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NEW HIGH MU TUBE

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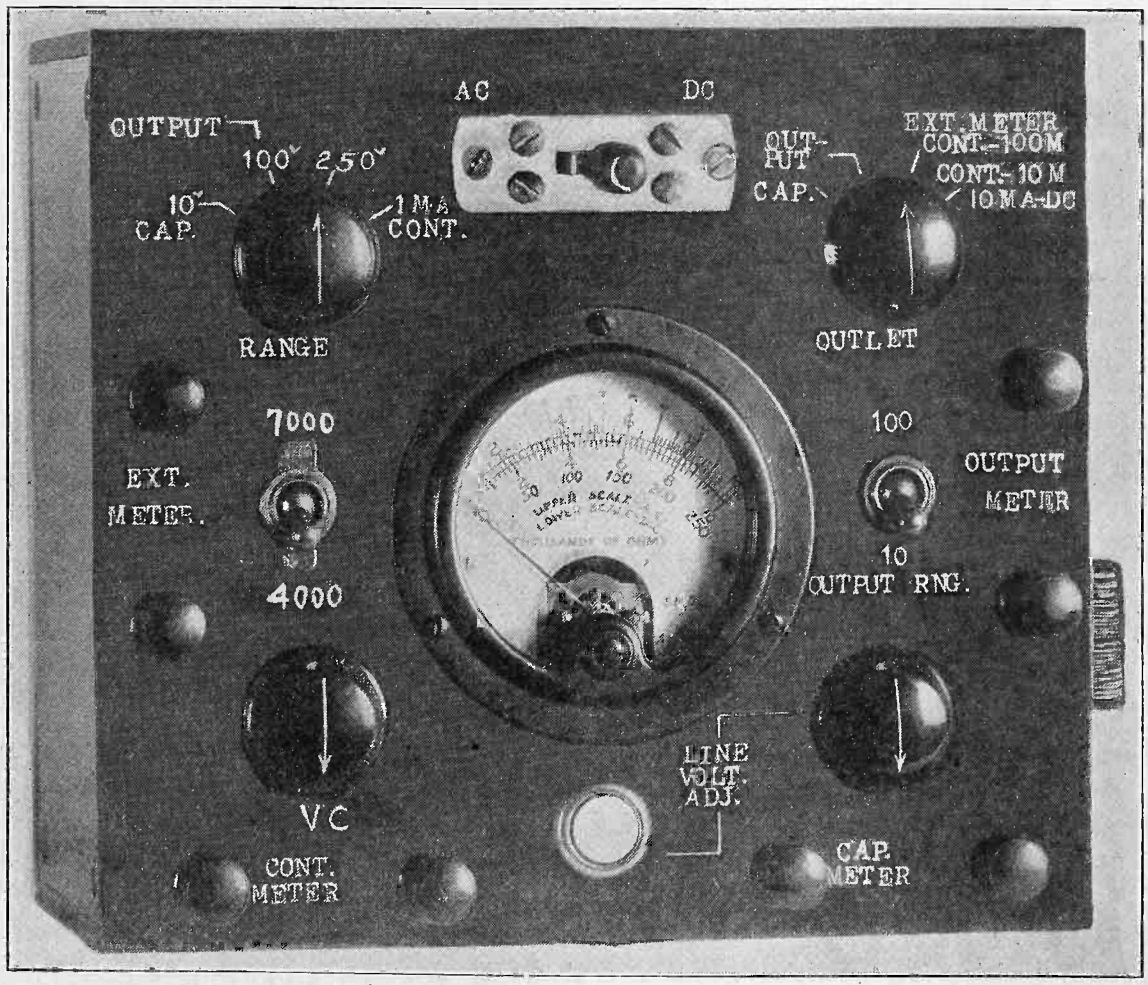

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A New High Mu Tube

For Receivers, Oscillators and Transmitters

By Franklin Ellis

A NEW tube has been announced by RCA and Cunningham and has been given the type number 841. It is primarily intended for amateurs and experimenters but it can also be used advantageously in high class radio receivers where high output and first rate quality are essential.

Its principle use in radio receivers is as an r-f and a-f voltage amplifier in a resistance coupled circuit, for it is of the high mu type, having an amplification factor of 30. When used for this purpose it should have a load resistance of 250,000 ohms, a plate supply voltage of 425 volts and a grid bias of 5.8 volts. With this combination of voltages and load the plate current will be 0.7 milliampere, and for that reason if it is to be self-biased the grid bias resistance should have a value of 8,300 ohms.

In general the characteristics of the tube are similar to those of the 210 tube. It takes a filament voltage, either AC or DC, of 7.5 volts, a filament current of 1.25 amperes and it uses the same base.

Use in Transmitters

It is also useful as an oscillator, a frequency doubler, a radio frequency amplifier of high power, and as a modulator in transmitters. As an oscillator it will put out 13 watts of radio frequency power with 450 volts on the plate and a grid bias of 30 volts.

The characteristics of the tube are given separately under the three different classes of service to which it is applied.

Class A Service is employed in the operation of well-designed audio and radio frequency amplifiers of radio receiver where fidelity of signal reproduction is of first importance. But fidelity is obtained at the expense of power output and at relatively low efficiency. In this service the tube is operated under conditions which make the dynamic characteristic essentially linear.

Class B Service is employed in radio frequency power amplifiers and in balanced or push-pull modulators of radio telephone transmitters.

It is also finding application for power output stages of some of the more recent designs of radio receivers. For these uses, the larger output is obtained without distortion and with good efficiency. But to obtain this large power, a high exciting grid voltage is required. When operated under these conditions the grid bias is so high that without the exciting grid voltage the plate current is very small. When a signal or exciting voltage is applied only the less negative half of the signal produces output power.

Class C Service covers those applications in which tubes are used as oscillators and radio frequency power amplifiers for transmitters. In such cases a very large output with high efficiency is of first importance. However, the output is obtained at the expense of considerable harmonic distortion, a fact which is taken advantage of in frequency doublers. In transmitters the harmonic distortion is removed by means of filters. In Class C Service the tubes are operated well beyond the point where plate current starts, or with a very high grid bias. When a large grid excitation voltage is applied large peaks of plate current are obtained in the output of the tube on each positive swing of the signal or exciting voltage.

Hum in A-C Is Used Before Output

If the grid bias is obtained by means of a grid leak, its value should be about 5,000 ohms. This value is not critical and correct circuit adjustment may be obtained with considerably different values.

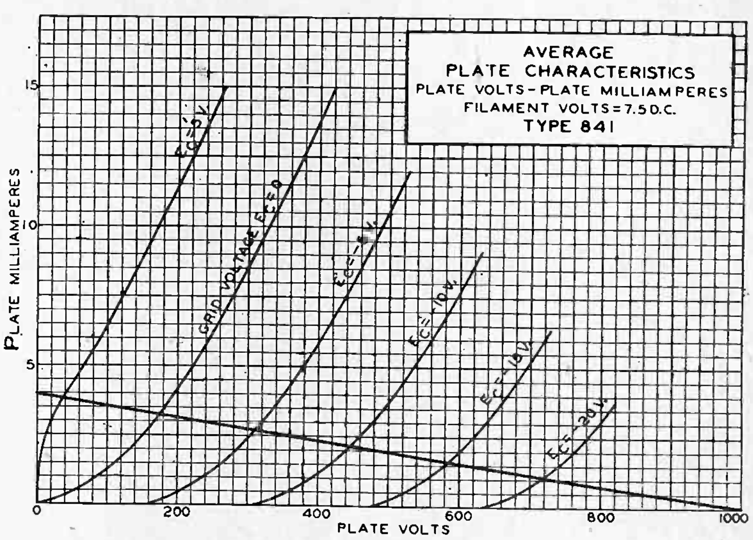

FIG. 1

Average plate characteristics of the 841 voltage amplifier tube. The load line is drawn for 250,000 ohms and 1,000 volts applied voltage.

The grid voltage is given with respect to the negative end of d-c operated filament. If the filament is operated with alternating current, the given values should be increased 3.75 volts and they should be measured with respect to the center point of the filament. The center may be obtained by centertapping the filament winding or by means of a centertapped resistance across the filament.

When the new tube is used as a voltage amplifier in front of a 250 power tube, it is advisable to use direct current on the filaments because otherwise there might be some hum in the output. Since the filament voltage is 7.5 volts for both tubes, an 8 volt storage battery should be used. To drop the extra 0.5 volt, a ballast resistor of 0.4 ohms should be used for each tube. If two tubes, such as one 841 and one 250, are put on the same ballast, a resistance of 0.2 ohm is required.

Average Characteristics

In case a 7.5 volt transformer is used to supply the filament current for both tubes it is advisable to have two 7.5 volt windings so that both tubes may be balanced with respect to hum independently and also to allow the use of different bias voltages. The 250 requires a bias resistance of 1,500 ohms and the 841 a resistance of about 8,000 ohms when the applied plate voltage is 425 and the load resistance is 250,000 ohms.

In Fig. 1 is shown the plate voltage, plate current curves of

(Continued on next page)

An 8-Tube Automobile

Provisions for Cars with Negative or

By Einar

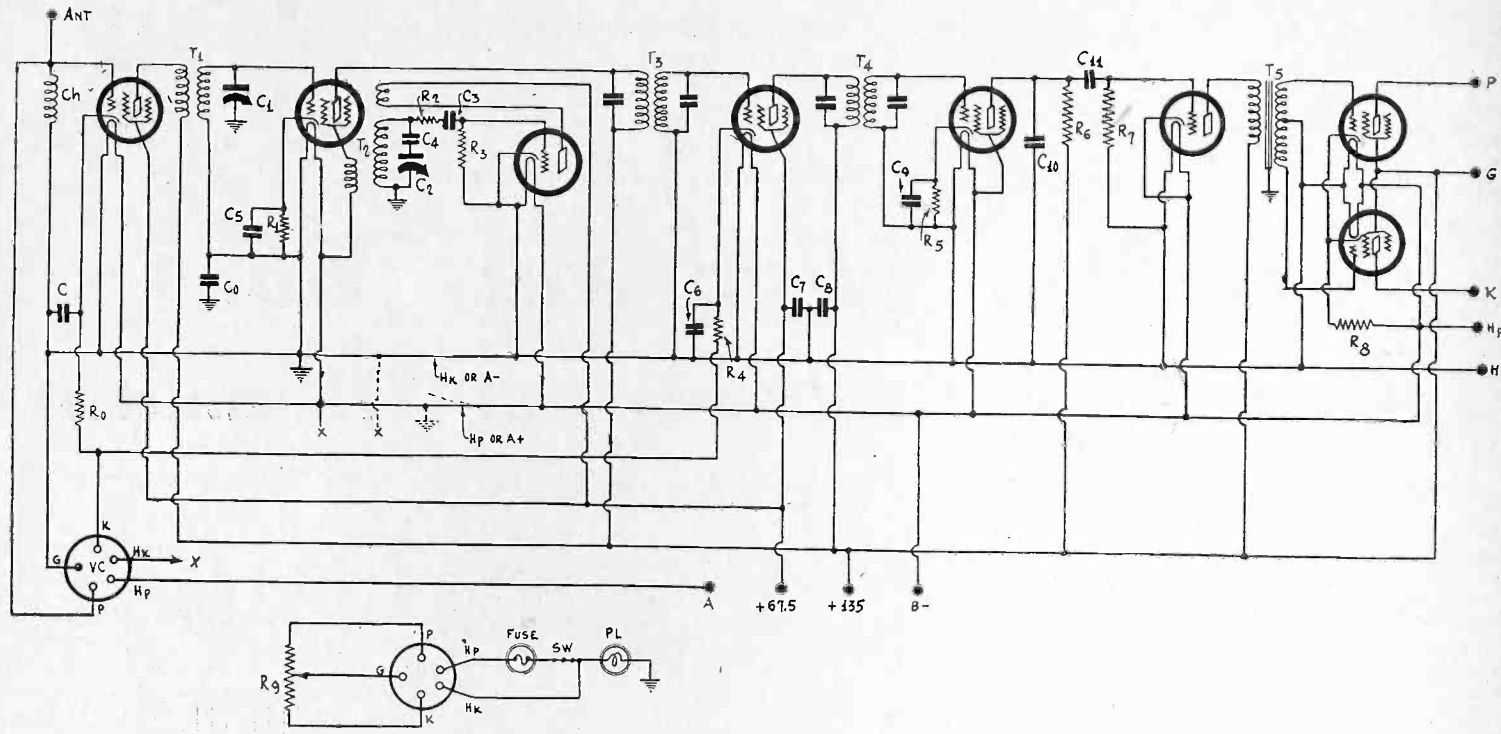

FIG. 1

The circuit of an eight tube automobile superheterodyne with remote volume and tuning control. Use full-line ground and X connection when negative of car battery is grounded, and the broken-line ground and X connections when the positive is grounded. Connect A to the "hot" side in either case.

THE demand for an automobile superheterodyne is urgent, no doubt due to the desire for more adequate sensitivity than is obtained with tuned radio frequency receivers. The question of selectivity does not enter because most automobile receivers are selective enough.

