 520	35. 19	9, 520	31. 49
530	565. 7	1, 530	196. 0	2, 530	118. 5	3, 530	84. 94	4, 530	66. 19	5, 530	54. 22	6, 530	45. 91	7, 530	39. 82	8, 530	35. 15	9, 530	31. 46
540	555. 2	1, 540	194. 7	2, 540	118. 0	3, 540	84. 70	4, 540	66. 04	5, 540	54. 12	6, 540	45. 84	7, 540	39. 76	8, 540	35. 11	9, 540	31. 43
550	545. 1	1, 550	193. 4	2, 550	117. 6	3, 550	84. 46	4, 550	65. 89	5, 550	54. 02	6, 550	45. 77	7, 550	39. 71	8, 550	35. 07	9, 550	31. 39
560	535. 4	1, 560	192. 2	2, 560	117. 1	3, 560	84. 22	4, 560	65. 75	5, 560	53. 92	6, 560	45. 70	7, 560	39. 66	8, 560	35. 03	9, 560	31. 36
570	526. 0	1, 570	191. 0	2, 570	116. 7	3, 570	83. 98	4, 570	65. 61	5, 570	53. 83	6, 570	45. 63	7, 570	39. 61	8, 570	34. 98	9, 570	31. 33
580	516. 9	1, 580	189. 8	2, 580	116. 2	3, 580	83. 75	4, 580	65. 46	5, 580	53. 73	6, 580	45. 57	7, 580	39. 55	8, 580	34. 94	9, 580	31. 30
590	508. 2	1, 590	188. 6	2, 590	115. 8	3, 590	83. 52	4, 590	65. 32	5, 590	53. 64	6, 590	45. 50	7, 590	39. 50	8, 590	34. 90	9, 590	31. 26
600	499. 7	1, 600	187. 4	2, 600	115. 3	3, 600	83. 28	4, 600	65. 18	5, 600	53. 54	6, 600	45. 43	7, 600	39. 45	8, 600	34. 86	9, 600	31. 23
610	491. 5	1, 610	186. 2	2, 610	114. 9	3, 610	83. 05	4, 610	65. 04	5, 610	53. 44	6, 610	45. 36	7, 610	39. 40	8, 610	34. 82	9, 610	31. 20
620	483. 6	1, 620	185. 1	2, 620	114. 4	3, 620	82. 82	4, 620	64. 90	5, 620	53. 35	6, 620	45. 29	7, 620	39. 35	8, 620	34. 78	9, 620	31. 17
630	475. 9	1, 630	183. 9	2, 630	114. 0	3, 630	82. 60	4, 630	64. 76	5, 630	53. 25	6, 630	45. 22	7, 630	39. 29	8, 630	34. 74	9, 630	31. 13
640	468. 5	1, 640	182. 8	2, 640	113. 6	3, 640	82. 37	4, 640	64. 62	5, 640	53. 16	6, 640	45. 15	7, 640	39. 24	8, 640	34. 70	9, 640	31. 10
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660	454. 3	1, 660	180. 6	2, 660	112. 7	3, 660	81. 92	4, 660	64. 34	5, 660	52. 97	6, 660	45. 02	7, 660	39. 14	8, 660	34. 62	9, 660	31. 04
670	447. 5	1, 670	179. 5	2, 670	112. 3	3, 670	81. 70	4, 670	64. 20	5, 670	52. 88	6, 670	44. 95	7, 670	39. 09	8, 670	34. 58	9, 670	31. 01
680	440. 9	1, 680	178. 5	2, 680	111. 9	3, 680	81. 47	4, 680	64. 06	5, 680	52. 79	6, 680	44. 88	7, 680	39. 04	8, 680	34. 54	9, 680	30. 97
690	434. 5	1, 690	177. 4	2, 690	111. 5	3, 690	81. 25	4, 690	63. 93	5, 690	52. 69	6, 690	44. 82	7, 690	38. 99	8, 690	34. 50	9, 690	30. 94
700	428. 3	1, 700	176. 4	2, 700	111. 0	3, 700	81. 03	4, 700	63. 79	5, 700	52. 60	6, 700	44. 75	7, 700	38. 94	8, 700	34. 46	9, 700	30. 91
710	422. 3	1, 710	175. 3	2, 710	110. 6	3, 710	80. 81	4, 710	63. 66	5, 710	52. 51	6, 710	44. 68	7, 710	38. 89	8, 710	34. 42	9, 710	30. 88
720	416. 4	1, 720	174. 3	2, 720	110. 2	3, 720	80. 60	4, 720	63. 52	5, 720	52. 42	6, 720	44. 62	7, 720	38. 84	8, 720	34. 38	9, 720	30. 85
730	410. 7	1, 730	173. 3	2, 730	109. 8	3, 730	80. 38	4, 730	63. 39	5, 730	52. 32	6, 730	44. 55	7, 730	38. 79	8, 730	34. 34	9, 730	30. 81
740	405. 2	1, 740	172. 3	2, 740	109. 4	3, 740	80. 17	4, 740	63. 25	5, 740	52. 23	6, 740	44. 48	7, 740	38. 74	8, 740	34. 30	9, 740	30. 78
750	399. 8	1, 750	171. 3	2, 750	109. 0	3, 750	79. 95	4, 750	63. 12	5, 750	52. 14	6, 750	44. 42	7, 750	38. 69	8, 750	34. 27	9, 750	30. 75
760	394. 5	1, 760	170. 4	2, 760	108. 6	3, 760	79. 74	4, 760	62. 99	5, 760	52. 05	6, 760	44. 35	7, 760	38. 64	8, 760	34. 23	9, 760	30. 72
770	389. 4	1, 770	169. 4	2, 770	108. 2	3, 770	79. 53	4, 770	62. 86	5, 770	51. 96	6, 770	44. 29	7, 770	38. 59	8, 770	34. 19	9, 770	30. 69
780	384. 4	1, 780	168. 4	2, 780	107. 8	3, 780	79. 32	4, 780	62. 72	5, 780	51. 87	6, 780	44. 22	7, 780	38. 54	8, 780	34. 15	9, 780	30. 66
790	379. 5	1, 790	167. 5	2, 790	107. 5	3, 790	79. 11	4, 790	62. 59	5, 790	51. 78	6, 790	44. 16	7, 790	38. 49	8, 790	34. 11	9, 790	30. 63
800	374. 8	1, 800	166. 6	2, 800	107. 1	3, 800	78. 90	4, 800	62. 46	5, 800	51. 69	6, 800	44. 09	7, 800	38. 44	8, 800	34. 07	9, 800	30. 59
810	370. 2	1, 810	165. 6	2, 810	106. 7	3, 810	78. 69	4, 810	62. 33	5, 810	51. 60	6, 810	44. 03	7, 810	38. 39	8, 810	34. 03	9, 810	30. 56
820	365. 6	1, 820	164. 7	2, 820	106. 3	3, 820	78. 49	4, 820	62. 20	5, 820	51. 52	6, 820	43. 96	7, 820	38. 34	8, 820	33. 99	9, 820	30. 53
830	361. 2	1, 830	163. 8	2, 830	105. 9	3, 830	78. 28	4, 830	62. 07	5, 830	51. 43	6, 830	43. 90	7, 830	38. 29	8, 830	33. 95	9, 830	30. 50
840	356. 9	1, 840	162. 9	2, 840	105. 6	3, 840	78. 08	4, 840	61. 95	5, 840	51. 34	6, 840	43. 83	7, 840	38. 24	8, 840	33. 92	9, 840	30. 47
850	352. 7	1, 850	162. 1	2, 850	105. 2	3, 850	77. 88	4, 850	61. 82	5, 850	51. 25	6, 850	43. 77	7, 850	38. 19	8, 850	33. 88	9, 850	30. 44
860	348. 6	1, 860	161. 2	2, 860	104. 8	3, 860	77. 67	4, 860	61. 69	5, 860	51. 16	6, 860	43. 71	7, 860	38. 14	8, 860	33. 84	9, 860	30. 41
870	344. 6	1, 870	160. 3	2, 870	104. 5	3, 870	77. 47	4, 870	61. 56	5, 870	51. 08	6, 870	43. 64	7, 870	38. 10	8, 870	33. 80	9, 870	30. 38
880	340. 7	1, 880	159. 5	2, 880	104. 1	3, 880	77. 27	4, 880	61. 44	5, 880	50. 99	6, 880	43. 58	7, 880	38. 05	8, 880	33. 76	9, 880	30. 35
890	336. 9	1, 890	158. 6	2, 890	103. 7	3, 890	77. 07	4, 890	61. 31	5, 890	50. 90	6, 890	43. 52	7, 890	38. 00	8, 890	33. 73	9, 890	30. 32
900	333. 1	1, 900	157. 8	2, 900	103. 4	3, 900	76. 88	4, 900	61. 19	5, 900	50. 82	6, 900	43. 45	7, 900	37. 95	8, 900	33. 69	9, 900	30. 28
910	329. 5	1, 910	157. 0	2, 910	103. 0	3, 910	76. 68	4, 910	61. 06	5, 910	50. 73	6, 910	43. 39	7, 910	37. 90	8, 910	33. 65	9, 910	30. 25
920	325. 9	1, 920	156. 2	2, 920	102. 7	3, 920	76. 48	4, 920	60. 94	5, 920	50. 65	6, 920	43. 33	7, 920	37. 86	8, 920	33. 61	9, 920	30. 22
930	322. 4	1, 930	155. 3	2, 930	102. 3	3, 930	76. 29	4, 930	60. 82	5, 930	50. 56	6, 930	43. 26	7, 930	37. 81	8, 930	33. 57	9, 930	30. 19
940	319. 0	1, 940	154. 5	2, 940	102. 0	3, 940	76. 10	4, 940	60. 69	5, 940	50. 47	6, 940	43. 20	7, 940	37. 76	8, 940	33. 54	9, 940	30. 16
950	315. 6	1, 950	153. 8	2, 950	101. 6	3, 950	75. 90	4, 950	60. 57	5, 950	50. 39	6, 950	43. 14	7, 950	37. 71	8, 950	33. 50	9, 950	30. 13
960	312. 3	1, 960	153. 0	2, 960	101. 3	3, 960	75. 71	4, 960	60. 45	5, 960	50. 31	6, 960	43. 08	7, 960	37. 67	8, 960	33. 46	9, 960	30. 10
970	309. 1	1, 970	152. 2	2, 970	100. 9	3, 970	75. 52	4, 970	60. 33	5, 970	50. 22	6, 970	43. 02	7, 970	37. 62	8, 970	33. 42	9, 970	30. 07
980	303. 9	1, 980	151. 4	2, 980	100. 6	3, 980	75. 33	4, 980	60. 20	5, 980	50. 14	6, 980	42. 95	7, 980	37. 57	8, 980	33. 39	9, 980	30. 04
990	302. 8	1, 990	150. 7	2, 990	100. 3	3, 990	75. 14	4, 990	60. 08	5, 990	50. 05	6, 990	42. 89	7, 990	37. 52	8, 990	33. 35	9, 990	30. 01
1, 000	299. 8	2, 000	149. 9	3, 000	99. 94	4, 000	74. 96	5, 000	59. 96	6, 000	49. 97	7, 000	42. 83	8, 000	37. 48	9, 000	33. 31	10, 000	29. 98

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A Vernier Variometer

Both Response Settings O

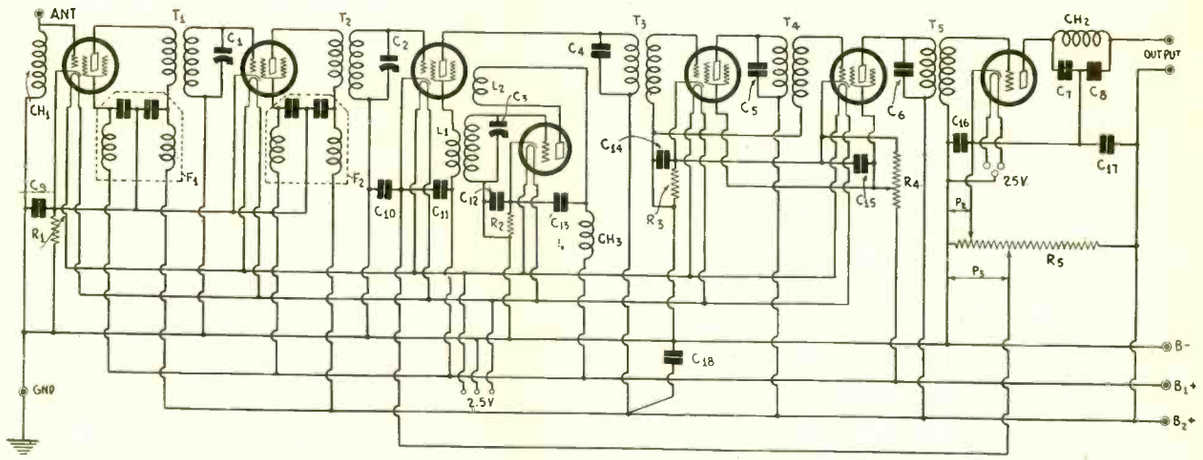

FIG. 1

The circuit diagram of a seven-tube superheterodyne tuner used by Mr. Jockwig in building a receiver the results of which surpassed his "fondest expectations."

