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1931

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RADIO WORLD

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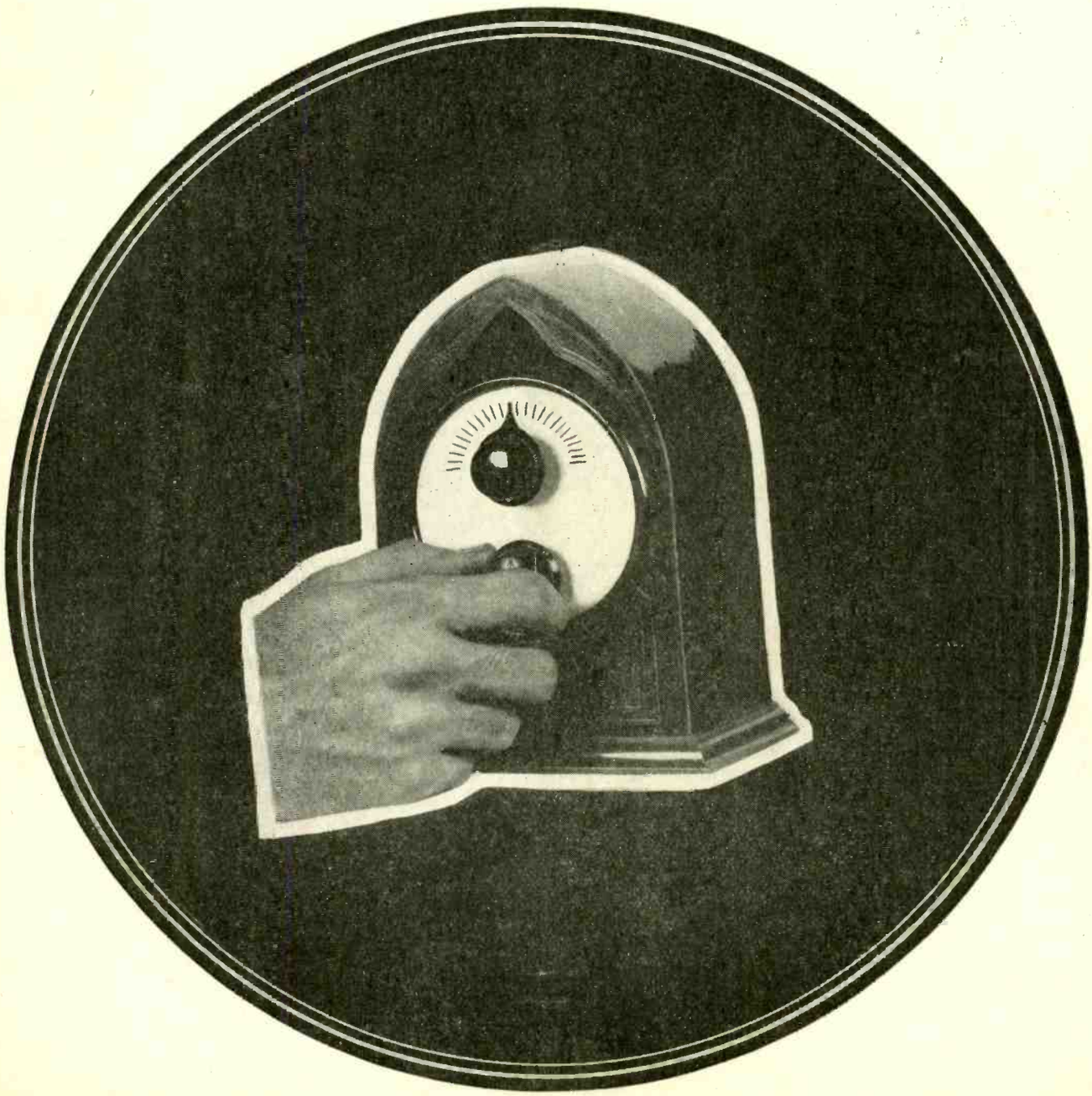
The First and Only National Radio Weekly

481st Consecutive Issue—TENTH YEAR

FULL TEXT of the Langmuir Opinion

"MICROSCOPIC" ALL-WAVE RECEIVER



A totally self-contained all-wave set was built in a Gothic cabinet about twice the size of a man's hand. **See page 12.**

Summer Bargains!

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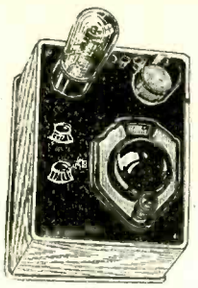

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PARTS

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A Dependable Adapter

All Voltages Derived from AC Set with Heater Tubes

THE method outlined herewith reveals how to obtain all the power from an AC-operated receiver for working a short-wave tuner, provided only that the AC set uses heater type tubes in the radio frequency sockets.

The radio frequency amplifier and the detector tubes of the set are removed, and the five-prong (UY) plug is inserted in one of the radio frequency sockets. Only three leads from this plug are used: two for the heaters and one for the plate. Obviously, the heater voltage is simply carried by the two cable leads to the sockets of the short-wave adjunct. The plate lead from the set undergoes a special treatment. As there is a coil in the plate circuit in the big set, the plate is bypassed in the little set as to radio frequencies by a 1 mfd. condenser, so that non-pulsating current remains, and this is what flows to the plates of the two tubes in the circuit, Fig. 1.

The total plate and screen currents taken by the circuit, Fig. 1, is not large enough to cause even a series plate resistor, if any, in the big set to drop much voltage. The combined currents are 8 mils.

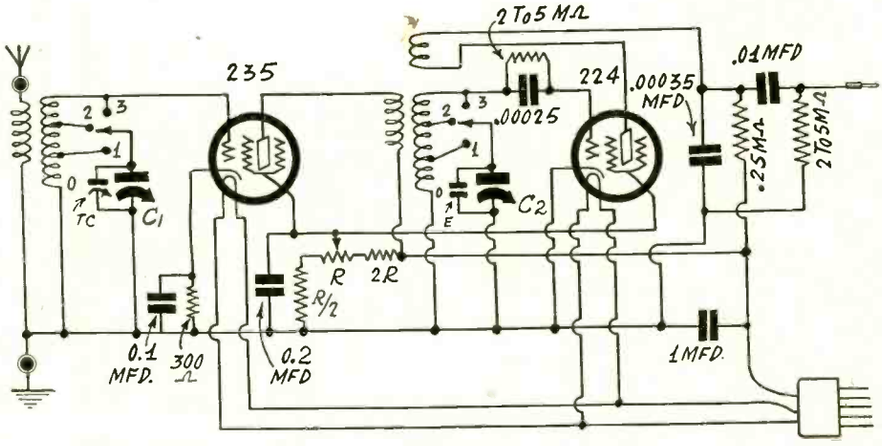

FIG. 1

The power for this short-wave adapter is taken directly from an AC receiver that uses heater type tubes. C1 and C2 may be .00035 mfd., E is any equalizer and TC is a trimming condenser. Whatever value is selected for R, twice that value obtains for 2R and half for R/2.

A variable mu tube is used as the radio frequency amplifier, a 224 as detector, and volume control is accomplished by varying their screen voltage. The total of 2R, R and R/2 should be no less than 3,000 ohms, but may be any value higher than that, depending on what value of potentiometer you have. The only reason for including R/2 is to prevent cutoff of the screen current, in other words, permit larger span of the volume control from maximum to minimum volume.

Output Is Certain

Also, the screen of the detector is tied to the same control, so that sensitivity and volume are governed together, and the radio frequency amplifier is prevented from oscillating when the detector is so prevented. It is a case of double check.

It is not known in advance what the plate voltage will be, as that depends on what the big set will afford, but it should be around 180 to 150 volts from sets using 224 or 227 tubes or both, and the proper proportion will be effective, due to the volume control system. The screen voltage will be approximately half the applied plate voltage, when the potentiometer arm is at one extreme (juncture between R and 2R).

The only remaining problem to consider is the output. The detector plate load becomes a known quantity by including the 0.25 meg. resistor, while a grid leak of from 2 to 5 meg. is provided for the first audio stage of the big set. Therefore all one need to do is to use a service man's adapter, to get at the grid of the first audio tube in the set, and insert the short-wave adjunct's tipped output lead into the circuit. The adapter permits keeping the tube in the same position in the set while taking off the grid connection.

It is possible to dispense with this special adapter if one is content to have the grid leak constitute a parallel load with the load already in the grid circuit of the first audio tube in the big set. The only requirement would be that some communicative conductive end be provided on the leadout wire. This may be done by baring the wire of its insulation, making a loop just large enough to fit snugly over the prong of the tube, and slipping this taut noose around the grid prong before reinserting the tube in the socket.

Either that method may be employed, or a regular lug, such as is commonly used in radio, will serve the purpose, if the hole in the lug is slipped over the tube prong, and the lug bent at a right angle, using the tube base as guide. Completion of the bending may not be practical on the tube, so the lug is removed for this purpose. Then the leadout wire is soldered to the solid end of the lug, and when connection is to be made, the tube prong is slipped into the lug hole and the tube put in the first audio socket where it belongs.

In case a lug is used, care should be taken, where the big set has a metal chassis, that the lug does not touch the metal, as this would short the grid circuit of the first audio tube, and nothing would be heard in the loudspeaker.

The bared wire loop has the disadvantage of causing the tube to sit a little lopsidedly in the socket.

So perhaps most users will prefer the adapter.

Earphones from leadout to ground may be used.

Excellent Results

Wave band changing is accomplished by switching. If desired, all-wave operation may be enjoyed. By using .00035 mfd. for C1 and C2, three taps would be enough. Data for winding coils have been published in connection with other circuits. Plug-in coils may be used, if preferred.

The object now is simply to show the method of deriving the voltages with a certainty of excellent results.

—HERMAN BERNARD.

Automotive Tubes in a

By J. E.

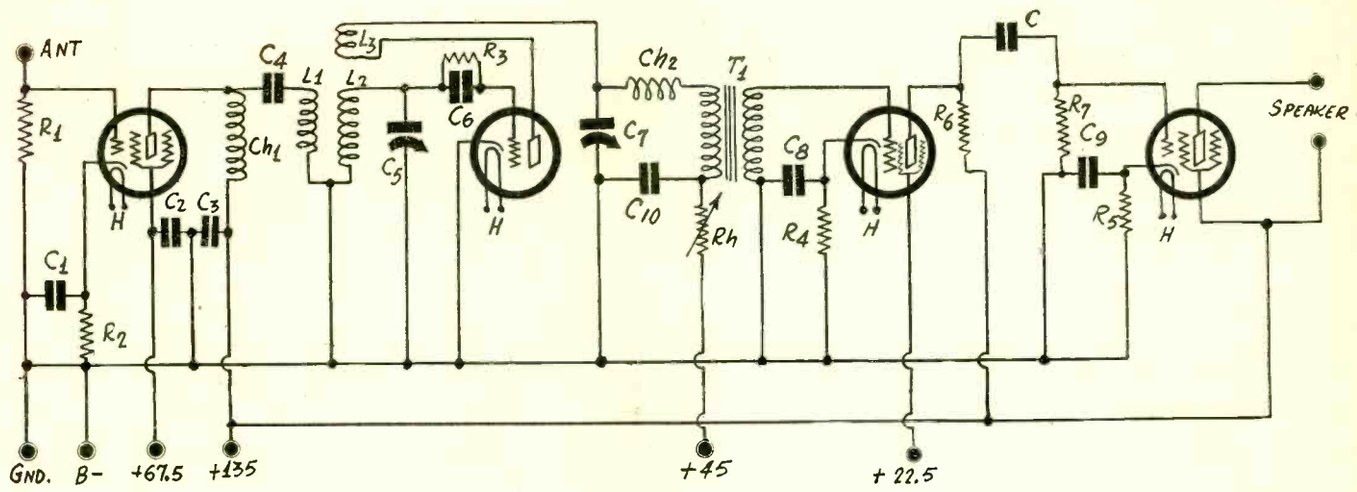

FIG. 1

The circuit diagram of a four tube short-wave receiver comprising one stage of untuned radio frequency amplification, a regenerative detector, and two stages of audio frequency amplification.

THOSE who do not have radio receivers sensitive enough to get satisfactory short-wave reception with converters, or those who have super-heterodynes without any radio frequency amplification or with insufficient radio frequency selection, will get better results with a short-wave receiver. Such a receiver may have an untuned stage of radio frequency amplification so that the antenna will not complicate the tuning. This stage will also increase the sensitivity of the receiver manifold and it will help greatly to get the necessary selectivity.

In addition to this the detector stage should be regenerative and capable of oscillation for this will not only increase the sensitivity and selectivity many times but it will enable the operator to receive continuous wave code as well as voice-modulated signals. A two stage audio amplifier after the detector will insure sufficient volume to operate a loudspeaker.

Reception Expectancy

With a receiver of this type, the J-13, diagrammed in Fig. 1, signals from almost any place on the earth can be expected. Of course, there are times when waves of certain frequencies cannot be received because they do not travel. Instead of hugging the earth they shoot off into space where no aerial will reach.

The antenna is coupled to the first tube by means of a resistance R1 of 250,000 ohms. This is an average resistance rather than one that must be used. A resistance as low as 10,000 ohms or as high as 1,000,000 ohms works well.

The coupling between first tube and the detector has been arranged so that a plug-in coil fitting a UY socket can be used and still have three windings. To get the plate voltage on the first tube an RF choke Ch1 is connected between the plate of the tube and the B supply. The condenser C4, of .0005 mfd. capacity, prevents the plate supply from being short-circuited through the primary L1 of the tuning coil.

L1 and L2 really consist of a single winding with a tap on it for the ground connection, the two windings being proportioned according to the frequency which the coil is to cover. The tickler winding L3 is separate and is wound with a separation of about ¼ inch from L2.

Much depends on the turns used on the tickler. If there are too many turns the condenser C7 will not control the oscillation and there will be nothing but whistling. If the winding does not contain enough turns there will not be oscillation and the set will not be sensitive.

The number of turns required depends on the efficiency of the coil, on the tube used for detector, on the plate and filament voltages, and on the values of the grid condenser and grid leak. For these reasons more turns than are required should be put on the tickler winding and then if the set oscillates uncontrollably turns should be removed from the L2 side of L3 until C7 controls the oscillation with the voltages selected on the tube.

There should be no squeals at any settings of the tuning dial when no station is tuned in, that is, there should be no squeals except those due to carriers. It may be that there will be squeals when C7 is set at maximum but it should always be possible to stop them by opening C7. Moreover, there should be oscillation at all settings on the dial of C5 as evidenced by heterodyne squeals.

LIST OF PARTS

Coils

L1 L2 L3—one set of of tuning coils as described.
Ch1, Ch2—Two 800 turn duolateral chokes.
T1—One Amertran de luxe audio frequency transformer.

Condensers

C1, C2—Two 0.1 mfd. by-pass condensers.
C3, C8, C9, C10—Four 2 mfd. by-pass condensers.
C4—One 0.0005 mfd. condenser.
C5, C7—Two 125 mmfd. Hammarlund Midline condensers.
C6—One 0.00025 mfd. grid condenser with resistance clips.
C—One 0.01 mfd. condenser.

Resistors

R1, R6—Two 250,000 ohm metallized resistors.
R2—One 300 ohm bias resistor.
R3—One 2 megohm grid leak.
R4—One 3,000 ohm grid bias resistor.
R5—One 1,300 ohm grid bias resistor.
R7—One 1 megohm grid leak.
Rh—One 30,000 ohm variable resistor.

Other parts

Nine binding posts.
Five UY sockets.
One filament switch (not shown on diagram).
Two condenser dials.
One 7x12 hard rubber panel.
One 8x12 hard rubber panel.

Optional Oscillation Control

The variable resistance Rh, of 30,000 ohms, may be used as an optional control of regeneration. When this is used C7 may be a fixed condenser of 0.0005 mfd., or both controls may be used. If they are, the number of tickler turns is not quite so critical. The circuit was operated both ways and it was found that better operation was obtained with 22.5 volts in the plate circuit when the variable condenser alone was used and that 45 volts worked better when the resistance also was used.

An audio transformer was used between the detector and the first audio tube because it was desired to get a high step-up of the signal voltage and also because smoother regeneration obtained in this way.

Between the first audio and the output tube a resistance coupler is used so that a screen grid tube may be used effectively in the first audio socket. This will provide sufficient amplification at audio frequency to load up the power tube about the same time that the detector is overloaded. The detector becomes overloaded when the output voltage at audio frequency is about 0.05 volt and the output tube, being a 238 pentode, becomes overloaded when the peak voltage on its grid is about 13.5 volts, which is the bias provided on the tube. In the resistance-capacity coupler, R6 is 250,000 ohms, R7

Pentode Short-Wave Set

Anderson

one megohm, and C is 0.01 mfd. These values insure high amplification at all frequencies down to at least 50 cycles per second.

Provision for Bias

The amplification will not be satisfactory either at radio or audio frequencies unless the tubes are biased properly. The proper bias for the first screen grid tube is 1.5 volts, and this will be obtained very nearly if the bias resistance R2 is 300 ohms. The first audio tube, which is of the same type as the first radio, also calls for a bias of 1.5 volts. But in this case the plate current is very low, and the screen current is correspondingly low, the sum being of the order of 0.5 milliampere. Thus a resistance of 3,000 ohms is needed for R4. The output tube requires a bias of 13.5 volts and the sum of the plate and screen currents is 10.5 milliamperes. Therefore R5 should be a resistance of about 1,300 ohms.

The circuit was designed for and operated with the new 6.3 volt tubes, the first and the third being 236 screen grid tubes, the second a 237 general purpose tube and the output tube a 238 pentode. The terminals of the heaters were brought out to two binding posts so that either a storage battery or a suitable transformer could be used for supplying the current. The various plate voltage terminals were also brought out to binding posts so that either batteries or a B battery eliminator could be used for supplying the plate voltage.

There is quite an assortment of plate and screen voltages. The screen voltage on the first tube is 67.5 volts. That on the screen of the first audio is 22.5 volts, necessary on the resistance coupled tube to prevent distortion on the positive side of the signal wave. The optimum value to use here depends on the grid bias and a voltage of 45 volts may be tried. The voltage on the plates of all the tubes, with the exception of the detector, and on the screen of the output tube, is 135 volts.

Loudspeaker Volume

Loudspeaker volume was obtained with this circuit, a magnetic speaker being used. This volume was obtained with a short indoor antenna not more than five feet high. With an antenna about 100 feet high no more volume was obtained, but this was due to the manner in which the long antenna was mounted in a dumb waiter shaft parallel to grounded BX cable.