As soon as we begin to consider a superheterodyne we find that to make a good job of it we have to use eight or more tubes. These tubes may be apportioned as follows: An untuned stage of radio frequency amplification, a modulator with tuned

LIST OF PARTS

Coils

Ch—One 800 turn duolateral wound coil
T1—One shielded r-f transformer as described.
T2—One oscillator coil as described.
T3, T4—Two intermediate frequency transformers.
T5—One push-pull audio frequency input transformer

Condensers

C, C5, C6—Three 0.1 mfd. by-pass condensers (all in one case)
Co, C7, C8, C9—Four 0.25 mfd. by-pass condensers
C1, C2—Two 0.00035 mfd. tuning condensers in one unit
C3—One 0.001 mfd. condenser
C4—One adjustable condenser of 300 to 1,000 mmfd. range, approximately
C10—One 0.00025 mfd. condenser
C11—One 0.1 mfd. condenser

Resistors

Ro, R4—Two 600 ohm resistors
R1, R5—Two 30,000 ohm resistors
R2—One 5,000 ohm resistor
R3—One 100,000 ohm grid leak
R6—One 250,000 ohm resistor
R7—One one megohm grid leak
R8—One 300 ohm resistor

Miscellaneous

Ten UY type sockets
One remote control unit consisting of dial, pilot light, volume control R9, fuse, plug and cable, one four-lead battery cable, and condenser drive attachment
One dynamic speaker with 6 volt field
One special chassis for receiver and one battery box

New Voltage Amplifier

(*Continued from preceding page*)

the 841 tube, when the filament heated with direct current. Curves are given for six different grid voltages from minus 20 to plus 5 volts. The load line drawn across the curves is for a load resistance of 250,000 ohms and a supply voltage of 1,000 volts. From this curve and the current curves we can compute the amplification. Suppose we give the grid a bias of 10 volts negative and that we swing the grid ten volts in both directions. At zero bias the load line crosses the current curve at 175 volts. This is the minimum plate voltage during the cycle. At minus 20 volts the load line crosses the current curve at 720 volts. This is the maximum plate voltage during the cycle. The change in the plate voltage is 545 volts, and this is caused by a change of 20 volts on the grid. Hence the amplification is 27.25 times. The mean voltage on the plate is the voltage at the operating point, or at 10 volts negative. The load line crosses the current line at 445 volts. Since this is more than the maximum that should be used, the operating bias should be reduced a little. The recommended value is 9.2 volts. This is nearly the voltage of 6 dry cells in series.

Characteristics of the 841 Tube

GENERAL DATA

Filament voltage (A.C. or D.C.)	7.5 volts
Filament current	1.25 amperes
Amplification factor	30
Plate to grid capacity	8 mmfd.
Grid to filament capacity	5 mmfd.
Plate to filament capacity	3 mmfd.
Maximum length	5 5/8 inches
Maximum diameter	2 3/16 inches
Bulb	S-17
Base	Medium 4-pin bayonet

Superheterodyne

Positive of "A" Battery Grounded

Andrews

input, an oscillator, a stage of intermediate with doubly tuned input, a detector also with doubly tuned input, a stage of audio amplification, with resistance coupling, and finally a stage of push-pull power amplification.

Why Untuned Stage

The question may at once arise as to why the first stage is not tuned. Would it not be better to tune this also? From one point of view it surely would be better, but when we take everything into consideration little is gained by tuning the input of the first tube, yet the use of the stage is advantageous. If we tune the first stage we must have an extra tuning condenser and an extra tuning coil. These take a lot of room, and that is something which is not plentiful. Then tuning the first stage does not add as much to the sensitivity as one would think, nor to the selectivity. A volume control must be used, and this takes the form of a shunt across the coil. This shunt reduces not only the amplification but also the selectivity. Hence a choke input can be used advantageously, and it takes little room.

Automatic Volume Control

There seems to be a strong demand for an automatic volume control in an automobile set. No doubt it is a useful adjunct, but is it worth the trouble and expense? A good one requires an extra tube, and even a good one does not control the volume as well as would be desired. And what is the condition that requires an automatic volume control? As the automobile recedes from a broadcast station the signals grow weaker, not rapidly but very slowly. The listener is hardly aware of the change. When the signals have reduced to the point where the operator thinks he should have a little more volume, it only takes a jiffy to turn the manual volume control. The same applies when the automobile approaches a station, only the change is in the reverse sense.

Sometimes, it is true, the volume changes rapidly as the car turns. This is indicative of a loop effect in the pick-up system. This can be prevented by using a non-directional antenna, just one wire from the set to the highest, or lowest, point in the car.

Another case where there may be sudden changes in the volume is when the car passes over bridges, under or over railroad structures, or past steel buildings. In such places there is very little need for radio entertainment. There is likly to be much traffic congestion which requires the entire attention of the car operator, and there is likely to be a great deal of extraneous noise to interfere. If such conditions obtain in sections where there is little traffic, the difficulty will be momentary. Hence at least some who have had experience with automobile sets regard an automatic volume control as excess baggage.

An Eight Tube Super

For these reasons the eight tube automobile superheterodyne shown diagrammatically in Fig. 1 does not have an automatic volume control. All other features in the set have been designed to give high sensitivity, adequate selectivity and versatility.

By versatility in this case is meant that it is easily adaptable to either type of car wiring, that is, to cars having the negative of the storage battery grounded as well as to cars having the positive grounded. This versatility is achieved by keeping the filament circuit independent of the receiver chassis as far as necessary.

There will be ten tube sockets in the receiver chassis. Eight of these will be for tubes, one for the loudspeaker, and another for the remote control plug. Note that all these sockets, with the exception of the remote control socket VC, are wired the same way in respect to the filament circuit. All the Hp terminals are connected together and likewise all the Hk are wired together. Neither side of the circuit is connected to the storage battery yet. The terminals of the speaker socket are arranged in a column at the extreme right of the drawing. The volume control socket is located at the extreme lower left of the diagram.

Completing the Heater Circuit

The heater circuit is completed in one of two ways, depending on the wiring in the car.

Before proceeding let us call attention to the wiring of the remote control unit. This is shown separate below the main diagram. R9 is the volume control potentiometer. This is connected to the P, G and K terminals of the remote control cable, which ends in a plug fitting into the volume control socket VC. The Hp terminal of the plug picks up the fuse in the remote control, and then the switch. Hk picks up the pilot light and the other side of the switch. The remaining terminal of the pilot light is connected to the frame of the control unit, which in turn connects with the chassis of the car by way of the steering gear.

Now let us assume that the negative of the car battery is grounded. The positive is then "hot." Connect the A lead in the battery cable to the positive side of the car battery. Also connect it to Hp on the VC socket in the receiver chassis. Then when the remote control plug is inserted into VC, Hp on the plug becomes positive. Then we pick up the fuse and the switch. As soon as the switch is closed the pilot light is on, for the circuit is completed through ground, that is, through the car chassis. But Hk on the plug is also connected to the switch. Hence when the switch is closed Hk on the plug becomes "hot" and when the plug is in the VC socket Hk of that socket is also "hot." This lead must be connected to the Hp terminals of all the sockets, exclusive of the VC socket. Hence the point marked X is connected to one of the Hp terminals in the receiver chassis. This is only for cars in which the negative of the battery is connected to the car chassis. But we have not yet completed the heater circuit. The Hk terminals remain open. All that is necessary now is to ground one of the Hk terminals to the receiver chassis.

When Positive Is Grounded

Now let us suppose that the positive of the car battery is connected to the chassis, as is the case in about half of the cars. The required change is only slight. The A terminal in the battery cable is now connected to the negative of the car battery. This side is now "hot." We can forget about the volume control and its plug. We pick up only X on the volume control socket and this time we connect it to the Hk terminals of the sockets in the set. To complete the circuit we ground the Hp terminals.

The changes are very simple and there are only three things to do to go from one type to the other. First, we connect the A terminal in the battery cable to the "hot" side of the battery, whichever side is "hot." Second, we connect X or Hk on the VC socket to Hp if A plus is "hot" or to Hk if A minus is "hot." Third, we ground the remaining side of the heater circuit.

(*Continued on next page*)

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ube Otherwise Like 210

CLASS A SERVICE

Maximum operating plate voltage		425 volts
Maximum plate dissipation		12 watts
Filament voltage (d.c.)		7.5 volts
Plate supply voltage	425	1,000 volts
Grid voltage	—5.8	—9.2 volts
Load resistance	250,000	250,000 ohms
Plate resistance	63,000	40,000 ohms
Mutual conductance	450	750 micromhos
Plate current	0.7	2.2 milliamperes
Peak grid swing	5.8	9.2 volts
Output voltage (5% harmonic)	126	225 volts
Gain (small signal)	24	26
Gain (5% harmonic)	21.7	24.4

The plate voltage is the voltage measured between the plate and the filament at the operating bias. The supply voltage is the voltage measured between the positive end of the coupling resistance and the filament. The plate voltage is always less than the supply voltage by the amount of drop in the coupling resistance. It is for this reason that the supply voltage may be 1,000 volts although the maximum plate voltage should not exceed 425 volts.

If a grid leak is used ahead of the tube it should not exceed 0.5 megohm.

Class A Service is that with which we are most familiar in radio receivers. The grid bias is chosen so that there is a variation in the plate current both on the negative and the positive half of the signal voltage, and also so that the two changes are approximately equal. It is customary to select a bias so that when the positive half of signal drives the grid just to zero bias the negative half does not drive the bias too close to the cut-off point of the plate current. It is customary to set a minimum plate current, which is determined by the allowable percentage of second harmonic in the signal, usually 5 per cent.

Expert Auto Set Design

Super for Real Performance in Car

(*Continued from preceding page*)

In case the negative side of the battery is grounded, G on the volume control, either plug or socket, may be grounded. This takes care of the grounding of Hk in the receiver chassis. However, it is best not to tamper with the G connection on the volume control unit. Before the unit is installed it must be ascertained that the wiring of it is as shown in the diagram.

The RF Tuner

The two tuning condensers C1 and C2 are of the same size and they should be coupled mechanically so that they may be tuned with the same control. The usual capacity of 350 mmfd. is satisfactory.

There are available small coils in metal shields suitable for such receivers as this. The secondaries are wound with 127 turns of No. 36 enameled wire on one inch tubing. The primaries vary, depending on the degree of amplification that is necessary. Since we need much in an auto set a coil having 100 turns on the primary will be all right. This winding consists of very fine silk covered wire and is wound over the secondary, being separated by several layers of empire paper or cloth to a thickness of about 1/32 inch. The inductance of these coils is dependent on the size of the shield can, which is about 2⅛ inches in diameter and 2⅝ inches high, so that if another size can is used it is necessary to adjust the turns. The inductance of the secondary is 245 microhenries measured in the can. This will just cover the broadcast range when the capacity of the tuning condenser is 350 mmfd. and the minimum capacity is not more than 46 mmfd.

The required inductance of the secondary of T1 depends only on the capacity across it and on the wave band to be covered. Not so with the oscillator inductance, that is, the inductance of the main winding on T2. This depends not only on the wave band to be covered and the tuning capacity but also on the intermediate frequency used.

Choice of Intermediate

The choice of intermediate frequency is more or less arbitrary. We are guided by the desire to get away from possible image interference. This calls for a high intermediate frequency. In most broadcast sets now the intermediate frequency is around 175 kc. But if the radio frequency tuner is not as selective as it might be, then it is advantageous to increase the intermediate frequency. In the present set the first tuner is not very selective for the reason it was necessary to use a large primary to get sensitivity. Also, the use of an untuned stage detracts from the selectivity. Hence we should choose a much higher intermediate frequency. We have picked on 400 kc for this one. This places the carrier which might interfere by way of the image route 800 kc away from the desired carrier. That ought to be far enough away for any practical tuner. For example, if we wish a station operating on 550 kc, a possible interfering station would operate on 1,350 kc. Therefore there are not many stations to interfere, at least not many broadcast stations. Likewise, if we wish a station operating on 1,500 kc, a possible interfering broadcast station is operating on 700 kc. If the first tuner does not suppress the possible interference it is no tuner at all.

Oscillator Inductance

On the basis of a 400 kc intermediate the oscillator tuner should cover the band of frequencies from 950 to 1,900 kc. If we adjust the minimum capacity in the oscillator circuit so that it is 50 mmfd., which is quite possible by means of the trimmer, we need an inductance in the oscillator of 140 microhenries. This calls for 100 turns of No. 36 enameled wire on a one-inch form, provided that we put the coil in the same size can as that used for the r-f coil.

We assume that the tuning condenser C2 has the same capacity as C1 for the same dial settings. At 550 kc C1 has a value of 342 mmfd. The series condenser C4 should be determined so that when C2 has the value 342 mmfd. the series combination should tune to 950 kc or so that the combined capacity is four times the minimum capacity. That is, C2 and C4 in series should have a value of 200 mmfd. This requires that C4 should have a value of 482 mmfd. It is best provided by a variable condenser of the type used in intermediate tuners. With this condenser it is possible quickly to adjust for discrepancies.

The Intermediate Transformers

The intermediate transformers are typical superheterodyne transformers, except that the coils have lower inductance. It is best to buy the coils ready made and approximately adjusted to 400 kc.

Of course, it is quite feasible to use 175 kc transformers in the super. In that case it is only necessary to use a suitable oscillator coil and a suitable value for C4. If this condenser is of suitable range it could be used for either intermediate. The range should be from about 350 to 1,000 mmfd.

Let us assume that two 400 kc transformers have been obtained and that the circuit has been wired up. The first thing to do is to tune the four intermediate circuits. This can be done in several ways. A source of modulated signal is required. This may be an oscillator tuned to 200 kc, 400 or 800 kc. Or a strong broadcast station signal of 800 kc may be used. The signal may be put into the screen circuit of the modulator, or into the grid circuit. Adjust the frequency of the signal to the proper value and then tune each circuit in turn in the intermediate amplifier until the output of the receiver is strongest, reducing the signal with the volume control in the set or in the source of the signal as the intensity increases.