THOSE who select a good circuit and build it painstakingly are invariably rewarded by a receiver about which they become enthusiastic. They are rewarded with sensitivity, selectivity, quality and volume. One of the finest examples of this kind is a receiver built by John H. Jockwig, New York following the diagram shown in Fig. 1 which was first published in "The Superheterodyne" by Anderson and Bernard being Fig. 37 in that book.

Certain minor changes were introduced into the circuit by Mr. Jockwig to effect stabilization. These changes relate to the method of getting bias on the modulator and the detector tubes. In Fig. 1 the bias for these tubes is obtained from drops in portions of resistor R5. Mr. Jockwig uses one 10000 ohm resistor for each tube, dispensing with the potentiometer. That is, the cathode of each tube was connected to ground through a resistor of this value. This change stabilized the circuit in that it eliminated certain feed back which the by-pass condensers alone could not eliminate and at the same time each tube got a grid bias suitable for detection. The main difficulty with the potentiometer method is that the resistance between ground and the cathode taps cannot be made small enough. At one setting there is no bias at all and at the next it is too much. Of course this can be remedied by connecting a resistance in series with R5 on the positive side so that the current through it will be less, or it can be remedied by connecting the positive end of R5 to B1 instead of B2, B1 being at a much lower voltage. But the grid bias method of providing bias worked out splendidly and it has the advantage that it is much less expensive and that it takes less room.

Variable Mu Tubes Used

The original circuit was described for 224 tubes in the amplifier stages because at the time the circuit was described the variable mu tubes were not available. Mr. Jockwig, however, put 235 tubes in the amplifier stages. No change in the circuit constants or the voltages are necessary to make the change. By direct comparison with the two different types of tubes it was found that there was no appreciable difference in the results, as judged by ear.

The volume controls, a variable resistor in the common cathode lead of the first two tubes and a potentiometer for varying the screen voltage on the two intermediate frequency amplifiers, were found to be quite satisfactory, the potentiometer being the more effective control.

The remarkable thing about the receiver was that it was so sensitive and powerful that it was not possible to use any audio frequency amplification. The dynamic loudspeaker was connected to the detector and that gave ample volume without a trace of distortion from overloading. The detector was a 227 tube with 180 volts on the plate. When a 210 tube was added the volume was so great the speaker could not handle it, and it was a large dynamic, well baffled. Not only was the speaker not able to handle all, but the ears could not tolerate the tremendous volume. And that was just as well, for the detector gave plenty with much better quality.

Quality Excellent

The quality of the output was all that could be desired. The low notes were full and rich, and the high notes, too, up to the limit of audibility, and in between these extremes there were no resonance points.

The strength of the high frequencies indicates a certain lack of selectivity. But this lack was not a drawback, for small stations in California could be brought in without interference from local New York stations. Selectivity ceases to be a virtue when it goes beyond this point. It becomes a vice.

The circuit was built with an intermediate frequency of 200 kc per second, which is a vary satisfactory frequency when the oscillator is controlled separately from the radio frequency tuners. Since the primaries are tuned, a high amplification is assured with the screen grid tubes, whether these are of the variable mu or ordinary types.

The oscillator contained the variable inductance feature described in RADIO WORLD, designed to pick out either the higher or the lower oscillator setting. That is, a small coil is connected in series with the tuned winding and mounted inside so that when the small coil is turned the inductance either increases or decreases, depending on the direction of the coupling. When the mutual inductance is positive the inductance increases, lowering the frequency, thus permitting picking out the low setting of the oscillator. When the mutual inductance is negative the inductance decreases, increasing the frequency and permitting picking out the higher oscillator setting. High and low here refer to frequency and not to dial setting of the condenser.

Limiting IF

This feature acts as a vernier tuner on the oscillator. It should be pointed out that it is not necessary when the oscillator condenser is separately controlled and not mounted on the shaft of the radio frequency tuning condensers. Its only advantage is to furnish a vernier action. However, when the oscillator condenser is ganged with the RF condensers the variometer feature is valuable.

It should be mentioned that there is a limitation on the intermediate frequency when this variometer feature is used if the variometer is to cover the necessary frequency band. If the broadcast band is just to be covered, the absolute upper limit of the intermediate frequency is about 161 kc, but it can never be reached, because this would require unity coupling between the rotor coil and the stator, which is an impossibility. But the feature may be used with a frequency of 100 kc. This limitation does not mean that the variometer feature cannot be used when the intermediate frequency is high, for it was used by Mr. Jockwig, but it does mean that the 550 kc frequency cannot be tuned in on the lower frequency setting by means of the variometer. The higher setting can be tuned in even when the IF is as high as 200 kc, or even higher.

Construction Features

The idea of the variometer feature is to make all the tuning condensers, including that of the oscillator, equal and putting them on the same control and also making all the tuning inductances the same. The inductance in the oscillator circuit is equal to the inductance in the radio frequency tuner when the variometer is set at neutral, that is, when the mutual inductance is zero and when the

in a Superheterodyne

btainable on Sensitivity

inductance of the oscillator is the sum of the inductances of the stator and rotor coils.

The fine workmanship of Mr. Jockwig's circuit may be seen from the three photographs shown herewith. In the top photo the receiver is seen from the rear, with the backs and tops of the shields removed. The three compartments at the left are the intermediate stages, the unshielded tube being the final detector. In the middle is the oscillator and at the right the two radio frequency stages. The two radio frequency tuning condensers are on one shaft and controlled by a vernier dial. The oscillator condenser is on a separate control, also provided with a vernier dial.

A better view of the layout is obtained from the middle photograph. Note that there is a tube and a tuner in each compartment and that each compartment is so large that there is no appreciable loss in the coils due to shielding. The two radio frequency coils are mounted diagonally in the compartments to increase the distance from the coil to the metal sides of the compartments. The small aluminum can in the oscillator compartment contains a choke. The first radio frequency tube in the circuit is outside the first compartment and very close to the second amplifier tube inside the compartment.

The transformer in the center rear is the filament transformer supplying the heaters. The audio transformer at the left, together with the tube near it, is an audio stage which is not used due to the tremendous volume obtainable without it.

In the lower photograph the set is seen from the front and top, the shield tops in place. The first dial to the left is the RF tuning control, the middle dial the control for the variometer on the oscillator coil, and the right dial the control for the oscillator condenser. The two volume controls may be seen at the bottom of the photograph, the potentiometer being at the right.

Filters, by-pass condensers and resistances are mounted under the sub-panel directly under the stages with which they go so as to minimize the length of leads. The two filters F1 and F2 are mounted in specially made copper shields.

Results

The results obtained with this set are best stated in Mr. Jockwig's own words: "The results obtained from the set so far (Summer reception) have surpassed my fondest expectations. On May 29th, a very hot night, I logged the following with enormous volume and absolute clarity. WSB, WLW, WMAQ, WSM, WGY, WHAS, WABC, WENR, WRC, XCD, WOC, KYW, WTAM, WOAI, WISN, WREN, WTMJ, WDAF, KOA, KGO, KFVD, KNX, WDOD, WJKS and KFOX." It will be noted that all of these with one exception are distant stations and that many are clear across the country and one is beyond the southern boundary.

Many of the remote stations come in with the same volume as the local stations and in many instances the only way to tell whether one is listening to a distant station or a local is to wait for the announcement.

It must be emphasized that a receiver built according to the circuit diagram can be made either good or bad depending on how it is built and adjusted. The reason for the exceptional sensitivity of Mr. Jockwig's set is apparent when one looks at the photographs. Everything has been done in a de luxe manner. Since the mechanical work was done in such excellent manner one may be sure that the electrical part was done equally well. All the coils were made to be efficient and the layout was arranged so that the efficiency of the coils was retained.

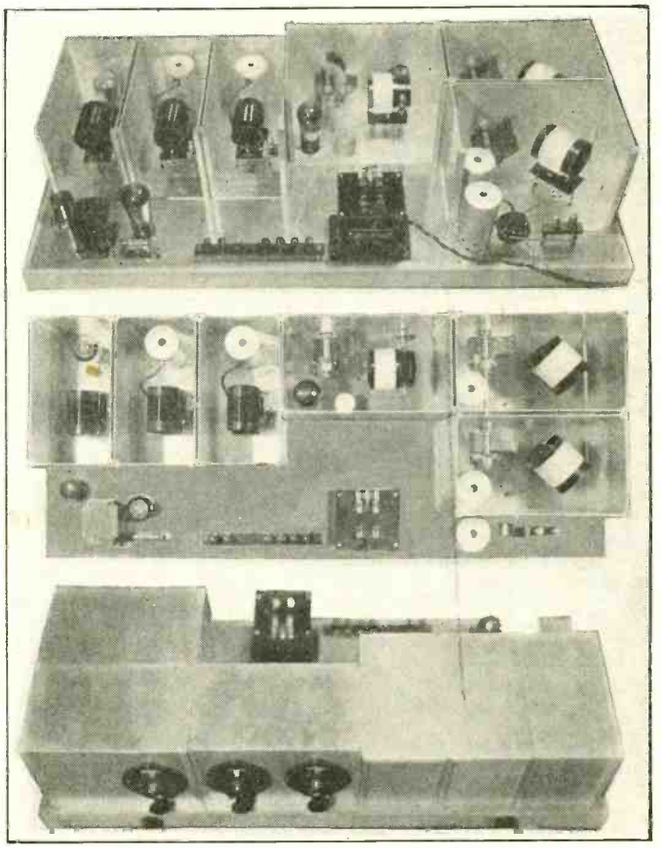

FIG. 2

Three photographs of Mr. Jockwig's superheterodyne, taken by the builder. The reason for the high sensitivity is apparent from the fine construction.

Questions and Answers

Small Coils

I HAVE some bakelite tubing one inch in diameter on which I wish to wind some coils for use on broadcast frequencies with a tuning condenser of 125 mmfd. How many turns are necessary and what size of wire should be used?—R.B.H.

The 125 mmfd. condenser will not cover the broadcast band so that it is necessary to put a tap on the tuned winding to reach the higher frequencies. The inductance necessary for 550 kc and 125 mmfd. is 670 microhenries, which will be given by 208 turns of No. 36 enameled wire. Coils of this type are not suitable because the resistance is too high. It is better to use a larger condenser so that the coil may be made smaller and more efficient and so that it is not necessary to tap the coil to reach the higher broadcast frequencies.

* * *

Controlling Oscillation With Resistance

I HAVE a short wave receiver in which the coupling between the detector and the first audio is resistance-capacity. It occurred to me that I could control the regeneration by using a variable resistance in the plate circuit and in that manner vary the effective voltage on the plate of the detector. Is it feasible? —G.F.M.

This is quite feasible but it is well to have a variable condenser in addition for controlling the feed-back.

* * *

Reverse Feedback

IS it a fact that the grid bias resistor causes a reverse feedback so that if the bias resistance is fairly large the tube will cease to amplify? I do not mean that the bias resistance is so high that the plate current is cut off, but such that it is about the same as if a correct grid battery were used.—W.F.T.

It is true, indeed, and conditions may be brought about so that the tube does not amplify at all. Suppose, for example, that the tube is a 171A with an internal resistance of 2,000 ohms, a bias resistor of 2,000 ohms, an amplification factor of 3, and a load resistance of 4,000 ohms. In that case the amplification, or the ratio of the signal voltage across the load resistance to the input voltage, is 6/7. That is, there is a loss rather than a gain. This does not mean that there is not considerable output power, for the load impedance is at least half the impedance in the plate circuit.

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An All-Wave Converter

PLEASE show a circuit of two-tube all-wave adapter for battery tubes provided with switches for changing the frequency range.—T. R. W.

Such a circuit is shown in Fig. 930. There is a single tuned circuit. It is a converter only when the tickler L3 is set so that the second tube oscillates. The detector then works both as oscillator and modulator.

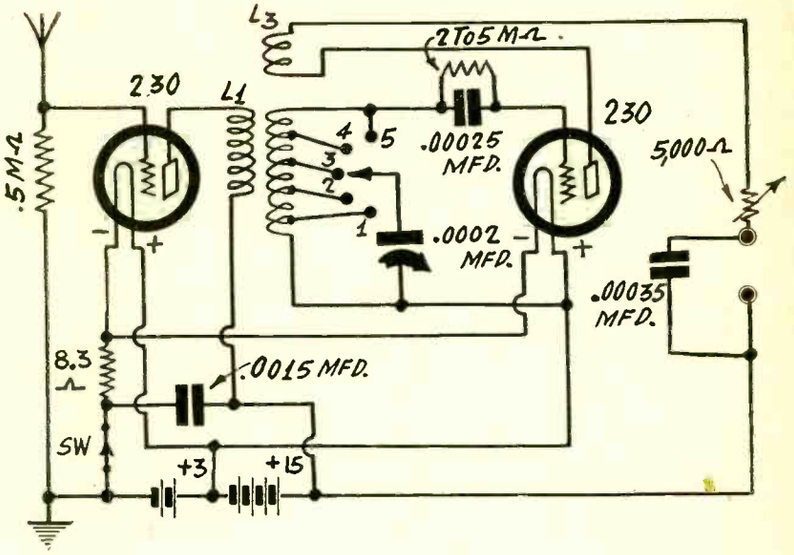


FIG. 930

The circuit of a short-wave converter with the functions of oscillator and modulator combined in one tube. The circuit is all-wave and designed for 2-volt tubes.