Since binding posts are provided for the heater voltage, it is a simple matter to change the circuit to fit 2.5 volt heater tubes. A 224 would be used for radio frequency amplifier and another for first audio frequency amplifier. A 227 would then have to be used for detector and either a 227 or a 247 in the last socket. The filament voltage would have to be 2.5 volts. It would not be necessary to change the plate and screen voltages. The grid bias resistances R2 and R4 could also be the same. A change, however, would be necessary in the last socket connections whether a 227 or a 247 tube is used.

In case a 227 tube is used in the output socket the bias resistance R5 should be changed to 2,000 ohms, the lead now going to the cap would have to pick up the G post of the socket, which is now connected to B plus.

In case a 247 tube is used in the output stage more change would be necessary. The grid bias resistance would have to join ground and the midtap of the filament transformer, the lead that now goes to the cap would have to be connected to the G post on the socket, as for the 227, and the K post on the socket would have to be connected to plus B, to which the G is now connected. Then also it would be desirable to boost the plate and screen voltages on the output tube to 250 volts. The 238 or the 227 tubes give enough output at 135 or 180 volts to operate a loudspeaker satisfactorily. Hence it is hardly necessary to make the many changes required for a 247 tube. The bias resistor required for a 247 tube is 418 ohms.

Adaptable to Direct Current

The circuit as diagrammed in Fig. 1 is adaptable to use on a 110 volt DC line. The heaters are then connected in series and one end of this series, say the left end of the heater tube, is connected to the grounded side of the circuit. In the other lead of the series a resistance capable of carrying 0.3 ampere and high enough in value to drop the voltage to 25.2 volts is connected before it goes to the positive side of the 110 volt line. If the voltage of the line is just 110 volts, the required resistance 283 ohms. Allowance must be made for higher and lower voltages for the line voltage may vary between 100 and 125 volts. Three and one-third ohms should be allowed for every volt the line voltage deviates from 110 volts, the ballast resistance being less when the line voltage is less and greater when the line voltage is higher.

When the heater current is taken from the line the plate voltage may also be taken from the line, at least in part. A suitable filter and voltage divider must be used.

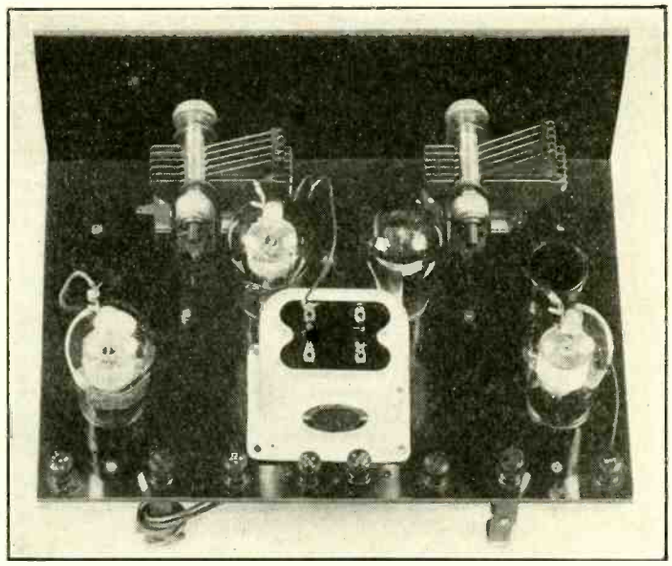

FIG. 2

A photograph of the short-wave receiver showing the arrangement of the parts on the subpanel.

Design of Coils

The coils are wound on forms that fit UY sockets. The K terminal goes to the end of the L1 L2 winding and the corresponding terminal of the socket is connected to condenser C4. The tap on the L1 L2 winding is connected to Hk and the corresponding terminal on the socket is connected to ground. The G post on the coil and the socket connects with the stator of C5 and the grid condenser and leak. The tickler winding is connected to P and Hp on the form and the socket. To insure oscillation the grid and the plate ends of the two windings should be farthest apart, assuming that the two windings are put on the same direction.

If the coils are wound on 1.25 inch forms with No. 28 enameled wire the largest coil in the set should have 55 turns for the tuned winding L2. L1 should have ⅔ as many, or 37 turns. The ratio of tickler to secondary turns found to work satisfactorily was 4 to 9. This would make the number of turns for the tickler on this coil about 24 turns.

The minimum capacity in the tuned circuit is approximately 25 mmfd. Hence the largest coil will tune to about 3,350 kc at the high frequency end. If the next coil is to start at 3,300 kc with the condenser set at maximum we need an inductance of 18.6 microhenries, which is given by 19.5 turns. This would require 13 turns for L1 and 8.5 turns for L3. The highest frequency to which this coil will tune is about 7,375 kc.

For smaller coils, that is, shorter in axial length, we may assume that the frequency to which a coil tunes is inversely proportional to the number of turns. Thus a 9 turn coil will tune to 16,000 kc. This coil should have a 6 turn primary and a 4 turn tickler. The tuning range is 1,500 kc to 16,000 kc, or about 200 to 19 meters.

In each case the tickler and the tuned winding should be separated by a distance of ¼ inch or slightly more.

NET PRICES OF SPECIAL TUBES

The following are the net prices (not list prices) of transmitting and oscillating tubes:

Type	*Net Price*	*Type*	*Net Price*
UX-199 SPL	$ 4.50	UV-851	$350.00
UV-203 A	25.00	UX-852	23.80
UV-204 A	97.50	UX-859	1.80
UX-210 SPL	5.40	UX-860	35.00
UV-211	25.00	UV-861	295.00
UV-217 A	20.00	UX-864	4.50
UV-217 C	20.00	UX-865	12.75
UX-841	9.50	UX-866	6.35
UX-842	9.50	UX-868	10.00
UV-845	30.00	UV-872	16.50
UV-849	168.00		

Intermediate Measurement

Calibrated Oscillator Used in Determining Coil's Selectivity

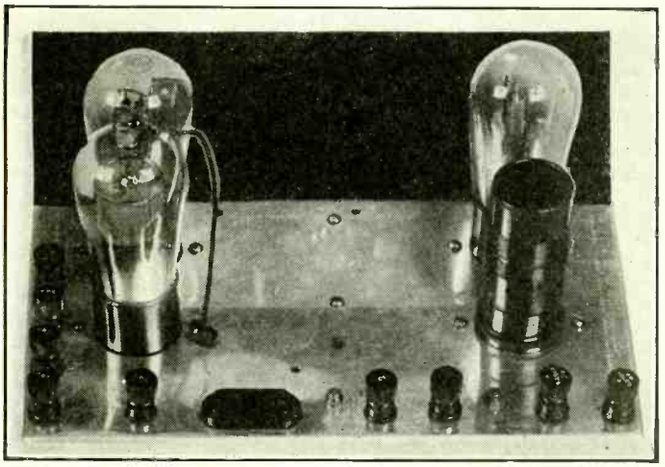

FIG. 1

A photograph of the radio frequency oscillator and transformer test circuit the diagram of which was published in the June 6th issue.

IN the June 6th issue, on page 15, we gave a circuit diagram of an oscillator and a test circuit to be used as an auxiliary oscillator in the calibration of other oscillators and also for taking curves on radio frequency transformers. In this issue, Fig. 1, we show a photograph of the finished circuit. It comprises a 227 oscillator tube, a 224 screen grid amplifier, and a 227 detector. A socket is provided for the plug-in coils.

A coil covering a frequency band just below the broadcast band was wound and the coil calibrated. This coil was wound on a wooden spool provided with four slots, each ⅛ inch wide and 5/16 inches deep, the separation between the slots being ⅛ inch. The outside diameter of this form was such that it just fit into the 1.25 inch forms used for the other plug-in coils. One slot was filled with No. 32 double silk covered wire for the grid winding. The tuned winding was put in two other slots and this winding consisted of about 400 turns of No. 32 enameled wire, divided equally between the two slots. The turns on the tuned winding were adjusted until the highest frequency to which the circuit would tune was just a little higher than the lowest frequency to which the next smaller coil would tune. The calibration curve of this coil is given in Fig. 2. Due to the high distributed capacity of the coil the frequency ratio was only about 1.8.

At first the grid winding consisted of a slot-full of No. 36 enameled wire but this was unsatisfactory for two reasons. First, the oscillation was too intense, so that the output contained too much harmonic current, and second, the grid winding determined the frequency so that it could not be varied with the tuning condenser. With the smaller winding of silk covered wire the output wave was reasonably pure and the tuning condenser across the plate winding determined the frequency throughout the range. The winding of the tuned coil in two slots also decreased the distributed capacity so that the frequency coverage of the coil was more satisfactory.

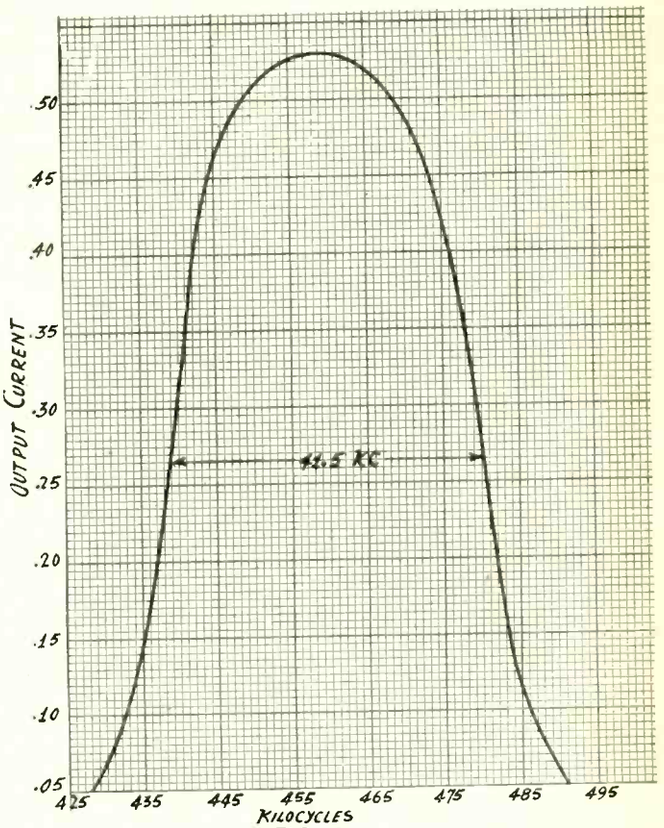

FIG. 3

A resonance curve of an intermediate frequency transformer with tuned primary and secondary windings taken with the test circuit and radio frequency oscillator.

A resonance curve on a doubly tuned radio frequency transformer consisting of two 300 turn duolateral coils, each winding shunted by a 100 mmfd. trimmer condenser, was taken by means of this coil and the oscillator circuit referred to. This curve is shown in Fig. 3, and as will be noticed, the maximum occurs at 459 kc. The range of the coil with the two trimmers was from 434 to 550 kc.

The ordinates of the curve are given in milliamperes and are proportional to the voltage developed across the second tuned winding of the transformer for a fixed value of oscillating current in the primary. Both windings were carefully tuned to the same frequency, namely, 459 kc, and then the frequency of the oscillator was varied through the entire resonance curve. At half output, or .265 milliampere, the width of the reconance curve is 41.5 kilocycles.

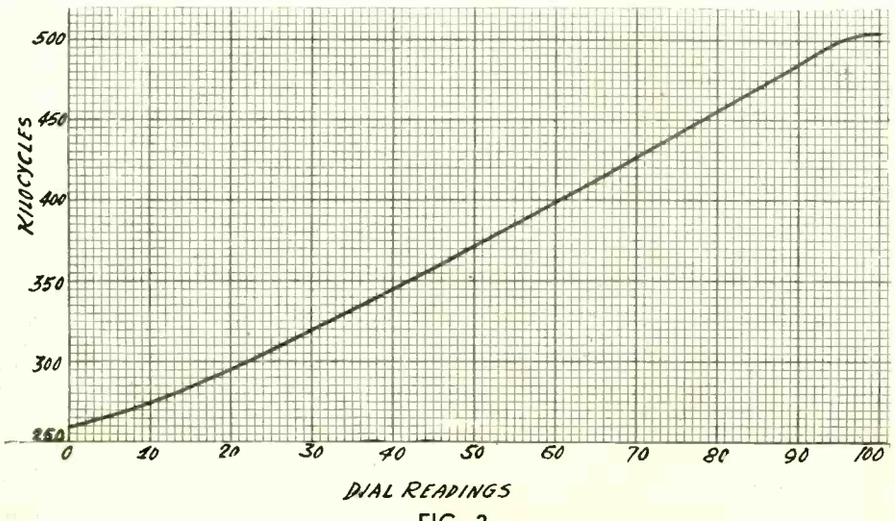

FIG. 2

The calibration curve of the oscillator coil covering the band of frequencies just below the broadcast band.

The ordinates of the curve are given in milliamperes and are proportional to the voltage developed across the second tuned winding of the transformer for a fixed value of oscillating current in the primary. Both windings were carefully tuned to the same frequency, namely, 459 kc, and then the frequency of the oscillator was varied through the entire resonance curve. At half output, or .265 milliamperes, the width of the resonance curve is 41.5 kilocycles.

Considering that this curve is for a single transfarmer tuned to about 450 kc, the selectivity curve is satisfactory. At the peak the deflection is .53 milliampere

(Continued on next page)

Planes and Cars Controlled

Mechanisms and Human Beings Directed from a Distance

RADIO is being applied more and more to the remote control of mechanisms or human beings under command of a central authority. When mechanisms are controlled, radio waves are utilized to actuate relays at a distance, which in turn control the power required to operate the mechanisms. When the actions of human beings are controlled by a central authority by means of radio waves, the persons under orders receive instructions and then act accordingly. An illustration of the control of human beings by a central authority is the modern radio police systems in which patrolmen in automobiles receive instructions from headquarters through radio sets which they carry in their automobiles.

Log Kept

News comes from Italy that this system of remote control of human beings has been made nationwide in an experiment to test its practicability. Instructions were sent out from Rome and Naples to automobiles all over Italy directing them to go through certain movements. Participants throughout the country were divided into groups and special instructions were issued to each group as well as to individuals in each group. Thus a certain group was directed to travel from one city to another by a certain route and a certain individual in one group was directed to leave his group at a certain city and travel by a specified route to another city, there to meet an individual from another group who had been detailed to leave his own group for this meeting.

Each car in every group was required to keep a log of its trip, entering all orders and test messages received, places visited, route traveled and so on. At certain control stations slips filled out by the participants were collected. The experiment was put in the form of a competition and competitors were judged on the completeness of their logs and their general performance.

The object of the test was to ascertain the practicability of controlling automobiles on the road and equipped with radio sets. If the system is practicable it will be useful in emergencies of all kinds, such as war, earthquakes, road congestions, floods, and many others.

Principle of Operation

A demonstration of the control of mechanisms at a distance by means of radio waves was recently given in Houston, Texas, when a pilotless airplane was operated from another plane flying over it above the municipal airport. To satisfy government regulation of operation of planes over cities, Whitey Owen, a transport pilot, took the ship up. Shortly after taking off he turned the controls over to Robert E. Autrey, inventor of the remote control device, who was flying in the other plane. Autrey kept the plane in control for about 15 minutes, putting it through various movements such as banking, dipping and turning. He was in complete control at all times except when the distance between the two planes became greater than half a mile, when he lost control momentarily.

The remote-controlled plane, a five-seater Stinson Detroiter, was equipped with double controls, one set for the pilot and the other for the radio mechanism. While no details on the method of control were given out, it is known such devices always operate by means of relays. In principle it is no more difficult to control an airplane than to control a teletype machine. Indeed, it is not nearly so difficult because there are not nearly so many separate movements that must be executed.

The operation of a telegraph printer of a certain type requires only two different kinds of impulses, and they differ only in the direction in which the current flows during the impulse. One impulse, let us call it positive, throws a relay in one direction, making a certain contact. The other impulse, which we call negative, throws a relay in the opposite direction. By sending five impulses in succession in different combinations of negative and positive it is possible to select any one of 32 keys on the typing machine. Most of these are for letters but some are for spacing and shifting and other necessary operations for controlling a typewriter.

Not Many Necessary

In a similar way, by having two different kinds of impulses, and a suitable arrangement of relays, we could perform 32 different operations on a plane either from ground or from another plane. The two impulses could be either two radio signals of different frequency picked up with different receivers in the controlled plane or they could be two different audio notes sent out on the same radio frequency.

It does not seem necessary to have 32 possible combinations to operate a plane. The next lower number of combinations with the two-signal system is sixteen, and the next eight. This would require only three successive impulses in different combination of positive and negative.

There are many other methods by which operations can be controlled at a distance. If there are not many they may be performed by one tone for each operation, all impressed on the same radio carrier, or there may be one carrier for each operation.

Electrical Selectors

In either case there would have to be electrical selectors for picking out the radio frequency or audio frequency currents and sending them on to the proper relay. If there were no selectors which accepted only one and rejected all the others the whole scheme would break down. If different radio carriers are used this would be no more difficult than tuning in a radio set. There would have to be one tuner for each carrier, permanently adjusted. If there is only one carrier and many audio tones on it the selection would have to be done at audio frequency.

This would be more difficult because audio tuners are heavier, costlier, and more unwieldy than radio tuners. Of course, the modulation on the single carrier might be at intermediate frequencies, which would make the tuners just about as simple as radio frequency tuners.

Side Frequency Analyses

(*Continued from preceding page*)

and at 30 kc below it is only .058 milliampere. The ratio of the maximum to the deflection at 30 kc below the peak is 0.913 and therefore the output is down 19.22 decibels. At 30 kc above it is down 1798 decibels. If there are three of these transformers in an intermediate frequency amplifier and all tuned to exactly the same frequency, a carrier 30 kc below the desired carrier would be down 57.66 decibels and a carrier 30 kc above would be down 53.94 decibels. A carrier 30 kc below would be only 1/762 as strong as the desired carrier.

Suppression of Side Frequencies

The suppression of side frequencies is very small. At 10 kc off resonance the transmission is down only 0.52 decibel, which for three similar transformers, all tuned to exactly the same frequency, would be 1.56 decibels. As tuned radio frequency transformers go, this is not a high selectivity and would not be satisfactory at all. But for intermediate transformers it is satisfactory. Suppose they are all tuned to 450 kc. The nearest interfering carrier which would cause any trouble from image interference would then be 900 kc. Frequencies so remote from the carrier would be practically eliminated. Of course, a carrier operating on a frequency only 10 kc from a desired station would not be suppressed by more than 1.56 decibles unless there is additional selectivity in the radio frequency level. There will be in every practical super-heterodyne.