Another way is to hook up the circuit for reception. Tune in a signal and adjust each intermediate for loudest signal. This will yield a good intermediate frequency but not necessarily 400 kc. If the intermediate frequency is not 400 kc it is necessary to make the proper adjustment in the oscillator coil and the series padding condenser C4.

Adjusting Oscillator for Any IF

When the tuning condensers are set at minimum, the series condenser C4 has a negligible effect on the frequency of the oscillator. It is determined mainly by the minimum capacity in the oscillator circuit and by the inductance. The minimum is adjustable over a small range and the inductance over any range desired, provided that we start with enough turns, and enough always means fewer turns than on the r-f tuner, the required turns on the oscillator being less the higher the intermediate frequency. Hence if we start with a coil equal to the r-f coil we can always adjust the turns until the inductance is right. Set the condensers at minimum, or as near minimum as a station can be found, and then remove turns from the oscillator until the signal from that station is loudest. As a final adjustment set the trimmer on the oscillator condenser. This determines experimentally the correct inductance for any intermediate frequency. To complete the adjustment of the oscillator it is only necessary to adjust the series condenser C4 when the tuning condensers are set at or near maximum. The series condenser is smaller the higher the intermediate frequency.

Tickler and Pick-up Windings

Besides the tuned winding on the oscillator there are the tickler and the pick-up windings. These may be over the tuned winding with any fine wire. The tickler winding should have about two-thirds as many turns as the tuned winding and the pick-up winding may have from 10 to 20 turns. It is necessary to put a few layers of insulating paper or fabric between the tuned and the two other windings. A thickness of 1/32 inch will do. The two auxiliary windings should be placed near the ground end of the tuned winding with the pick-up winding nearer the grid end of the tuned winding. Since it may be necessary to remove turns from the tuned winding at least part of it should not be covered with the insulator layer. One reason for using fine wire on the two outside windings is to leave room for this adjustment.

Connections in Receiver Chassis

Note carefully that all grid returns are made to the negative side of the heater circuit and in no case to the receiver chassis. The screen return of the first detector or modulator is made to the positive side of the heater circuit. That is, one side of the pick-up coil is connected to the screen and the other side to the positive heater terminal on the same socket. The screen of the second detector is made directly to the positive heater terminal on that socket. The cathode of the first audio tube is connected to the positive side of the heater circuit on the socket. The connections in the power stage should also be noted. The cathodes are joined and are then connected to a 300 ohm resistance, R8. The other end of this resistance is connected to the positive side of the heater circuit, or to Hp on the most convenient socket.

A few more words about the connection to X and ground will not be amiss. In Fig. 1 the negative side of the circuit is shown to be grounded. This is to be done only in case the car battery is grounded on the negative side. The connection of X is shown to be to the positive side. This is to be done only when the negative of the car battery is grounded. In case the positive side of the car battery is grounded follow the dotted lines.

If there is no connection between the volume control in the remote control unit and the frame of the device and also if only one side of the pilot light is connected to the frame, there is no need of changing the wiring in the control unit for different cars. The grounded side of the pilot light will pick up the car chassis not matter which side of the battery is connected to it. The battery lead to the device will be "hot" provided it is connected properly outside the unit.

Data on Coil Winding

Ratios Used for Determining Taps

By William A. Boddis

THE problem of placing taps on short-wave tuning coils so as to cover certain frequency ranges with a variable condenser often arises. The problem is to place them so that there will be some overlap of one range and the next, without an excessive overlap. It is easily solved as soon as we have one coil, the largest, and the capacity of the tuning condenser.

The first thing that must be known is the minimum capacity of the tuned circuit, which includes the capacity of the grid circuit of the tube, the capacity of the coil, and the minimum capacity of the tuning condenser. Ordinarily the minimum capacity of the condenser is given by the manufacturer, the capacity of the tube is given by the maker of the tube, and the capacity of the coil can be taken to be equal in micromicrofarads to the number of centimeters in the diameter of the coil. Let us assume that the minimum capacity of the condenser is 20 mmfd., that the capacity of the grid circuit of the tube is 10 mmfd., and that the coil has a diameter of 1.75 inches. Then the capacity of the coil is about 4.5 mmfd. The total is 34.5 mmfd. This is a reasonable value to assume as the minimum capacity in the circuit, but let us call it 35 mmfd. Also assume that the maximum capacity is 150 mmfd., which is mainly determined by the tuning condenser. We then have a capacity ratio of 150/35, or 4.29. The square root of this is the frequency ratio covered by the tuning condenser, which therefore is 2.07.

The Inverse Proportion

If a coil is short the inductance is directly proportional to the square of the turns, and the frequency for any given setting of the tuning condenser is inversely proportional to the number of turns. Hence if we start with a coil of N turns and we wish to put a tap on it to cover the next lower band, we should have N/2.07 turns in the tuned circuit after the tapping. Call this new number N'. The next coil should have N'/2.07 turns, and so on. This applies both when the smaller coils are made by tapping a large one and when the smaller coils are separate, provided that the diameter remains the same.

Strictly speaking, the inverse proportion does not hold unless the windings are the same in length, regardless of the number of turns. But if the windings are short the error is not large enough to make any practical difference.

If it is desired to make an oscillator coil which nearly tracks with the r-f tuner, the same proportion may be used. The frequency ratio in this case is that between the signal and the oscillator frequencies. Suppose, for example, that the signal frequency is 1,500 kc and that the intermediate frequency is 750 kc. The oscillator frequency then should be 2,250 kc. The ratio is 1,500/2,250, or 0.667. Hence the turns on the oscillator coils should be 0.667N, where N is the number of turns on the corresponding r-f coil.

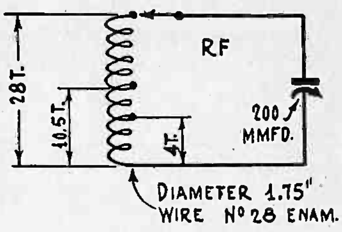
Determining Oscillator Coils

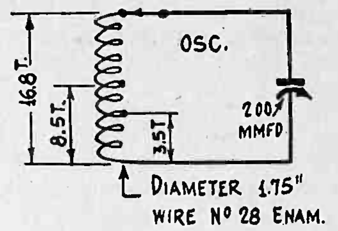
In the case of the oscillator coil we cannot use the same factor for all the coils as we did in the r-f coils, because the frequency ratio varies. We have to take each r-f coil and find the correct oscillator for it. We found above that the second r-f coil should have N/2.07 turns. Or, it should have 0.4825N turns. Now if the r-f frequency at start is 1,500 kc, the frequency of the next coil, for the same setting of the tuning condenser, is 3,100 kc. Therefore the oscillator frequency, for 750 kc intermediate, will be 3,850 kc. Now we have a frequency ratio of 3,100/3,850, or 0.805. Therefore the second oscillator coil should have 0.4825 x 0.805N turns, 0.388N turns. Or if we use N' as determined before, the second oscillator coil should have 0.805N' turns.

The same method may be used for any intermediate frequency and for any variable condenser. But it must be remembered that if the coil form is so small that the largest coil will be long, the proportion does not hold. It holds well for signal frequencies above 1,500 kc and for coils 1.75 inches, or larger, diameter. It holds more accurately for large tuning condensers than for small, for the small will require longer coils.

A Practical Case

Let us work out a set of coils for a short-wave converter covering the range from 1,500 kc up to as high as practicable, using a tuning condenser of 200 mmfd. and an intermediate frequency of 1,000 kc. We first have to determine N, the number of turns required on the r-f coil for the lowest frequency band. The tuning condenser has a minimum capacity of about 10 mmfd. The coil has about 5 and the tube 10 mmfd. The total minimum is 25 mmfd. However, let us say that it is 30 mmfd. so that we





are sure to have sufficient overlapping of tuning ranges. The maximum capacity is 220 mmfd., the sum of the condenser and stray capacities.

This makes the capacity ratio 7.33 and the frequency ratio 2.71. The frequency band to be covered will be from 1,500 kc to 30,000 kc, approximately. We need one coil from 1,500 to 4.060 kc, one from 4,060 kc to 11,000 kc, and another from 11,000 to 29,800 kc., that is, a total of three coils, or one coil with two taps on it.

Let us assume that the diameter of the coil is 1.75 inches and that the wire is No. 28 enameled. Thus for the largest coil we need an inductance of 51.1 microhenries, which is given by 28 turns, very nearly. The next coil should have 28/2.71, or 10.32 turns, the next 3.82, or as near these numbers as practicable.

The Oscillator Coils

Since the intermediate frequency is 1,000 kc the lowest oscillator frequency is 2,500 kc. Hence the ratio of the signal to oscillator frequencies at maximum condenser setting is 0.6. The largest oscillator coil should therefore have 0.6N, or 16.8 turns. The next frequency ratio is 4,060/5,060, or 0.803 and therefore the second oscillator coil should have 0.803x10.32, or 8.3 turns. The frequency ratio in the next band, at maximum setting of the condensers, is 11,000/12,000, or 0.917. Since the smallest r-f coil should have 3.82 turns the smallest oscillator coil should have 0.917x3.82, or 3.5 turns.

The fractional turns should not be taken too literally. Use the nearest whole number of turns, or nearest half turn, above the value obtained by the ratio method. For example, one of the coils might be made 10.5 turns and the other 4 turns. When the middle winding has been decided on the third should be determined on the basis of that choice. Thus if we decide to use 10.5 turns in place of 10.32 turns, the third coil should have 10.5/2.71 turns, or 3.87. The nearest practical number of turns in either case is 4. The effect of choosing the larger number of turns is to reduce the highest frequency to which the circuit will be tuned, but this may be more than compensated for by a liberal estimate of the minimum capacity in the circuit.

The method used here to determine the positions of the taps on the coils, or for determining the number of turns on smaller coils of the same diameter, is based on the inductance formula $L=0.025D^2n^2K$, in which D is the diameter in inches, n the number of turns, and K is a factor depending on the radio of D to the length. For short coils of equal diameter the formula may be written $L=kn^2$, where k is now some constant. For constant capacity the frequency is inversely proportional to the square root of the inductance, and hence to n.

A Midget Receiv

Economy of Operation a Portability and a

By Burton

IN many homes there is a need for an auxiliary radio receiver or two, a receiver on which one member of the family only can listen to his favorite programs when the rest of the family listens in on the main set. This need is particularly great when there are both young and old members of the family or when the members have widely divergent tastes. For example, the young members may want to listen to dance music when the older members prefer more sedate entertainment, or dad and the boys may want to listen to a boxing match or a football game while ma and the girls prefer to listen to love stories and mysticism. If there is only one set in the house there is likely to be an argument in such cases.

Sensitivity Requirements

This situation may be the reason why there is a considerable demand for small receivers which are suitable for earphone listening or for use with a low power loudspeaker. The demand particularly is for small receivers utilizing the 2-volt tubes.

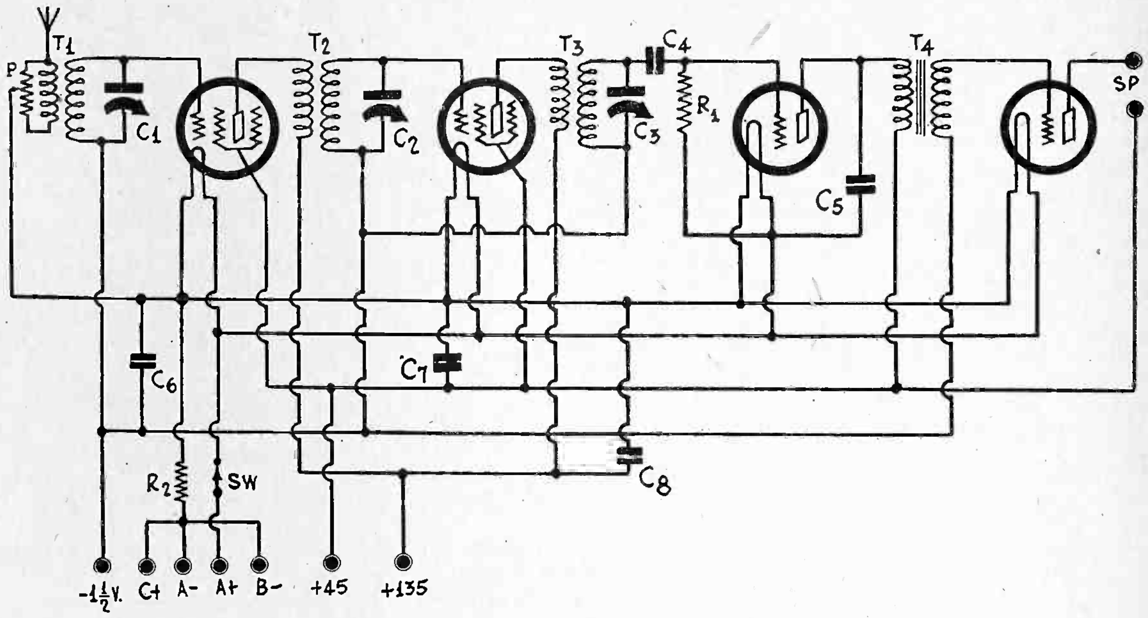


FIG. 1
The circuit of a four tube battery operated midget receiver for use with headphones or low power speaker. The two volt tubes are used for economy of operation. The receiver may be operated with four No. 6 dry cells connected in series-parallel. This set is both sensitive and selective.

The sensitivity requirements for such a receiver are no less rigid than those for a larger receiver. Indeed, the small receiver should be more sensitive because one of its purposes is to listen to distant stations.