Variation of Screen Current

HOW does the screen current of a screen grid tube vary with the grid bias? Does it vary in the same way as the plate current or in the opposite way? Is the screen current ever larger than the plate current?—F. G. W.

The screen current varies in the same way as the plate current. That is, it decreases as the grid bias on the tube increases and increases as the bias decreases. In other words, the plate and screen currents are in phase. It is possible to arrange the circuit so that the screen current is larger than the plate current, but the tube will not function properly when this is the case, except in the instance of the dynatron oscillator. The screen current may be larger when the screen voltage is larger than the plate voltage. When there is a high resistance in the plate circuit and none in the screen circuit the screen current will become larger than the plate current for low values of grid bias because the voltage drop in the resistance in the plate circuit is so high that the effective plate voltage is less than the effective screen voltage. The tube will not function in such cases.

* * *

Short-distance Phone Communication

I HAVE a problem and need help to solve it. I wish to install a telephone between my office and my home a short distance away. I cannot use radio because I have no license to transmit and I cannot use wires because there is a public road between the two points. I can use lights for signalling but this is not satisfactory for my wife, with whom I want to talk, does not know the dot-and-dash code. Can you suggest a way out?—F. W. B.

There does not seem to be anything left than using a system based on light communication. You might install an audio amplifier and a microphone, terminating the amplifier with a neon tube. If this neon tube can be seen from the other point the problem is not difficult. The neon light will flicker according to the sound that falls on the microphone. Train a lens, or a system of lenses forming a telescope, on the neon lamp from the other point. In front of the telescope place a sensitive photoelectric cell and connect a good audio amplifier to this. A headset or a loudspeaker connected to this amplifier will reproduce what is spoken before the distant microphone. To make this system two-way, it will have to be duplicated in every particular. The system is not very practical, but it is possible.

* * *

Eliminating Strays

WHEN untuned input is used to a radio frequency amplifier, which is better, a high resistance or a choke coil? Suppose the volume is controlled by a potentiometer in the grid circuit of the tube, could this be connected in shunt with the choke, or would there be any advantage in using both?—R. E. M.

As far as sensitivity is concerned there is no appreciable difference between a resistance and a choke in the antenna circuit provided that the impedance of the two is about the same over the frequency range to be covered. The advantage of the resistance is that the coupling is the same for all the frequencies, and the advantage of the choke is that it does not pick up so much noise since its impedance at low frequencies is practically zero. There is an advantage in leaving the choke across the potentiometer when the volume is controlled by this means in that noise is shunted to ground. This does not mean that the choke will not pick up a lot of noise if it is present, for most of the noise comes in at radio frequency where the choke is efficient.

* * *

Crystal Detection

COULD a crystal detector be used between a radio frequency amplifier and a push-pull resistance coupled audio amplifier without killing one side of the amplifier as is done when a tube is used as detector? Would the crystal be effective working into a high resistance? I still believe in crystals and want to do some experimenting.—I. C.

Yes, a crystal detector can be used in this way and it works all right into a high resistance. In fact, it is likely to be more stable when working into a high resistance than when working into a low impedance. But there must be a by-pass condenser on the output side so that there will be a low impedance to the radio frequency currents.

* * *

Inductance of Coil

I HAVE some coils wound with 48 turns of No. 24 double cotton covered wire on 2.5 inch bakelite tubing. What is the inductance and what should the capacity of the tuning condensers be to cover the broadcast band?—C. S.

The inductance of each coil is 142 microhenries. This does not take account of the fact that the diameter of the coil is greater than the diameter of the tubing by the diameter of the wire. Hence the actual inductance may be slightly larger than 142 microhenries, but not more than one or two microhenries. If the tuning condenser has a capacity of .0005 mfd. and there is a distributed capacity of 25 mmfd. in the coil and associated circuit, the lowest frequency to which the circuit will tune is very nearly 550 kc. A tuner of this kind mounted in a large shield tuned slightly lower than 550.

* * *

Mutual Conductance of Pentodes

WHAT is the mutual conductance of the 247 pentode? What of the 238 pentode? How is the mutual conductance obtained? F. W. R.

The mutual conductance of the 247 pentode with 250 volts on the plate and the screen and 16.5 volts on the control grid is 2,400 micromhos. That of the 238 pentode is 900 micromhos at 13.5 volts on the control grid and 135 volts on the plate and the screen. Curves on these tubes were published in the June 20th issue. From the curve for the 247 at a grid bias of 8 volts we find the slope of the curve to be about 1,900 micromhos. Between zero and five volts the slope is about 2,000 micromhos.

* * *

Design of Superheterodyne

I WISH to build a superheterodyne with an intermediate frequency of 450 kc arranged so that I can select either the higher or the lower setting of the oscillator. I am willing to use an extra tuning condenser in parallel with the oscillator condenser. Will you kindly tell how this may be done?—R. E. C.

This is not practical with such a high intermediate frequency. In order to get the lowest broadcast station on the lower setting of the oscillator the oscillator would have to be made to oscillate at 100 kc. This cannot be done easily by means of coils and if it were to be done with an extra condenser this would have to have a very high capacity. No condensers large enough are available. When the intermediate frequency is so high only the higher of the oscillator settings should be used.

* * *

A 227 As Power Tube

IF only a moderate room volume is desired is not a single 227 tube sufficient in the output tube, assuming that the speaker used is well matched to the tube?—F. W. R.

The 227 will give about the same output as the 112A, and that is rated as a power tube. As a test, the 227 tube was used as power detector and the loudspeaker coupled to it by means of a suitable matching transformer. The volume of output was plenty to be heard throughout the apartment and the quality was very good. The plate voltage was a little in excess of 180 volts and the bias on the tube was obtained from a 10,000 ohm resistance in the cathode lead of the tube. This resistor by-passed by a 2 mfd. condenser. There was a sensitive superheterodyne ahead of this tube which insured plenty of signal voltage to load up the tube, but this, of course, had nothing to do with the volume the detector delivered.

* * *

Increasing Intermediate Frequency

I HAVE a set of intermediate frequency transformers rated at 450 kc. I want to use these in the lower part of the broadcast band. I can just reach that band now but I should like to be able to go a little higher in frequency. What is the best way of increasing the frequency, if it is possible to do it?—W. H. L.

The best way is to take off a few turns from each of the tuned windings in the intermediate frequency transformers. Remove the same number from all. If you now can tune them to just 550 kc and if you want to go to some higher frequency F, use the formula NF=NoFo, in which N is the new number of turns, No the old number, and Fo is the present highest frequency. Thus if No is 800, Fo 550 kc, and F is to be 650 kc, N should be 676 turns. That is, you remove 124 turns. This assumes that the coils are wound compactly.

* * *

Advantage of Double Tuned Circuits

IS there any real advantage in using intermediate frequency transformers with both windings tuned over transformers using only one tuned winding, and if so, what is it? If doubly tuned transformers are desirable why would they not be equally advantageous in the radio frequency tuner?—E. S.

One of the advantages of doubly tuned transformers is that a band pass effect is possible without any decrease in the selectivity. As to the voltage transfer there is little difference. Due to the increased selectivity there is less transfer of strays and other undesirable voltages. There would be an advantage in tuning both the primary and the secondary of a radio frequency transformer if it could be done in a simple manner with condensers available. But with the tuning condensers available double tuning is likely to make a less selective set than with tuning only one of the windings.

* * *

Regeneration in Grid Bias Detector

IS it possible to make a grid bias detector regenerative? It is my understanding that the grid leak, grid resistor type detector is an amplifier as well as a detector and it is for this reason that regeneration can be used, but that the grid bias detector is only a detector. Am I right?—F. W. R.

Just about right. The grid leak, grid resistor detector detects in the grid circuit and amplifies the detected voltage because the circuit is essentially an amplifier. It is because of the combined detection and amplification that this detector is more sensitive than the other. But the grid bias detector amplifies, too, especially if it is not overbiased. Hence if a tickler is used it does some good—a great deal of good in some instances.

* * *

Open Grid Bias Resistors

I HAVE a receiver which stopped working. There is voltage on all the plates and all the screens, measuring between B minus and the plates or screens. But there are several tubes in which I do not get any plate current. What do you think is wrong? —P. C. B.

It appears that a grid bias resistor has burned out and that it is common to those tubes in which you do not get any plate current. As a test, measure the voltage between the cathodes and the plates. If the resistor is open you should not get any voltage reading. You might also short-circuit the bias resistor temporarily. After this has been done you should get plate current. If you find the resistance open replace it with one of equal value.

* * *

Quality of Screen Grid Audio

IN a resistance coupled amplifier using three-element tubes there is a great loss in amplification at the high audio frequencies due to the high effective input capacity as well as the high plate to cathode capacity of the tube. Is this also true when screen grid tubes are used as audio frequency amplifiers in the same type of circuit? If so, what should be done to minimize this loss of amplification?—W. H. J.

It is true to some extent but not nearly as much as for three-element tubes because the effective input capacity depends on the plate to grid capacity of the tube. This is only about 1,500 as large for a screen grid tube as for a three-element tube. The best way of reducing the effect is to reduce the plate load resistance. But it is hardly necessary to do that if screen grid tubes are used.

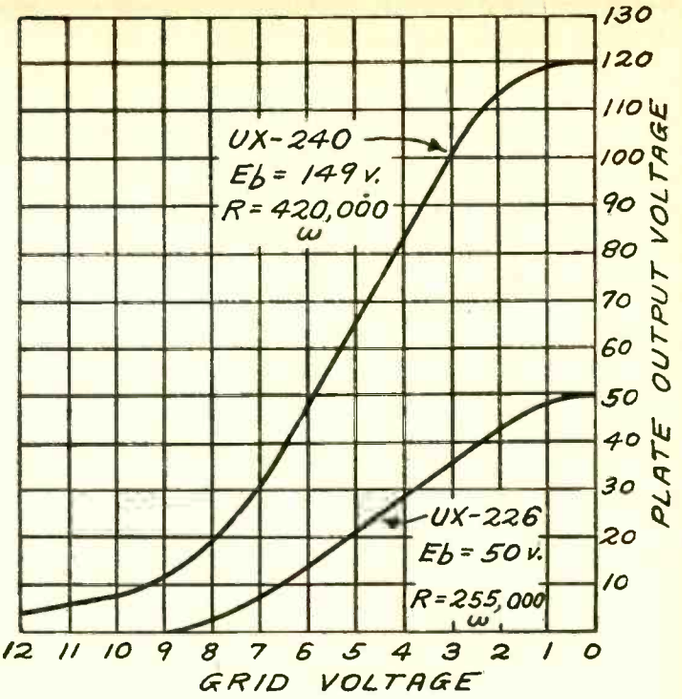


FIG. 931

The upper curve in this figure shows the amplification obtained with a 240 high mu tube in a resistance coupled amplifier.

* * *

Operation of 240 Tube

IF you have any curves showing the performance of a 240 tube in a resistance coupled amplifier, will you kindly show it? About what amplification can be obtained from it?—F. W. R.

In Fig. 931 is a curve taken on this tube with 149 volts in the plate circuit and 420,000 ohms for coupling resistor. If the bias is adjusted to 5 volts, the amplification is 17.5 times. The ordinates in the curve are the voltage drops in the load resistance so the amplification is given directly. The upper bend in the curve is due to the fact that the grid is positive, which is due to the fact AC was used on the filament. With DC on the filament a suitable bias is 4.5 volts. There is practically no change required in this if the load resistance is changed but if the applied voltage is increased the bias should be increased also.

* * *

Connecting Voltmeters in Series

I HAVE two voltmeters, one reading to 150 volts and the other to 100 volts. Is it possible to connect these meters in series for measuring higher voltages than either will read by adding the readings of the two? If this is not possible, please explain why?—F.R.C.

This is possible only on one condition, that the two voltmeters have the same sensitivity, that is to say, the same ohms per volt. However, it is possible to extend the range of either meter by means of the resistance in the other. Suppose you connect the two meters in series across a battery of known voltage. Both meters will read less. Suppose one of them reads just half the voltage of the battery. Then every other voltage connected across the two meters will show only half value on the meter. In this case one of the meters is disregarded entirely. This is only a substitute for an external resistance, and more satisfactory results could be obtained by using the proper external resistance in series with the meter. The second meter could then be used for other measurements at the same time.

* * *

Modulated Oscillator Coils

RECENTLY you published a description of a modulated oscillator and gave coils suitable for broadcast and short waves. Can this oscillator also be made for intermediate frequencies? If so, what are the windings necessary?—G. E.

It can be extended, as was stated in the article. The specifications for a coil which will cover the band of frequencies just below the broadcast band was published in the June 13th issue. While the coil there given was for a four-prong base it is only necessary to put it in a UY base to fit it to the modulated oscillator. If lower frequencies are desired just put on more wire on the coils. For rough design work it is good enough to assume that the frequency is inversely proportional to the number of turns.