Band Pass Effect

The broadness of the resonance curve is due to the band pass effect of two tuned circuits coupled loosely together and is not due to resistance in the coils and the condensers. The broadness is near the top of the curve rather than at the bottom so that there is considerable discrimination between the desired and the undesired frequencies without undue suppression of the high side frequencies. The scale of the curve has been chosen so as to accentuate the broadness. The width of the curve at half output, namely .265 milliampere, is the determining factor rather than the appearance of the curve, and the width of the curve is 41.5 kilocycles. If the two coils in the transformer were placed just a little farther apart, say an eighth of an inch, the width of the band would be narrowed considerably but then the height of the peak would be less and the output of a receiver with such transformers would be much less than with the more closely coupled type.

Supreme Court Expounds Vac

Highest Tribunal, Voiding High Vacuum Patent, Analyzes

[The Supreme Court of the United States unanimously decided against the General Electric Company on its contention that the patent granted to Dr. Irving Langmuir on a high vacuum in radio tubes was valid. The court of first instance likewise had held that the patent was invalid, the Circuit Court of Appeals at first agreed it was invalid, then, on rehearing reversed its position. The Supreme Court spoke the final word in the decision printed herewith in full. —EDITOR.]

* * *

DEFOREST RADIO COMPANY
v.
GENERAL ELECTRIC COMPANY
Supreme Court of the United States.
No. 630.

On writ of certiorari to the Circuit Court of Appeals for the Third Circuit.

SAMUEL E. DARBY JR., *and* THOMAS G. HAIGHT (CARL A. RICHMOND *and* WILLIAM R. BALLARD with them on the brief), for petitioner; RALPH B. EVANS (HUBERT HOWSON, PAXSON DEETER, ALBERT G. DAVIS and HOWSON and HOWSON with him on the brief), for respondent.

Opinion of the Court
May 25, 1931

Mr. Justice Stone delivered the opinion of the Court.

Certiorari was granted, 282 U. S. 836, to review a judgment of the Court of Appeals for the Third Circuit, holding the Langmuir Patent, No. 1558436, granted Oct. 20, 1925, for "electrical discharge apparatus and process of preparing and using the same," valid, and infringed by petitioners. The District Court for Delaware, in which respondent, the assignee of the patent, brought suit for infringement, held the patent invalid for want of invention and because of prior use and prior invention, and gave judgments dismission the complaint, 23 F. (2d) 698, which the Appellate Court at first affirmed, and then, on reargument, reversed 44 F. (2d) 931.

Validity of Patent Is Pivot

Infringement is conceded if the claims of the patent are valid. It is known as a high vacuum tube patent, and the alleged invention is exemplified in high vacuum tubes of familiar use as detectors or amplifiers in the art of radio communication and telephony. Correct appreciation of the contentions made requires, at the outset, an understanding and some exposition of the scientific principles which it is agreed are brought into play in the high vacuum tube or which at least are accepted as working hypotheses accounting for its operation.

A radio tube of the audion or three electrode type consists of a bulb, within which a vacuum has been created, enclosing a filament, which is a negative electrode, or cathode; a plate, which is a positive electrode, or anode; and a third electrode, known as a grid, located between the filament and the plate. The grid is connected with an input circuit, over which electrical radio activity, actuated at the sending station, is gathered from the ether and passes to the grid. When the tube is used as an amplifier, the plate is connected in circuit with a telephone receiver or loudspeaker.

Operation of a Vacuum Tube

In operation the filament is heated to incandescence by passing an electric current through it. In its incandescent state, electrons, or negative charges of electricity, are developed at the filament and pass to the plate, attracted to it by its positive potential, and cause a flow of electricity through the plate-loud speaker circuit. The sounds given out by the loud speaker are produced by variations in the current passing to it. Radio amplification depends on producing in the more powerful current of the loud speaker circuit, variations exactly corresponding to the variations in the weaker input or voice current which are actuated by the sending station.

In the vacuum tube of the three electrode type this is accomplished by passing the input or voice current over the grid. Variations in that current produce variations in potential of the grid which, by reason of its location between the filament and plate, effects like variations in the effective potential of the plate with corresponding variations in the loudspeaker circuit.

The number of electrons emitted by the filament is determined by its temperature. But the current passing through the plate loudspeaker circuit depends on the number of electrons drawn from the filament to the plate, and this in turn depends on the voltage of the current passing to the filament.

Condition of Saturation Defined

When it is high enough to force all the electrons emitted by the filament to pass from filament to plate, increase in the voltage at the filament will not produce any increase in current in the loudspeaker circuit and the tube is then said to be "saturated." As successful operation of the tube depends on the response of the loudspeaker current to changes in voltage effected by the voice or input current, the tube is most efficiently operated at a voltage of a range below saturation, and a current within this range is known as the "space current."

Of critical importance in the present controversy is the effect of the presence of gas within the tube. As in the practical art of bulb manufacture no scientifically perfect vacuum can be attained, air or other gas is always present within the vacuum tube. This consists of a small amount of residual gas, after the vacuum is created by pumping out of the tube in the process of manufacture. There is also gas in the walls of the bulb and the eletrodes, described as "occluded," which, if not expelled from them, and removed in course of manufacture, is later freed in varying amounts when the tube is in use, by the action of the heat of the filament and the electrons generated there.

Electronic Action of Atomic Entities

The passage of electrons from filament to plate at certain voltages produces changes in the gas, known as "ionization." Ionization is the manifestation of a rearrangement of the constituent electrons of the gas atoms which occurs, in low vacuum tubes, if other factors of causation remain constant, at known voltages within a range of from 20 to 30, but varying somewhat with different ages.*

The atom, according to present day scientific theory, is composed of an electrically positive nucleus, around which revolve at high speeds electrically negative electrons. In its normal state, the atom, whose nucleus and electrons are in electrical balance, exhibits no electrical effect; but within a thermionic tube, the impact upon the gas atoms of the electrons, passing from cathode to anode at velocities induced by ionization voltages, forces off negative electrons from the atoms.

The atoms from which the electrons have thus been detached are then electrically positive and are known as ions. Ionization, which begins at the ionization voltage, is increased with increasing voltages as the tube approaches saturation, when extreme ionization takes place; and, for reasons which need not be elaborated here, the tube then ceases to function as a radio tube, a condition visibly manifested by a blue glow within it.

Ions Facilitate Electron Flow

Gas ionization in the vacuum tube is of great practical importance because of its effect on the current passing from filament to plate. Ionization, when it occurs, may operate within the range of the space current to increase "conductivity" of the tube, that is, the discharge from filament to plate, above what it would be at the same voltage in the absence of ionization, through the development of the positive ions, which pass to the cathode, and of the negative electrons, which pass to the anode.

The ions facilitate the flow of electrons from cathode to anode and increase their number by impact on the former, which raises its temperature. The result is that, in low vacuum tubes, saturation with the blue glow effect is reached, other factors remaining constant, at lower voltages than in high vacuum tubes. Hence, in the range of voltage above ionization and below saturation, within which the tube is commonly operated, a low vacuum tube, because of the increase of current due to ionization, is more responsive to slight changes in voltage produced by the operation of the grid or input current. In consequence, the low vacuum tube is more sensitive both as a detector and as an amplifier than a tube of high vacuum.

Reduced Ionization Produces Stability

But this advantage is accompanied by a serious disadvantage, especially when the tube is used for amplification, in that ionization produces variations in the electronic discharge from filament to plate, which correspondingly affect the current passing through the loudspeaker circuit. Ionization is affected by the amount of gas in the tube, and hence by the degree of vacuum and the amount of occluded gas freed in operation by heat and bombardment. Since the discharge varies with the amount of ionization, the effective current in the loudspeaker circuit varies with different tubes and with the same tube at different times; and critical adjustments of the current flowing to the filament are necessary to improve operation.

From what has been said it is apparent that the problem of securing evenness or regularity of discharge from filament to plate and hence of current flowing through the loudspeaker circuit is dependent upon the reduction of ionization in the tube, and this in turn is dependent, within certain ranges of limits, upon a number of variables, the more important of which are (1) the geometry of the tube, that is, its size and shape and the location of electrodes, (2) heat of the filament, (3) voltage of the filament, and (4) of vital importance here, amount of gas, that is, pressure within the tube. With the other variables controlled so as to remain approximately constant as is practicable, reduction of pressure reduces ionization and increases steadiness of current and in turn raises the saturation point of the tube, permitting its use with higher than ionization voltages.

Reduced Pressure Makes for Constancy

As in the low vacuum tube regularity or evenness of the loud-

*The word *ages* evidently should be *gases*.—Editor.

uum Tube in Langmuir Opinion

the Construction and Operation of Thermionic Valve

speaker current was more or less imperfectly secured by varying the voltage at the filament with different tubes and at different times with the same tube, the desired result may also be attained, and far more effectively, by reducing the pressure in the tube and keeping other factors constant. When a vacuum is produced of as low a pressure as a few hundreths of a micron (a micron is equal to 1-1000 of a millimeter of mercury in terms of barometric pressure), the discharge is independent of the degree of vacuum, when the tube is used with appropriate space charge.

The discharge then passing from cathode at constant temperature to anode, varies directly with the 3-2 power (square root of the cube) of the voltage imposed on the cathode. This is equivalent to saying that steadiness of current through the loudspeaker circuit is obtained, with an increase in power, until saturation, in known relationship to the increase of the imposed voltage. While the effectiveness of the low vacuum tube begins to diminish, in the upper range of ionization voltages, with high vacuum tubes, currents of much higher voltages may be used without loss of effectiveness.

The desired reduction of pressure in the tube involves the use of methods for producing a high vacuum and reducing to a minimum the effects of occluded gas. By evacuating the tube by pump or other suitable means, and at the same time freeing it of occluded gas by heating tube and electrodes, and also, as may be done, by passing a current through the filament, causing "bombardment" of the electrodes by electrons, a high vacuum tube is produced. By such procedure the disturbing influence of ionization may be removed, with consequent stability of discharge.

Important to Tube Manufacture

The result is of great importance, since by adaptation of the procedure to manufacturing methods tubes giving uniform stability of current may be commercially produced, suitable for use in the complex modern radio receiving sets employing multiple tubes, without necessity for the critical adjustments of the filament circuit necessary with low vacuum tubes.

It is the high vacuum tube of this type which respondent says embodies the Langmuir invention. As a product or structure it differs from the low vacuum tube, of which the Fleming valve and De Forest audion are well-known types, only in that the pressure has been reduced to such a point that there is no appreciable ionization, with the resulting constancy of current in the amplifier circuit.

In the light of the explanation given of the operation of the vacuum tube, we now examine the claims of the patent. The application, filed Oct. 16, 1913, was pending for 12 years before it was issued Oct. 20, 1925, a period which witnessed the most important beginnings and many of the chief developments of the radio art. The original application was for a process or method patent only. It contained five claims covering methods of obtaining a high vacuum in vacuum tubes and expelling occluded gas from them. These claims were all ultimately cancelled. Other process claims, substituted by amendment, of which four only survived in the patent as issued, were amplifications of the original method and process claims.

Langmuir's First Claim in 1913

Late in 1913 Langmuir first made claim to invention of the tube as a structure or device, in four claims, all of which were amended one or more times. All but the third, which was amended four times, were cancelled in 1925, the year the patent issued. There are 28 claims for the structure or device in the patent as issued. Of these one was filed by amendment in 1913, one in 1917, nine in 1919, three in 1921, and 14 in 1925. During the 12 years the patent was pending, there were 67 amendments of specifications, of which 45 were in 1925. Amended claims filed, and additions and cancellations of them made, number 100 in all, of which 42 were in 1925.

The process claims cover methods of creating the high vacuum tube in the manner already described, that is, freeing the tube of occluded gas by heating tubes and electrodes and by electronic bombardment, at the same time vacuating the tube of air or gas by approved methods, such as the use of the Gaede molecular pump or chemical means. The court below did not rest its holding of validity of the patent on these claims, and respondent does not seriously urge their validity here.

Langmuir Antedated

It suffices to say that an examination of the prior art discloses that long before the earliest date claimed for Langmuir, the necessity for removing occluded gas from tubes or other electrical discharge devices in order to procure a high vacuum, and the methods of doing it by heating and electronic bombardment, were known, as was the procedure for constructing the high vacuum tube by expelling occluded gas while evacuating the tube.

An article by Duncan, American Electrician, May, 1896; one by Doane, Electrical World and Engineer, of May 21, 1904; the Dwyer Patent, No. 496694, Jan. 4, 1898, for a process for producing high vacuum in incandenscent lamps or similar receptacles during their manufacture; the Soddy Patent, No. 859021, July 2, 1907, for the employment of certain reagents in the process of producing high vacuum; the Thather Patent, No. 1028636, June 4, 1912, application filed March 30, 1910, for method of exhausting vessels; and an article by Lilienfeld in 1910, to be mentioned later, disclosed before Langmuir the essentials for producing a high vacuum, described the present process claims. They were in use in laboratory practice by Millikan and others before 1911.

Anticipated by Fleming and De Forest

It was upon the claims for the high vacuum tube structure or device that the court below based its decision, and they are urged upon us here as the grounds for sustaining the patent. They put forward, in a great variety of forms, claims for an electrical discharge device consisting of a tube with cathode and anode within it, with relation of parts and degree of evacuation (vacuum) such that the device is capable of operation with higher than ionization voltages in a range below saturation, substantially unaffected by ionization. Claim 2, which respondent selects as typical, reads:

"2. A discharge tube having a cathode adapted to emit electrons and an anode adapted to receive said emitted electrons, the tube walls being fashioned or shaped to permit the direct passage of a useful proportion of said electrons from cathode to anode, the gas content or residue of said tube and the relation of the parts of the tube being such that the tube is capable of being so operated in a range below saturation and materially above ionization voltages that the space current is governed or limited by the electric field of said electrons substantially unaffected by positive ionization."

But this claim, as well as all others of the Langmuir patent, must be read in the light of the fact, fully accepted by the parties to this litigation, that electrical discharge devices, such as the Fleming valve and the De Forest audion, patents on the latter of which expired in 1925, which were well-known before Langmuir, comprise all the elements of the combination claimed except the presence within it of a high vacuum. It is conceded that if the requisite high vacuum be created in a De Forest audion, it becomes the high vacuum tube of the patent and is an infringing device if the patent is valid.

Degree of Vacuum Is Crucial Test

The degree of the vacuum within the tube is therefore the crucial feature of the invention claimed. Langmuir, in describing in his patent the method of producing the device, says: "The evacuation of the device should be preferably carried to a pressure as low as a few hundredths of a micron, or even lower, but no definite limits can be assigned." In at least 13 of the claims, the device claimed is one in which the gas within the tube, or the pressure, is sufficiently reduced, or the vacuum raised high enough (all of which are synonymous), to produce the desired result, that is, a discharge unaffected by ionization when the tube is operated by the appropriate space current, which may be of higher voltage than that for the low vacuum tube.

The characteristics of the discharge named by the inventor in the specifications "in order to distinguish electron discharge devices made in accordance with my invention from the prior art" are the following: (1) Gas ionization absent or negligible; (2) cathode not heated by the discharge; (3) no blue glow or visible evidence of discharge; (4) 3-2 power relation of current to voltage; (5) discharge independent of degree of vacuum within intended limit for particular tube; (6) regularity and reproducibility. But all these characteristics may be summed up in the simple statement that in the tube of the patent, there must be an absence of harmful ionization; and since, as already indicated, harmful ionization disappears when the requisite vacuum is attained, the device or structure of the patent is one in which such a vacuum has been produced.

High Vacuum an Improvement

That the high vacuum tube was an improvement over the low vacuum tube of great importance is not open to doubt. Even though the improvement was accomplished by so simple a change in structure as could be brought about by reducing the pressure in the well-known low vacuum tube by a few microns, still it may be invention. Whether it is or not depends upon a question of fact, whether the relationship of the degree of vacuum within the tube, to ionization, and hence to the stability and effectiveness of discharge passing from cathode to anode was known to the art when Langmuir began his experiments. If that relationship was then known, it required no inventive genius to avoid ionization and secure the desired result by creating the vacuum in a DeForest tube or other form of low vacuum discharge device.

That this relationship was known was the fact found by the district court and not challenged by the court of appeals. In 1910 Lilienfeld, in a paper published in Annalen der Physik, vol. 32, on "The Conduction of Electricity," made a complete and explicit disclosure of the essentials of all the structures and methods of the Langmuir patent. The paper described methods of obtaining the "extreme vacuum" desired by freeing electrical discharge devices of occluded gas in the manner already described and at the same time evacuating

(*Continued on next page*)

Fleming, DeForest and Others

Working Tube in Which All Elements

(*Continued from preceding page*)

the tube. He described the space-charge effect, not mentioned in Langmuir's original specification, but later recited in the claims of the patent, in the following language:

"One can formulate more generally the conditions for high voltage and large current density as follows: The production of a state in which the volume density of the electrons carrying the current is as large as possible compared with the density of gas molecules in which there exists therefore a tendency for the formation of the maximum possible space charge in the path of the current."

Raising Vacuum Raises Effectiveness

To one skilled in the art, this could only mean that increased effectiveness of an electrical discharge device, to which it suitable current is applied, could be obtained by raising the vacuum in the manner which the writer had described. He also stated that "from a definite maximum density of the gas downwards, the discharge phenomena are independent of the gas density in the region investigated," a statement equivalent to the fifth characteristic of the discharge in the Langmuir specification, namely, that it is independent of degree of vacuum within the intended limit for the particular tube.

Lilienfeld also deduced from meter readings and stated, the 3-2 power relation of current to voltage, as Langmuir later stated it in his patent. From this the conclusion is inescapable that Lilienfeld knew and stated, in terms which could be understood by those skilled in the art, that in a high vacuum the current produced is under control, stable, and reproducible; and, as he employed high voltages, that high power levels of the discharge may be obtained by the employment of a high voltage in a high vacuum tube. Space charge effect was also described by Lilienfeld in Physikalische Zeitschrift, in 1908, in which he pointed out that by raising the vacuum there is an increase in the number (volume density) of the negative electrons, and said: "The higher the vacuum, the greater the current density, the more pronounced this new kind of discharge becomes."