A receiver of the type shown diagramatically in Fig. 1 is suitable for earphone listening as well as for loudspeaker listening provided that only a low sound power is desired. It employs four 2-volt tubes, the first two 232s and the second two 230s. The amplification of the two screen grid tubes is about the same as that in modern midgets, and since the circuit has three tuners, the selectivity is of the same order. That means that it is adequate for the purpose the circuit is intended. The detector operates on the grid leak and condenser principle and since this is more sensitive, on weak signals at least, there will be no lack of gain. The detector is followed by an audio transformer and a small output tube. Since there is considerable gain in the transformer and in the fourth tube, the sensitivity is greatly increased.

The output tube is given a plate voltage of only 45 volts. This is enough for earphone work, but it will hardly be enough for a loudspeaker. In case it is desired to operate the set with a small loudspeaker, the plate voltage on the last tube should be increased to 135 volts and at the same time the grid bias on the tube should be increased 7.5 volts. In case it is desired to use the set for earphones as it is, another tube could be added for loudspeaker work. This tube could either be a 233 pentode or a 231 power tube. The coupling between the extra tube and the receiver as drawn could be a transformer just like T4.

An extra power tube will require considerable filament current, for the 231 draws 130 milliamperes and the 233 draws 260 milliamperes. The set as shown takes only 240 milliamperes and it can be run on four No. 6 dry cells connected in series parallel for considerable time. If a power tube is added it is preferable to use some other source of filament current.

Limiting the Voltage

The voltage of the filament battery will be 3 volts if two dry cells are used in series, and this is the least number that can be used for the tubes will not operate on 1.5 volts. Since the tubes should not have more than 2 volts, it is necessary to put in a filament ballast resistor to take up the excess voltage. This ballast is R2. Since the current through this resistance is 0.24 ampere and the drop in it should be one volt, the value of the resistance should be 4.16 ohms. A wirewound resistance of 4 ohms will be close enough,

LIST OF PARTS

Coils

T1, T2, T3—Three shielded radio frequency transformers of 0.00035 mfd. condensers.
T4—One audio frequency transformer, three to one ratio.

Condensers

C1, C2, C3—One gang of three 0.00035 mfd. tuning condensers with trimmers.
C4, C5—Two 0.00025 mfd. fixed condensers.
C6, C7, C8—Three 0.1 mfd. by-pass condensers, in one case.

Resistors

R1—One 2 megohm grid leak.
R2—One 4 ohm resistor or a 6 or 10 ohm rheostat adjusted to 4 ohms.
P—One 10,000 ohm potentiometer.

Miscellaneous

Sw—One filament switch with knob to match knob on P.
Four UX sockets.
Ten binding posts.
Two grid clips.
One 135 volt B battery.
One 1½ volt grid bias battery.
Four No. 6 dry cells.

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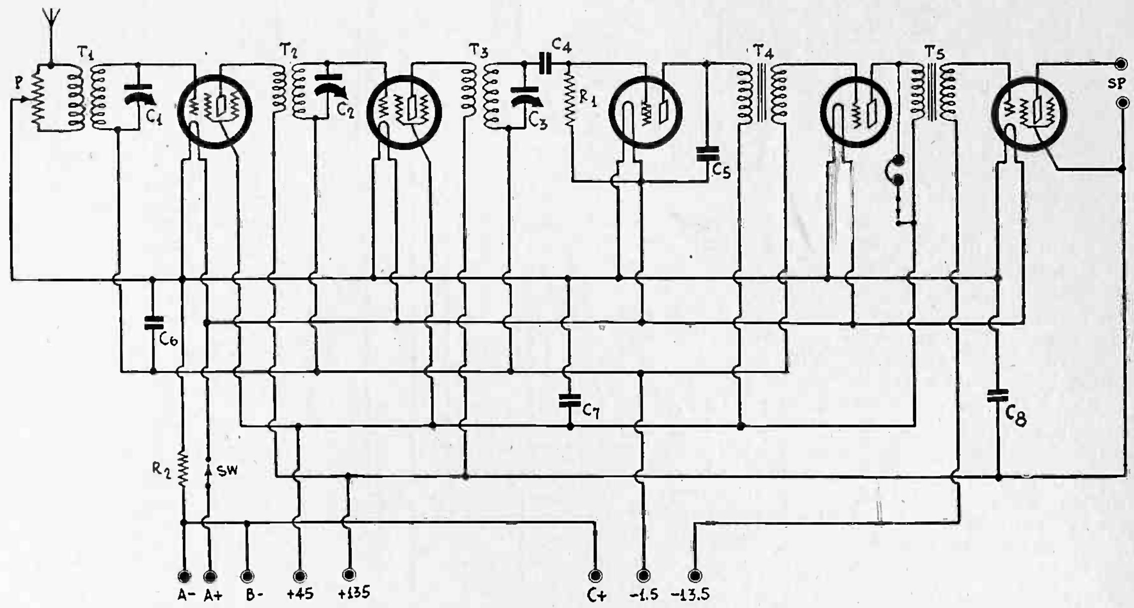
FIG. 2
The same circuit as in Fig. 1 except that another stage with power pentode has been added to give greater loudspeaker volume. The headphones may be connected either as shown or in place of the loudspeaker, provided that a 10,000 ohm resistance is connected in series with it. An air cell or a 2 volt storage cell is preferable for filament supply.



or an amperite intended for a 201A on 6 volts will do for this has a resistance of 4 ohms. A rheostat of 6 or 10 ohms could also be used but if there is danger of giving the tubes too much voltage, and the temptation to do so is strong. For this reason the rheostat should be set with the aid of a voltmeter connected across the filaments. The rheostat should be adjusted until the meter reads 2 volts and then it should be left alone. After the battery has been used for some time the voltage across the tubes will drop below 2 volts, when the adjustment of the rheostat may be repeated, again with the aid of the meter. The makers of the tubes recommend that the voltmeter be connected in the circuit permanently so that the filament voltage may be checked and readjusted every time the set is turned on.

The Tuners

The three tuning condensers C1, C2, and C3 should be of 0.00035 mfd. capacity and should be ganged together. Each should have a trimmer built in. The coils T1, T2, and T3 should be wound to match. Coils suitable for this are available. They come in 2⅝ by 2⅛ inch metal cans, are wound with No. 36 enameled wire on one inch tubing. The secondaries have 127 turns of this wire, wound closely, except that at the grid end about six turns are separate from the rest 1-16 inch. The primaries are wound over the secondaries, being separated from them by a layer of empire cloth or paper. They consist of No. 40 silk covered wire and vary in the number of turns depending on the relative importance attached to sensitivity and selectivity. Fifty turns is a good average. The primary of a coil should begin at the ground end of the secondary and extend as far toward the grid end as the thickness of the primary wire determines.

The stopping condenser C4 has the usual value of 0.00025 mfd. and the grid leak R1 should be 2 megohms. The by-pass condenser C5 may also be a 0.00025 mfd. unit. The three other by-pass condensers C6, C7, and C8 may be 0.1 mfd. units, all mounted in one case.

Control of Volume

The volume is controlled by means of a 10,000 ohm potentiometer connected across the primary of the first radio frequency transformer T1. The slider is connected to the negative side of the filament circuit. It is better to control the volume in this way by controlling the input than to tamper with the filament current in an endeavor to control the amplification, because the second method results in distortion on strong stations.

The particular method of constructing a circuit of this kind is not very important. Either a metal or an insulating chassis can be used. If the chassis is of metal, the negative side of the heater circuit should not be connected to it but rather the frames of the tuning condensers, which naturally makes the C minus ground.

The layout best suited for the circuit is that which is most convenient. First place the condenser gang on the chassis and arrange it so that the tuning control is in the center of the panel. Then put the three shielded coils along the condensers, away from the moving plates and as close to the condensers as practicable. The r-f tubes should be placed as near the coils and condensers as the layout permits, always placing the sockets so that the plate leads are shortest. There is no need of wasting a lot of time, though, in an endeavor to make the leads half an inch shorter than some other arrangement would make them.

Adding a Tube

Those who wish to build a five tube receiver of the same type, one intended primarily for loudspeaker operation, can follow the circuit diagram in Fig. 2. This shows a stage of pentode amplification added to the circuit in Fig. 1. There are only a few changes in the diagram and a few additions to the list of parts. Another socket is needed, this of the UY type. The filament ballast resistance R2 must be changed to compensate for the increased current. The total current now will be 0.5 ampere. Hence the ballast resistance should be 2 ohms to drop one volt. This ballast may be an amperite intended for a 112 tube on six volts, which has a value of 2 ohms. Or, as before, a rheostat may be used, and this can be of the same value as in the other circuit. If a rheostat is used, the same precautions against giving the tubes too much voltage must be observed.

This two ohm ballast applies to the case when the filament supply is a 3 volt battery. For steady operation dry cells are not economical and it may be better to use an air cell, in which case no ballast is needed. Again, the supply may be a two volt storage battery, in which case also the ballast may be omitted. While the filaments are critical as to filament voltage, they are not so critical that allowance need be made for the change in voltage of a storage cell.

Grid Bias Provision

In both circuits the drop in the ballast resistance is used as part of the grid bias. If the supply voltage is just two volts so that the ballast is omitted, the bias should be increased by means of the grid battery. This refers only to the tap for the screen grid tubes and the first audio tube.

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The Lab Box, A Versa

A-C and D-C Currents and Voltages, Resist

By E. M.

THE advent of the rectifying type voltmeter for measuring both a-c and d-c voltages and currents has made it possible to construct compact testers having a great variety of applications. Indeed, a small laboratory can be put in a small box.

The meter may be used for measuring resistances and for testing continuity, for measuring the capacity of a condenser, since this is the a-c counterpart of the resistance meter, for measuring a-c and d-c voltages and currents in different ranges, and for measuring the output of radio receivers. When the same meter is used for these purposes it is only a matter of arranging the proper switching system to change the instrument from one circuit to another.

Most of the switching can be done with a single four pole double pole switch and two one pole four throw switches ganged together. The four pole double throw switch serves to convert the instrument from an alternating to a direct current instrument, or vice versa. For changing the range of the instrument a one pole four throw switch is used, which is independent of the gang of two similar switches.

It will be noticed that all the parts used in the meter are standard and can be obtained in nearly all radio stores or from manufacturers' stock items.

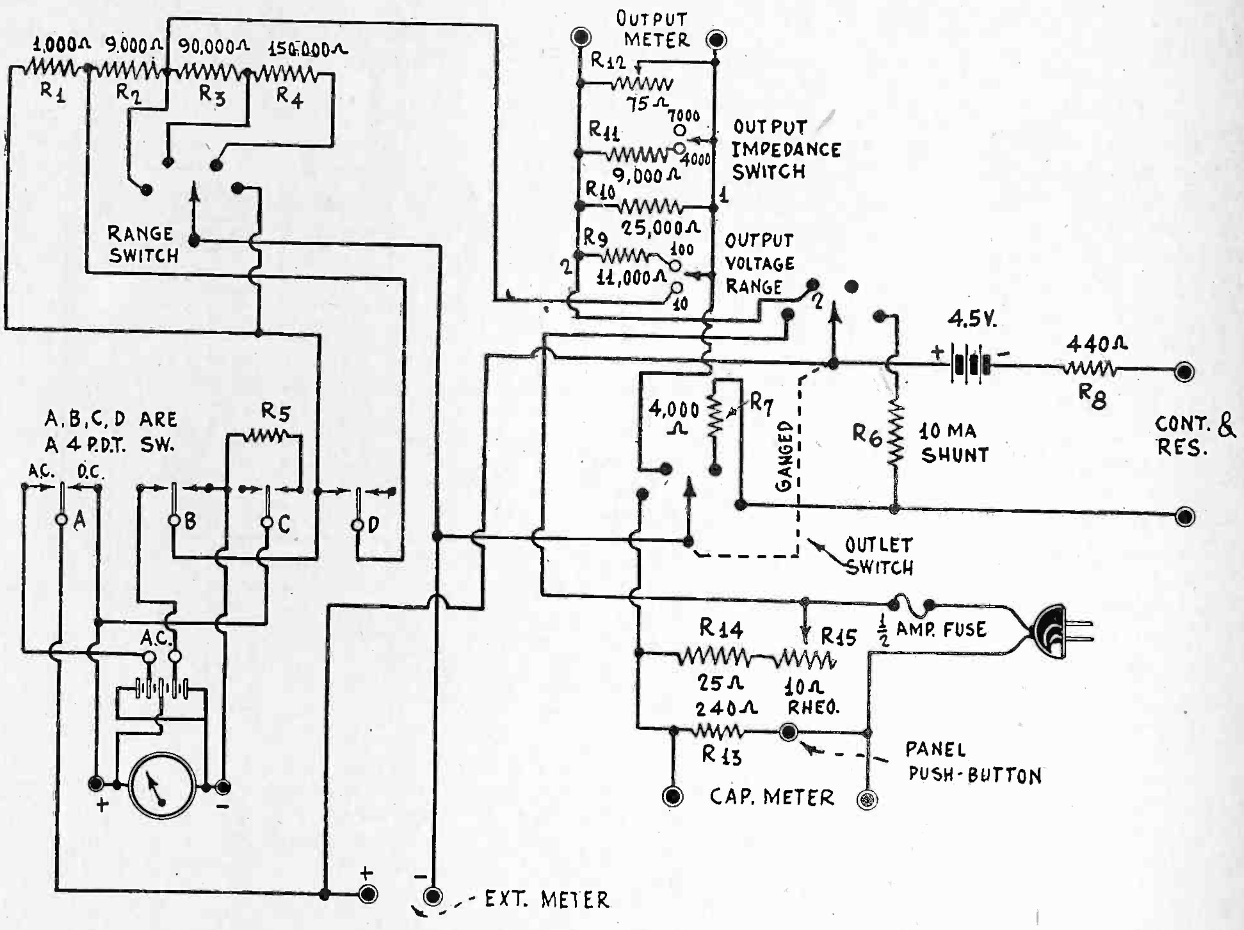


FIG. 1.