Board Holds Hearings on Move

RCA PICTURES PLIGHT SHOULD LICENSES FAIL

[One of the most important cases ever to arise in the history of world radio is the case now being pressed against the Radio Corporation of America and its subsidiaries, by the Federal Radio Commission, whereby the licenses of 1,409 stations, including broadcasting, experimental and commercial message stations, are at stake. The great seriousness of a situation which by an unfavorable turn could wreck the National Broadcasting Company and some other subsidiaries, including the Radiomarine Corporation of America, not to mention the crippling of the parent company itself, is recognized by both the Commission and the companies. All over the world those interested in radio are watching for developments in the case, hence the full presentation that follows.—EDITOR.]

Washington

The vastness of the enterprises of the Radio Corporation of America and its subsidiaries, and the severity of the blow that would result if the radio service licenses of these corporations were revoked, were explained by witnesses on behalf of RCA and subsidiaries at a hearing before the Federal Radio Commission on applications for renewal of fifteen station licenses.

The hearing was held as a result of the finding of the Federal Court at Wilmington, Del., upheld by the Circuit Court of Appeals at Philadelphia and not disturbed by the United States Supreme Court, that RCA and affiliates had violated section 3 of the Sherman Act in the inclusion of "clause 9" in contracts with set manufacturers that were its licensees.

Radio Law Invoked

This clause required that only RCA tubes be used in initially equipping the sets made by these manufacturers. The section of the Sherman Law relates to contracts monopolistic in character and constituting, or tending to constitute, restraint of trade. Section 13 of the Radio Law directs the refusal of license renewals if a concern or its subsidiary violates the anti-trust laws.

The defense of the RCA and its associated corporations is that the Sherman Law adjudication was in a civil suit. The question involves an interpretation of the word "guilty" in the Radio Law, as to whether it applies to a finding in a civil case as well as in a criminal adjudication of guilty, as could be the outcome only of a direct suit instituted by the Government itself. If the application holds in a civil case, RCA contends, the Radio Law is unconstitutional.

The RCA tried unsuccessfully to prevent the holding of the hearing, on the ground that even the hearing alone would result in irreparable damage, hence asked for an injunction. Justice Jennings of the Supreme Court of the District of Columbia refused to grant an injunction, but said that he would retain jurisdiction in the case, so that if the eventualities proved that irreparable damage might result, he would still be able to issue an injunction. However, such an injunction, if issued after the hearing, and presumably only after a finding adverse to the RCA, would relate to the execution of the Commission's order.

1,409 Licenses at Stake

The RCA and its subsidiaries hold 1,409 licenses, including broadcasting, point-to-point communication, ship-to-shore communication, experimental, and marine relay. Broadcasting is under the jurisdiction of the National Broadcasting Company, one of the subsidiaries. The NBC holds licenses for 19 stations, of which seven are broadcasting and 12 are experimental.

The seven broadcasting stations are: WJZ, New York; WEAF, New York; WTAM, Cleveland; WRC, Washington, D. C.; WENR-WBCN, Chicago; KOA, Denver, and KGO, San Francisco. All seven were among the fifteen stations whose license renewals were under consideration.

WENR-WBCN occupies half time on 870 kc. WTMJ, Milwaukee, is an applicant for this channel. Therefore Elisha Hanson, counsel, was permitted by the Commission to be an intervenor for WTMJ, while also Oswald F. Schuette, for the Radio Protective Association, Representative Frank Reid, of Aurora, Ill., and E. N. Nockels, representing the American and Chicago Federations of Labor, were permitted to take part.

Commercial and Experimental Stations

The commercial and experimental licenses involved, including among the total of fifteen, include:

W3XAK, National Broadcasting Co., Boundbrook, N. J., 2,100-2,200 kc., unlimited time, 5 kw. W9XAF, Downers Grove, Ill., 6-020 kc., unlimited time, 5 kw.

W8XJ, Radiomarine Corp. of America, West Dover, Ohio, renewal license, 3,106, 3,082, 3,088, 3,160, 3,172, 3,178, 5,570, 5,540, 5,660 kc., daytime only on 5,370, 5,540, 5,660 kc., 350 w.

W3XAD, RCA Victor Company, Inc., Camden, N. J., renewal license, 2,100-2,200, 43,000-46,000, 48,500-50,300, 60,000-80,000 kc., unlimited time, 500 and 50 w.

KEQ, RCA Communications, Inc., Kahuku, Hawaii, renewal license, 6,732.5 kc., unlimited time, 80 kw.

KPH, Radiomarine Corp. of America, Bolinas, Calif., renewal license, 143, 500, 5,525, 5 kw.; 11,050, 16,580, 22,100, 100 w.; 126, 136, 436, 6,500, 1,200 w.; 8,390, 12,550, 12,730, 70 kw.; 16,700, 21,940, 21,980 kw.; unlimited time, 70 kw.

WCI, RCA Communications, Inc., Tuckerton, N. J., 18.4 kw., unlimited time 200 kw.

The case is therefore one of wide importance, not only as to its legal aspects, which are expected finally to reach the United States Supreme Court, but also as to its immediate practical results.

Vice Chairman E. O. Sykes, presiding, said the hearing was called by the Commission on renewal of 15 licenses of the four RCA subsidiaries, "in order that the Commission might determine whether the Radio Act of 1927, and particularly section 13 thereof, it is now precluded from granting renewals in view of the judgment in the Delaware court, in the case of Lord, Receiver, against the RCA."

Judge Sykes further said that the ruling as to the admissibility of exhibits and testimony in the case would be reserved.

Judge Sykes said the Commission had decided to limit time to two hours on each side. In other words, he explained, RCA will be allotted two hours, and the four intervenors to divide two hours.

Titus is First Witness

As first witness, for the RCA companies, Louis Titus, counsel for the companies, placed on the stand William A. Winterbottom, vice president and general manager of RCA Communications, Inc. Describing the activities of the company, he said its radio circuits penetrate 39 foreign countries.

"The frequencies RCA Communications is using and has long used with the consent of the Federal Radio Commission and the concurrence of every other government in the world would likely be lost to the United States if our licenses were denied," said Mr. Winterbottom.

"There is a long waiting list now registered by other nations at the Berne Bureau. To cancel the frequencies used by RCA Communications would likely result in their transfer to foreign applicants in Russia, Mexico, or any other country that could place transmitters on the frequencies formerly occupied by RCA Communications. It has taken 10 years to build this system. Its frequencies might be lost to itself and to America in a day if its licenses were cancelled."

RCA Communications Worth $20,000,000

Of the 1,409 licenses held by the four RCA companies RCA Communications holds 130, Mr. Winterbottom said, all of which are world-wide in range. Of this number, 112 are for point-to-point service in the international bands, 17 for experimental service and one for marine relay. The company handles 10,000 messages a day on an average.

The value of the tangible property of the RCA Communications is approximately $20,000,000.

Mr. Reid made the motion that the Commission "strike out" the entire testimony of the RCA executive. "There is not a word about section 13 in it," he said.

Judge Sykes reserved ruling.

In cross-examining Mr. Winterbottom, Mr. Reid asked particularly about the part played by the vacuum tube in radio communications. Mr. Winterbottom said that the associated and subsidiary companies of the RCA are, for the most part, "large customers of the RCA."

Contracts for $17,000,000

M. H. Aylesworth, president of the National Broadcasting Company, according to "The United States Daily," described the activities of the network and traced its history from its establishment in 1926. He has been president of the company since its organization.

In the NBC network there are 76 stations, and the stations owned and operated by the NBC are "necessary" to the continuation of the network, Mr. Aylesworth testified.

In 1930, he testified, $20,000,000 represented the networks revenue while contracts now are signed for $17,000,000 in commercial programs, he said. There are more than 1,300 persons on the payroll of the company, not including talent, he declared.

"We hope to bring television into the practical field during the coming year as a result of experimental operations," said Mr. Aylesworth. The network is experimenting with ultra short waves for possible use in connecting network stations and replacing land lines now employed as the connecting links, he said.

Fears Almost Total Loss

Experiments in sychronization designed to alleviate congestion in broadcasting and make room for additional transmitters by allowing highpowered stations to operate simultaneously on the same channel without interference also were described. This repre-

to Oust RCA Companies from Air

sents three years of experimentation and an investment of $500,000, he asserted.

"If these licenses are not renewed," concluded the witness, "our property will be almost totally lost. We have $2,171,000 in fixed assets, such as studios."

When Mr. Reid inquired about the vacuum tube case, Mr. Aylesworth said he was not conversant with it and did not know of the relationship of section 13.

Mr. Schuette questioned Mr. Aylesworth as to the general operations of his company. Similar questions were asked by E. N. Nockels, representing the Chicago Federation of Labor, and Mr. Aylesworth said he was unable to answer legal questions and other technical questions relating to patents.

Charles W. Horn, general engineer of the NBC, described the technical setup of the network. He estimated the value of the transmitting equipment of the NBC owned and operated stations at $1,617,000. Of this he estimated the NBC owned $727,500.

Marine Activities

Commissioner Ira E. Robinson asked Mr. Titus whether he was "trying to construe a statute by the introduction of evidence."

Mr. Titus replied that he was endeavoring to show not only that section 13 is not applicable to the present case, but also that it is "unconstitutional and void." The question of its constitutionality, however, can not be considered by the Commission, he said.

Activities of the Radiomarine Corporation of America, engaged in ship-to-shore communications and coastal contacts, were outlined by T. M. Stevens, general superintendent of the company. Tangible assets of the company were said by the witness to be approximately $2,900,000. He said that in 1930 the company had a gross revenue of $1,536,544. In 1929 it was $2,154,171, he said.

The company has 1,173 ship licenses, 31 coastal licenses, as well as 28 relay stations and 10 point-to-point stations in Alaska, and has approximately 1,700 operators aboard ships using its apparatus and approximately 225 ashore, he said.

Contracts Requested

Questioned by Commissioner Robinson, Mr. Stevens said that if the licenses of Radiomarine are revoked it would take several years before any other company would be enabled to equip ships in the same manner. He said that not more than 75 per cent of the American vessels are equipped with RCA apparatus and service. The RCA installs, maintains and operates the apparatus. The service takes care of approximately 1,200 American-flag vessels out of 2,000, he asserted.

A request that Manton Davis, vice president and general attorney of the RCA, be subpœnæd to produce all contracts of the RCA and subsidiaries covering the use of patents, was made by Mr. Schuette. The Commission called a 10-minute recess to consider the request.

"The application for a subpœna duces tecum for Col. Manton Davis will be denied as beyond the scope of the present hearing," Vice Chairman Sykes announced following the recess.

E. E. Schumaker, president of the RCA Victor Co., was the final witness called by Mr. Titus. He said that television experimentation constitutes the main activity of his company in radio operations.

Whereas a year ago television was a subject discussed only by technicians, he said that today it is a "matter of accomplishment, not of speculation."

Progress of Experiments

"There is every prospect of the success of these experiments," continued Mr. Schumaker. "More than $20,000,000 has been spent by the RCA in research and experimentation. The RCA Victor Co. has spent $1,000,000 exclusively in television research," he said.

"As a result of the work now in progress and of the expenditures which have been and are now being made," Mr. Schumaker declares, "it is expected that a new industry of sight transmission and reception will be created and that the RCA Victor Company will be in a favorable position to manufacture and market radio television broadcasting equipment and receiving sets, thereby receiving compensation for the heavy investments which it has already made in this new art.

"Should the RCA Victor Company's experimental television licenses be denied the moneys expended in previous experimentation and research will be largely lost, its experimental television broadcasting and receiving equipment will have only such value as it would bring at forced sale, less than one-fifth of its present real value and the public will lose the benefit of the experimental research and development work already done by this company and its associated companies in this field."

Tube is Heart of Radio

Mr. Schumaker, questioned by Mr. Schuette, said he had no official knowledge of the several damage suits, amounting to nearly $50,000,000, pending against the RCA because of its defeat in the tube litigation. He declared he had heard of the cases, but that he was not conversant with the details.

V. Ford Greaves, Acting Chief Engineer of the Commission, was called as a witness by the Commission, in connection with the part of the vacuum tube in radio communication.

He described what constitutes a radio transmitting system, and the origin of the tubes.

An objection to the introduction of any testimony relating to vacuum tubes, of the character offered by Mr. Greaves, was made by Mr. Titus. The Commission, however, overruled the objection and an exception was taken.

Mr. Titus said that the purpose of such testimony obviously had to do with the decision of the Delaware courts in the tube case and therefore was wholly irrelevant and incompetent, and not pertinent to the issue before the Commission.

Judge Robinson said that he was "impatient" because "extraneous issues" were being raised. He said it was generally known that the tube is the "heart of radio."

Difference in Tubes

Col. Davis interrogated Mr. Greaves as to the characteristics of partjcular types of tubes, purporting to show that transmitting tubes may not be used for receivers under ordinary circumstances and vice versa.

Mr. Schuette asked the witness whether a monopoly in radio tubes would be created if the RCA owned all the radio tubes and then did not permit their use freely.

"It is perfectly obvious to me that if you withdraw from use the vacuum tube you would wreck the industry," Mr. Greaves replied.

Elmer E. Bucher, assistant vice president of the RCA, said there is a marked difference between receiving and transmitting tubes and that they are not interchangeable. Prior to 1930, he said, General Electric manufactured tubes for the RCA. Other manufacturers make broadcasting tubes, he said, while transmitting tubes are manufactured by some of the companies.