Device Itself Lacking in Patentability

The very fact that Lilienfeld knew and described the methods of the patent for obtaining high vacuum carries with it as a necessary corollary that the device itself, apart from its functioning and use, is lacking in patentable novelty. Hence, invention, if any there be, is embraced in the discovery of the principle that discharges above ionization voltages can be produced without substantial ionization if the vacuum be sufficiently high, and the disclosure that the device of the claims constitutes suitable means for putting the principle into practice. But Lilienfeld, in his paper of 1910, disclosed that he obtained discharges free from the effects of ionization, as Langmuir testified in interference proceedings in the Patent Office, and that he accomplished this through the attainment of high vacua by the very methods later described in the Langmuir patent.

Fleming, the inventor of the Fleming valve, in a paper read before the Royal Society on the conversion of electric oscillations into continuous current by means of a vacuum valve, Feb. 9, 1905, pointed out the possibility of creating "an ideal and perfect rectifier for electric oscillations" by enclosing within a tube a hot carbon filament and a cold metal anode "in a very perfect vacuum"; and he described a method of procuring the vacuum by exhausting the bulb while freeing it of occluded air.

High Vacuum Methods Described

In his patent, No. 803634, Nov. 7, 1905, he describes the method of securing a high vacuum within the bulb by freeing it of occluded gas by heating the bulb and filaments to incandescence and at the same time evacuating it. He defined a high vacuum as one reduced to "one hundred millionth of an atmosphere," which is less than 1-100 of a micron, the pressure in the tube of the patent; and in an article in "The Scientific American," supplement for Jan. 20, 1906, on "electric conductivity of a vacuum," he disclosed not only that electrons are emitted by hot cathodes in a high vacuum, but also "that a high vacuum may be a very good conductor, provided the negative electrode is rendered incandescent." Thus Fleming knew, and stated, the advantages of the high vacuum, its definition, and the method of procuring it. The state of the art and the progress of scientific knowledge in this field was accurately summed up in the statement of the law examiner in the Patent Office who passed on the Langmuir claims:

"It is apparent after a review of the record that there is no single element which is broadly novel in the assemblage of elements making up an electron discharge device of the character defined in the issue. An evacuated tube having therein an incandenscent electron emitting cathode and an anode was old prior to the filing of Langmuir's application, and methods of attaining high vacua, sufficient to give a relatively pure electron discharge in a properly designed tube, were also well-known and available to persons skilled in the art."

The narrow question is thus presented whether, with the knowledge disclosed in these publications, invention was involved in the production of the tube, that is to say, whether the production of the tube of the patent, with the aid of the available scientific knowledge that the effect of ionization could be removed by reducing the vacuum in an electric discharge device, involved the inventive faculty or was but the expected skill of the art.

The question is not, as respondent argues, whether Lilienfeld or others made a practical high vacuum tube, but whether they showed how it could be made and demonstrated and disclosed the relationship of the discharge to reduced pressure, and how to reduce it. See Corona Co. v. Dovan Corporation, 276 U. S. 358, 384. That the production of the high vacuum tube was no more than the application of the skill of the art to the problem in hand is apparent when it is realized that the invention involved only the application of this knowledge to the common forms of low vacuum discharge devices such as the Fleming and DeForest tubes.

Once known that gas ionization in the tube caused irregularity of current which did not occur in a high vacuum, it did not need the genius of the inventor to recognize and act upon the truth that a better tube for amplifying could be made by taking out the gas. Arnold, who was skilled in the art, and who had made studies of electrical discharges in high vacua, when shown a DeForest audion for the first time on Nov. 14, 1912, immediately recognized it and said that by increasing the vacuum the discharge would be sufficiently stable and have adequate power levels to enable the tube to be employed as a relay device in transcontinental telephony. The very fact that all of significance in the Langmuir improvement was obvious to one skilled in the art as soon as he saw the improved tube, as the direct court said, "lies athwart a finding of invention."

Avoidance of Objective Forced Claimed

Respondent recognizes the force of this objection to patentability, but seeks to avoid it by insisting that the invention claimed is not as we have described it, but that "Langmuir's invention consisted in taking out (of the tube) the gaseous conductor upon which the prior art relied, and putting nothing (a vacuum) in its place." It adopts also the statement in the opinion of the court below, upon which its decision turned, "A vacuum, or, indeed, change of vacuum, isolated and standing by itself, is not the Langmuir invention, but it is a working tube in which all the elements—cathode, plate, vacuum—so co-ordinate and interwork that the current flow is not affected by gas," a statement which, as we have already pointed out, takes no account of the scientific knowledge, available before Langmuir, that increase of vacuum in well-known devices was all that was necessary to produce the desired result.

Respondent elaborates by saying that "in the practical prior art devices (that is to say, low vacuum tubes) the conduction of current depended upon gas ionization; the art, moreover, believed that unless there was enough gas to act as a conductor no current could flow and the tube would not work."

It says that the high vacuum tube of the patent works on a different principle, that of the "pure electron discharge," and that it was the recognition of this scientific truth and the adaptation of the device to it in which the invention consists.

Definition Conflicts with Patent

But if Langmuir's invention is to to be defined, it is not the invention claimed by the patent. Respondent puts forth as sustaining this denfiition, statements in the specifications of the patent, to the effect that in the device of the patent, in which gas ionization is absent, the discharge is "distinct in its characteristics" from the described discharge taking place in an ionized gas and again that it is "characterized by regularity and reproductibility with given conditions."

But while these and many other statements in the patent indicate that high vacuum was an effective means of producing in the old tubes of the art the stable current which could not be produced in the presence of ionization they do not suggest any discovery of a scientific truth that essentially different principles control the discharge in low vacuum tubes from those which operate in high, other than that ionization, present when gas is present, has certain effects, notably on stability of current in a low vacuum, which is absent in the high, when ionization is absent, as Lilienfeld and others had disclosed.

If it were necessary to a decision we could not find that any such scientific truth is established by this record. Respondent, to support the contention, does not rely on evidence, but on a collection of more or less casual statements by various writers, made before 1915, to the effect that the gas or ionized gas of the low vacuum tube is a conductor. Before the development of the electron theory, "conductivity" of substances was a convenient expression for explaining the flow of electric currents.

Pure Electron Discharge True, But Not Proved

Fleming, in a statement in 1906, already quoted, referred to the high vacuum as a good "conductor" if a hot cathode was used. The present tendency is to ascribe the flow of current from a hot cathode through both high and low vacua to the flow or discharge of elec-

Fully Anticipated Dr. Langmuir

Co-ordinate Found Not an Invention

trons. Millikan, the eminent physicist, testified that this theory was generally accepted before 1912. Langmuir himself so explained the flow of current in a gaseous tube in his specifications. The known truth is that current flows through both low and high vacua and is unfavorably affected by ionization in the former; but that the flow is due to conductivity of the ionized gas in one and to something different, pure electron discharge in the other, is not established by the evidence before us. There is some testimony to the contrary. Nor is our attention directed to anything which suggests that Langmuir thought there was such a difference, or relied upon it to remove ionization effects, rather than upon the simple expedient of removing the gas known to be responsible for them.

Even if the asserted difference were established, it is no more than the scientific explanation of what Lilienfeld and others knew, before Langmuir, of the effect of the high vacuum on the discharge, and the methods and devices for procuring the vacuum. It is method and device which may be patented and not the scientific explanation of their operation. See LeRoy v. Tatham, 14 How. 156, 174-6.

Not a Practical Need Then

Only when invention is in doubt may advance made in the art be thrown in the scale to support it. If we were to assume that invention here was doubted, we can find little to suggest that the high vacuum tube when produced satisfied a long felt want or that its present utility is indicative of anything more than the natural development of an art which has passed from infancy to its present maturity since Langmuir filed his application. There was little or no practical use for a high vacuum tube in 1913. The DeForest audion was not in general use and Langmuir did not see one until that year.

The many amendments of Langmuir's application during its long pendency, disclosing his uncertainty as to what he had invented, and the exhibits in this case constitute a history of the development of the art, which indicate unmistakably that the resort to the high vacuum tube for discharges above ionization voltages was but the adaptation to the natural development of the art, by those skilled in it of the scientific knowledge which had been accumulated by investigation and experimentation. When the need became apparent, De Forest and Arnold, as well as Langmuir, found ready at hand the knowledge which would enable one skilled in the art to satisfy it.

Prior Use Finding Upheld

The court below, contenting itself with finding invention, said nothing of the finding of the prior use by the district court. We hold that this finding of the district court was supported by the evidence and should have been given effect. As we have concluded that the Langmuir patent did not involve invention, we refer only briefly to the facts which establish prior use. In 1911 and until September of 1912, De Forest was in the employ of the Federal Telegraph Co. of California, then engaged in the commercial transmission and reception of radio messages, in which audion detectors as well as audion amplifiers were used. In July, 1912, De Forest sought and obtained a high vacuum in the audions used as amplifiers, and observed that when the vacuum was too low the blue glow effect occurred at from 15 to 20 volts.

In order to secure higher voltages from the audions used as amplifiers and to procure the requisite high vacuum, he had some of the bulbs reexhausted while super-heated. During 1910 to 1912, the Telegraph Company used De Forest amplifying audions at 54 and 67½ volts, which was possible only because he had exhausted the tubes of gas, which would otherwise have ionized at from 20 to 30 volts. The vacuum was lower than that obtained by later and improved methods; but the effect of high vacuum upon voltages above the point of ionization was then known, and the knowledge was thus availed of in practice. Whether De Forest knew the scientific explanation of it is unimportant, since he did know and use the device and employ the methods which produced the desired results, and which are the device and methods of the patent.

Reversed.

Mr. Justice McReynolds concurs in the result.

New Organization Starts With a Bang!

Enrolments for membership in Radio World's new Short-Wave Club started with unexpected volume, the names of the first 54 being printed herewith. See next week's issue for further announcements. Use the coupon or separate sheet or card to enrol.

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One Tube and Two T

By Herma

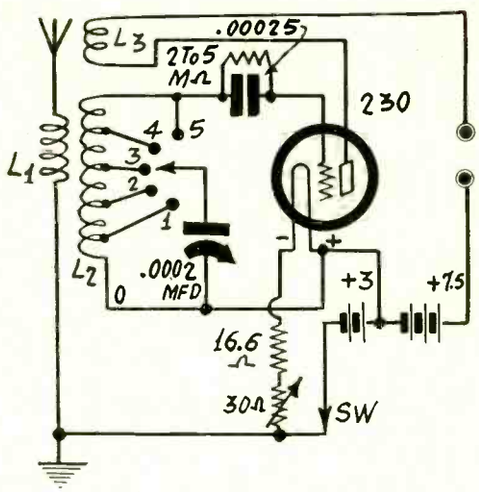

Fig. 1
A single circuit all-wave receiver, with built in battery voltage supply, which can be housed in a tiny mantel clock cabinet.

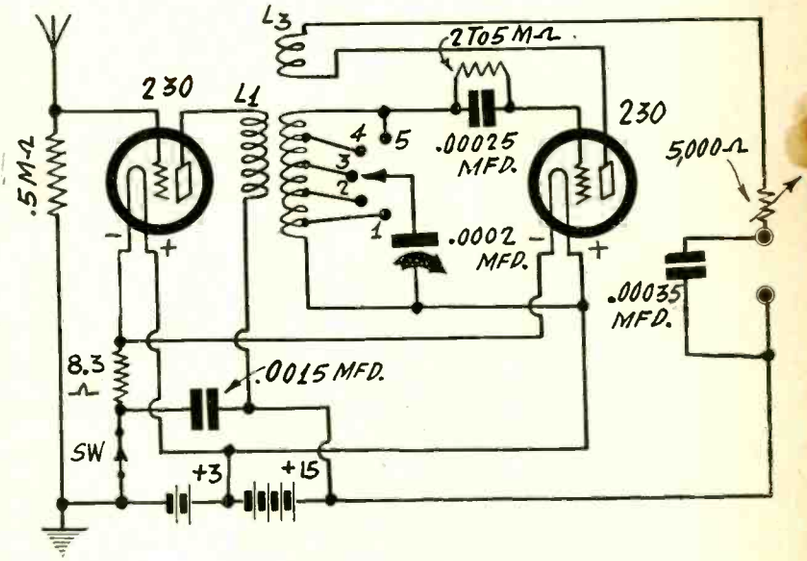

Fig. 2
A blocking tube is added to check radiation.

MINIATURE all-wave receivers are attracting considerable interest, and an investigation of their construction and operation shows that the fingers get a little tired working the parts into tight places, but that the performance is not impaired by the compactness.

A one-tube set is shown in a moulded gothic mantel type cabinet, only 7 inches high, and 5½ inches wide at the base, and into the resultant compactness goes everything necessary to provide reception, except earphones. The range is from 15 to 600 meters. Switching from one band to another is accomplished by moving a tipped lead from the stator of the tuning condenser to the desired jack on the back of the cabinet. As can be seen from Fig. 1, five jacks would be necessary. The tipped flexible lead might be a single speaker cord, which is usually made of the very pliable tinsel wire.

The circuit is regenerative. The rheostat controls the feedback. Due to small space, there is room for only 7.5 volts of B battery, and when you add the 2 volts dropped across the filament of the 230 tube, you have 9.5 volts of plate voltage applied. There is no question about detection. Good detection can be obtained with this tube although the plate voltage is low. In fact, experiments conducted by the author a few months ago showed that detection was adequate at an applied plate voltage of only 6 volts. However, feedback is not so certain. It is necessary to use a greater number of turns on the tickler than would be required were the plate voltage high. Thirty turns should be ample on a diameter of 1¾ inches.

The plate current drain is small indeed, around 2 milliamperes, but the filament drain is 60 milliamperes, therefore what you might humorously call a huskier battery is needed for A supply. The dry cells of about 1.5 inches diameter, used in larger flashlights, will serve nicely, especially as the cap at center of the top (positive) of one may be soldered to the metal base (negative) of the other. That constitutes series connection of two cells, each with a voltage of 1.5 volts, and affords the 3 volts.

Coil Data for Figs. 1 and 3

At 60 milliamperes (.06 ampere) the resistance necessary to drop 3 volts of the battery to the required 2 volts of the tube is 16.6 ohms. The voltage difference (1 volt) is divided by the current (.06 ampere) to obtain the resistance, by Ohm's law. Such a value of resistance is not commercially obtainable, so 15 ohms will serve the purpose, particularly since there is a rheostat of 30 ohms in series.

The coil data for Figs. 1 and 2, using 1.75 inch diameter, and a .0002 mfd. condenser, are: The primary is wound at one end and consists of 10 turns of any kind of wire. The secondary is begun ⅛ inch away, and consists of a total of 85 turns of No. 28 enamel wire, tapped at the 55th, 73d, 79th, and 83d turns. Expressing the same winding in terms of turns between taps, the data are: from (5) to (4), 55 turns; from (4) to (3), 18 turns; from (3) to (2), 6 turns; from (2) to (1), 4 turns, and from (1) to (0), 2 turns. The final twelve turns may be wound of large sized wire, taps (3) to (0), say, No. 18 enamel.

The tickler, spaced ⅛ inch from the secondary, at the opposite end than is that occupied by the primary, consists of 30 turns of No. 28 or finer wire.

The tickler connections should be reversed experimentally if no oscillation is obtainable.

Regeneration and Radiation

The circuit works well, but it has some objectionable features. One of them is filament control of regeneration, which does not permit of very fine adjustment, so that you may be too far below the point of oscillation at one setting, and in trying to remedy this may cause the circuit to break into violent oscillation. The resultant radiation will be annoying to others who are tuning in short waves.

The next step is toward the elimination of radiation, or at least its severe reduction. This may be accomplished by putting an untuned stage ahead of the detector, serving as a "blocking" stage with a plate voltage twice that used in the previous instance, while retaining the single tuned circuit. Feedback is provided by the smoother method of an adjustable resistor in the plate circuit. As this resistance is intended to act as a damper, is it not good policy to have any bypass condenser across it, so the earphone condenser is connected simply across the phones.

Since more room is necessary to build this set, and one is not confined to the close quarters of a tiny metal clock type cabinet, one not only uses two series-connected 7.5 volt C batteries to furnish 15 volts of B battery, but also introduces an inductance switch, so that the wave band may be changed from the front panel.

May Use Two 4 Ohm Units

Since two 230 tubes are required for the circuit in Fig. 2, and as the A battery voltage is the same as heretofore, the filament resistor should be 8.3 ohms. This is not a commercial value, either. However, 8 ohms will suffice, particularly as with use the A battery voltage goes down, not up. Two 4 ohm units, such as would be used to reduce 6 volts of battery voltage to 5 volts of filament voltage for a 201A tube, may be connected in series to constitute the 8 ohms.

More room also permits the inclusion of bypass condensers, one of which has been mentioned, the other being the .0015 mfd. capacity from A minus to B plus.

The applied plate voltage here is 15 plus 2, or 17 volts, which is an excellent voltage for detection by the leak-condenser method, indeed, is near the optimum voltage.

For amplification 17 volts is small, but in the present circuit we do not depend on the first tube to provide much amplification.

ube All-Wave Circuits

n Bernard

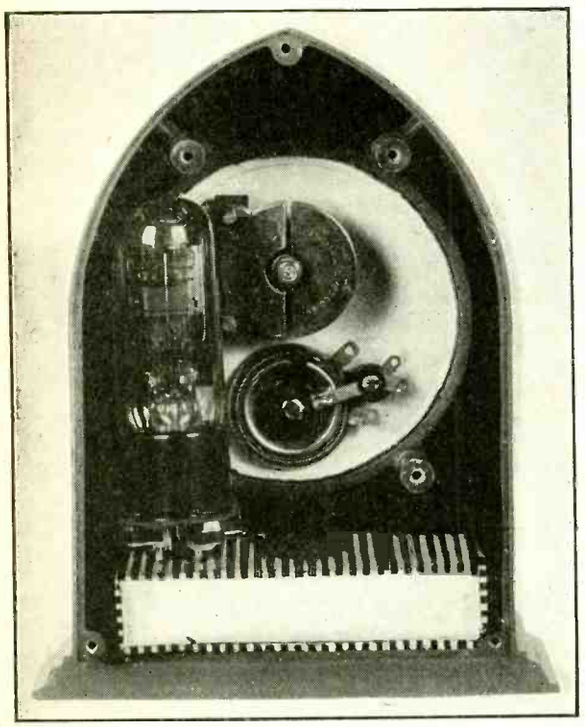

Fig. 3
Rear view of the cabinet used for the Fig. 1 circuit, with position of some of the parts illustrated.

What we are utilizing is the tube's property of carrying current one-way, so that the signal will come from the aerial, flow through the first tube and into the detector tube, without the oscillation of the detector tube flowing back through the first tube to the aerial.