The circuit of a multiple laboratory meter utilizing a universal 0-1 meter. The circuit measures capacity, resistance, output voltage, current, and voltage and it may be used on both a.c. and d.c. Photo on front cover, gives the layout of the meter.

Circuit of Tester

In Fig. 1 is a circuit diagram of a tester of this kind. Suppose we wish to measure resistance, which includes the test for continuity. We connect the unknown resistance across the terminals marked "CONT. RES." and turn the switches to the positions indicated for continuity. For any resistance less than 10,000 ohms we set the outlet switch on the extreme right, and we also set the four pole double throw switch on "D. C." This completes a circuit which includes the unknown resistance, a 440 ohm limiting resistance R8, a 4.5 volt battery, and the indicating meter, which is now used as d-c instrument. A scale on the dial of this instrument indicates the correct resistance. It will be noticed that when the circuit is set for reading a resistance of less than 10,000 ohms, a resistance R6 is connected in shunt with the d-c meter. This resistance is supplied with the a-c, d-c instrument.

When a resistance up to 100,000 ohms is to be measured the outlet switch is set on the second position from the right, other connections being the same. In this position the shunt R6 is left open and a 4,000 ohm resistance R7 is connected in series. The resistance scale on the dial now indicates the resistance provided that the reading is multiplied by 10.

Measuring Capacity

The measurement of capacity is based on the same principle as the measurement of resistance but alternating current is used, and instead of employing the 4.5 volt battery the 115 volt a-c line voltage is used as a source of power, there being compensation for other line voltages. Let us consider the simplest case. Suppose we connect a condenser of capacity C in series with an a-c voltage V and an a-c milliammeter. We have a circuit in which alternating current will flow, and this current will be indicated by the meter. If the current is I and the frequency times 6.2832 is w, then $I = VCw$. Thus if V is a constant voltage and w a constant frequency, we can calibrate the scale of the milliammeter in terms of capacity instead of in current units. But electrolytic condensers cannot be measured this way, for they require d-c.

In the instrument in Fig. 1 the circuit is not quite so simple but in principle it is the same. We insert the plug in a 115 volt a-c outlet to give us a source of known voltage and frequency. The 0.5 ampere fuse is used only as a safeguard, of course. The unknown capacity is connected across the two terminals marked "CAP. METER." The purpose of R13 across the capacity terminals will be explained later. The a-c current meter is connected in series with the line but it is shunted by R14 and R15.

Adjusting for Line Voltage

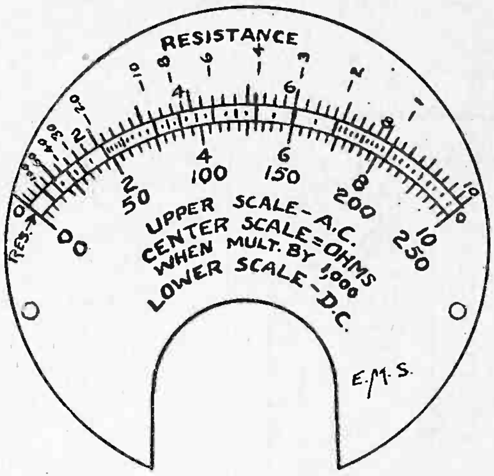
It may be that the voltage of the line is not exactly 115 volts, for which the capacity scale on the universal meter has been calibrated. To insure accuracy when the voltage has some other value, the shunt resistance R15 is varied. Before the condenser is put across the terminals the push-button switch in series with R13 is depressed and R15 is adjusted until the meter reads 10 mfd., or full scale. R13, which has a value of 240 ohms, is equivalent to a capacity of 10 mfd. There is considerable current through R13 when the push-button is depressed. For this reason the adjustment should be made quickly or the resistance will get hot. After the adjustment has been made, the condenser to be measured should be connected across the terminals, when the correct capacity will be indicated on the universal meter. The capacity range is from 10 to about 0.1 mfd.

tile Measuring Device

ance, Continuity and Capacity Determined

Shiepe

FIG. 2.
A reproduction of the scale attached to the meter. This makes it a direct reading ohmmeter, capacity meter, voltmeter, and milliammeter.



When capacity is measured the outlet switch should be set at the extreme left, the four pole, double throw switch should be set on "AC," and the range switch should be set at the extreme left.

External Meter

The terminals marked "EXT METER" are provided to make the universal meter accessible for independent use as a voltmeter, either for a-c or d-c. When a-c voltages are to be measured the four pole double throw switch is moved to the left and when d-c voltages are to be measured it is thrown in the opposite direction. For either position the range switch is set at an appropriate point for the voltage to be measured. There are three positions for voltage, namely, 0-10, 0-100, and 0-250. The scale on the universal meter is appropriately calibrated. The fourth point at the extreme right on the range switch is for current measurement, the range being 0-1 milliampere.

When the meter is used for measuring direct current or voltage and the four pole double throw switch is set at the right, a resistance R5 is shunted across the meter. This is to compensate for the resistance of the rectifying element. In order to make the a-c meter read correctly it has been necessary to make the movement more sensitive to direct current than would have been necessary for a d-c instrument. Hence when it is used for d-c the shunt R5 is necessary to restore the sensitivity of the meter to 0.1 milliampere. The resistance R5 has a value of about 400 ohms and is supplied with the instrument.

Voltage Compensation

It is also necessary to compensate for the resistance of the rectifying element when the meter is used as a voltmeter. The resistance of the rectifier is 1,000 ohms. This must be taken into account when selecting the values of the multiplier resistances when the circuit is to be used on alternating current but not when it is used on direct current. The first resistance R1, of 1,000 ohms value, is this compensator. When the four pole double throw switch is set for the a-c position this resistance is shorted out by means of the D section of the switch. The internal resistance of the rectifier takes its place. When the meter is set for direct current the D section of the switch is open and R1 is in series with the d-c meter. The C section of the switch controls the shunt resistance R5 and it connects this resistance in shunt at the same time that the D section puts R1 in series.

Output Voltage Measurements

As an output meter the instrument is essentially an a-c voltmeter. The outlet switch is set on the second position from the left, as is the range switch, and the four pole, double throw switch is set in the left position. These changes connect the two "OUTPUT METER" terminals across the voltmeter with the proper resistances in series with the instrument.

The output meter can be used in several combinations. In the first place it may be used for measuring the voltage across the voice coil, in which case the meter is substituted for the voice coil and by means of R12 the meter impedance is adjusted to approximate equality with the voice coil impedance. Since the voice coil voltage will be low the output voltage range switch is set on the 0-10 range. R12 is represented on the panel by a knob, marked VC in the layout drawing of Fig. 2.

The VC control has an off position at the extreme left, and it should be kept in this position except when the meter is to replace the voice coil. The VC control may be used with the output impedance switch in either position without error.

Tube Output Measurements

Many output measurements are made in the plate circuits of power tubes, through an appropriate filter to eliminate the d-c component of the current. When the output of a 245, a 171A, or any tube having about the same output impedance, the output meter should be adjusted so that its impedance is 4,000 ohms in order to get the correct voltage reading on the output meter. If the output of a 247 pentode, or any tube having an output impedance equal to that of this tube, the output meter should be adjusted to an impedance of 7,000 ohms. The output impedance switch provides for this change. The circuit has been adjusted for 7,000 ohms and when it is to be changed to 4,000 ohms it is only necessary to throw a 9,000 ohm shunt across the line, or more accurately, 9,350 ohms. This is resistance R11. It should be noted that the error in using 9,000 ohms in place of 9,350 ohms is entirely negligible. For, in the first place, it causes only a small change in the load impedance on the tube, and, in the second, a small change in the load impedance causes only a minute change in the output voltage.

Multiplier Resistances

The multiplier resistances R1, R2, R3 and R4 are based on the fact that the meter takes one milliampere at full scale so that the voltmeter is a 1,000 ohms per volt instrument. On the 10-volt scale the total resistance is 10,000 ohms, on the 100-volt scale, 100,000 ohms, and on the 250-volt scale, 250,000 ohms. These resistors should be wire-wound to an accuracy of one per cent. or better. Moreover, these resistors should be wound non-inductively since they are to be used on a-c as well as d-c.

The resistors in the output meter circuit are not very important and may be carbon resistors.

It is not practical to extend the range of the meter as a milliammeter, particularly on a-c, because the impedance of the meter is not constant so that shunts would not give accurate readings.

The rectifying meter is calibrated at commercial frequencies but it holds quite accurately for frequencies up to 35,000 cycles per second. Beyond that, the readings are too low due to the capacity in the rectifying element.

Although the instrument is inaccurate at radio frequencies, it is possible to measure the gain per stage at radio frequencies, provided that it is done at one frequency. The error will be the same in both positions but the ratio will be correct. That is, provided that there is enough to measure. When the amplification in the radio frequency amplifier is to be measured it is better to measure the audio frequency output twice, one with the stage of r-f cut out and again with it in. This is simple when the r-f amplifier employs screen grid tubes, for then it is only necessary to move a grid clip to cut out a stage.

It is not advisable to attempt to measure currents or voltages of very high frequencies because the capacity current, which is not indicated by the instrument, might damage the rectifying element. It is best to confine the use of the instrument to direct and audio frequency currents and voltages.

In case it becomes necessary to measure radio frequency voltages, this can be done indirectly with the instrument. A vacuum tube voltmeter is first constructed and calibrated against the universal instrument. This vacuum tube voltmeter can then be used to measure radio frequency voltages.

Small capacities of the order of 0.02 mfd. cannot be measured directly with the instrument for the same reason that extremely high resistances cannot be measured accurately with an ohmmeter, unless it has been designed especially for it. However, it is still possible by means of this universal instrument to measure smaller capacities. If the meter, set for measuring alternating current, is connected in series with 115 volts, 60 cycles, and the condenser the capacity of which is to be measured, the relation between microfarads, and milliamperes is C=0.0231. Since a current as small as 0.1 milliampere can be measured, it follows that a capacity as small as 0.0023 can also be measured.

[Other illustration on front cover]

A Simplified Converter

Any Intermediate Frequency May B

By Ja

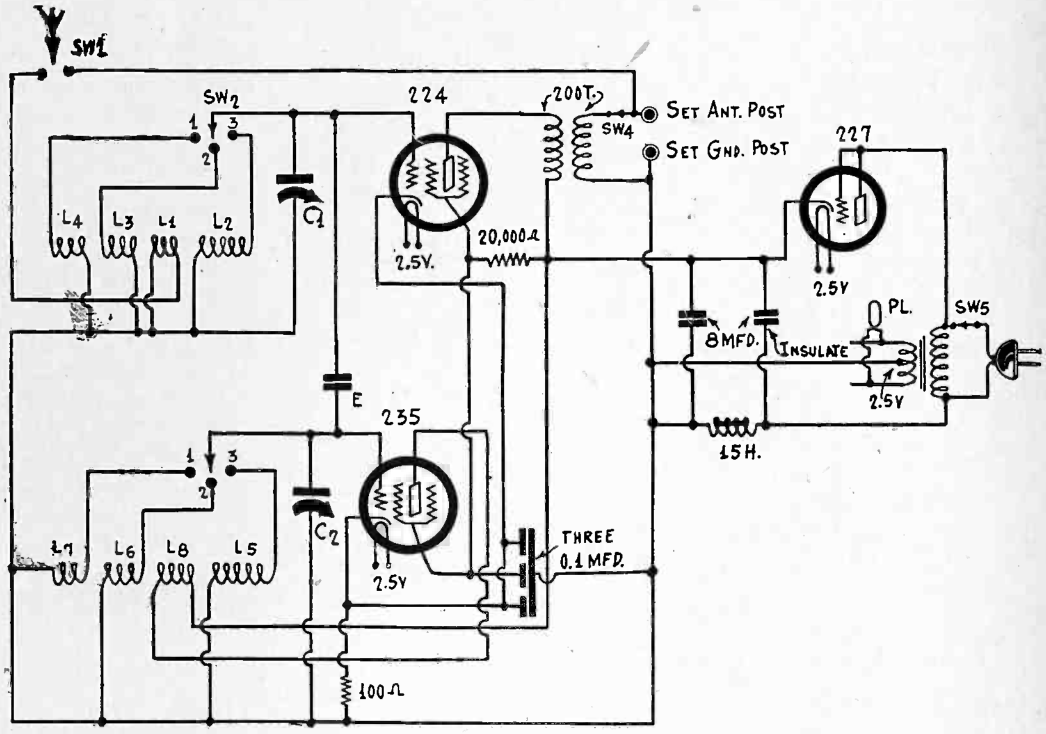


FIG. 1
A very simple a-c operated short-wave converter, 15 to 200 meters, that affords very excellent results and avoids or solves several difficulties. The coupling problems are treated with especial care.

IN almost every issue of radio publications there is a short wave converter circuit, and always there is something different from the other circuits. Sometimes a stage of built-in intermediate frequency amplification is featured, other times padding of oscillator for various ranges so that single tuning control may be enjoyed, other times wave traps to stop direct interference from broadcast stations. Therefore each converter must have its purpose. The object of the present one is to afford best results, with unmost simplicity, and without resort to any intricate or difficult work, such as padding. Moreover, any intermediate frequency of which the receiver is capable may be used.