HUGE MILLIONS ARE AT STAKE IN TRUST CASE

A Great Menace

The decree in the Delaware case related only to receiving set tubes, Col. Davis asserted.

Demand that RCA be divested of the licenses held by four subsidiaries because of violation by the four intervenors.

Representative Reid, appearing as counsel "for the public," declared it was the duty of the Commission to refuse renewal of the licenses. "In my opinion," he said, "a radio trust is the greatest possible menace to the Nation.

Schuette suggested that the penalties of section 13 could be avoided by the four companies, if they divested themselves of the parent company which has been "adjudged a monopoly."

Hanson held that section 13 applied and that the Commission was duty-bound to refuse license renewals. This same view was reflected by Nockels.

For RCA, Titus contended that section 13 in no wise fitted the judgment of the lower court in the tube litigation.

A THOUGHT FOR THE WEEK

NOBODY should be surprised that suits and countersuits should disturb the sweet tenor of radio affairs. How about the early days of the automobile and motion pictures? Legal cannon volleyed and thundered all over the place and smoke obscured the vision of even the most far-seeing. So radio is merely following in the path of older industries. It is still suffering from puppy troubles. The U. S. Supreme Court will act as physician extraordinary many times before the air is cleared and everybody in radio knows what's what and settles down to a more or less undisturbed existence.

RADIO WORLD

Title Reg. U. S. Pat. Off.

The First and Only National Radio Weekly
Tenth Year

Owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.

Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager; J. E. Anderson, technical editor; L. C. Tobin, advertising manager.

German Delegation Visits Seven Cities

A group of six members of the Association of German Radio dealers (Reichsverband deutscher Rundfunkhaendler) arrived in New York on the S. S. Hamburg to make a tour of the United States. They were: *Hans Bruckner,* engineer, of Pasing, near Munich, connected with Bruckner & Stark, radio and telephone construction firm; *Robert Kapp,* connected with Electro Constructions S. A., Strassburg-Meinau; *Ernest Plathner,* engineer and manager of the Owin Radio Construction firm, Hanover; *Christian Asbach,* of Alfred Wennerscheid, manufacturer of radio accessories and insulated wire; Hermann Pawlik, of the Electrotechnical Works Heliogen, Blankenburg; *Friedrich Weiler,* of Bruckner & Stark, Nuremburg.

After a four days' stay in New York at the Hotel Wellington, the party proceeded to Philadelphia, Washington, Pittsburgh, Detroit, Schenectady and Albany, returning to New York to spend a few days sightseeing, then sailing for home on the S. S. Deutschland.

Sound Track on Both Sides of WLW Film

Sound on film broadcasts are being transmitted by WLW, Cincinnati. The films were run through a Phototone sound head. This unit was manufactured by the Phototone Equipment Corporation in Indianapolis.

Joseph Chambers, chief engineer of WLW, has been experimenting with broadcasts from films rather from the discs, which are used more commonly. A special film was made for him with the sound tracks on both sides of the film, which enabled him to run the film through then reverse it and run it through again. There is no needle scratch.

At a test recently made over the regular wave length and on the short-wave transmission the program was picked up in England and reports say that the reproduction was good.

The outfit was specially constructed and included a standard photo-electric cell sound head.

UNION FIGHTS CENSORSHIP

The American Civil Liberties Union, 100 Fifth Avenue, New York City, announces the organization of The National Council on Freedom from Censorship. The scope includes radio, movies, periodicals, books and plays. The slogan is "Censorship Covers Up But Does Not Cure."

The announcement discusses radio censorship as follows:

"Censorship of radio hides behind station policies. Unlike the publishing or theatrical business, radio is a strictly limited field in which competition for public favor runs high. The general policy, therefore, is to avoid controversial subjects that might cause embarrassment to business interests or incumbent political powers.

"Three major considerations must be met by any program aimed at making radio free from censorship and firm in its rightful place as a constructive educational medium.

"First, it must prevent a continuation of selective consorship at the stations, now greatly in evidence. Secondly, it must prevent domination of the industry by two or three large groups. Thirdly, it must protect public interests in free speech against discrimination in issuing licenses."

The officers are Hatcher Hughes, chairman; Barrett H. Clark, Fannie Hurst and Elmer Rice, vice-chairmen; Harry Elmer Barnes, treasurer; Gordon W. Moss, secretary.

Others listed in the announcement are: Helen Arthur, Bruce Bliven, Louise Stevens Bryant, Witter Bynner, James Branch Cabell, Henry Seidel Canby, Edward Childs Carpenter, Marc Connelly, Mary Ware Dennett, Walter Pritchard Eaton, Morris L. Ernst, Rabbi Sidney E. Goldstein, Paul Green, Louis I. Harris, Arthur Garfield Hays, Theresa Helburn, B. W. Huebsch, Sidney Howard, Rupert Hughes, Inez Haynes Irwin, Dorothy Kenyon, Kenneth MacGowan, H. L. Mencken, Lewis Mumford, Henry Raymond Mussey, George Jean Nathan, Rabbi Louis I. Newman, Rev. Robert Norwood, Eugene O'Neill, Maxwell E. Perkins, G. Shearman Peterkin, Llewlyn Powys, Aaron J. Rosanoff, Robert E. Sherwood, Claire Sifton, Paul Sifton, Harry Weinberger, Stewart Edward White, Ira S. Wile and Harry Leon Wilson.

Schedule of Time Signals from Elgin Transmitter

W9XAM, Elgin National Watch Company, Elgin, Ill., operating on 4795 kc (62.56 meters) is transmitting radio time signals according to the following schedule (Central Standard Time).

7:55 a. m.— 8:00 a. m.	daily except Sunday.
9:55 a. m.—10:00 a. m.	daily except Sunday.
11:55 a. m.—12:00 noon	daily except Sunday.
1:55 p. m.— 2:00 p. m.	daily except Saturday and Sunday
3:55 p. m.— 4:00 p. m.	daily except Saturday and Sunday
9:55 p. m.—10:00 p. m.	daily except Sunday.

During these transmissions, which are in code, a dot is given for each second of the minute except the 29th, 55th, 56th, 57th, 58th and 59th seconds which are omitted for reference points. The final signal, which occurs exactly at the beginning of the hour, is a long dash.

They Say

BEN H. DARROW, Director of the Ohio School of the Air, Ohio State University: "With millions of dollars being contributed each year to the endowments of the greatest galaxy of colleges and universities the world has ever known, it seems to me that some of these endowment funds ought to go into the educational broadcasting stations of the country. For example, why shouldn't Ohio State University have a radio station which will make the entire State her campus? Why shouldn't the faculty of the university gradually develop a larger and larger group of professors who can take their message, to which students must listen in order to get credits, and so suit it to the understanding that dad and mother back home may, for the first time, get an idea of just what is meant by the words, 'economics,' 'sociology,' and so forth?"

* * *

MORRIS METCALF, president Radio Manufacturers' Association: "It has been estimated that the radio industry spends approximately $30,000,000 annually advertising its products. Possibly $100,000,000 has been spent in five years. I venture to say that half this amount spent collectively in an instructive and educational manner, and without competitive selling arguments, would have doubled the sale of radio sets and scrapped two-thirds of the 5,000,000 obsolete sets now in existence."

Forum

THANKS for publishing the full text of Millikan's talk from Los Angeles. It was chopped off in the middle because of broadcasting schedules, and I fished wildly from 550 to 1,500 kc, and searched the next day's papers, without learning what Millikan had planned to say.

Those of us who read your sheet from cover to cover—because it is the finest in its field—were human beings before we were radio hams; and Millikan's speech, awkward and difficult though it is, has quite as much importance for homo sapiens in the large as it has for the sub-species hamo radioensis. RADIO WORLD apparently sees this, and publishes the full text. It is this breadth of appreciation, perhaps, that makes RADIO WORLD a little different. We need help in understanding this rather devilish world.

BROOKS SHEPARD.
22 East 38th Street, New York, N. Y.

Television Called Crude but Promising

Atlantic City

"Technically and commercially, television today is just as much of an experiment, just as crude, yet just as promising as the feeble attempts at propagating entertainment by radio telephony prior to 1920," M. H. Aylesworth, president of the National Broadcasting Company, said in a speech prepared for delivery before the National Electric Light Association Convention.

The idea of television dates back to 1884, when a German scientist, Paul Nipkow, patented a method of translating light waves into electrical energy, transmitting this energy by wires and changing it back into light terms and reassembling the image, he recalled.

CAMERA USED FOR TELEVISING ENTIRE SCENES

By D. E. REPLOGLE

By means of a new television camera the use of a stage has become an accomplished fact in television. The new camera is now ready to be used to enlarge the size of pickup space in the studio and expedite the televising of outdoor scenes.

In experimental work at W2XCD, Passaic, N. J., the camera has supplanted the flying spot method entirely and will be used for program work at that station from now on.

Under the older flying spot method, in use at all of the stations now on the air with anything like programs, the object to be televised was limited in size to a closeup bust image or part of the person. A dancer could be seen from the hips down, or a singer or speaker from the waist up, but the full-length image was out of the question.

Takes in a Larger Space

With the camera pickup the image can take in a space four feet deep by seven feet wide by seven feet high with great detail, and outdoors the pickup of a moving train, automobiles and airplanes in flight has already been accomplished.

This pickup device is the result of several years of extensive laboratory development. The principle on which this operates is different from that used in any television studio today. The studio flying spot pickups throw a high intensity light over the subject being televised which is picked up by sensitive photo-electric cells then amplified and used to modulate a radio transmitter.

Opens Way to Outdoor Pickup

It can be readily understood that this method can not be used outdoors, as the flying spot of light would not affect the photo-electric cells nearly as much as would the powerful rays of the sun.

Hence some other method must be used to pick up outside events and transmit them so they can be received in the home on standard television receivers. The method used in the new direct pickup camera is to focus the image by means of a high-grade camera lens on a revolving Nipkow disc. Behind the disc is a sensitive photo-electric cell and contained in the camera is a six-stage amplifier which feeds the amplified photo-electric currents into a low impedance line to the main amplifier.

Flexible Apparatus

The apparatus just described is mounted on a yoke which can be raised or lowered, tilted up or down or revolved in any direction to follow the action. In front of the pickup disc a neon lamp is mounted which can be seen by the operator through the shadow box, thereby enabling him to monitor the program being picked up.

Just above the shadow box is a knob which adjusts the focus of the lens. All this apparatus is mounted on a small electric truck which can be steered or made to go backwards by means of a small electric motor under the truck. This truck houses all the batteries necessary to operate the direct pickup camera and makes it a complete self-contained unit.

Practice Reversed in New Antenna

Boston.

A new antenna about to be erected on the roof of the Shortwave and Television Corporation's building, instead of being composed of two towers which support wires consists of a tower supported by wires. It is said to be the first antenna of its kind to be erected in the United States for a commercial station.

Since an antenna is metal and antenna towers are metal the antenna tower could be used for an antenna without adding wire. This is the basic idea. Upright shafts enclose the wire.

The advantages claimed are a 40 per cent. increase in the effective power and the elimination of the sky wave to reduce fading and signal distortion.

SYSTEM FOUND, NBC ANNOUNCES

"We've got it!"

That is the position taken by the National Broadcasting Company in regard to the television system of the future.

An announcement issued by the company sets forth:

"The National Broadcasting Company and its associated companies have not yet offered to the public any television service, preferring to retain the art in the research laboratories until it develops to more substantial proportions.

"The research staff in the RCA-Victor plant at Camden, New Jersey, has experimented with a variety of techniques, has tried, compared and improved them. Out of this vast amount of experimentation *there has slowly but surely emerged a system which in the future will become the basis of television in the home.*"

The NBC and RCA-Victor are subsidiaries of the Radio Corporation of America.

From remarks made by executives of RCA, including David Sarnoff, president, it is believed the "system" consists of scanning by a sharp-light oscillograph tube, using the cathode ray principle, and permitting projection, instead of only peep-hole observation, besides eliminating mechanical scanning by discs.

Convicted "Wildcat" Loses Court Appeal

Washington.

Robert Gordon Duncan, the self-styled Oregon Wildcat, who broadcast from a station in Portland, Ore., speeches that were demed obscene and indecent, and for which he was convicted criminally, lost in his attempt to have the United States Supreme Court upset the conviction. He had attacked the constitutionality of the radio law, on the ground that it was enacted for the regulation of radio transmission, and that criminal provisions were outside its scope. His petition for a review on this ground was denied.

Duncan was a strenuous opponent of chain stores and also was active in politics. It was charged his talks were offensive both in the commercial and political fields, continuing to attack the victorious candidate for Congress long after his own defeat. The United States Attorney had Duncan seized.

TUBE SCANNER WINS APPROVAL OF U.S. EXPERT

Washington.

Ralph L. Walker, an examiner on the staff of the Federal Radio Commission, recommended, after a hearing, that a television sending license be granted to Don Lee, Inc., of Los Angeles, particularly because the applicant intends to use an oscillograph cathode ray tube for scanning, instead of the mechanical disc.

Don Lee, Inc., operates KHJ, Los Angeles, and KFRC, San Francisco, besides the short-wave station W6XK at Los Angeles.

The application was for an assignment of 500 watts power unlimited time on the television channels of 2,100 to 2,200 and 2,850 to 2,950 kilocycle bands.