At high amplification in the first tube it would be necessary to introduce neutralization to prevent the first tube itself from oscillating, or from coupling the detector's own oscillation to the aerial, but the low plate voltage for amplification renders neutralization unnecessary.

The coil data for Fig. 2 are exactly the same as for Fig. 1, the only difference being in the connection of the primary, which is here in the radio frequency amplifier's plate circuit, instead of in the aerial circuit.

The antenna load on Fig. 2 is a resistor, marked .5 meg. (equal to 500,000 ohms), but almost any value may be used here, from .02 meg. (20,000 ohms) up.

Two Tuned Circuits

With the addition of a tuned circuit, and an increase in the B voltage to 22.5 volts, we come to the popular circuit embodied by one stage of tuned radio frequency amplification and a regenerative detector with tuned input, Fig. 4.

The tuning condensers have been increased to .00035 mfd. maximum capacity, so that the entire broadcast wave band can be covered without switching, and the number of switch points is reduced to four, consisting of the three taps and the grid end of the secondary coil.

Of course, a compound switch is needed, one that with a single operation contacts the two stators to the switch points of the respective inductances. This is known as a three-point double throw switch, but if there are more points on the switch than are needed, this makes no difference, as you use only what you need. However, see that you utilize pairs of lugs on the switch, not diverse connecting points.

Coils for Fig. 4

The applied plate voltage is 24.5, there is a 1 mfd. bypass condenser across the series-connected batteries, regeneration is controlled by a rheostat in series with the feedback coil (although a potentiometer may be used by ignoring one of the

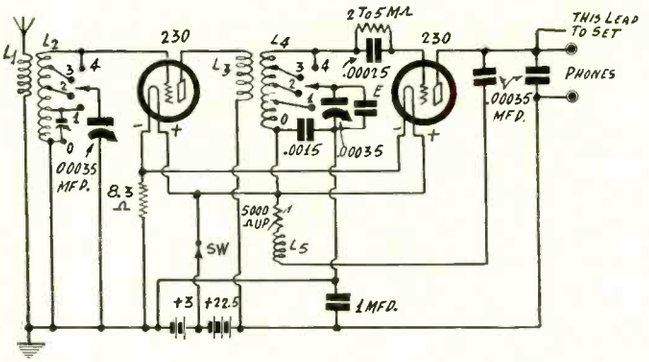

Fig. 4
The popular TRF stage and regenerative detector for compact assembly.

extreme terminals), and a larger assembly is required. A high resistance rheostat in this postion provides smooth control.

Since the condenser is of higher capacity, the total inductance of the secondary must be smaller than in the previous instance. Using a 1.75 inch diameter tubing, L1 would consist of 10 turns, L2 of 70 turns, tapped at the 47th, 63rd and 68th turns, i.e., the number of turns between taps is (4) to (4), 47 turns; (3) to (2), 16 turns; (2) to (1), 4 turns and (1) to (0), 3 turns. The interstage coil, L3 L4 L5, has the same primary and secondary, while the tickler has 20 turns. Reverse the tickler if no regeneration is is obtainable.

If it is desired to use any of these models in conjunction with a broadcast receiver, the detector tube of the broadcast set should be removed from its socket, and only one output terminal of the present device put to use. That is the plate lead, to which a wire is connected, the other bared end of the wire being inserted into the plate prong of the detector socket of the set. That detector tube is not used.

The B voltage for the present little set's detector would be obtained automatically from the set, provided the B minus or grounded lead of the little receiver is connected to the B minus, usually the ground lead, of the big receiver. Then reproduction will be enjoyed on the loudspeaker of the big set.

A manual trimming condenser is shown across the lower part of the secondary of the first coil. This may be any small variable condenser of 35 mmfd. or less, and to be sure that the capacity in the detector circuit will be lifted high enough to permit of effectiveness of the trimming condenser in the other stage (which can only add capacity to that stage), an equalizer E is connected from stator of the detector tuning condenser to ground, so that the effect of the trimming condenser in the first stage will be more pronounced at the higher frequencies.

It will be observed that the detector condenser's rotor goes to grounded B minus, but that the coil is returned to positive filament. This would leave the resistance of the battery and of the filament and the filament resistor in the tuned circuit, were it not for the bypass condenser of .0015 mfd. that completes the tuned circuit.

[Other Illustration on Front Cover]

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.*

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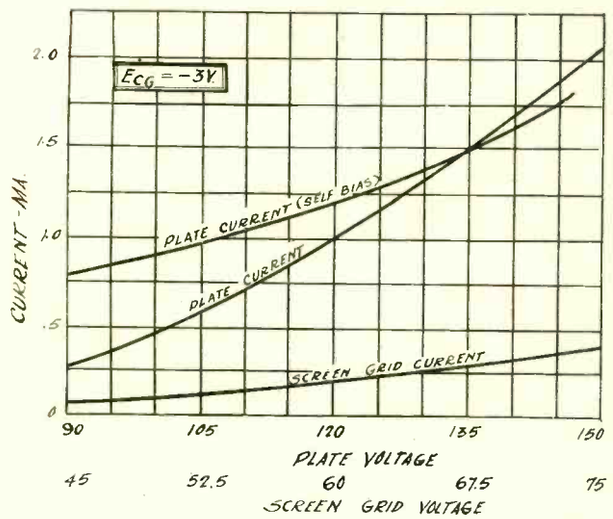


FIG. 926

These curves show the effect of a grid bias resistor on the amplification by the tube. The decreased slope of the self-bias curve shows the decrease in the amplification.

Effect of Bias Resistance on Amplification

IF you have any curves showing the effect of the grid bias resistor on the amplification when this is not by-passed will you kindly publish them? I am anxious to know whether the loss in the amplification is enough to make a by-pass condenser worth while.—F.X.O.

In Fig. 926 are two curves showing the effect of the bias resistor on the plate current. The bias resistor has been adjusted so that the plate current is 1.5 milliamperes when the plate voltage is 135 volts, the grid bias at that adjustment being 3 volts negative. One curve is taken with a constant bias of 3 volts while the other is taken with a constant grid bias resistor. It will be noticed that below the intersection of the two curves, that is, for lower plate voltages, the plate current is greater for self-bias than for constant bias, and for plate voltages higher than the intersection, the plate current is greater for steady bias. The lower slope of the self-bias curve indicates that the amplification is less with self-bias than with a constant bias and that the difference is enough to justify the use of a large by-pass condenser.

* * *

Size of Television Image

I HAVE noticed television receiving sets with observation glasses about ten inches in diameter. Is the television set developed to a picture this size?

No, but the effect is that of a picture two or more inches square. The larger size glass permits it to be seen from different angles, as well as providing for future developments which will provide a bigger scene.

* * *

Location of Transmitter

WOULD results be better for a short-wave transmitting set if it were located in a "shack" on top of an apartment building, or in a shack in an open field, on the ground?

By all means, in the open field, because of the absence of metallic objects to cause losses.

* * *

Fluctuating Volume

MY SET operates quite well, except that the volume will jump suddenly from moderate to very strong and then suddenly drop off again. There is a click each time this happens. I cannot locate any loose connections and thought you might be able to tell me where to look for the trouble.

There are dozens of possible places for such a defect. The aerial itself might have a bad connection, or might be touching something, such as a grounded wire. A tube might have a loose element or contact in it—try a new tube in every socket as a test, one at a time. The volume control is a likely place for trouble and you might be able to determine this by jarring it when the set volume drops low. The trouble may be located even in your neighbor's set if your antennas are close.

Advertising and Television

WHAT do you think of radio broadcasting, television and phonograph records as to their future in advertising? I have always felt a strong interest in advertising.

There is probably a large future ahead for all three. Of course, the regular broadcast program is already well developed for advertising purposes and finances most of our broadcasting today. The television field is just beginning, but there seems to be every reason why it should eventually develop into wide usage. As for recorded advertising programs, this idea is already in fairly extensive use and will probably spread still farther.

* * *

To Build or Buy

AS short-wave apparatus is rather tricky, would you advise one to purchase a ready-made short-wave set or to build one from parts?—G. D. F.

That depends somewhat on your experience in radio construction. Naturally, you are more certain of good results if you buy a good set, but equally good results can be obtained if a "kit" of parts and complete assembly directions are obtained. The usual trouble one runs into lies in an effort to employ different materials and different assembly from that advised in the instructions. Considerable radio knowledge is needed to construct a short-wave set in such a way.

* * *

Two Sets on One Antenna

IS IT possible to operate two receiving sets from the same antenna in the same house? We have in mind using one in an invalid's room.—F. C. E.

Yes, it can be done, but there will be some interaction, especially when both attempt to listen to the same station. The better plan is to put up a separate aerial, preferably as far away from the main aerial and as nearly right angles to it as possible.

* * *

Tapping in Headphones

PLEASE advise how to attach headphones to a radio set so the speaker will work, too.

Radio stores usually supply a special connector for the purpose. Headphones can be attached to the speaker, with a suitable variable resistance (about 100,000 ohms) in series with one of the leads.

* * *

Output Tubes Compared

PLEASE compare the use of two 245 tubes in push-pull with one 250 tube as the power amplifier.—B. F.

The 250 tube, provided it receives somewhat stronger input voltage to the grid, will give much greater volume, at good quality, than the 245 system. However, the 245 provides ample good quality and volume for even a large room, and is much less costly, requiring only about half the plate voltage.

* * *

Reducing Speaker Hum

HOW can I reduce the hum in a dynamic speaker? I know the speaker is at fault, because a 6-volt speaker does not hum at all.—F. W. C.

The current for the energizing coil is not sufficiently rectified. An A condenser may be attached in some cases, depending on the type of speaker, or extra condensers of the proper voltage characteristics may be added to the power supply and filter system of the speaker.

* * *

Close Approximation in Formula

IN your article on testing radio receivers you give a formula for computing the voltage induced in a loop antenna in terms of the dimensions of the loop, the turns on the two coils and other factors. This formula does not agree with formulas given elsewhere, especially that given in the year book of the Institute of Radio Engineers. The formula given there, as well as in other places, contains a sine term involving the frequency and the distance across the loop. If your formula is correct it must be an approximation, and if so, just how close is the approximation?—B.W.R.

The formula is approximate and is based on the fact that for small angles the sine is equal to the angle. Suppose the distance across the loop (s in the formula) is one meter and the frequency in question is 1,500 kc. At this frequency the approximation is poorest. The angle in this case is .015708 radians. The sine of the angle is about 40 parts in a million less than this. That is, only the last place in the number given is affected and that by less than one. Even if the frequency had been 6,000 kc the error would have been negligible within the accuracy required. As long as the ratio of the wavelength to the length of the loop is 45 or larger the approximate formula is all right.

AC Measurements

I WISH to make some AC measurements but my equipment is very limited. I have a thermocouple milliammeter going up to 115 milliamperes and I also have a vacuum tube voltmeter with which I can measure peak values. Can I use the milliammeter for measuring the voltage induced in the secondary of a transformer with the meter in the primary? If so, how can it be done?—W.H.J.

If the mutual inductance between the primary and the secondary is M henries, the current measured in the primary is I amperes (AC only), and the 2 pi frequency is w, then the voltage induced in the secondary is MwI volts. Suppose the peak of this voltage is measured for one value of I, say Io, and it turns out to be Eo, effective value, then M = Eo/Iow. Substitute this for M in MwI and cancel out w. Then we have E = EoI/Io. That is, as long as the frequency is constant the voltage induced in the secondary is proportional to the current in the primary and the proportionality factor is obtained by only one measurement of the secondary voltage. Eo is the peak value multiplied by .707. We might find that the peak voltage when the current is .115 ampere is 40 volts. Then the proportionality factor is 0.707×40/.115, or 248 and the equation for any voltage in terms of the current is E = 2481, I being measured in amperes and E in volts, both effective values. If the current is measured in milliamperes, the formula is E = .2481, E being given in volts. If the current should happen to be 10 milliamperes, the voltage induced would be 2.48 volts. If the frequency is known one measurement of the voltage and the corresponding current gives a means of measuring the mutual inductance between the coils.

* * *

Effect of Antenna on Tuning

WHY is it that when the antenna is coupled closely to a tuned circuit the selectivity is very poor and a different capacity is required to tune the circuit to a given frequency?—H.L.W.

The why of it cannot be answered, but the how can be. The antenna consists of a circuit comprising inductance, capacity and resistance. Therefore it has a natural frequency of its own. When the secondary is tuned to a frequency close to the natural frequency of the antenna a high resistance is introduced into the tuned circuit. The antenna capacity or inductance may also be added, in part, to the capacity or inductance of the tuned circuit. The manner in which this happens can best be set down in mathematical terms. In order to make the secondary circuit selective it is necessary to arrange the antenna so that its natural frequency is widely different from the resonant frequency of the tuner. The antenna may be either capacitive or inductive but it must not be resonant to the frequency of the secondary circuit. In case it is, it is necessary to make the coupling very loose. The standard antenna has a capacity of 200 mmfd., and inductance of 20 microhenries, and a resistance of 25 ohms. These do not differ much from the constants of an average real antenna. The natural frequency of the standard antenna is about 2,500 kc. Since this is higher than the broadcast band, there is always a possibility of having the antenna resonate with some frequency when the set is an all-wave receiver covering frequencies from the broadcast band up, and there is also the possibility that the set will not be selective in some region of the tuning range.

* * *

Push-Pull From Antenna to Speaker

WOULD it be practical and advantageous to build a radio receiver which was push-pull throughout, from the antenna to the loudspeaker? What would the advantages, if any, be of having push-pull in the radio frequency amplifier, the oscillator and the intermediate frequency amplifier?—F.W.T.

It could be done all right, so that makes it practicable if not practical. The advantage would be in the elimination of harmonics in every stage but since there are tuners to eliminate harmonics at radio and intermediate frequencies no great gain results. Push-pull in the oscillator might be advantageous in that even harmonics would not be generated and would therefore not be a source of interference. It is really difficult to see any real advantage in using push-pull ahead of the second detector, or only detector in case of a tuned radio frequency circuit. Push-pull in the detector would be highly desirable if it could be worked out. But a strictly linear detector would be just as good, and that is something that can be approximated closely. Push-pull in the audio is very desirable and is so recognized everywhere. This could be extended to the loudspeaker. There is one possible advantage in push-pull throughout and that is the minimization of hum, including modulation hum. But this can also be eliminated by other means.

* * *

Cause of Squawking Sound

I HAVE a regenerative receiver in which the feedback is controlled by means of a variable condenser in series with the tickler coil. The trouble is that regeneration is extremely critical and when increased there is a raucous sound which is most disagreeable and which spoils reception entirely. What is the cause of this noise? I thought it might be due to too high value of grid leak resistance but I have tried many different values without any improvement. If you can suggest a remedy I shall appreciate it.—G.B.M.

Perhaps all you need is to lower the voltage on the detector tube. Before you do this, however, set the tuner at 550 kc and the tickler control condenser at maximum. Then reduced the turns on the tickler until the circuit just oscillates a little. Make sure that it oscillates at all settings of the tuner with this tickler. If the raucous sound does not stop, reduce the plate voltage also. The circuit should work all right with a voltage from 22.5 to 45 volts on the plate. If it is higher there may be trouble in controlling the oscillation.

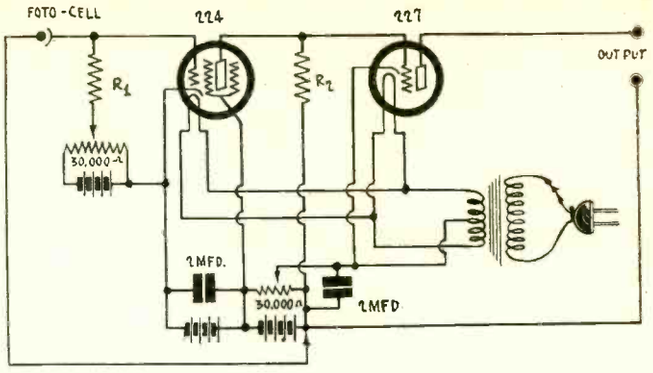


FIG. 927

A resistance coupled amplifier of the non-reactive type arranged for use with a photo-electric cell. Batteries should be used for the plate voltage to avoid reactance.

* * *

Photo Cell Amplifier

WILL you kindly publish an amplifier for use with a photo electric cell? It is essential that the amplification be as free from frequency distortion as possible.—A.B.N.

In Fig. 927 is a direct coupled amplifier especially arranged for use with a photo electric cell. The load on the cell is a very high resistance R1 and the positive voltage for the cell is obtained from the B battery. A grid battery, shunted by a 30,000 ohm potentiometer, is used to adjust the grid bias on the tube to the correct value. Direct resistance coupling is used between the two tubes in the circuit and the proper bias for the second tube is obtained by adjusting a second 30,000 ohm potentiometer.

* * *

Cosmic Rays

IN your June 6th issue you had a speech by Prof. R. A. Millikan in which there is reference to cosmic rays. As far as I know you have never explained what these rays are. Will you kindly explain what they are? Where do they come from or how they are created?—W.H.L.

Cosmic rays are radiations that come from every direction in space. Nobody knows how they originate or where they actually come from. It is known that they have tremendous penetrating power. By a study of their penetrating power through various substances, such as air and water, scientists have concluded that they are waves of extremely short wavelengths, vastly shorter than the wavelengths of the shortest and most penetrating X rays. They study them by their effect on special photographic films. Because these rays have been studied extensively by Dr. Millikan they are also called Millikan rays, although Dr. Millikan did not discover them first. Dr. Millikan believes that they are the result of creation of matter out in so-called free space. He believes that matter lost from stellar bodies by radiation is recreated in space, forming hydrogen, and that the rays are released in the process. He has much experimental evidence for the correctness of this belief.

* * *

Resonance Wave Coil Reception

SOME TIME ago you described a resonance wave coil for use in a receiver by means of which the selectivity could be increased greatly. Would it be possible to use such a coil for tuning in short-wave stations? If so, how should the tuner be arranged?—S.G.

A resonance wave coil of proper design can be used at any frequency. The resonance wave coil is a long solenoid having a length many times greater than its diameter, say 25 times, wound uniformly with wire. The antenna is connected to one terminal and the ground is connected to a metal plate running parallel with the coil and close to it. The grid of a tube is connected to the other. A high resistance leak should be connected between the grid and ground to provide a leakage path across the coil and plate. Tuning is done by moving the plate farther away or closer to the coil. The tuning is rather critical so that it is necessary to have a very good mechanism for moving the plate. Of course, the plate may be fixed and the coil moved in respect to it also. A coil of this type was tried as the RF tuner in a short-wave converter, but it was found that when the wave coil was in resonance the oscillator would not function.