The system herewith illustrated (Fig. 1) contemplates the use of two separate tuning condensers, and since for the first two (lowest frequency) bands there will be considerable dissimilarity the modulator condenser, C1, is of larger capacity than the oscillator condenser, C2. Each is tuned separately, the oscillator condenser with a vernier dial, the modulator condenser with a knob, and this independent tuning makes possible the selection of any intermediate frequency the set affords. All gang tuning systems, whether or not intermediate frequency stages are built in, leave no choice as to the intermediate frequency to be used.

LIST OF PARTS

Coils

Modulator and oscillator coils on two forms, as described.
Two 200 turn honeycomb coils, to be put together to constitute a transformer, as described.
One 2.5 volt filament transformer with center-tapped secondary.
One 15 henry B supply choke coil, about 400 ohms d-c resistance.

Condensers

One 0.00035 mfd. junior midline condenser, C1.
One 0.0002 mfd. junior midline condenser, C2.
One shielded block containing three 0.1 mfd. condensers (black, common, to ground, reds interchangeable to destinations).
Two 8 mfd. electrolytic condensers, one with insulating washers and connecting lug in case metal panel is used.

Resistors

One 0.02 meg, pigtail resistor (20,000 ohms), but may be up to 0.075 meg. (75,000 ohms).
One 100 ohm pigtail resistor.

Miscellaneous

One a-c cable and male plug.
One rotary selector switch, insulated shaft type, two decks, three points for connection on each deck.. (SW-2, SW-3).
One single pole double throw switch (SW-1).
One optional push-pull switch (SW-4).
One a-c shaft type switch (SW-5).
One chassis.
Three UY sockets.
One front panel.
One vernier dial with pilot lamp.
One knob for dial, one for C1.
One 224, one 235 and one 227 tubes.

Troubles Considered

The tuning condensers preferably should be of the midline or straight frequency line type, so that more leeway is afforded to the knob-actuated modulator condenser when the higher frequencies of the second coil and all the frequencies of the smallest coil are tuned in, since the high capacity settings of the modulator much in excess of the maximum of the oscillator will not be used. This is because the percentage of frequency difference contracts as the frequency is increased. An intermediate frquency of 1,500 kc is 10 per cent. of a carrier frequency of 15,000 kc, but is nearly 100 per cent. of 1,600 kc, and the oscillator has to be "off tune" in respect to the modulator by the absolute amount of the intermediate frequency.

Let us state some of the troubles associated with converters and see whether the present circuit solves them:

(1)—Adequate coupling between antenna and modulator.
(2)—Adequate coupling between modulator and oscillator.
(3)—Adequate coupling between output of converter and the input of the receiver.
(4)—Operation of the receiver at a sensitive frequency.
(5)—Elimination of direct interference from broadcast stations.
(6)—Repeat tuning points, two for each particular carrier.
(7)—Calibration.
(8)—Assurance of oscillation on the smallest coil (where some converters fall down)

hat Is a Real Performer

Jsed, and Sensitivity Is High Indeed

Tully

As to coupling between antenna and modulator, this should provide a good input to the modulator, whether there is r-f ahead of the modulator or not. It has been found from long experience that an untuned r-f stage provides virtually no gain, because if the antenna load is a coil, then the coil may be all right for one band but, being frequency discriminatory, will constitute a "losser" for the other bands, and the main reason for inclusion of an untuned stage would be to reduce radiation. At the expense of not being able to tune in many stations otherwise receivable it is doubtful whether the constructor would desire to be so altruistic. If the coupler is a resistor, then if the resistance is of low value the impedance will be too low, and if it is of high value the capacity effect present will be so great that at the higher frequencies particularly there will be more current sidetracked to ground than delivered to the grid circuit of the tube. That is, the impedance always will be too low. So the first tube may as well be the modulator, as constructing and handling a t-r-f stage would provide altogether too many complications. A series condenser may connect from aerial to grid, but for a strong input the condenser would have to be large, and thus introduce too much of the antenna capacity into the tuned circuit, reducing the frequency range and decreasing the inductance-to-capacity ratio. A stronger input, with less capacity effect, can be provided by a primary winding, and the antenna capacity reflected in the secondary will be smaller even if the separation between windings is as little as 1/16 inch.

Mixer Coupling

As for the coupling between oscillator and modulator, various excellent methods have been presented, including screen, cathode and grid coupling, while plate coupling also has been used, but it is advisable to shun plate coupling because of the strong harmonics. As simple a method as any is the one illustrated, whereby a small condenser, E, of 20-100 mmfd., joins the two grids. There can be no doubt about this coupling, and the only thing to be said against it is that the coupling increases with frequency, instead of remaining constant, yet virtually all methods used, that work the tubes at their best, do the same thing. When resistors are used in screen or cathode circuits, the common resistor can have no bypass condenser across it, as this would remove the coupling, and with the bypass condenser omitted there is negative feedback, which means greatly lessened sensitivity. So it is well to serve practice, rather than theory, since inversely varying coupling is indeed better than no or poor results. Since E is adjustable, it may be used with plates about half way in, affording a little more than the minimum capacity required for coupling at the lowest frequency.

Output Circuit

The output is a transformer, which is unusual in converters, but it is well to use a transformer, for then a screen grid modulator becomes practical, especially if the impedance of the primary is suitable for broadcast frequencies (from which the intermediate frequency will be selected). The transformer used consisted of two 200 turn honeycomb coils, about ¼ inch apart. These were commercially wound on separate dowels, the short dowel extremes being connected end to end, a screw running through the core hole and permitting fastening to the subpanel. Thus the ratio was 1-to-1, and the plate load was adequate. The coupling being loose, the effect of the load on the secondary (normally primary of the antenna coil of the set) becomes confined almost exclusively to the transformer's secondary, and enabling even a high impedance (screen grid) tube to work properly into a low impedance load.

Since any intermediate frequency may be selected, the receiver can be worked in its most sensitive range. If there is a powerful local on or near a particular frequency you will have to choose an intermediate frequency in the high sensitivity range that does not bring about interference. Receivers are not normally highly sensitive at a particular frequency, but rather over a range of frequencies, so a choice within the range is afforded. Poor selection of the intermediate frequency will result in direct reception of broadcasting, or as a high audio frequency whistle, so to remove either, select some other intermediate frequency.

Repeat Points

Repeat tuning points may occur. These are due to the possibility of tuning the oscillator, since it is independently actuated, to a frequency either higher than or lower than the modulator frequency. The difference in either case is the intermediate frequency. The higher the intermediate frequency, the fewer the occasions of repeat tuning. Repeats will be confined to strong short wave stations. Since the modulator is tuned to the incoming signal, this stage is not affected by the repeats, so only in the oscillator tuning will they be present. They afford an advantage, besides a slight inconvenience, since the alternate setting may bring in without interference a station that on the other setting had considerable interference, and although the higher frequency setting is usually the more sensitive, sometimes the other one is.

Calibration

Calibration may be effected as soon as the favorable intermediate frequency is selected. So long as the same intermediate frequency is used the calibration holds, particularly as it is the oscillator that is tuned by the dial. The modulator tuning is not at all critical, except on weakest signals, hence needs only a knob.

Oscillation will be present on even the smallest coil, as the simplified coil construction varies the mutual impedance between the single plate and multiple grid windings of the oscillator for the three wave bands. If the winding is done on the basis of oscillation for the smallest winding, there will be oscillation when the other grid windings are used.

Coverage and Switching

There are other considerations, such as wave band coverage, switching, rectifier and type of tubes. The band coverage is determined principally by the condenser capacity ratio. With the 0.000325 mfd. condenser used in the modulator circuit the ratio, including minimum capacities of all types, is 10-to-1, and the frequency ratio is the square root of that, a little more than 3-to-1. This ratio prevails only on the first band, because of the relatively greater effect of the minimum capacity at the higher frequencies. However, the moulator will tune from 1,500 to 4,500 kc when L2 consists of 45 turns of No. 28 enamel wire. The lowest intermediate frequency, of 550 kc, would require that the oscillator tune from 2,050 to 5,050 kc, a frequency ratio of about 2.5 to 1, and this may be slightly exceeded by a 0.0002 mfd. condenser used in the oscillator circuit, for the ratio then is 2.6-to-1. And, if the highest frequency is used, say, 1,500 kc, then the oscillator should tune from about 3,000 to 5,000 kc, whereas it would tune, if begun at 3,000 kc, to 7,500 kc. This simply means that for the first band, since the modulator tuning is a limiting factor, the oscillator dial covers more than the band permitted by the modulator, but "missing" frequencies will be found when the next coil system is introduced. However, the necessity for providing for intermediate frequencies at least 1,050 kc apart requires enough inductance on the first oscillator grid coil to enable response at 550 kc intermediate, so 30 turns will be used for L5. Then the tuning starts at 2,050 kc and goes to around 5,000 kc. Now, 5,000 kc is high enough to have the oscillator rightly "off tune" for 550 kc, so the one coil serves all the intermediate frequencies.

The modulator is subject to 2.5 ratio for the next coil, so the number of turns for L3 is 18, and the oscillator has a 2.3 ratio, so the number of turns for L6 is 13. For the smallest coil the oscillator is controlling, and with a ratio of slightly better than 2-to-1, so that the two coils may be the same, 9 turns each. The range is 15 to 200 meters, all told.

Switching

The switches for this purpose are SW-2 and SW-3, and they are on one shaft. Access is at the front panel. SW-1 switches the antenna from converter to set. If you desire you may use also SW-4, so that when aerial is connected to set the secondary of the output transformer will not be across the receiver input impedance, for it reduces signal strength a little in some instances.

The rectifier is of the simple type requiring only a filament transformer. The tube used is a 227. The 15 henry choke is in the negative leg, so if a metal penal is used, insulate the identified 8 mfd. electrolytic condenser. If a wooden or bakelite panel is used that alone is insulation enough. The other tubes are 224 modulator and 235 oscillator, the same bias making one a modulator and the other an amplifier.

(*See coil diagram on page* 20)

Chronology of Radio

Highlights of Progress in U.S. Bureau Report

An epitomized history of radio is contained in the report, "Radio Activities of the Department of Commerce," rendered by W. D. Terrell, director of the Radio Division of the Department. This chronology is reprinted herewith in full, with permission of the Department:

1827. Savary found that a steel needle could be magnetized by the discharge from a Leyden jar.

1831. Faraday discovered electromagnetic induction between two entirely separate circuits.

1837. The first patent for an electric telegraph was taken out by Cooke and Wheatstone (London) and by Morse (United States).

1838. Steinheil discovered the use of the earth return.

1840. Henry first produced high-frequency electric oscillations and pointed out that the discharge of a condenser is oscillatory.

1842. Morse made wireless experiments by electric conduction through water.

1843. Lindsay suggested that if it were possible to provide stations not more than 20 miles apart all the way across the Atlantic there would be no need of laying a cable.

1845. Lindsay made experiments in transmitting messages across the River Tay by means of electricity or magnetism without submerging wires, using the water as a conductor.

1849. Wilkins revived the same suggestions for wireless telegraphy.

Doctor O'Shaughnessy succeeded in passing intelligible signals without metallic conduction across a river 4,200 feet wide.

1862. Heyworth patented a method of conveying electric signals without the intervention of any continuous artificial conductor.

1867. Maxwell read a paper before the Royal Society in which he laid down the theory of electromagnetism, which he developed more fully in 1873 in his great treatise on electricity and magnetism. He predicted the existence of the electric waves that are now used in wireless telegraphy.

1870. Von Bezold discovered that oscillations set up by a condenser discharge in a conductor give rise to interference phenomena.

1872. Highton made various experiments across the River Thames with Morse's method.

1879. Hughes discovered the phenomena on which depends the action of coherer. The coherer was later used practically by Marconi.

1880. Trowbridge found that signaling might be carried on over considerable distances by electric conduction through the earth or water between places not metallically connected.

1882. Bell's experiments with Trowbridge method on the Potomac River resulted in the detection of signals at a distance of 1½ miles.

Professor Dolbear was awarded a United States patent in March, 1882, for wireless apparatus in connection with which he made the statement that "electrical communication, using this apparatus, might be established between points certainly more than one-half mile apart, but how much farther I can not say." It appeared that Professor Dolbear made an approach to the method that was, subsequently in the hands of Marconi, to be crowned with success.

1883. Fitzgerald suggested a method of producing electromagnetic waves in space by the discharge of a conductor.

1885. Edison, assisted by Gilliland, Phelps, and Smith, worked out a system of communication between railway stations and moving trains by means of induction and without the use of conducting wires. Edison took out only one patent on long-distance telegraphy without wires. The application was filed May 23, 1885, at the time he was working on induction telegraphy, but the patent (No. 465971) was not issued until December 29, 1891. In 1903 it was purchased from him by the Marconi Wireless Telegraph Co.

Preece made experiments at Newcastle-on-Tyne which showed that in two completely insulated circuits of square form, each side being 440 yards, placed a quarter of a mile apart, telephonic speech was conveyed from one to the other by induction.

1886. Dolbear patented a plan for establishing wireless communication by means of two insulated elevated plates, but there is no evidence that the method proposed by him did, or could, effect the transmission of signals between stations separated by any distance.

1887. Hertz showed that electromagnetic waves are in complete accordance with the waves of light and heat, and founded the theory upon which all modern radio signaling devices are based.

Teaviside established communication by telephonic speech between the surface of the earth and the subterranean galleries of the Broomhill Collieries, 350 feet deep, by laying above and below ground two complete metallic circuits, each about 2¼ miles in length, and parallel to each other.