Examiner's Report

Mr. Walker's report set forth:

"The system of television broadcasting which the applicant proposes to use differs from the usual television system in that it does not employ scanning discs or other rotating devices, being an electrical system of scanning rather than a mechanical system.

"In the proposed apparatus, motion picture film is moved uniformly through a modified projector to provide the image for transmission. Simultaneously with this motion, and in a direction transverse to it, a beam of light is vibrated across the film, according to a peaked wave shape of energy, by an oscillograph type of element. The light transmitted through the film impinges upon a photo-electric cell, producing current variations in it, which are amplified and modulated onto a radio frequency carrier in the usual manner.

Uses Tube Scanner

"A peaked-wave scanning generator, a vacuum tube device, is used to excite the oscillograph element at a frequency of 1,200 cycles per second, giving an image of 80 lines, which is repeated 15 times per second.

"The applicant believes that the peak scanning wave gives more useful detail in the received image than is usually secured when a fixed frequency spectrum, such as the 100-kilocycle channel, is used.

"The receiver employs a cathode ray oscillograph tube for forming the image instead of the customary scanning disc or drum. A peaked-wave generator identical to and operating in synchronism with that used at the transmitter, or peaked voltage waves sent over a line from the transmitter, are used at the receiver.

"A saw-tooth waveform low frequency vacuum-tube generator is used to provide the image repetition frequency of 15 cycles per second. A contact closing commutator located on the projector originates current pulses to be introduced into the image frequency channel, or transmitted to the receiver by wire, for the purpose of maintaining this generator in step."

TRADE NOTES

The Westark radio chain, headquarters in Chicago, and operating the Walthal stores in New York City, was petitioned in bankruptcy, as was Wireless Egert, of New York City.

Weston has bought out Jewell, which will continue to be run as a separate organization.

DR. KLEIN SEES BRIGHT FUTURE FOR INDUSTRY

By DR. JULIUS KLEIN
Assistant Secretary of Commerce

[*An address delivered before the annual convention of the Radio Manufacturers' Association in Chicago.*]

World conditions of the last two years have signally failed to have any noticeable effect on the forward march of radio. People throughout the world are and have been buying radio equipment above the scale of past years, however prosperous they may have been.

The number of sets in use is constantly increasing. The world total is now estimated at 26,000,000 to 30,000,000, and an increase of 250,000 monthly is maintained. Foreign countries are calling upon us for more and more radio equipment. Production and domestic sales are also moving forward with astonishing momentum.

Radio exports have grown by leaps and bounds since the inception of broadcasting. From 1921 through 1930, radio apparatus to the value of $99,580,680 left the United States for use in other lands. Nearly 50 per cent of this total was shipped in equal amounts during the peak-and-depression years of 1929 and 1930. But one decrease in radio exports is shown in any year since it has figured in our export statistics, and that in the midst of our greatest prosperity.

1931 Figures Showing Gain

The 1926 total was less than 1925 because 1925 was unusually high. But 1929 was practically double 1928, and the so-called "slump year," 1930, was just $11,000 higher than the 1929 total of $23,122,147. Early 1931 figures are exceeding those for the same months of the past two years or any previous year.

The production of radio equipment as reported biennially by the Census of Manufactures continued to advance through 1929, and trade estimates indicate that this year will mark a further increase.

From $54,000,000 in 1923, the production jumped on successive biennial censuses to $170,000,000 and $183,000,000 and on to $375,000,000 in 1929. According to trade indices, domestic sales have similarly increased.

Industry Rode on Crest of Wave

These are the records of the radio industry. One feels at first inclined to congratulate the industry, but rather than that I bear a gentle admonition. You, the radio industry, have ridden on the crest of a wave of popularity, which, if I may speak frankly, was not entirely the result of your own creation.

Radio as a truly amazing piece of scientific wizardry is a success, and you are its beneficiaries. The future beneficiaries will be those who recognize their business as an orderly, far-sighted business rather than a speculative venture with an extraordinary new art.

You have heard it said, and with substantial authority, that one of the invaluable elements of business reconstruction is the vigorous participation of new industries. In that respect yours was an invaluable contribution in accelerating our recovery after the slump in 1921-22.

Subsequently, however, you suffered from another accompaniment of every new industry, namely the hectic confusion resulting from overcrowding, the lack of knowledge as to business practice and possibilities because of the absence of available data on previous experiences.

These factors, the inescapable results of the youthfulness of the industry, certainly indicate the imperative necessity of one thing, namely, cooperation. To a peculiar degree this industry must demonstrate its capacity for collaborative action.

Much has been said during this depression of the value of cooperation. What does it mean? Simply belonging to a trade organization, paying dues and attending conventions? Or does cooperation have a deeper significance? By going so far with your trade organization arrangements you have established the means of cooperation, but not in all cases the fact.

Opportunity to Improve Selves

You have there the facilities for mutually beneficial trade studies, with and without the correlated action of the Department of Commerce as that action may or may not be necessary.

You have the means of stamping out the practices that interfere with good will toward yourselves and your products. You have the means of reducing overhead, increasing returns, increasing sales, improving your relations with dealers. But are you sure that you are making the maximum use of these facilities for the attainment of such highly desirable objectives?

Reports still persist of the resort to short-sighted business practices on the part of irresponsible firms and individuals. As one instance, I might mention the occasional regrettable marketing of receiving sets of distinctly dubious performance. While these cases are, of course, exceptional, nevertheless, they do discredit the industry in the eyes of consumers and they heighten the difficulties of radio administration. Here again is a field for sorely necessary collaboration.

High Type of Leaders

Among radio manufacturers, dealers, engineers and broadcasters are to be found as high a type of judgment and ability as is to be found in any group. Some of you would have succeeded had you been producing peanut roasters. Some of you have made greater success than your opportunities and facilities warranted, because of your own activities. You have cooperated with your trade association, given good to it and drawn good from it. You are good business men.

You have here the organizations that can and will, if you let them, practically guarantee against most of the evils that beset your interests. By cooperation, you can carry on studies by which you will know your markets. It matters not what phase of broadcast radio you may be interested in, or of commerce, of industry, or of living, the greatest good always comes from cooperation.

Overproduction is one of the troubles that have beset you most severely. If producers know their markets thoroughly, and consult distinterested opinions, they do not undertake expansion programs that burden them with white elephants in the shape of useless factory space.

Advises Caution in Production

Public opinion is fickle in the matter of what set to buy as in anything else. No matter how deserved may be the popularity of one model, nor what difficulties there may be in keeping production up to orders in one year, unless this represents a merely normal increase, it should be viewed with suspicion before contracts are let for more acres of factory space.

That is not the kind of spending that contributes either to your own or to general prosperity. It is the kind of spending that creates individual depression. It is also the source of the most vicious overproduction. Study your markets, get them in hand, and know something about what they are going to absorb before you send a model into heavy production.

The wholesalers are not excepted in the general need of cooperation, though their problems are different. They are mediators between two groups, the manufacturer and the retailer, having many diametrically opposed interests. They are often forced to cooperate in two different directions.

Responsibility of Jobber

Each wholesaler knows his area, what it will buy voluntarily and what can be sold to it. He has in this a knowledge that is indispensable to the manufacturer, and he has the means of putting that knowledge to work.

The very idea of wholesaling is service cooperation. But that does not mean that the wholesaler is thereby relieved of responsibility for greater cooperation. It does not mean that he cooperates just be-

(*Continued on next page*)

22,300 Attendance at Trade Show

Excellent business during the fifth annual trade show of the Radio Manufacturers' Association of Chicago was reported by a large majority of exhibiting manufacturers, according to an official statement from the RMA.

Attendance was normal under existing conditions, it was stated by Bond Geddes, executive vice-president of the association, and show manager. The attendance passed the 22,300 mark.

"While the attendance was smaller, as expected, than the peak radio year of 1929 and the association's show last summer at Atlantic City, actual business transacted was reported generally to be better. The trade show visitors this year came for business and not pleasure. Business was the keynote of the entire show week and actual orders totaling several millions of dollars were reported."

Officers of the RMH elected for the ensuing year were:

President: J. Clarke Coit, Chicago, United States Radio & Television Corp.

Vice-presidents: A. S. Wells, Chicago, president, The Gulbransen Co.; Fred D. Williams, New York City, manager, radio tube division, National Carbon Co., Inc.; N. P. Bloom, Louisville, Ky., president, Adler Mfg. Co.

Treasurer: Leslie F. Muter, Chicago, president Muter Company.

Other directors elected for a period of three years are: W. J. Barkley, Passaic, N. J., sales manager, DeForest Radio Company; Harry A. Beach, Rochester, N. Y., radio sales manager, Stromberg-Carlson Telephone Mfg. Co.; E. R. Farny, Chicago, Ill., president, All-American Mohawk Corp.; E. V. Hughes, Peru, Ind., sales manager, Wasmuth-Goodrich Co.; F. E. Johnston, Cincinnati, O., director of engineering, The Crosley Radio Corp.; Arthur Moss, New York, N. Y., president, Electrad, Inc.

TRADE ADVISED BY U.S. OFFICIAL TO END ABUSES

RANGER'S TUBE ORGAN IS HEARD OVER STATIONS

The demonstration of the electric organ developed by Captain Richard H. Ranger, inventor of devices for sending pictures and facsimiles by wire and radio, marks another forward step in the development of electric and synthetic music. Many attemps of this nature have been made by various workers in the radio field, beginning with Marconi long before the advent of tube oscillators, and continued by De Forest, Theremin and research workers in Radio-Victor laboratories at Camden, N. J. and others.

It is reported that Marconi, while on a visit to New York with his yacht Elettra, treated the few radio listeners at that time to music produced by spark transmitters having spark frequencies corresponding to the musical tones. Later, it is reported, De Forest transmitted electric or synthetic music generated by audio frequency oscillators which had been made possible by the invention of the audion.

A few years ago the Russian inventor and mathematician Theremin announced his ether music device, which is now well known. This instrument utilized the heterodyne principle, permitting the player of the instrument to produce any desired tones by moving the hands in the air.

Principle of Ranger Organ

Recently Radio-Victor announced the development of an electric instrument in which small mechanical vibrators were excited electrically and the vibrations picked up by magnetic means and amplified by ordinary audio frequency amplifiers. This instrument, it is said, has a wide range of tones, timbre and volume.

And now comes the announcement of the development of the electrical organ by Captain Ranger. This instrument, too, is characterized by its versatility in pitch, timbre and volume, in the hands of a skillful musician.

In the organ developed by Captain Ranger 12 electrically driven tuning forks generate the fundamental tones from which the music is obtained, each fork accurately tuned to a given musical tone. Eleven amplifiers, requiring 150 tubes, are used to amplify the sounds generated by the forks, and eleven separate electrodynamic speakers to reproduce the music. The speakers are mounted on a door for baffling effect.

Claims Substantiated

By means of keys, relays, and switches, the player is enabled to change the timbre of the music at will, making the instrument sound like different instruments and even the human voice. In the hands of a skillful musician, Captain Ranger said, the instrument would make it possible to imitate a complete symphony orchestra, representing every instrument, including the repercussions.

The electric organ was demonstrated publicly by broadcasting over WEAF and WOR during which Captain Ranger and Charles M. Chourboin, Belgian organist of the Church of Resurrection at Rye, N. Y., alternated at the console. The instrument was played in the home of Captain Ranger in Newark, N. J. and the music was conducted to the transmitting stations by wire in the usual way.

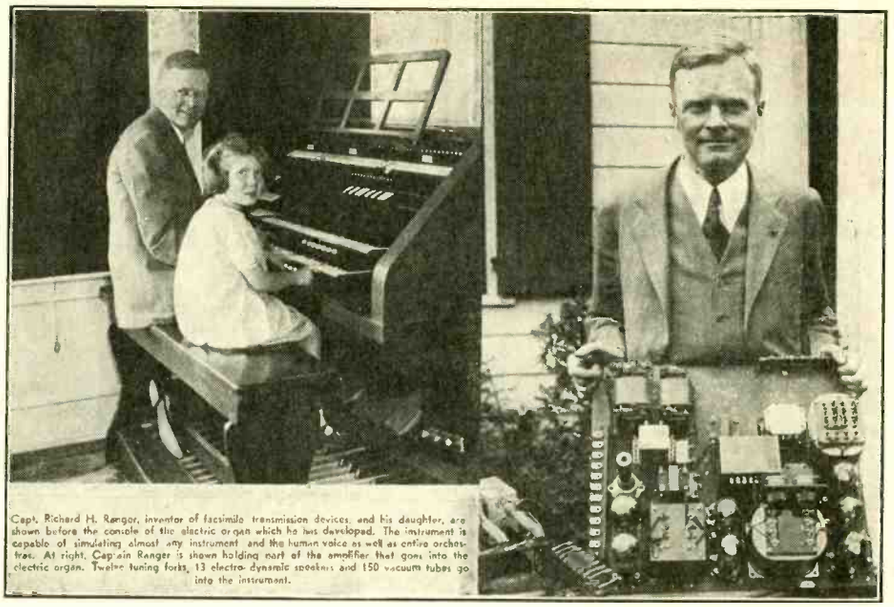
The claims made for the instrument in the preliminary announcement sent out a week before the public demonstration were that the electric organ would produce tones ranging from a whisper to a full chorus and of a quality simulating that of an organ or almost that of any other instrument desired. This versatility was in evidence during the playing. At times the tones were like those of an organ, at times like those of woodwinds, and at other times like those of a string instrument.