NEW ANTENNA HELD BOON TO SMALL STATION

Washington.

A ray of hope is held out to the stations assigned to the higher frequencies, the so-called "graveyard" in the broadcast band, in an application by KSTP, St. Paul, Minn., to the Federal Radio Commission for authority to reconstruct its antenna and use 25,000 watts on its assigned frequency of 1,460 kc. The station is licensed at 16,000 watts, but uses 10,000 watts.

The station asserts that there has been hardly any actual experimental work in the use of high power on the higher frequencies, and therefore asks permission to attempt to solve the problem in a manner calculated to increase the service area and strengthen the signal in the existing area, yet without increasing the interference with other stations on equal, adjoining or otherwise closely related frequencies.

Developed by Wilmotte

A new antenna system, developed by Raymond M. Wilmotte, has been acquired by a subsidiary company, and the station desires to try out this device. Wilmotte was for several years in charge of antenna research for the British Broadcasting Company, which controls all stations and programs in England.

The skip distance effects, found on short waves, are said to be present on the higher broadcast waves, and the station hopes to overcome this effect, in part at least.

The application sets forth the following:

"One of applicant's associated companies has secured the services of Raymond M. Wilmotte, who, as engineer in charge of development and research on antennas for the British Post Office Department, spent many years studying antenna design, effects and so on.

Wants to Do Some Exploring

"Mr. Wilmotte has developed a new antenna design which it is believed will suppress sky wave effect to even a greater degree than a half wave vertical antenna. Applicant desires to install such an antenna and operate with various powers up to 25 kw. to determine the effects of such an antenna system.

"Unless the station can be operated with power up to 25 kw., we will not be able to reach many of our listeners in the Northwest who are dependent on us for service. We would, however, get a stronger signal in the territory embracing what is commonly known as the good service area of stations with the use of the new antenna system.

"No one has ever ascertained by actual experimental operation the effect of using 25 kw. power on frequencies of the order occupied by KSTP, and applicant desires to carry out these experiments.

"Applicant believes the new antenna system with 25 kw. power will improve its service and that it will not create any greater interference than now exists because of the effect the new antenna design will have in sky wave transmission.

Cites Aircraft Experience

"It is also the purpose in conducting these tests to demonstrate the theory that the low angle radiations are not the ones which cause interference at a distance. It is expected as a result of these experiments that not only will the signals be increased in intensity at nearby points from the station, but that also at distant points in the order of 300 miles and over there will be a material reduction in interference.

"One basis for this claim is that aircraft flying over the sea at distances of 300 to 400 miles at various heights, are able to receive signals from radio stations, the angles of radiation of which must be low, thus indicating that low angle radiation tends to follow the curvature of the earth. If the tangential ray did not follow the curvature of the earth, it would have been impossible for those aircraft to receive the signals without going to heights in excess of 40,000 feet.

"Another experiment which supports this theory is one conducted on ultra short waves in the order of 60,000 kilocycles directed in a beam. This beam strikes the curvature of the earth at about 15 miles and for several miles further on, this short wave beam hugs the contour of the earth and is then reflected to the sky, never to return. Inasmuch as the tendency to hug the earth increases with the decrease in frequency, it is reasonable to expect a similar condition, but to a greater extent, in the broadcast band."

New Sending Circuit Approved

Washington.

A new order has been promulgated by the Federal Radio Commission which permits the use of a simpler and less expensive transmitter design. The new regulation (General Order 115) amends order No. 91.

Andrew D. Ring, broadcast engineer of the Commission, said that since 1925, when the crystal control was adopted, there have been gradual improvements in transmitters, especially in accomplishing 100 per cent modulation but that this was not brought about by "any marked revolution in transmitter design." The new type of transmitter allowed under the order, he said, does not have any special improvements over the former types "but it permits of much simpler circuit design and is less expensive."

DILL PRAISES U. S. PROGRAMS

In a talk from London, picked up by short wave by the Columbia Broadcasting System, and sent out on broadcast waves on its chain, Senator C. C. Dill, of the State of Washington, who is studying radio conditions in Europe, vindicated the American system of sponsored programs, as against the European method of taxing sets. He said that under our system programs are better, more diversified and have greater human interest, while the programs in most of the European countries are "stiff and formal." There broadcasting is a government monopoly, like the postal service.

"The programs in the United States," he said, "are far superior, being tinted with humor and human interest, having greater diversification and appeal, while those in most of the European countries are stiff and formal."

The Government monopoly system of radio is a case of "chain programs with a vengeance," he added, and observed that there is a waste of radio facilities abroad, despite the congestion of the air and the many countries that share the same waves.

Senator Dill drew up the radio law that obtains in the United States and is prominent in radio legislation.

NEW EXECUTIVE AT CECO

CeCo Manufacturing Company has hired Thomas E. Conway as assistant to the president, in charge of the production and engineering departments. The company is a tube manufacturer at Providence, R. I.

RETICENCE OF BEST LISTENER ROILS BELLOWS

By HENRY H. BELLOWS

Vice-President, Columbia Broadcasting System; official of National Association of Broadcasters; former Federal Radio Commissioner.

Even with the immense gains made by radio advertising in 1930, very few broadcasting stations have sold more than forty per cent of their total operating time. The chains are sending out about two hours of unsponsored programs for every commercial hour. Even if the proportions were reversed, we should still have less advertising time in relation to the unsponsored periods than we have advertising space as compared to editorial matter in the newspapers.

However, even if the broadcasters could sell every minute, they would never dare do so, for the excellent reason that their listeners would not tolerate it. No first-class broadcasting station can possibly afford to alienate any considerable class of potential listeners.

Complains of Lack of Response

Even if four listeners out of every five wanted entertainment all the time, which they don't, no reputable station could possibly afford to ignore the desires of the remaining one-fifth. The college professor may not have much influence in determining the character of a program advertising tooth-paste, but if he takes the trouble—which he rarely does—to tell his nearest radio station what kind of a non-commercial program he wants, he is pretty sure to get it.

The most discouraging feature of the broadcasting business is the lack of response to programs of the best type. Do you think that one per cent of the people who value such programs take the trouble to say so?

Most stations have more unsold time on their hands than they know what to do with. They offer to turn it over without charge, to educational institutions, in the generally vain hope that they will make sensible use of it.

Field Open to Education

I have no hesitancy in saying that the state universities could have, without cost to them, five times as many hours on commercial broadcasting stations as they are now using, and win the undying gratitude of the broadcasters to boot, if only they were equipped to put on reasonably interesting programs. As for the public schools, most broadcasting stations periodically beg the school authorities to make use of their facilities—in vain. Even our regional governing bodies, garrulous as they normally are, turn suddenly shy when it comes to making use of free radio time; the task of utilizing as much as fifteen minutes a week taxes their facilities to the utmost.

MIDGETS SWING UPWARD

The compact or midget set has become an important factor in radio sales. In 1930 it was estimated that 1,130,400 midget sets were sold, making up about 45 per cent of the volume that year. These small sets, selling at prices substantially lower than the highboy or console models, are expected to make up 75 per cent of the 1931 volume.

WEAF AND WJZ AMONG 6 CITED IN TRUST CASE

Washington,

The serious aspect of the outcome of litigation wherein the Radio Corporation of America was adjudged guilty of infraction of the Clayton anti-trust law was brought home when the Federal Radio Commission designated six of the seven large stations of the National Broadcasting Company for a hearing on their license renewal applications.

WEAF and WJZ Included

Two of the stations are the biggest pair of the system, WEAF and WJZ, New York City. The four others are WRC, Washington, D. C.; WTAM, Cleveland; WENR, Chicago, and KOA, Denver. The National Broadcasting Company has seven broadcasting stations, the seventh being KGO, Oakland, Calif., but the renewal application of this station had not been received up to the time the hearing was set for the others.

The adjudication of monopolistic activity took place in a suit brought by the DeForest Radio Company and other independent tube manufacturers, seeking an injunction against the inclusion of "clause 9" in RCA licenses to set manufacturers. RCA required that all receivers made by these set licensees be initially equipped only with RCA tubes. The injunction was granted against RCA, and the case carried to the United States Supreme Court, which did not disturb the finding of the lower court that the clause was a violation of section 3 of the Clayton Act.

Hearings Set for June 15th

Under the Radio Law the Federal Radio Commission is directed to refuse the renewal of a license to any company that violates the anti-trust law by monopoly in restraint of trade. The hearings are to be held June 15th on the basis of this provision of the Radio Law.

The National Broadcasting Company is a subsidiary of the RCA, as are the Radiomarine Corporation of America, the RCA-Victor Company and RCA Communications, Inc. The Radio Law affects subsidiaries as well as the parent company. All told, the RCA and its subsidiaries hold 1,409 licenses for radio service, all of which are in jeopardy.

New Selection

At first the Commission had decided to hold hearings on the applications of minor stations, but later decided that the six large broadcasting companies should be cited instead.

The objectionable clause was eradicated from contracts with licensees before the injunction was granted, and the practice was wholly abandoned as an unwise policy. However, RCA maintains that the Radio Law does not apply to the circumstances in this case, because there was no adjudication of guilt in a criminal proceeding under the Anti-Trust law, but only a finding in a civil suit for money damages.

Infringement to Be Charged

The actual trial of the damage suits is pending. RCA will contend not only was there no damage, but that the so-called independents seeking to recover damages were actually violating the tube patents of RCA and associates, and a counterclaim is not unlikely. Since the suit was begun the independents have become tube manufacturing licensees of RCA and associates, excepting the DeForest Company, which says it needs no license.

New Element Cited for Tube Filament

Washington.

A newly discovered element, hafnium, offers possibilities for use as the filament or cathode of a radio tube, according to the Bureau of Mines, Department of Commerce. There is very little of this element in the United States now, although some of its compounds can be bought for $25 a gram. It is believed the scarcity is due to lack of present use for the element.

Hafnium, which is element 72, is named for Hafniae, the Latin name for Copenhagen, Denmark, where Coster and Hevesy discovered the element.

A statement issued by the Bureau set forth:

"Hafnium, one of the most abundant of the newly discovered elements, has not yet found a definite place for itself in industry. A commercial future for hafnium, however, is already glimpsed in the radio industry, and its high melting point and electronic emissivity have already led to the taking out of patents for its use in radio tubes and incandescent electric lamp filaments and for the cathode surfaces of such devices as X-ray tubes and rectifiers."

At present tungsten and barium oxide are the principal materials used in filaments and cathodes of radio tubes.

JEANS DETAILS UNIVERSE VIEW

The electron theory has revolutionized physics, and the mechanistic concept of the universe is in at least temporary abeyance, Sir James Jeans, noted British scientist, said in a broadcast speech, just before he sailed for home. He had received the Franklin medal a few days before, from the Franklin Institute, in Philadelphia. His talk was given at a dinner in his honor in New York.

"To-day," said he, "if any one asks a question about the universe it can not be answered except by a mathematician, and when the answer is given no one can understand it except a mathematician."

Time and space are now regarded as finite entities, so that if one goes on in time and space, one is bound to return to the starting point, he said. As recently as twenty-five years ago, when he was teaching in the United States, he found the mechanistic theory prevailed, when the physicist built mechanical models to illustrate the universe around him. To-day, he said, this can't be done, even though the materialists insist that, since space is expanding, it can be expanding into nothing but more space.

A physicist can't even discuss the subject with one who thinks in terms of mechanical models, he pointed out, because the mechanistic adherent doesn't understand the subject. Physics to-day, he said, is a subject for the specialist, and cannot be brought home to the average man.

Association Asks Leave to Intervene

Washington.

The Radio Protective Association, through Oswald F. Schuette, executive secretary, asked permission of the Federal Radio Commission to intervene in the hearings, so that "certain important matters may be called to the attention" of the Commission. The association is constantly opposing the so-called radio trust.

CHAINS EXTEND STATION TESTS OF TELEVISION

The two large chains, The National Broadcasting Company and the Columbia Broadcasting System, are competitively busy with television experimental plans.

Columbia has just started television tests on W2XAB, on the 2750-2850 kc channel, and soon will be sending 6-hour daily television, with occasional sound-sight synchronization between W2XAB and WABC, the System's key station. The television studios are at 485 Madison Avenue, New York City.

Uses 60-Hole Disc

The 60-hole disc is used at 1200 r.p.m. While the television sending is principally for the experimental benefit to be derived by the System's engineers, comments on reception, with suggestions, are invited from lookers.

The National Broadcasting Company ultimately will inherit the transmission of television images, with sound accompaniment, from its parent company, the Radio Corporation of America, which is conducting experiments on a large basis at the RCA-Victor plant, Camden, N. J.

Plans Four New Transmitters

Plans have been made by RCA for the establishment of a television sending station atop the new RCA Building in New York City and atop a still higher building, for service to the metropolitan area, with another such sender in Chicago and one on the Pacific Coast. Height of the antenna is regarded as of great advantage in television sending.

These experimental stations are regarded by both companies as necessary before television can be developed to the service stage on a practical commercial basis. The stations are looked on as an extension of the laboratory work and not as a present attempt to institute television for general public use.

Questionnaire Brings Strange Definitions

"Are you well read?" asked Lowell Thomas, in a recent Literary Digest program broadcast over a National Broadcasting Company network. He listed certain names and terms which had appeared more or less often in the nation's press during recent months and which should be familiar to the well-read person. A teacher in Mississippi State Teachers' College used the list as a test for one of his current topics classes. Nearly all answered correctly, but here are some of the incorrect answers:

Mozart—"An ancient musician who died in poverty."

Communist Octopus—"Octobus, man against or who is not in favor of capital punishment."

Gandhi—"Mail leader in Indian Revolution."

Mayor Cermak—"Peace leader in England."

Earl Carroll—"King of Hungary."

Archeologist—"One who studies punishment of criminals."

Archeologist—"Arkiologus, one who is studying the principles of sea-drome."

Tammany—"Refers to those against prohibition in New York."

Autogiro—"A ghost."

A THOUGHT FOR THE WEEK

AMOS 'N' ANDY receive some thousands of dollars a week for their activities on the stage, in pictures, and over the air. Here's a little idea that would help listeners-in to continue their interest in the team of comedians: let Amos 'n' Andy spend a few hundred dollars a week and get some professional comedy writers to furnish some interesting continuity which will hold their public. An actor generally is as good as his material.

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.

Millikan's Talk

WE salute Dr. Robert A. Millikan, noted scientist. He was selected as the first to speak in a series of talks by famous persons under the auspices of the National Advisory Council on Radio in Education, and his discussion of "Radio's Past and Future" was carried by the Columbia Broadcasting System to what was estimated as an audience of 100,000,000 persons. Having been personally in contact with the growth of radio, he was able to talk on the subject with a glowing intimacy, and proved an interesting talker, as would be expected of a Nobel Prize winner.

His talk, moreover, was important in that it stimulated thought. He pictured broadcasting as something that tends to make a true social democracy of our republic, with a speaker's voice possibly audible to our entire 120,000,000 inhabitants, likening this to the situation of "the free citizens of Athens when they gathered around the Acropolis to listen to Pericles." Then a few hundred heard Pericles. Now many million hear Millikan. Of this Millikan cannot complain. Pericles might.

There were some statements in Dr. Millikan's speech that may be challenged. The vast radio audience, he said, "must create a new type of speaking and writing." He added: "For the speaker, however technical his field, must now divest himself of all his specialized lingo and present in simple terms, understandable to all, the essential elements of his subject."

Dr. Millikan's own talk was mostly historical, and history is essentially simple. Were he to tell about his isolation of the electron or of his measurement of the cosmic ray—the Millikan ray—he might not have had such an easy task in bringing his ideas home to his assorted listeners, particularly since the Office of Education of the Department of the Interior recommends that speeches for broadcasting be gaited to the mental age of 13.

Scientific knowledge is highly specialized, and for precision of expression and accuracy of statement it uses its special terminology. Scientists record that knowledge for scientists. The so-called methods of simplification nearly always introduce inaccuracy. They state the fact without revealing the truth.

An example may be taken from Millikan's own radio talk. Discussing transmission and reception, in an exposition of ether waves, he said "the sound waves which your speech produces are transformed by the microphone into which you speak, into exactly similar electrical current variations in the circuit of which the microphone is a part, are then amplified a million or more times without distortion by the telephone-tube-repeater on their way to the wireless antennas, where these giant electrical variations impress in some way their identical wave forms upon the ether, which, in turn, in some way transmits this wave form with the speed of light through space, to be picked up by another electrical circuit containing a microphone and retransformed by it by its well-known mechanism into sound waves exactly like those your voice emitted at the transmitting end."

Thus did Millikan purposely omit, for simplification, the explanation of the radio frequency wave's generation in the oscillator at the transmitter, and the effect of the amplified audio frequency pulsations of the microphone circuit upon the carrier wave. Without an exposition of the carrier, the false thought is left that the microphone circuit's amplified output is radiated at audio frequencies from the antenna.

Everyone understands that there is a microphone in the studio, an instrument into which one talks, but the statement that at the receiving end there is "another electrical circuit containing a microphone" must be confusing to many, who are sure that in their sets is no such instrument as is found in the studio. Millikan was referring to the loudspeaker, which transforms into sound waves the audio frequency current variations in the speaker circuit.

It is not true, of course, that leaders in thought must be denied access to the studio microphone simply because it is necessary to reduce their talks to a lower level to make them mean much to the listener. It is only true that the speaker on a highly specialized subject must compromise as best he can between accuracy and simplicity, and he, above all, must realize that so soon as he goes over the heads of most of his listeners he is wasting time. The bigger the words he uses, the nearer he comes to talking to himself, an unwelcome disclosure he has money in the bank.

Millikan himself departed a little from his own advice about "simple terms" for broadcast talks. What about *plethora*, right at the beginning of his remarks? What about *inertialess electron streams in exhausted tubes?* What about *hibernianism* and, above all, *adumbrated?* Half of his listeners do not know what *plethora* means, while *inertialess* is supposed by popular error to mean motionless, and *exhausted* to mean only played out. Listeners must have thought he was talking of motionless electron streams in worn-out tubes and perhaps thought he was joining in the commercial reminder to replace all tubes in the set at least once a year. As for *hibernianism* and *adumbrated*, we refer you respectfully to the National Advisory Council on Radio in Education, 60 East Forty-second street, New York City.