1892. Preece adopted a method which united both conduction and induction as the means of affecting one circuit by the current in another. In this way he established communication between two points on the Bristol Channel and at Lochness in Scotland.

Branly devised an appliance for detecting electromagnetic waves, which was known as a coherer.

1894. Rathenau experimented with a conductive system of wireless telegraphy and signaled through 3 miles of water.

1895. Marconi's investigations led him to the conclusion that Hertzian waves could be used for telegraphing without wires.

1896. Marconi lodged his application for the first British patent for wireless telegraphy. He conducted experiments in communicating over a distance of 1¾ miles successfully.

The first demonstration of directional wireless using reflectors was given in England. Experiments were conducted to determine the relative speed of propagation of light waves and the electric vibrations which actuated a receiver at a distance of 1½ miles between reflectors.

1897. March: Marconi demonstrated communication being established over a distance of 4 miles.

March 17: Balloons were first used for the suspension of wireless aerials.

July 10-18: Marconi maintained communication between the shore and a ship at sea distances up to 10 miles.

September and October: Apparatus was erected at Bath, England, and signals received from Salisbury, 34 miles distant.

November 1: First Marconi station erected at the Needles, Alum Bay, Isle of Wight. Experiments were conducted covering a range of 14½ miles.

December 7: First floating wireless station was completed.

1898. June 3: The first paid radiogram was transmitted from the Needles (Isle of Wight) station.

July 20-22: Events of the Kingstown regatta in Dublin reported by wireless for a Dublin newspaper from steamer *Flying Huntress.*

1899. The American battleships *New York* and *Porter* were equipped with radio apparatus.

July: During the naval maneuvers three British warships equipped with Marconi apparatus interchanged messages at distances up to 74 nautical miles (about 85 land miles).

The international yacht races (yachts *Shamrock* and *Columbia*), which took place in September and October, were reported by wireless telegraphy for the "New York Herald." At the conclusion of the races series of trials were made between the United States cruiser *New York* and the battleship *Massachusetts,* signals being exchanged between the vessels at distances up to 36 miles. On the return journey from America Marconi fitted the steamship *St. Paul* with his apparatus, and on November 15 established communication with the Needles station when 36 miles away. Reports of the progress of the war in South Africa were telegraphed to the vessel and published in a leaflet entitled "The Transatlantic Times," printed on board.

1900. Between 1900 and 1905 Doctor De Forest was granted numerous patents in the United States and other countries for inventions connected with wireless telegraphy.

1901. January 1: The bark *Medora* was reported by wireless as water-logged on Ratel Bank. Assistance was immediately sent.

January 19: The *Princesse Clementine* ran ashore, and news of the accident was telegraphed to Ostend by wireless.

February 11: Communication was established between Niton Station, Isle of Wight, and the Lizard station, a distance of 196 miles.

March 1: A public wireless telegraph service was inaugurated between the five principal islands of the Hawaiian group, viz, Oahu, Kauai, Molaki, Maui, and Hawaii.

August 16: According to reliable sources the first regularly operated commercial communication stations in the United States were placed in commission. They were located at Siasconset (Nantucket), Mass., and on Nantucket Shoals Lightship *No. 66.* The first exchange of messages was with the ocean liner *Lucania,* when she was 72 miles east of Nantucket. The "New York Herald" owned and operated the stations and the greater part of the work during the earlier days consisted of reporting passing vessels which data the "Herald" published in its daily marine news.

October 15: The first fan aerials were erected for experiments between Poldhu and Newfoundland.

December 12: The letter "S" was received by Marconi from Poldhu, England, at St. Johns, Newfoundland, a distance of 1,800 miles.

Prof. R. A. Fessenden applied for United States patent on September 28 for "Improvements in apparatus for the wireless transmission of electromagnetic wave, said improvements relating more especially to the transmission and reproduction of words or other audible signals." It appears that in connection with this apparatus there was contemplated the use of an alternating-current generator having a frequency of 50,000 cycles per second. Professor Fessenden was granted a number of United States patents between 1890 and 1905 covering devices used in connection with radiotelegraphy.

1901-1904. During this period Dr. John Stone was granted more than 70 United States patents covering radiotelegraphy.

1901-1905. More than 40 United States patents were granted to Harry Shoemaker covering certain apparatus used for radio communication.

1902. February: Steamship *Philadelphia*, American Line, received messages a distance of 1,551½ statute miles and received Morse signals up to a distance of 2,099 statute miles from Poldhu station, Cornwall, England.

June 25: The first moving wire magnetic detector actuated by clockwork was installed on the Italian cruiser *Carlo Alberto*.

December: On the seventeenth the first wireless message was transmitted across the Atlantic. On the eighteenth wireless messages were dispatched from Cape Breton station to King Edward VII.

1903. March 30: First transoceanic radiogram was published in the London Times.

August 4: First International Radiotelegraphic Conference was held at Berlin.

Poulson patented the improved arc oscillation generator, using a hydrocarbon atmosphere and a magnetic field.

1904. January 20: The first press message was transmitted across the Atlantic.

August 15: The wireless telegraph act of Great Britain was passed.

November 16: Dr. J. Ambrose Fleming took out his original patent No. 24850 for thermionic valves.

1905. In October of this year erection of Clifden, Ireland, high-power radio station was commenced.

1906. Doctor De Forest was granted a patent on January 18 for a vacuum rectifier, commercially known as the audion.

Second International Radiotelegraphic Convention was held at Berlin, and a convention was signed by a majority of the principal countries of the world.

Dunwoody discovered the rectifying properties of carborundum crystals and Pickard discovered the similar properties of silicon crystals. These discoveries formed the basis of the widely used crystal detectors.

1907. Tests of radio apparatus, including radiotelephone, were carried out through the use of facilities of the United States Navy, the first shipboard radiotelephony tests being conducted in 1907 and 1908 during a world cruise.

1908. February 3: Transatlantic radio stations were opened to the general public for the transmission of messages between the United Kingdom and the principal towns in Canada.

In carrying out his invention Professor Fessenden constructed a high-frequency alternator with an output of 2.5 kilowatts at 225 volts and with a frequency of 70,000 cycles per second. Later Professor Fessenden reported successful wireless telephonic communication between his station located at Brant Rock, Mass., and Washington, D. C., a distance of about 600 miles.

October 15: A 10-kilowatt station was placed in operation at Kahuku Point, Oahu, Hawaii, at which time it was probably the most powerful station on the Pacific Ocean. Night communication was established with the station of the United Wireless Co., located on Telegraph Hill, San Francisco, Calif. This was the first direct radio communication between Hawaii and the United States, a distance of 2,100 miles.

During 1908 to 1911 the United States Navy built the first substantial highpower radio traffic station at Arlington, Va.

1910. The steamship *Principessa Mafalda* received messages from Clifden at a distance of 4,000 miles by day and 6,735 miles by night. On April 23 the Marconi trans-Atlantic (Europe-America) service was opened.

June 24: Act approved by the United States Government requiring radio equipment and operators on certain passenger-carrying vessels.

1911. July 1: Radio service organized in Department of Commerce and Labor to enforce the act of June 24, 1910.

1912. F. A. Kolster, of the Bureau of Standards, invented and developed the Kolster decremeter, which is used to make direct measurements of wave length and logarithmic decrement. This instrument has been used by the radio service of the Department of Commerce since it was invented.

In February the Marconi Co. procured the patents of Bellini and Tosi, including those for the wireless direction finder.

On February 9 the Australian Commonwealth station was opened.

On April 15 the steamship *Titanic,* on her maiden voyage, struck an iceberg and sank, but owing to the prompt wireless call for assistance the lives of more than 700 of her passengers were saved.

The International Radiotelegraphic Conference opened in London on June 4 and approved important regulations to have uniformity of practice in wireless telegraph services. On July 5 the International Radiotelegraphic Convention was signed at London.

July 23: Act approved by the United States Government extending act of June 24, 1910, to cover cargo vessels and requiring auxiliary source of power, efficient communication between the radio room and the bridge, and two or more skilled radio operators in charge of the apparatus on certain passenger-carrying vessels.

August 13: Act approved by the United States Government licensing radio operators and transmitting stations.

1913. F. A. Kolster submitted to the Government a paper pointing out the advantages of certain applications of radio signaling for use at lighthouses, lightships, and life-saving stations, especially in time of fog.

During this year the Governments of France and the United States experimented between the Eiffel Tower station and Washington by wireless to procure data for comparing the velocity of electromagnetic waves with that of light.

On October 11 the *Volturno* was burned in mid-Atlantic, and in response to the wireless appeal 10 vessels came to the rescue, 521 lives being saved.

November 12: Safety at Sea Conference held in London. At this conference the use of radio received appropriate consideration.

On November 24 the first practical trials with wireless apparatus on trains were made on a train belonging to the Delaware, Lackawanna & Western Railroad.

The station at Macquerie Island was the means of keeping Doctor Mauson, the Australian explorer, in touch with the outer world. Radio dispatches were published in a small journal which was established, called the Adelle Blizzard.

1914. Experiments in wireless telephony were carried out between several vessels lying at anchor five-eighths of a mile apart, ordinary receivers being used with success. The wireless-telephone experiments were continued between two warships on the high seas, and the reception was consistently good over a distance of 18½ miles. Successful wireless-telephone communications were effected later, using only very limited energy, between vessels on the high seas 44 miles apart. These experiments were repeated where land intervened between the communicating vessels, and in this case again excellent results were obtained. On this day radiotelephonic communication was constantly maintained for 12 hours.

On April 15, at Godalming, England, a memorial was unveiled to the memory of Jack Phillips, chief radio operator of the ill-fated *Titanic,* who died at his post when the vessel foundered in mid-Atlantic on the 15th of April, 1912.

A new departure in the application of radiotelegraphy to the safety of life at sea was the equipment of the motor lifeboats of the steamship *Aquitania with radio apparatus.*

High-powered transoceanic stations were completed at Carnarvon, Wales, Belman, Honolulu, and San Francisco during the autumn of 1914. The Honolulu-San Francisco stations were opened to public service September 24. The Tuckerton-Eilvese and Sayville-Nauen stations were in operation about this time.

Most of these stations made use of the latest developments in the art, using undamped and long waves as produced by the Poulsen arc and the radio-frequency alternator.

On October 6 E. H. Armstrong was issued a patent covering the regenerative circuit also known as the feed-back and the self-heterodyne circuit.

During 1914 and 1915 the United States Navy duplexed its principal shore stations in order that these stations could communicate with ships and with each other simultaneously.

1915. During this year F. A. Kolster, of the Bureau of Standards, developed a radio compass said to be more effective than that which was being used.

April 1: Service was established between the station at Wahiawa, Oahu, Hawaii, and the United States naval station at Tutuila, Samoa Islands, a distance of 2,400 miles.

On May 12, in Battery Park, New York City, the mayor unveiled the monument in memory of wireless operators who had lost their lives at the post of duty.

On July 27 wireless communication between the United States and Japan was effected. Two terminal stations were located at San Francisco and Funabashi, near Tokyo, and the messages were relayed through Honolulu.

On July 28 the American Telephone & Telegraph Co., working in conjunction with the Western Electric Co., succeeded in telephoning the wireless across the American Continent from Arlington to Hawaii, a distance of nearly 5,000 miles.

On October 26 the wireless telephone experiments were continued, communication being effected across the Atlantic from Arlington to the Eiffel Tower, Paris.

During this year ship service was greatly improved through the installation of new equipment, embodying features of great practical value, by various operating companies. Efficient emergency radio transmitters came into wider use, owing considerably to the efforts of the radio service of the Department of Commerce and its refusal to pass inefficient equipment.

1916. During the course of a severe blizzard in the United States during February wireless telegraphy was extensively used for train dispatching, as the telegraph wires were down.

The determination of the difference in longitude between Paris and Washington with the aid of radio which had been in progress since October, 1913, was completed during May, the result, expressed in terms of time, being 5 hours 17 minutes 35.67 seconds, and has a probable accuracy of the order of 0.01 second.

The initiation of the newly established trans-Pacific wireless service between the United States and Japan was celebrated on November 5 by an interchange of messages between the Mikado and President Wilson.

1917. June 2 marked the "coming of age" of wireless telegraphy in England; that is ,that 21 years had elapsed since the registration of patent 12039 in 1896.

1918. The trend of progress toward continuous-wave communication as distinct from that by damped waves was very marked during this year, a particular impetus being given by the continued development of the electron tube as an efficient receiver and generator of undamped oscillations. Steady improvement was also evident in the arc form of generator which was installed in many new high-power stations.

(*Continued on next page*)

(*Continued from preceding page*)

Wireless telephony also progressed to a marked extent, particularly in the direction of reliability and increase of range, due mainly to the development of valve generators and receivers.

In the equipment of aircraft with wireless great progress was made, both in radiotelegraphy and radiotelephony.

In April a high-power station was opened at Stavanger, Norway, for the use of the Norwegian Government. The station communicates with the United States.

In the Argentine the erection of a station destined for direct communication with the North American Continent was commenced in the vicinity of Buenos Aires.

On July 31 the United States Government took over all wireless land stations in the United States, with the exception of certain high-power stations, which remained under the control of commercial companies.

On September 22 messages transmitted from Carnarvon were received in Sydney, 12,000 miles away. Cable confirmations of these messages were sent forward at the same time, but were received some hours later than the corresponding radiotelegrams.

At the end of the year a high-power station, erected by the United States Government, was opened at Croix d'Hins, near Bordeaux.

1919. The successful trans-Atlantic flights of Alcock and Brown, of the American *NC4* and of the British dirigible *R34* during the summer of the year focused attention upon the application of radio for aviation purposes and its great value for aerial navigation.