Distinctive Tones

Certain apparent defects were in evidence, such as lack of strength on the low tones, transient effects at the beginning of tones, which may have been due to key clicks or surges in the circuits. But these defects can well be accounted for by the characteristics of the transmission line between the instrument and the broadcast stations. Moreover, a new and entirely different instrument should not be judged by comparison with older instruments, but rather by the tones it produces. The characteristic tones of the piano are not defects just because they are different from those of the older harpsichord. Of course key click transients would be defects.

There are limitless possibilities for the inventor of electrical musical instruments, for the composer who can create music for these instruments, and for the musician who can learn to play them. Natural tones can be reproduced electrically, either directly or with modified timbre, or entirely synthetic tones can be produced of any desired timbre.

ORGAN INVENTOR GOES ON THE AIR



Capt. Richard H. Ranger, inventor of facsimile transmission devices, and his daughter, are shown before the console of the electric organ which he has developed. The instrument is capable of simulating almost any instrument and the human voice as well as entire orchestras. At right, Captain Ranger is shown holding part of the amplifier that goes into the electric organ. Twelve tuning forks, 13 electro-dynamic speakers and 150 vacuum tubes go into the instrument.

(Acme-P. & A.)

Conserve Your Assets Dr. Klein Advises

(*Continued from preceding page*)

cause he is a wholesaler. One of the fields in which he has yet a great opportunity is the assistance he can give the manufacturer in suggestions for sales promotion programs.

As I said before, your industry rendered invaluable assistance in the great task of lifting American business out of the post-war collapse. You can again render an equal service in the present depression by conserving fully the great assets of vigor and resourcefulness which are so conspicuous in this young giant in the business world.

Capital Not Seriously Impaired

Our recovery, which happily is already definitely under way, can be most helpfully accelerated by any measures which you take to put your trading and production practices in the best of good order.

The enormous savings and capital reserves of this Nation have not been seriously impaired. They await the stimulus of skillfully directed resourceful salesmanship. In this field the radio industry should by very reason of its youth, its lack of impediments in the shape of archaic traditions, be in a position to assume outstanding leadership in our march out of the abyss.

CURATOR GIVES KEY TO SCIENCE TALKS ON AIR

By AUSTIN H. CLARK

[*How to compose and deliver a radio talk on a technical subject so as to make a hit with the listeners was described in a statement prepared by Austin H. Clark, curator of echinoderms at the Smithsonian Institution, Washington, D. C., and printed in "The United States Daily."*]

Radio talks given in a manner even remotely suggestive of a desire to instruct are bound to be pathetic failures. They must be wholly devoid of any suggestion that the speaker is better informed or more learned than the listeners.

The preparation of a radio talk is no simple matter. A radio talk should be written in such a fashion that any newspaper will be glad to print it in the issue immediately following its delivery. If a local newspaper editor will not consider printing any given radio talk—at least in a more or less condensed form—that talk should be dropped in the waste basket and another written.

In a radio talk the opening paragraph must include something sure to interest the listener so much that he or she will continue to listen.

A Bad Beginning

For instance, suppose I am giving a talk on the cow-bird and I begin:

"Our cow-bird, like most cuckoos, the honey-guides of Africa, some weaver-finches, some hang-nests, and a South American duck, and according to recent information one of the paradise-birds, lays its eggs in the nests of other birds which hatch these eggs and raise the young," the number of listeners will be reduced to the vanishing point long before I have reached the end of the sentence.

In the first place the title—"The Cow-bird"—is too grimly prosaic and means nothing to most people. In the second place, honey-guides, weaver-finches and hang-nests, wholly unfamiliar names of foreign birds, would cause the mind to skid unpleasantly and finally to run off the road entirely.

A Good Beginning

But if I change the title of the talk to "Abandoned Bird Babies" and begin, "Those unfeeling mothers who leave little babies upon the doorsteps of prosperous peoples' houses have their counterparts among the birds," etc., I shall be able to follow it up with a very considerable amount of information, and many people will learn that there are many different kinds of parasitic birds of which our common cow-bird is a typical example.

A radio talk must be so written as to be an elaboration of the idea conveyed in the first paragraph. It must be a closely knit unit from beginning to end, and the last paragraph must be as strong as the first.

The composition of a radio talk is essentially the same as that of a newspaper article. But there is one important difference. While a radio talk must be a complete unit from beginning to end, and the last paragraph must be as strong as the first, a newspaper article must be so written that, if pressed for space by some unforeseen occurrence, the editor can clip off a series of paragraphs up to about half the total number without affecting the unity of the subject matter remaining.

Professor Needs Assistance

All radio talks before delivery should be edited by someone familiar with the difficult and highly specialized technique of writing for popular consumption, and who will not be afraid to commit the most fearful sort of butchery if necessary.

In scientific writing a series of facts is presented. and then the conclusions based upon those facts are given. For a radio talk, as for a newspaper article, this procedure must be almost completely reversed. It becomes almost impossible, therefore, for anyone trained in science to write a good radio talk without assistance.

If no trained writer is available, a good plan is to read a prospective radio talk to someone with not more than a high school education and then find out from him or her what is the chief idea which has been conveyed—if any.

An Alternative Method

The chief idea conveyed by a radio talk to an average person is often most disconcertingly at variance with the main point of interest, in the opinion of the writer. Nevertheless, painful as the process may be, the talk should be rewritten along the lines suggested by the listener.

All radio talks should be written in a manner suitable for publication by the press, and also suitable for assembling in the form of pamphlets or small books will meet a ready sale.

Dialogues are always popular. Talks on distant and more or less wild regions, or regions commonly supposed to be wild, are very effective if presented as dialogues between traveler and a young lady with a voice that sounds as if she were very pretty who asks more or less silly questions. The whole dialogue, of course, must be written by one person, and the participants must go over it several times before they give it.

It is needless to remark that all radio talks must begin and end exactly on the second.

Much Information in 15 Minutes

There is one other point to be considered in regard to radio talks. The subject matter must be presented in more or less condensed form. In a lecture the subject matter must be well diluted, for otherwise the audience will tire.

In a lecture the audience is only partly occupied in listening to what is being said: a considerable part of the interest on the part of the listeners is taken up in watching the mannerisms and subconsciously appraising the personality of the speaker.

In a radio talk the audience is to all intents and purposes blind; the visible mannerisms and personality of the speaker are wholly eliminated, and the listeners are entirely occupied in hearing what he has to say. The result of this is that quite as much information can be conveyed in a radio talk of 15 minutes length as in a lecture occupying an hour.

Dubilier is Victor Over Amplifier

Washington

The United States Patent Office has ruled in favor of William Dubilier and against Radio Corporation of America over the Thilo patent, No. 1,690,881. Priority was at issue.

The patent is said to relate to amplifiers licensed by R. C. A. and also by Loftin-White.

105 HOSPITALS OF ARMY TO BE RADIO-EQUIPPED

Washington.

A project recently approved by the War Department directs the installation of radio receiving equipment in 105 Army hospitals located throughout the United States, Panama, Hawaii, Porto Rico and the Philippine Islands. The Chief Signal Officer is charged with the preparation of the estimates and supervision of the installation, which is to be completed in 1935.

Present plans provide for a central receiving set in each of the hospitals. By means of electric cables to each bed, programs will be sent to the individual patients who will be provided with high quality head sets or "radio pillows."

Radio Pillows Used

The devices consist of a small receiver encased in a sponge rubber cushion, with an outlet to permit of undisturbed reception. Recent tests of these pillows indicate their entire practicability for this purpose. Individual volume control devices will be installed to enable the patient to adjust the volume of the reception.

Short Waves, Too

Due to heavy static, reception of ordinary broadcasts in Panama, Porto Rico and the Philippines is unsatisfactory. A number of short-wave receivers will be furnished the hospitals in these places for the reception of programs broadcast in the United States and foreign countries. In addition, local broadcasts will be made possible in these hospitals by means of electric phonographs which will also be provided.

The Radio Census

Nebraska

The whole number of families in Nebraska on April 1, 1930, was 343,781, as compared with 303,436 in 1920. The number of persons per family in 1930 was 4.0, as compared with 4.3 in 1920. The number of families reporting radio sets in 1930 was 164,324, or 47.8 per cent of the total.

* * *

Montana

The Director of the Census announced the results of a preliminary count of the number of families in the State of Montana according to the 1930 census, together with the number of families reporting radio sets. The whole number of families in the State on April 1, 1930, was 137,010, as compared with 139,912 in 1920. The number of persons per family was 3.9, the same as in 1920. The number of families reporting radio sets in 1930 was 43,809, or 32.0 per cent of the total.

* * *

Indiana

The whole number of families in Indiana on April 1, 1930, was 844,463, as compared with 737,707 in 1920. The number of persons per family in 1930 was 3.8, as compared with 4.0 in 1920. The number of families reporting radio sets in 1930 was 351,540, or 41.6 per cent of the total.

ADAPTERS ANNOUNCED

Two types of adapters, a one-tube device with one tuned circuit, using a 224 tube, and a two-tube model, two tuned circuits, using 235 and 224, are announced by Supertone Products Corporation, 216 Wallabout street, Brooklyn, N. Y.

SERVICE MEN'S NEW ADAPTER

Here is a new adapter that does the very trick you've wanted done—enables interruption of the connections to a tube, so current can be read, at the same time affording direct access to the prongs for voltage tests. Remove tube from socket, insert adapter in socket, put tube in adapter, and you're all set. Removable links, supplied with adapter, permit access to current.

For 5-prong tubes, Cat. B-1 @ $1.05.
For 4-prong tubes, Cat. B-2 @ $1.05.
Connecting cables, 2 ft. long, jack pins at both ends. Cat. 2067 (two leads), @ 36c.
Connecting cables, 2 ft. long, jack pin one end, forked lug at other, Cat. 2066 (two leads), @ 48c.

DIRECT RADIO CO.
143 West 45th Street,
New York, N. Y.

Tubes at 50¢ Each

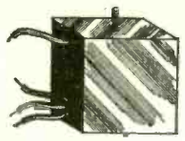
280 200A
226 245
171

Sold on basis of remittance with order. We will pay the postage.

RELIABLE RADIO CO.
143 West 45th Street New York, N. Y.

HAMMARLUND SFL
Hammarlund's precision .0005 mfd. condenser, with removable shaft; single hole panel mount. Lowest loss construction; rigidity; Hammarlund's perfection throughout. Order Cat. HAM-SFL @ $3.00 net price. Guaranty Radio Goods Co., 143 W. 45th St., New York.

Three 0.1 mfd. in One Case



Three Supertone non-inductive fixed condensers of 0.1 mfd each, (250 v.) in steel case, 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.

NATIONAL DRUM DIAL

National Velvet Vernier drum dial, type H, for ¼" shaft. An automatic spring take-up assures positive drive at all times. Numbers are projected on a ground glass. Rainbow wheel changes colors in tuning. Modernistic escutcheon. Order Cat. ND-H @ $3.13.

GUARANTY RADIO GOODS CO.
143 West 45th Street, New York, N. Y.

SYNCHRONOUS MOTOR, $4.25

For use on 60-cycle AC line. 12-inch turntable included. 80 revolutions per minute. The speed is self-regulated. This compact synchronous motor may be used with a phonograph pickup to play records. Cat. SYN-M @ $4.25.

DIRECT RADIO CO., 143 W. 45th St., New York, N.Y.

RADIO WORLD AND RADIO NEWS. Both for one year, $7.00. Radio World, 145 W. 45th St., N. Y. City

AMER-TRAN AUDIOS

First stage, de luxe (illustrated), primary, in detector circuit, has 200 henrys inductance at 1 ma; turns ratio, 1-to-3. Cat. DL-1, list price, $8.00 net $4.70.

Push-pull input transformer, turns ratio, 1-to-2½; single primary; two separate windings for secondary; Cat. 151, list price, $12; net, $7.05.

[Remit with order and we pay transportation.]

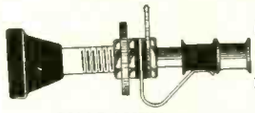
GUARANTY RADIO GOODS CO.
143 West 45th Street, New York, N. Y.

NEW VARIABLE MU TUBE

TO remedy cross-modulation and cross-talk, without circuit changes, a new screen grid tube has been developed. In AC circuits where the volume control varies the grid bias or the screen voltage, or in which there is an automatic volume control, the new tube works wonders. This is the sensational tube developed by Stuart Ballantine. Order VM-51. Price $2.66.

RELIABLE RADIO CO.
143 WEST 45th ST. N. Y. CITY

"A" BATTERY SWITCH



A push-pull switch for battery-operated sets. Made by Benjamin. Firm, sure contact, extremely long life. Price, 25c.

GUARANTY RADIO GOODS CO.
143 West 45th St., New York, N. Y

"MATHEMATICS OF RADIO."—A great help to everybody interested in radio. $2 postpaid. Radio World, 145 W. 45th St., N. Y. City.