Despite a few departures from his own advice, Dr. Millikan certainly did present an interesting paper, and inaugurated a series that is bound to prove of vast interest to listeners, since it will include talks by Dr. Nicholas Murray Butler, Charles Evans Hughes, Walter Lippman and John Dewey, with Dwight W. Morrow, Julius Rosenwald, Silas Strawn, Gerard Swope and Newton D. Baker possibly to follow.

The Radio Census

South Dakota

The Director of the Census announced the results of a preliminary count of the number of families in the State of South Dakota 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 161,332, as compared with 142,793 in 1920. The number of persons per family in 1930 was 4.3 as compared with 4.5 in 1920. The number of families reporting radio sets in 1930 was 71,361, or 44.2 per cent of the total.

They Say

PRESIDENT HOOVER: "It is distinctly a public service that the leaders in thought in our country have banded themselves together to give to the radio audience an opportunity of knowing from those who can speak with authority the progress that we are making in the fundamentals of civilization."

* * *

CHARLES McK. SALTZMAN, chairman, Federal Radio Commission: "The broadcasting station must have some means of support, for the operation and maintenance of such a station is an expensive matter. England, for example, has solved this problem by taxing radio receiving sets. No advertising is heard in British broadcasting. The average citizen of our country has a feeling today that the tax concession has already been oversubscribed and I doubt if our people want a broadcasting tax. In the early days of broadcasting in the United States, several unsuccessful plans were tried to raise the necessary funds for the support of stations. The result was the development of the 'sponsored' program, which is a genteel, lady-like term for radio advertising. It is estimated that there are 15,000,000 radio receivers used in the United States. Which method of supporting radio broadcasting would these 15,000,000 owners prefer? A tax or a 'sponsored' program? There is little doubt that the sponsored program would win."

* * *

RAY LYMAN WILBUR, Secretary of the Interior: "To be frank, we must admit that no one knows just what the radio will do in education. A special committee has made a study in this field, with very promising results. The unique quality of the radio is that it can reach every ear in the United States, regardless of college degrees, color of skin, profession or economic status. Probably because it can originate from different sources and can reach everyone, it will not lead to standardized thinking. People react so differently to the same thing. Its limitations must also be considered. There is no likelihood of replacing adequately the personal relationship of teacher and student. The pupil can ask questions and receive answers back. In general, I think as a people we are better readers than we are listeners. Most of us can fasten things in better through the eye than through the ear."

* * *

E. F. MORFORD, radio sales manager, Stewart-Warner: "Interest in low-wave broadcasts has grown by leaps and bounds, but it is news to many set owners that it is now possible to pick up a foreign program any hour of the day or night. Broadcasting stations on low wavelengths are now operating in seventeen different foreign countries. With the new broadcast sets incorporating this new low-wave converter, set owners not only enjoy the outstanding reception of programs on the usual wavelengths, but their enjoyment is extended to include the broadcasts of foreign countries, such as England, Italy, Japan, Hawaii, Holland, France, Switzerland, Russia, Cuba and South America. The adventure of dialing for police signals and tuning in amateur broadcasts is no longer confined to owners of sets specially designed for low-wave reception. The new model of the low-wave converter, offered as a separate, individual unit, to be used with practically any AC set, permits the listener to indulge in this rare sport and is bound to inject new interest into radio entertainment."

REITH PREDICTS WE'LL TURN TO ENGLISH PLAN

Sir John C. W. Reith, director general of the British Broadcasting Corporation, which by government charter has a monopoly of British broadcasting, visited the United States to study American radio systems.

He was quite certain in his talks with officials, including Federal Radio Commissioners, that the British system of having no advertising on the air, but taxing sets instead, was not only preferable, but would be adopted finally in the United States, with the end of the sponsored program.

"America should give the English system a trial," he recommended.

Can't Become Reconciled

He contrasted the 600-odd stations in the United States with the 22 transmitters in England, and said that he can not become reconciled to the American system. He admired the British programs, and analyzed the offerings as follows:

"Many talks and plays are put on the English air, but on an average about 75 per cent of the time is devoted to music. Most of the talks have a high educational value yet they are not what one could call specifically educational.

"For instance, every night there is what we call a series talk, of twenty minutes length.

Each One on Own Footing

"It is invariably highly educational in character, and is of a type which does not require knowledge of what the talk was yesterday or what the topic will be tomorrow. We present our most popular program between 9 and 10 o'clock at night. It is then that we have the largest number of people listening in."

Frost and Minton Form Set Company

A compact radio receiving set that can be kept among the books in any bookcase, is manufactured by the Frost-Minton Corporation, of 12 East 41st street, New York City.

The receiver is manufactured in two models, the FM-4, a four tube set for alternating current, and the FM-5, a five tube set for alternating or direct current.

This one dial receiver uses a new circuit arrangement, the result of two years' laboratory and field work by John Preston Minton, B.S. Ph.D. Fellow I.R.E.

The entire assembly, including the reproducer, is housed in an artistic metal cabinet, 13¾ inches long, 8 inches high and 6¾ inches deep.

Herbert H. Frost, formerly head of the H. H. Frost Company, later vice-president of the Cunningham Company and the Kolster Radio Corp., is president and treasurer of the manufacturing concern, and Dr. John P. Minton, the inventor, is vice-president and chief engineer.

DAMROSCH 50 YEARS IN MUSIC

Walter Damrosch, National Broadcasting Company musical counsel, entered his fifty-first year in music recently.

He admitted, when first congratulated, that the anniversary date had altogether slipped his mind. It was recalled by friends who unearthed an ancient program.

He has been with N. B. C. five years.

Canada Ducks Ether Ruling

Ottawa, Canada.

The existence of property right in the ether, and the question of what, if anything, is the ether, are vexing the Supreme Court of Canada, too. In a radio case counsel for Quebec questioned the existence of the ether as the medium through which radio waves travel. The court refused to answer whether the ether exists.

"We will be very careful to limit our answers to matters of present-day knowledge," stated Chief Justice Anglin.

"It will be difficult," commented Justice Smith, "to prove that the ether and the waves in it are property."

Studio Personalities

One rainy afternoon recently Lucille Wall left the NBC studios after a rehearsal and discovered when she reached the street that she had forgotten her rubber overshoes, according to a story Nellie Revell told recently during a broadcast of her "Voice of Radio Digest" program. When she returned to the studio she discovered that it was filled with musicians, but believing that another rehearsal was in progress, she approached the leader and said: "I'm sorry to interrupt you, but I've come back for my rubbers." A nearby microphone picked up her apology and it was broadcast over a nationwide network.

* * *

A novel reason for buying time on the air brought a telephone call to NBC's San Francisco studios.

"My daughter is being married, and we want music for the ceremony," a feminine voice said. "I have engaged a violinist and a 'cellist, but I find I cannot get a piano into my house, and I should like to buy half an hour's time on the air, and have a pianist in your studio play the wedding music. The violin and 'cello could follow the piano as the music came through our radio set."

Network programs, she was regretfully informed, would interfere with her plan.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers concerning standard parts and accessories, new products and new circuits should send a request for publication of their name and address. Send request to Literature Editor, RADIO WORLD, 145 West 45th Street, New York, N. Y.

H. J. Richardson, Box 487, Clear Lake, Iowa.
Glenn D. Montgomery, 1234 Stout, Denver, Colo.
W. J. Laws, 114 N. Randolph St., Pleasant Hill, Mo.
Geo. J. Lexa, 556 11th Ave., Wauwatossa, Wis.
Robert L. Aucoin, R. F. D. Box 51, Morgan City, La.
W. Patterson, 341 14th St., Portland, Ore.
Joseph Peters, 17134 San Juan Dr., Detroit, Mich.
R. W. Emerson, 6920 Carnegie Ave., Cleveland, Ohio.
Chas. S. Waldie, 107 Shonnard Place, Yonkers, N. Y.
A. Fraser, Jr., Cert. Radiotrician, 21 Hillside Ave., Kearney, N. J.
H. F. Weston, 1739 No. San Fernando Rd., Glendale, Calif.
Howard B. Newcomb, Newcomb Radio Service, 821 East 10th St., Ada, Okla.
Charley R. Estes, 111 South Jackson St., Brunswick, Mo.
Joseph B. Boland, 5447 Alabama Ave., St. Louis, Mo.
Clyde P. DeLancey, DeLancey's Hotel, Hampton Beach, N. H.
Alfred M. Stump, Jr., 301 North Jefferson St., New Castle, Pa.
Alvan Frost, 501 Wabash Ave., Kansas City, Mo.
Vincent D. Ryan, 16 Hamilton Ave., So. Norwalk, Conn.
Hugo W. Ideler, 3153 Ogden Ave., Hawthorne sta., Chicago, Ill.

DECAY OF FOOD IS CHECKED BY AN OSCILLATOR

Washington.

Another use of the vacuum tube has been found in checking the decay of food. A method has been devised in Holland for utilizing short waves for this purpose, and the Department of Agriculture of the United States is making similar experiments with oscillators. Dr. Karl F. Kellerman, of the department, furnished the following information:

The United States Department of Agriculture has been experimenting along similar lines, but as yet no practical methods to accomplish this purpose have been found in the Department's experiments.

The unofficial reports received by the Department relative to the discovery which has been made in Holland state:

"The apparatus used generates ultra-short waves in the area of 25 centimeters to one meter, and these waves form an electromagnetic field after about 10 days within a radius of approximately 20 meters from the machine in which no organic product is allowed to decompose. Everything in the field of the machine, which is an electromagnetic field—a globe of about 30,000 cubic meters—is penetrated, including stone walls, lead, iron, wood and glass indoors and outdoors in any atmosphere or temperature.

Uses Small Amount of Current

"The machine, which occupies only a few cubic meters, uses up only as much electricity as an ordinary 200-candlepower electric bulb, and the results are claimed to be much better than those of a modern cold storage warehouse."

The Department of Agriculture did carry on some experiments with the same purpose in view in the magnetic field, but it was found impossible to discover any influence either in the fungi or higher plants, and no further experiments were attempted in that field.

The Department is experimenting, however, in short wave lengths, especially extremely short ones, such as X-rays and ultra-violet rays, and it is recognized that these rays have more or less effect upon different kinds of life. The waves used by the Department in its experiments, however, are very much shorter than those used in the reported Holland invention.

Short Waves Kill Bacteria

For a considerable period it has been recognized that short wavelengths do have the power of killing bacteria, but such a process has not been commercially established up to the present time.

Some of the difficulties which the Department has not been able to overcome in its experiments, in order to prove such a process commercially practicable, are: (1) it has not been possible to get thorough control by the use of short waves; (2) the cost of the equipment is too high and the equipment must be too delicately adjusted.

Most of the experimental work of the Department has looked toward prevention of losses by spoilage or decay by modern methods of crop disease control and through other methods, especially by field practices to improve the quality of the product at the time of shipment, and by improvements in handling and cold storage facilities.

3 INDUSTRIES UNITE IN PLEA FOR BIG POWER

The Radio Manufacturers Association, comprising virtually all prominent radio makers; the National Electric Light Association, consisting of the electric light and power interests, and the National Electrical Manufacturers Association have formed a joint coordination committee with the object of furnishing electrical facilities of each type to the public in the most efficient manner.

Recommend High Power

Improvement of radio reception, nationally and locally, by eliminating or reducing various noises and other interference in radio reception and broadcasting, is a major effort of the joint industry committee. Coordination of radio with other electrical utilities, with study of many engineering problems involved, to promote harmony in various uses of electricity, is the objective of the committee. This includes design of machines and power systems as well as radio apparatus and the use of electricity for light, heat, power and transportation.

The first recommendation of the joint committee, which has been transmitted to the Federal Radio Commission at Washington, is a resolution urging high power in broadcasting. It is pointed out that high power smothers and greatly reduces radio noises and vastly improves radio reception of the public.

Separate Indorsements

The resolution of the joint committee was indorsed separately by the three organizations.

Representing the Radio Manufacturers Association on the joint industry committee are H. B. Richmond of Cambridge, Mass., former president of the RMA and now director of its Engineering Division; Tobe Deutschmann, of Canton, Mass., chairman of the RMA Interference Committee; Ralph H. Langley, of New York, chairman of the RMA Standards Sub-Committee on Receiving Sets; E. M. Hartley, of Camden, N. J.; R. F. Herr, of Philadelphia; W. K. Fleming, of Canton, Mass., and Bond Geddes, of New York, Executive Vice President of the RMA.

Machine Design Studied

At present the joint coordination committee is gathering statistical data on the present situation of the various uses of electricity. It has begun many important engineering studies and is developing instruments and methods of measurement.

Consideration is being given to factors in design of machines in power systems which may affect radio reception and to the characteristics of radio receiver design, as well as shielding and sensitivity.

Calls for 54,756 Stations

The call letters in use by broadcasting stations have three or four letters. New licenses are issued for four-letter calls only. There is hardly any difference in the time taken to pronounce one type or the other.

In each of the three-letter call groups allocated, there are 67 combinations and in each of the four-letter groups there are 26 times that number (17,576) making a total of 54,756 combinations available for assignment to United States stations.

Aerial for Planes Is Improved

Washington.

A new antenna for airplanes has been developed by the Bureau of Standards. The vertical pole antenna previously used, while free from course errors, was subject to mechanical vibration and ice formation. The new antenna is of the symmetrical longitudinal T type. The supports are 10 to 18 inches, instead of 5 to 6 feet previously used.

Equivalent effective height is obtained through the use of the flat-top elements. To prevent directional effects, which introduce course errors, the two flat-top elements are symmetrical with respect to the vertical lead-in, so that voltages in the horizontal portions cancel. The T antenna then behaves electrically exactly as the vertical pole antenna.

To obtain the results outlined, it is essential that the longitudinal T antenna be located in a position such that the electrical effect of the airplane frame acting as the counterpoise is symmetrical. This is not always possible in the case of open cockpit airplanes, but is usually possible in cabin airplanes.

The symmetrical longitudinal T antenna described is free from course errors in radio range-beacon reception. It is superior to the vertical pole antenna in respect to the problems of ice formation and mechanical vibration.

FIRST AID SHIP SERVICE GROWS

American merchant ships in the Atlantic and the Pacific, or in any waters within reach of the transmitters of the Public Health Service, receive advice in cases of sickness or accident, if there is no physician aboard. So far 1,100 patients have received treatment in this manner aboard ships that have no doctors.

The Marine Hospital, at Port Townsend, Wash, recently was added to the service, thus increasing the range, particularly for ships plying the Pacific Coast and Pacific Ocean generally.

Many of the small and larger freighters do not carry doctors, and this type of ship frequently calls for medical advice by radio. It is believed some lives have been saved as a result of this service, and that many patients suffering from injuries, or sick, have had their recovery expedited by the radioed advice.

NEW REALLOCATION PLAN

Washington.

A new plan for the reallocation of broadcasting stations has been proposed to the Federal Radio Commission by Commissioner Sykes. The details were not revealed, but it was reported that he favors twenty clear channels for stations on 10,000 to 50,000 watts and twenty channels for stations from 5,000 to 10,000 watts, with smaller geographical separation between stations that use high power. Consideration of the plan has been deferred by the Commission.

PHILIPPINE RADIO CONTROL

The Department of Commerce and Communications of the Philippines advocates the retention of Government control over Philippine radio service for resultant efficiency and increased Government revenue.

PUBLIC ADVISED TO TUNE OUT IF ADS NAUSEATE

By CHARLES McK. SALTZMAN
Chairman, Federal Radio Commission

There are many cases of stations operating mainly for the profits to be gained that are permitting excessive and nauseating advertisements. These stations are hastening the day when grave consideration must be given to the question as to whether they are operating in the public interest, convenience and necessity.

Why doesn't the Federal Radio Commission do something about it? Although Congress did prohibit the Radio Commission from censoring programs, there is another censor that can do much to regulate objectionable advertising and other obnoxious features of radio programs.

Public Can Be Censor

That censor is the listening public, for whom Congress wrote the Radio Act of 1927.

The average broadcaster today is much in the position of a storekeeper. The storekeeper keeps on his shelves the goods that the people want to buy. In general, the broadcaster puts on the air the kind of program his listeners wish to hear.

If you are tired of the advertising of beauty parlors or filling stations, or the merits and price of the last consignment of prunes, you can censor that program by turning the dial to another station.

Magical Effect

The broadcaster, in general, wants to know what his listeners want to hear. Let him know. Of course, he must accept advertising; otherwise his station will die, but the value of his advertising and the rates he is able to prescribe depend on the number of hearers he reaches. If excessive and objectionable advertising causes a large number of his hearers to tune in another station, the effect will be magical on the broadcast owner.

May Plug Set Blindly Into AC or DC Line

A new radio receiver will soon be introduced to the public. This receiver for the present is built in a portable form and can be plugged in any house current. It is not necessary for the user to know if the current supply is direct or alternating, as the power unit is designed to operate on both currents. This power unit was built under Alexis Poncel and Paul Desfesse patents Nos. 1,801,022 and 1,807,343. The cost of operation for this radio receiver, comprising seven tubes, is only a fraction of a cent per hour.

Formerly the power unit of this receiver was designed to operate in conjunction with the 15 volt tubes, but the pentode tubes of the automotive series are now used to a better advantage, on account of the series connections of the heaters and of the lower voltage requirement of the plates. The primary of the specially designed plate current supply transformer is in series with the filament circuit, further reducing the consumption of the house current. The transformer is also tunable to respond to any frequency of the power line.

'ONE SIDEBAND' TEST SUCCEEDS ON 16 METERS

Washington.

Commercial short-wave transmission and reception by use of a single side band is under experiment by several large American companies, said V. F. Graves, acting chief engineer of the Federal Radio Commission.

The system is reported to have been successfully demonstrated in Europe recently, between Paris and Madrid. The object is to double the use to which channels may be put.

Single side band radio telephony employs only part of the ordinary radio wave for perfect reception, but the receiver must be kept effectively tuned with the transmitting station. A distinctive feature of the Paris-Madrid demonstration was the use of a "plot wave" transmitted solely to keep the distant receiver in phase with the transmitting station.

Pilot Wave Used

Use of extremely high frequencies naturally makes precise tuning a difficult matter, but with the "pilot wave" the task was said to have been accomplished.

Single side band systems in the short waves are not new. The "pilot wave" method, however, is said to reduce interruption due to fading and atmospherics or interference from other stations, and requires only one-sixth of the normal power of the transmitting station.

Advantage Stated

The advantage of single side band communication in long-wave radio and in wire communications have been demonstrated and are in practical use, but have not been commercially applied in the short waves, or in broadcasting. It is not expected that it can be applied to broadcasting at this time because of the technical complications that enter into the receiving apparatus, and because at the present state of the art side bands are considered essential.

The report from Europe states that the single side band system is practical commercially, and probably will be introduced on several international radiotelephone circuits assigned to permit immediate application.

* * *

16 Meter Wave Used

Paris.

The single side band demonstration was made on the 16 meter band (around 18 megacycles). The transmitter kept the receiver in tune by means of an additional pilot wave. The transmitting power was about one-sixth of that used for the same receiver output on double side band transmission. Speech was unusually clear. A. H. Reeves, a London engineer, had much to do with the demonstration.

BETTER FREQUENCY ADHERENCE

The continuous check-up of station frequencies by the Radio Division, Department of Commerce, shows that more stations are adhering closer to their assigned frequencies, including stations that do not deviate more than 50 cycles. At present a 500-cycle deviation is allowed, but it is intended to promulgate a rule, effective a year later, making 50 cycles the maximum deviation to stop heterodyne interference.

Music with Errors Called Difficult

HARRY SALTER

People want to listen to melody and like to remember pleasing airs, said Harry Salter, a microphone maestro for seven years. The only exception he can think of it "Rhapsody in Blue," which he says is both popular and intricate.

He gave this inside story of playing music with purposeful mistakes in the rendition:

"In my Real Folks band there are just enough mistakes in each passage to make them noticeable to those who have no musical education, and to prevent their offending the musician's keener sensibilities. I believe this kind of work for the musician, giving an air of naturalness to an orchestra that is just irritatingly off key, is harder than offering an intricate piece that is played correctly."

Salter also conducts the Weber and Fields Orchestra, the Central Savings Serenaders and the Golden Blossom Orchestra, a dance band.

CHRISTIANSEN HEADS PARLEY

Copenhagen, Denmark

Two radio congresses with 209 delegates from different countries attending opened recently in Christianborg Castle, where J. F. N. Friis-Skotte, Minister of Public Works, received the delegates. The congresses meet to discuss technical and scientific questions preparatory to the International Radio Convention to be held in Madrid in 1932.

General Ferrie, the French delegate, expressed thanks to Denmark after which the delegates were entertained with a film showing the great development of radio since Dr. Valdemar Poulsen and Professor P. O. Petersen in 1905 operated a successful radio telephone.

In the evening the delegates were entertained at a banquet given by the Minister of Public Works. At the first plenary session Kay Christiansen, Danish engineering chief, was elected president of the congress.

STOCKHOLDERS SUE SPRECKLES OVER LOSSES

Suit has been filed in the Supreme Court in New Jersey against Rudolph Spreckles, of San Francisco, by Kritzer Barnes in behalf of himself and other stockholders of Kolster Radio Corporation for an accounting of losses to stockholders in connection with the failure of the radio company. Others named as defendants in the suit are Frederick Dietrick, Ellery W. Stone, George F. Breen and Henry C. Lang.

The plaintiff asserts that the alleged attempt to corner the Kolster stock was illegal and damages are asked because Spreckles, Stone and Dietrick failed to dispose of 174,171 shares of the common stock of the company. The plaintiff furthere asserts that in the sale of stock on the market Spreckles made $12,000,000, Dietrick $5,000,000, and Stone $600,000.

Spreckles and his associates in the Kolster company were absolved of legal blame for the stock sales in a report of John A. Bernhard, special master in chancery in Newark.

During the hearing before the special master Spreckles testified that he had underwritten 54,246 shares of Kolster preferred stock after New York bankers had declined to do so, that he had lent the company $500,000, and indorsed $1,350,000 of its notes. He denied that there had been any "rigging" of the market.

The Kolster company went into the hands of a receiver, the assets were sold under court order, and a new company is about to undertake manufacture.

Television Forum Is Demonstrated

Schenectady, N. Y.

The practicability of conducting an open forum, with the questioners gathered in one room and the "oracles" at any other point that television permits whereby those answering would be both seen and heard by the audience, was demonstrated here at a Rotary Club gathering.

The meeting was held in a large hall, while under the same roof, in another room, a laboratory was set up by the General Electric Company, so that full-length images of the "oracles" were cast upon a screen in the hall. The sight transmission was over a telephone line, but it was explained that the transmission could be just as readily accomplished by radio.

Microphones scattered throughout the hall permitted the "oracles" in the other room to hear the questions, while the reverse sending, and television, permitted the questioners to hear the answers and see the answerers. As the demonstration was made just to acquaint the business man with the possibilities of sound-sight transmission and reception, the conversation resolved itself into airy persiflage, and no momentous questions were asked, expected or answered.

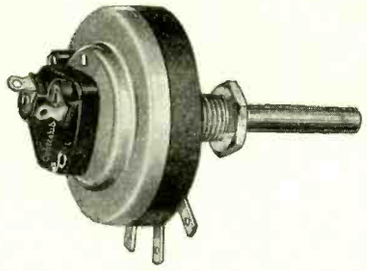
SOUND PICTURE CASE

Washington.

The litigation over an alleged infringement of the Ries sound picture patent has reached the Supreme Court. The case was brought by the General Talking Pictures Corporation and De Forest Phonofilms, Inc., against the Stanley Company.

The Trade Announces—

Central Radio Corporation



Volume Control with Special Type of AC Switch Attached

The exhibit of Central Radio Laboratories, Milwaukee, Wisconsin, is at Booth 36. This company retains its character as a specialist in resistances. It has expanded its line to include fixed resistors of a distinctive composition type.

The finished fixed resistor looks like stone before it is color-coded to identify various resistance values. It is manufactured by forcing the resistance material under tons of pressure through double dies in conjunction with a paste-like ceramic. The resistors come out like spaghetti, with the resistance material entirely surrounded by the ceramic. These are then baked in huge ovens and fired at 2,500 degrees F. This makes the entire mixture hard as stone and as permanent.

An addition to the volume control line is the new 110-volt switch manufactured by Centralab especially for its volume control. The complete assembly of volume control and switch requires very little more space for mounting than the volume control alone.

Acme Parvolt Condensers

The Parvolt line of condensers has been manufactured for several years by the Acme Wire Company, of New Haven, Conn., who for more than twenty-five years have been manufacturers of electrical products.

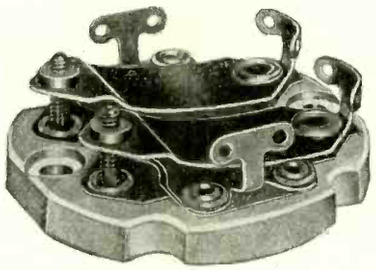
Parvolt condensers conform to R. M. A. and N. E. M. A. standards.

Scientific instruments are used to test the special papers and foils used in the construction of Acme Parvolts.

Ozarka Settles Suit, Gets Kellogg License

Ozarka, Inc., has settled by accepting a consent decree in the suits for patent infringement filed by Radio Corporation of America and others in the United States District Court at Chicago. RCA has consented to the transfer to Ozarka, Inc., of the license issued to the Kellogg Switchboard and Supply Company.

Hammarlund's New Intermediate Condenser



A small size, double intermediate tuning condenser for use in intermediate transformer units in midget Superheterodynes, has just been developed by the Hammarlund Manufacturing Company, 424 West 33rd Street, New York City. It measures only 1-15/16" in diameter and is available in capacity ranges of from 10 mmf. to 70 mmf.; 70 mmf. to 140 mmf., and 140 mmf. to 220 mmf. It is known as the MICD type.

The same unique constructional features embodied in the larger types are incorporated in this model. Treated isolantite bases, insuring moisture-proof characteristics, are used. Sclerescope tested phosphor bronze, selected mica films, solder dipped terminals, fibre "shock pad" and cut thread screws are among the features of this new condenser. There is ample space for coil mounting with excellent provision for capacity adjustment.

Da-Lite-R Owners Report DX Reception

The Moore Radio Company, of 72 Cortlandt street, New York City, has received many letters from the owners of the Moore Da-Lite-R tuner. Recently one from Mr. A. G. Peach of Canada, stated that when directly comparing his Da-Lite-R tuner with his short wave set, both tuned to the same station, 1 RO Rome (441.1 and 25.4 meters), he found the broadcast wave decidedly outperformed the other for clear reception and loudspeaker work. He went on to say that nightly for one week he tuned in Rome, Algiers, London, Cuba, Mexico and California, and that stations around New York, Philadelphia and Chicago come in like locals any hour they are on the air.

Then just to show that such reception is not confined to Canada, a letter came from Paris, France, in which the Da-Lite-R owner advises he listens to WGY, WLW and WJZ, weather permitting, at 4:30 a.m. French time. Still another, located on Long Island, N. Y., heard KNX and CMK dance music as early as 9 p.m., and is convinced he tuned in one of the Argentine stations.

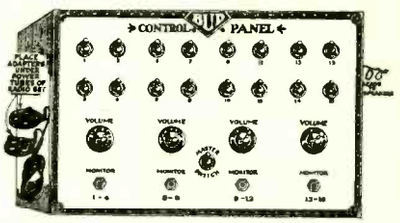
The Da-Lite-R tuner does not have any short wave coils, but covers the regular broadcast band only. Its selectivity is controlled from the panel.

With the new variable mu tubes in the R. F. stages, a decided increase in volume, selectivity and tone quality is found.

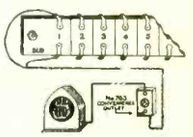
This circuit is adaptable to all of the the screen grid tubes, A. C., or 2 or 6 volts D. C. types. The pentode can be used if desired for the audio end.

Bud Extends Line; To Enter Television

Bud Radio Inc., 2744 Cedar avenue, Cleveland, Ohio, will display a very complete line of radio accessories at the Trade



A Bud Control Panel, which enables the operation of sixteen speakers from one Radio Set.

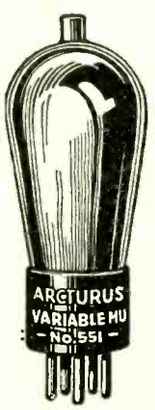


Show. The corporation manufactures a short-wave converter, an aerial eliminator, a complete line of radio convenience outlets for the wiring of homes, schools, hospitals, hotels, apartments, etc., aerial kits, tone controls, an interference filter, a voltage control, ground clamps, ground rods, lead-ins, lightning arrestors, radio silencer, test leads, neutralizing tools and an aerial filter.

Its engineers are at work on Television, and expect to announce several products for use for building television radio sets.

Arcturus Radio Tube Co.

Because of the interest in the new variable mu and pentode tubes, and in view of Arcturus' work in introducing these tubes, the booth of the Arcturus Radio Tube Co. features these. Architecturally designed, the modernistic booth employs a unique scheme of lighting effects that lends motion and color to the entire display.



Besides the prominent display of the two new tubes, the complete line of Arcturus Blue Tubes will be exhibited.

Another focal point of attention in this interesting exhibit will be an array of tubes depicting the pioneering achievements of Arcturus. These various tubes and developments expedited the perfection of the AC receiver.

The Arcturus booth is located in spaces 45 and 46 in the Grand Ball Room of the Stevens Hotel.

READING GROWS WITH RADIO

The swift growth of radio in the past six years has had no deterrent effect on the demand for books. It had been assumed that as people listened more they would read less, but the Office of Education reports that during that period there was a remarkable expansion in libraries and an increased demand for books.

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BIG BARGAIN—500 fine Vellum, neatly printed Business Cards, including strong Card Case, $1.50, postpaid. Handprint your copy. Mail with remittance to Roth Press, 846 Sutter Ave., Brooklyn, N. Y.

BODINE 60 cycle generator, 110 v. DC to 110 v. AC, 225 watts. New. $60.00. Supreme model 400-B with calibrated oscillator for IF, 130 to 180 K.C. and 560 to 1500 K.C. Complete, $75.00. Examination permitted at express office. Thos. J. Turney, P. O. Box 454, Coral Gables, Fla.

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.

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.

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

SITUATIONS WANTED

RADIO DESIGNER AND CUSTOM SET BUILDER; ten years' laboratory experience in short and long wave radio; desire connection in some research laboratory or as field and installation expert; am 26, single; college graduate and free to travel; employed now. Available on 10 days' notice. Don't misrepresent. I haven't. Floyd Hoskins, Jr., care of Y. M. C. A., Macon, Ga.

YOUNG MAN, 20, desires position in radio, with chance for advancement. Has some experience in building radio receiving sets. Speaks German and English. Also very much interested in short-wave transmission and reception. Walter Schmatter, 288 Wilson Ave., Brooklyn, N. Y.

YOUNG MAN TWENTY-SEVEN YEARS OF AGE. Ten years' experience in radio servicing, installing, selling, and receiver building. Seven years' experience in electricity with local power and light company. Have open mind for new knowledge of radio. Graduate of high school and L. L. Cooke School of Electricity. Am married and will go any place for any reasonable salary. John William Hostetter, 601½ So. 12th St., Quincy, Ill.

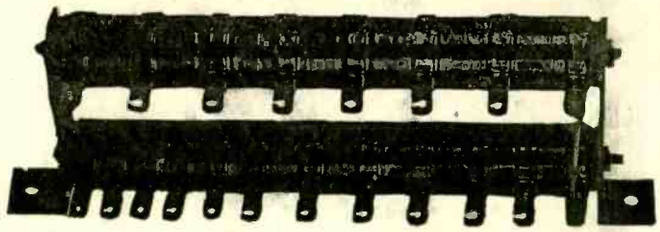
YOUTH, 18, would like offers from reliable radio dealers in college towns, to take care of servicing end of business. Graduate R.C.A. Institutes. High School graduate. Excellent references. Experience limited but have excellent training in radio from A to Z. Can handle code, and will also consider any other offers in other branches of radio. Robert C. Farrington, Iowa Falls, Iowa.

EXPERIENCED, AGE 25, SINGLE. Have had training as battery and auto electrician, and in radio and sound work, and short wave receiving and transmitting. Own a variety of test and working equipment. Would consider connection with store, corporation, or radio laboratory. Can start immediately. John Zillman, 228 Union Street, Jersey City, N. J.

GRADUATE R.C.A. Institutes, Inc., CX-7540. Desires radio position with a future. Salary no object. Will go any place, but preferably east. Age 28. Robert H. Clark, 1 Walton Place, Chicago, Ill.

Best Quality Parts *Free!*

MULTI-TAP VOLTAGE DIVIDER



THE resistance values between the twenty taps of the new Multi-Tap Voltage Divider are lower left to right, 0, 50, 50, 100, 200, 400, 450; 500; 550; 650; top right to left, 700, 800, 2,000, 2,000, 3,000 and 3,000 ohms. The total is 17,100 ohms and affords nineteen different voltages.

The Multi-Tap Voltage Divider is useful in all circuits, including push-pull and single-sided ones, in which the current rating of 100 milliamperes is not seriously exceeded and the maximum voltage is not more than 400 volts. Higher voltages may be used at lesser drain. Conservative rating, 40 watts.

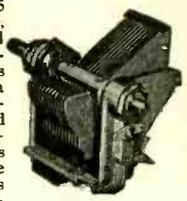
The expertness of design and construction will be appreciated by those whose knowledge teaches them to appreciate parts finely made.

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

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

Send $4 for 35 weeks subscription and order PR-MTVD, as a premium. Shipping weight, 2 lbs.

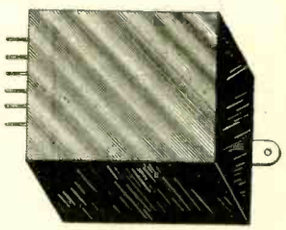
HAMMARLUND .0005 SFL



Hammarlund's precision .0005 mfd. condenser, removable shaft, protruding front and rear, and permitting reversing the condenser, as where two condensers are used on opposite sides of a drum dial. This is a most excellent condenser for calibrated radio frequency oscillators, short-wave converters and adapters and TRF or Superheterodyne broadcast receivers. Lowest loss construction, ridigity; Hammarlund's perfection throughout.

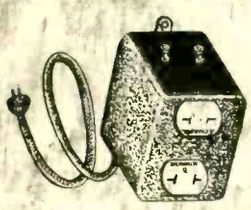
Sent free with 6 mos. subscription, 26 weeks, at $3. Order PR-HSFL. Shipping weigh, 1 lb.

FILTER BLOCKS



An excellent filter block, providing very high capacity for the B filter, a total of 14 mfd., with by-pass capacities of .1 and .5 mfd. This block is for standard 245 filtration (DC rating is 350 volts continuous). It is suggested that the 6 mfd. be placed next to the rectifier and the 8 mfd. at the other end of the B supply choke coil. No other filtration capacity is necessary. The physical dimensions are 5 inches wide x 4 inches front to back x 3 inches high. This Flechtheim block will be sent free with a $6 subscription (52 weeks). Order PR-FLB. Shipping weight, 4 lbs.

"B" ELIMINATOR - "A" BATTERY RELAY

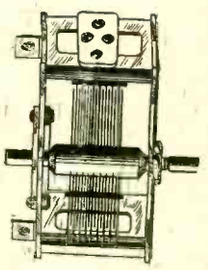


Here is a mighty handy and serviceable product for those who operate sets with storage battery and B eliminator—a genuine Brach relay, that switches charger on and set off, also set on and charger off.

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

Send $1.50 for a 3 month's subscription, 13 weeks, and get this relay (PR-BRL) free. Shipping weight, 1 lb.

SCOVILL .00035 MFD



A single tuning condenser of .00035 mfd. capacity, with brass plates and mounting feet. It may be mounted on a front panel, by removing the mounting brackets and drilling a 1" diameter hole large enough to pass the locknut. This condenser, made by Scovill, increases capacity in a clockwise direction. It is useful both for broadcast and short-wave work. Send $1 for an 8-weeks trial subscription and get this condenser free. Order PR-SC-35. Shipping weight, 1 lb.

180-V TRANSFORMER

180-volt power transformer for short-wave sets and converters, for use with 280 rectifier. 2½ v. at 12 amps., 2½ v. at 3 amps., 5 v. at 2 amps; high voltage at 100 ma.; all secondaries center-tapped. Primary 110 v. 50-60 cycles. In polished aluminum case. Send $8 for 70 weeks subscription and get this dandy power transformer FREE. Order PR-SWPT. Shipping weight, 7 lbs.

B SUPPLY CHOKE

30-henry choke, 100 ma. rating, free with $3 subscription, 26 weeks. Order PR-30H. Shipping weight, 4 lbs.

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- ☐ PR-FLB, $6 for 52 weeks (1 yr.); shipping weight, 4 lbs.
- ☐ PR-SC-35, $1 for 8 weeks; shipping weight, 1 lb.

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