Quick Action Classified Ads

Radio World's Speedy Medium for Enterprise and Sales

7 cents a word—$1.00 minimum—Cash with Order

LARGE AMPLIFIER AND MICROPHONE OUTFIT FOR SALE. Used less than 24 hours. Sampson Pam-19 six-tube amplifier, with 250 push pull as output, a Sampson Mik I Speech Amplifier, using two 227 and one 280, and a brand-new General Industries Microphone three button. Will handle 20 speakers. Total retail value, $375, less tubes. Price $95. We are responsible—look us up in the rating books. Reid Motor Supply Co., Quincy, Ill.

25,000 OHM POTENTIOMETER, wire wound, in shield case; takes ¼" shaft. Will stand 20 ma. easily. Excellent as a volume control. Price, 90c. Direct Radio Co., 143 West 45th Street, New York, N. Y.

BARGAINS in first-class, highest grade merchandise. Phono-link pick-up with vol. control and adapter, $3.32; four-gang .00035 mfd. with trimmers built in, $1.95; .00025 mfd. Dubilier grid condenser with clips, 18c. P. Cohen, Room 1214, at 143 West 45th Street, N. Y. City.

BALKITE A-5 RECEIVER, eight-tube, three stages of Neutrodyne RF and two stages audio with push-pull output. Good distance-getter and very sensitive. Has post for external B voltage for short-wave converters. Brand new in factory case. Berkey-Gay walnut table model cabinet. Price $35 (less tubes). Direct Radio Co., 143 West 45th St., New York.

U. S. BROADCASTING STATIONS BY FREQUENCY.—The April 11th issue contained a complete and carefully corrected list of all the broadcasting stations in the United States. This list was complete as to all details, including frequency, call, owner, location, power and time sharers. No such list was ever published more completely. It occupied nine full pages. Two extra pages in the April 11th issue were devoted to a conversion table, frequency to meters, or meters to frequency, 10 to 30,000, entirely reversible. 15c a copy. RADIO WORLD, 145 West 45th Street, New York, N. Y.

"SHORT WAVES", by Charles R. Leutz and Robert B. Gable. Fully bound, 384 pages, 75 illustrations. Size 6 x 9. All new subjects. $3.00 Radio World, 145 W. 45th St., N. Y. City.

JEWELL 199 SET ANALYZER for screen grid tubes. Guaranteed like new. Cheap. Write Lynn Chapman, 309 Commercial, Waterloo, Iowa

SHORT-WAVE NUMBERS OF RADIO WORLD. Copies of Radio World from Nov. 8, 1930 to Jan. 3, 1931, covering the various short-wave angles, sent on receipt of $1.00. Radio World, 145 W. 45th St., N. Y. City.

HAMMARLUND SFL — Hammarlund's precision .0005 mfd. condenser, with removable shaft; single hole panel mount. Lowest loss construction; rigidity; Hammarlund's perfection throughout. Order Cat. HAM-SFL @ $3.00 net price. Guaranty Radio Goods Co., 143 W. 45th St., New York.

TRANSFORMERS—1½, 2½, 5 volt; 2½ volt, 7¼ amp.; or 7½ volt, 3 amp.; 99c each; shielded $1.45. Shielded 2½ volt, 11 amp.; $1.60. All center-tapped. Shielded .00035 or .0005 coils, .50; 3 coils, $1.45. Four gang .00035 mfd. condenser with drum dial, $1.25. Special transformers, tube testers, etc. Custom work. Phone: Walnut 0615-J. L. Waterman, 2140 Kirby West, Detroit, Michigan.

STREAK BARGAIN OF 1931—Set tester, made by the famous Readrite Company, accurate to 98%, contained in a convenient small chromium-plated case measuring 8 x 3 inches, net weight 2½ lbs. Consists of three double reading meters, with cable plug, 4-prong adapter, test cords and screen grid cable, enabling simultaneous reading of plate voltage, plate current and filament or heater voltage (DC or AC), when plugged into the socket of any set. The ranges are filament, heater or other AC or DC: 0-10 v, 0-140 v; plate current: 0-20, 0-100 ma; plate voltage: 0-60, 0-300 v. INSTRUCTION SHEET INSIDE. Made to sell for $20.00, we offer you the big opportunity of obtaining it for $8.25 remittance with order, plus $3.51 to be paid in 90 days. Direct Radio Co., 143 W. 45th St., N. Y. C.

"SOUND PICTURES TROUBLE SHOOTER'S MANUAL," by Cameron and Rider, an authority on this new science and art. Price $7.50. Book Dept., Radio World, 145 W. 45th St., N. Y. City.

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

PRINTING: 1000 BUSINESS CARDS $2.75 POSTPAID. Other printing reasonable. Samples free. Miller, (RW), Printer, Narberth, Pa.

SITUATIONS WANTED

SEEKING LABORATORY POSITION. Expert on experimental work. Have five years' intensive experience. Can start at once. M. Steinhurst, 109 Herzl St., Brooklyn, N. Y.

GRADUATE R.C.A. Institutes, Inc., CX-7549. Desires radio position with a future. Salary no object. Will go any place, but preferably east. Age 28. Robert H. Clark, 1 W. Walton Place, Chicago, Ill.

EXPERIENCED, AGE 26, MARRIED. National Radio Institute graduate, with five years' experience in radio sales, repairing, and servicing all makes of radios. Willing to start with fair salary. Excellent references. Sam F. Kyburz, Jr., Forrest, Ill.

RADIO SERVICE MAN AND ELECTRICIAN, age 23, wishes any kind of work, radio or electrical, or as a helper. Graduate of Coyne Electrical School, Chicago, Ill., and Y.M.C.A. Radio Institute, New York City. Have Supreme Analyzer Model 90 and tools and own a car. Have one year practical experience, and best of references. Speak Ukranian, Russian, Polish, Slavish. Go anywhere. Address L. K. J., 213 Morris Ave., Newark, N. J.

ELECTROLYTIC CONDENSERS

Large triple Polymet electrolytic condenser, three capacities of 8 mfd. in one copper case; upright mounting.

Connections: Case to negative, each anode (at top) to positive. Anodes may be used separately for 8 mfd. each, or two interconnected for 16 mfd. or three for 24 mfd.

Rating: Peak voltage, 420 volts; recommended maximum working voltage, 375 volts.

Performance: Self-healing, low leakage, high capacity lasts.

Order Cat. C-729, consisting of electrolytic condenser and mounting bracket. List price, $5.00; net price, $2.94.

RELIABLE RADIO CO.
143 West 45th Street, New York, N. Y.

PENTODE, $1.00 VARI-MU, $1.00

We carry the full line of Rextron tubes, at smashing prices for first-class, A-1 tubes with 10-day money-back guarantee. The 247 pentode @ $1 and the 235 exponential or vari-mu tube @ $1, as well as the 2-volt battery tubes @ $1, afford a genuine opportunity to get the new type tubes at new low prices for "firsts."

List of Tubes and Prices

247 (pentode)	$1.00	120	1.00
235 (vari-mu)	1.00	200A	1.00
230	1.00	WD-12	1.00
231	1.00	224	1.80
232	1.00	227	1.00
222	2.10	245	1.00
171A	1.00	210	2.95
171 (for AC)	1.00	250	2.95
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112 (for AC)	1.00	280	1.00
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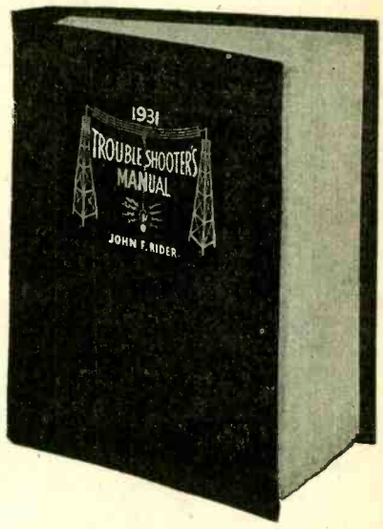

THE most complete service man's manual is the 1931 edition of "Trouble Shooter's Manual," by John F. Rider, published April, 1931, and ready for immediate delivery. Wiring diagrams of ALL popular commercial receivers and kit sets from 1922 to 1931, inclusive. Also contains a course in trouble shooting. Loose leaf pages, 8½ x 11", bound. 853 pages; index and advertisements on additional pages. Order Cat. RM-31, and remit $4.50. We will then pay postage. (Shipping weight, 6 lbs.) Ten-day money-back guarantee.

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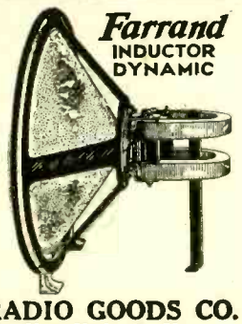
The inductor dynamic offers high sensitivity and true tonal response. It requires no exciting field current, unlike other dynamics. Order model B for 112A or pentode, and Model G for all other output tubes.

Cat. 9-G (9" extreme outside diameter) $8.49

Cat. 9-B $8.49

Cat. 12-G (12" extreme outside diameter) $10.03

Cat. 12-B $10.03



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Works on 110-120 volts, AC or DC; power, 50 watts. A serviceable iron, with copper tip, 5 ft. cable and male plug. Send $1.50 for 13 weeks' subscription for Radio World and get these free! Please state if you are renewing existing subscription.

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METALLIZED RESISTORS

PLAIN ENDS

1.0 meg. and 2.0 meg.

PIGTAIL ENDS

.02 meg. (20,000 ohms) .5 meg. (500,000 ohms)
.05 meg. (50,000 ohms) 0.1 meg. (100,000 ohms)
2.0 meg. and 5.0 meg.

Price, 25c each, all sizes as above.

Mounting for plain end leaks, Lynch moulded product, 15c.

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PHONOGRAPH PICK-UP — Made by Allen-Hough. $3.32. Guaranty Radio Goods Co., 143 W. 45th St., N. Y. C.

EVEREADY RAYTHEON 4-PILLAR RADIO TUBES

TRADE MARKS

Every Tube Guaranteed Electrically and Mechanically Perfect

ALL THE NEW TUBES—

235, the new sensational variable mu radio frequency amplifier tube for great reduction or elimination of crosstalk, direct inter-station interference and hissing background noises. It has a high mu for low bias and a low mu for high bias. Net price, $1.54.
551, variable mu, substantially the same operation. Net price, $2.20.
247, power pentode for use in the last stage, either alone or in push-pull. It has a greater power sensitivity than any other tube available. Net price, $1.26.
233, a 2-volt power pentode tube for use as output tube in circuits utilizing the 231 and the 232. Net price, $1.83.
237, a 6.3-volt general purpose tube of the heater type, suitable for use in automobile receivers. It may be used as detector, oscillator or amplifier. It may be heated with either direct or alternating current. Net price, $1.23.
236, a 6.3-volt screen grid tube of the heater type which may be used for amplification in receivers utilizing the 237. Net price, $1.83.
238, a 6.3-volt power pentode tube for use as output tube, singly or in push-pull, in receivers utilizing the 236 and 237. Net price, $1.93.

ALSO THE STANDBYS—

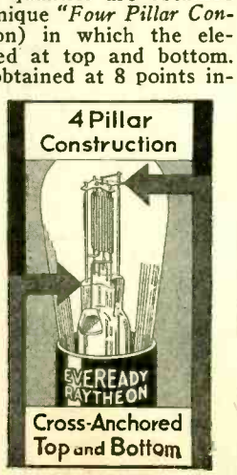
227	@$0.88	V-199	@ 1.93	222	@ 3.15
224	@ 1.40	X-199	@ 1.75	230	@ 1.12
226	@ .88	120	@ 2.10	231	@ 1.12
171A	@ .98	201A	@ .77	232	@ 1.61
210	@ 4.90	200A	@ 2.80	280	@$0.98
245	@ .98	240	@ 2.10	281	@ 3.50
250	@ 4.20	112A	@ 1.05	BH	@ 3.10
Kino Lamp @$4.75				BA	@ 5.20

EVEREADY RAYTHEON 4-pillar radio tubes are built to give consistently good service over long periods of time. Their performance is uniform day after day and they can be depended on to give maximum results.

These highly desirable qualities are obtained through the use of the unique *"Four Pillar Construction"* (see illustration) in which the elements are cross anchored at top and bottom. In this way, support is obtained at 8 points instead of 4 as in ordinary tubes.

This rugged trouble-proof feature enables Eveready Raytheon tubes to "stand up" under the most severe conditions and insures the same high degree of performance in the set of the consumer as they exhibit on factory tests.

These tubes have gained recognition for their precision workmanship and long life and are guaranteed to be electrically and mechanically perfect. Also, they are especially well packed in sturdy boxes.



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—SPECIALS—

Five-lead cable, 2 ft. long, with plug to fit a five-prong (UY) socket. The cable is connected at the factory so that following wires represent the respective prongs of the socket: Blue with white marker—G post of socket; Red—plate of socket; Green—cathode of socket; Yellow—heater adjoining cathode; Black with yellow marker—heater adjoining plate. .....Net 65c

MARCO black bakelite vernier dials. Read 0-100 with a supplementary scale reading 0-10 between figures on large scale. Takes a ¼" shaft...Net 50c

Parts for "A" battery eliminator: Dry rectifier, $2.10; 0-10 ammeter, 75c; 20-volt filament transformer, $2.50. Will handle up to 2 amperes filament current.

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