In February a Spanish decree was issued to the effect that all sailing vessels of 500 tons or over and carrying 50 or more passengers must be equipped with wireless apparatus.

On June 30, 1919, there were 2,312 ship stations of the United States, having increased from 1,478 on June 30, 1918. At this time new ship stations were increasing at the rate of 100 a month. This increase was due to the great number of vessels built during the war period.

During the year the Radio Corporation took over the radio interests of the American Marconi Co.

The war-time ban on private and experimental wireless stations was removed.

1920. The steady development of continuous-wave wireless work was continued during the year and some further progress made in the commercial application of tube apparatus.

1921. Experiments were carried out in France with successful results in the application of Baudot and similar high-speed telegraph apparatus to radio work.

The progress made in amateur and experimental wireless is exemplified by the attempts made in February and December of this year to effect communication on short-wave lengths between the wireless amateurs of the United States and Great Britain. The first attempt was unsuccessful, but during the second test signals from many American amateur stations were heard both by British radio amateurs and by the representative of the American Radio Relay League who was sent over for the tests. The signals were also heard in Holland.

The American Radio Relay League held its first annual convention in Chicago, August 30-September 3, at which many thousands of amateurs of the United States were present.

The first licenses for broadcasting stations in the United States were issued in September of this year.

New York radio central station opened on Long Island.

1922. During this year broadcasting stations increased rapidly in keeping with the great interest taken in the art.

First Annual Radio Conference held in Washington, D. C., February 27.

On June 7 E. H. Armstrong read a paper before the Institute of Radio Engineers on some recent developments by him of regenerative circuits. Professor Armstrong was granted a patent for the superregenerative circuit.

Experiments in radiotelephony from ship to shore were conducted during this year. In tests from the steamship *America* it was proved possible to communicate with land telephone stations more than 400 miles distant from the ship.

1923. On March 2 L. A. Hazeltine, of Stevens Institute of Technology, presented a paper before the Radio Club of America on tuned radiofrequency amplification with neutralization of capacity coupling. Professor Hazeltine was granted a patent for the nonradiating neutrodyne receiver.

On March 4 the Cleveland. Ohio (KDPM), station of the Westinghouse Electric & Manufacturing Co. successfully repeated short waves from the East Pittsburgh, Pa. (KDKA), station for the first time in history.

Second Annual Radio Conference held in Washington, D. C., March 20.

The Marconi Co. made a tender, which was accepted, for the erection of a transmitting station in Australia of a power of 1,000 kilowatts with 20 steel masts, 800 feet high. Corresponding stations were to be provided in England and Canada. The receiving arrangements would permit simultaneous reception from five stations.

The construction of a large radio station in a valley between the Herzogstand and the Stein, two of the foothills in the Bavarian Alps, was undertaken. The aerial was suspended by wire cables stretched between the tops of the two hills, the aerial wires being suspended from these cables.

The increase in traffic on some of the large liners of the Atlantic route led to the installation of apparatus for high-speed automatic transmission and reception on several lines.

Successful tests on wireless-controlled airplanes were carried out at the Etampes Aerodrome in France. Flights were made without a pilot. Flights were also made with a pilot using a gyroscopic stabilizer and special steering motors which could be controlled from the ground.

The International Commission for Aerial Navigation agreed, as a general principle, that all aircraft engaged in public transport must carry radio apparatus.

The General Electric Co. developed a tube capable of delivering 20 kilowatts of high-frequency energy to an aerial. Using six of these tubes in parallel with 15,000 volts on the anode, a current of 310 amperes in an Alexanderson multiple-tuned aerial was obtained. A tube of the magnetron type was developed by the same company capable of giving 1,000 kilowatts at 20,000 cycles with an efficiency of 70 per cent.

Short waves were used to greater advantage than heretofore.

The McMillan expedition to the polar regions had radio as their only means of direct communication. Using low power and short waves, their vessel, *Bowdoin*, communicated with several stations in the United States while they were frozen in thousands of miles away. Broadcasting concerts from United States stations were heard during the long dark nights of the Arctic Zone.

During the year foreign countries became interested in radiotelephone broadcasting.

Broadcasting in the United States heard in England. British programs were also heard in the United States.

November 26: 2-way amateur communication was conducted for the first time between a station in the United States and a station in a foreign country. Station 1MO, West Hartford, Conn., operated by Fred Schnell, and station 8AB, Nice, France, operated by Leon Deloy, were the participants. The transmissions were made on a wave length of 100 meters. Stations IXAM and 1QP, operated by John Rineartz, South Manchester, Conn., also was successful in communicating with 8AB.

On December 31, East Pittsburgh, Pa. (KDKA), transmitted a program to Great Britain on a short wave.

1924. The high-power station at Monte-Grande, Argentina, was opened in January for direct communication with New York, Paris, and Berlin. The service to be extended to Great Britain when a corresponding transmitting station was available. The power of the station was 800 kilowatts, the aerial being carried on 10 masts, each 690 feet high. The receiving station was at Villa Eliza, 30 kilometers from Buenos Aires, the actual control being effected from a central office in Buenos Aires.

On February 5 a radio program broadcasted in the United States from the East Pittsburgh, Pa. (KDKA), station of the Westinghouse Electric & Manufacturing Co. was received and rebroadcast in England for the benefit of English stations.

On February 23 a concert broadcast by the same station and relayed from London, England, was heard clearly in Calcutta, India.

In July an agreement was concluded between the British Government and the Marconi Wireless Telegraph Co. (Ltd.) for the construction of a wireless station on the beam system, capable of communicating with Canada and of being extended to India, South Africa, and Australia, the transmitting station to have an input of at least 20 kilowatts and the receiving station to have an aerial designed to focus the received waves within an angle of 30°.

The short-wave direction system of radiotelegraphy and the results obtained in tests made on it were described in a lecture before the Royal Society of Arts, in July by Senatore Marconi.

During the period from August 5 to September 24 the East Pittsburgh, Pa. (KDKA), station maintained communication with the ship *Arctic* while on its expedition to the Arctic regions. Upon the ship's return it was reported that messages sent on short waves by the East Pittsburgh station were received at Cape Sabine within 11° of the North Pole. This is the farthest north radio messages have been received.

Third National Radio Conference held in Washington, D. C., October 6.

On October 11 signals from the East Pittsburgh station were successfully repeated from a station in Cape Town, Africa.

An expedition from the United States, under the leadership of Hamilton Rice, to explore the Amazon and Orinoco Rivers in Brazil and Venezuela, in the interest of geographical sciences in general, had radio as their only means of communication.

A wireless lighthouse was set upon an island in the Firth of Forth, Scotland. Wireless waves were concentrated by reflectors into a beam which could be sent 100 miles, giving ships their position in a fog.

1925. Considerable progress was made during 1925 in working with short waves. Several transoceanic stations are working foreign stations at great distances on wave lengths varying from 22 to 103 meters.

In an experiment between the Hastings (Nebr.) station and the East Pittsburgh (Pa.) station the Westinghouse Electric & Manufacturing Co. demonstrated that a 64-meter wave could be picked up, and by placing it on a short transmission line to the transmitting station, increasing the strength of the signals to their original power or greater, if necessary, the amplified wave could be transmitted onward. This experiment showed that repeater stations could be constructed in different parts of the world and be fairly certain of transmitting a strong signal.

(*Continued on next page*)

A number of short-wave transmissions were made by East Pittsburgh (KDKA) transmitting to South Africa and Australia.

During July programs were broadcast to the American naval fleet in Australian waters.

The practical use of the telephone and radio for the transmission of photographs was more clearly demonstrated during the year.

Broadcasting programs from airplanes was done in a few instances.

The General Electric Co., the Radio Corporation of America, and the Westinghouse Electric & Manufacturing Co. conducted experiments in broadcasting, using as high as 50 kilowatts.

The Department of Commerce placed in commission a "radio test car" which is equipped with an assortment of radio instruments used in conducting tests and investigations.

The Fourth National Radio Conference was held in Washington, D. C., November 9, 1925.

The Radio Corporation of America began the operation of a high-powered broadcasting station at Bound Brook, N. J., for transmision of programs to Europe. This station is equipped so as to use as high as 50 kilowatts.

One of the large electrical companies conducted experiments to determine the characteristics and peculiarities inherent in the piezo crystals. Several stations are now using this quartz crystal to maintain a constant frequency which eliminates to a great extent the "beat notes" resulting from two stations heterodyning at an audio-frequency. The radio-inspection service of this department has been supplied with these crystals to insure accuracy in frequency or wavelength measurements.

1926. During this year directional or beam transmission developed to a point where it may now be considered as practical for commercial usage.

The use of quartz plates for maintaining constant frequency or radio transmitters advanced considerably during the year.

Successful radiotelephone experiments were conducted between New York and London. This service will be used commercially in the near future.

With the development of transmitting pictures by radio it is now practical to transmit weather maps to vessels at sea.

The single-dial receiver came into greater use for reception of programs from broadcasting stations.

Commercial pictoradiogram services are now in operation between New York and London and between San Francisco and Hawaii.

On July 8 the Attorney General of the United States rendered a decision to the effect that the Secretary of Commerce has no jurisdiction as to the wave length, with the exception of the band betwen 600 and 1,600 meters reserved for Government stations, or the power used by commercial stations, including broadcasting stations.

Radiotelephone was used for the first time in directing the filming of a naval scene, off the coast of California, for a photoplay.

During the year successful development of a wireless system for controlling fog signals from unattended lighthouses and beacons marked a great advance on the automatic or semiautomatic systems for starting and stopping acetylene fog-signal gun by wireless impulses.

Successful experiments of synchronizing two or more stations in order that simultaneous operation on the same wave length without interference may be accomplished were conducted by the Westinghouse Electric & Manufacturing Co. during the year.

1927. Transatlantic radiophone service opened to the public on January 7.

Radio act of 1927 passed February 23, creating the Federal Radio Commission.

On April 7 the experimental radio station of the Bell Telephone laboratory at Whippany, N. J. (3XN), was successfully used in a public demonstration of television; the facial expression and voice of Secretary of Commerce Hoover could be seen and heard in New York distinctly and at the same time.

Radio was used by the airplane *America* on June 29 for the first time by an airplane in crossing the Atlantic Ocean from the United States to France.

International Radio Telegraph Conference held at Washington, D. C., October 4 to November 25.

As a result of experiments conducted during the past two years on methods of synchronization broadcasting stations WBZ at Springfield, Mass., and WBZA at Boston, Mass., owned by the Westinghouse Electric & Manufacturing Co., are now being regularly operated simultaneously in absolute sychronism, the wave length of the transmitter at the Boston station being automatically controlled by the Springfield transmitter so that any variation at Springfield will create a similar variation at Boston, assuring absolute synchronism at all times during the operation of these stations.

Experiments are now being conducted for the synchronization of two or more transmitters by radio control instead of by wire as in the case of the two stations referred to.

The U. S. S. *Kittery,* experimenting with a radio compass during hurricane weather, found that the intensity of static may be useful in detecting and locating storms at a considerable distance.

The experimental station of the General Electric Co. at Schenectady, N. Y., call signal 2XAG, in experiments used a vacuum tube of 100,000 watts power.

The Department of Commerce began the installation of directional radio-beacons for use in aviation. Two-way communication experiments between plane and ground carried on with considerable success.

1928. January: Commander A. Hoyt Taylor, United States Navy, was awarded the Morris Liebman memorial medal by the Institute of Radio Engineers for research in short-wave phenomena during the previous year.

February 8: A successful television demonstration was carried on during the night between station 2KZ in London, England, and amateur station 2CVJ in Hartsdale, N. Y.

March 7: A successful ship-to-shore television test was conducted from a London (England) station with the steamer *Berengaria.*

March 28: Amendment to the radio act of 1927 approved.

June 27: A 2-way short-wave radio circuit was first used commercially for telephony between America and Europe. The short-wave circuit supplements the long-wave circuit which was opened for commercial service during 1927.

September 11: Station WGY, Schenectady, N. Y., was the first station to broadcast a play by television. The play, a 1-act drama, entitled "The Queen's Messenger," was broadcast during the afternoon and again in the evening.

November 1: 2-way telephone communication established between Sydney, Australia, and Schenectady, N. Y., a distance of 10,000 miles.

November 6: In broadcasting the returns of the presidential election the National Broadcasting Co. had 59 stations throughout the United States connected into a single network, and the Columbia Broadcasting System had 26 stations connected in another network.

November 26: The transatlantic radiophone service between North America and Europe was extended to another continent —Africa—by the establishment of service to Ceuta, Spanish Morocco.

December: Commander Richard Byrd, on a scientific expedition in the Antarctic, operated a radio station, located farther south than any station heretofore, to keep in touch with civilization. Programs of the short-wave relay broadcasting station of the East Pittsburgh (Pa.) station of the Westinghouse Electric & Manufacturing Co. were received by the station.

At one time during the political campaign 106 broadcasting stations in the United States were connected into a single network by means of approximately 25,000 miles of telephone circuits together with about 48,000 miles of telegraph circuits for program coordination and auxiliary communication.

During the year radio apparatus was used to detect mineral deposits in the United States.

Amateur and commercial stations were used to great advantage through lack of other means of communication during the Florida and Porto Rico storms.

The use of receiving sets operated by house current and dynamic loud speakers came into greater use during the year.

The General Electric Co. developed a vacuum tube, 5 inches in diameter and about 2 feet long. It was operated as a self-excited oscillator on a wave length of 6 meters and was capable of radiating from 10 to 15 kilowatts of high-frequency power—probably fifty times as much as any short-wave tube had previously been able to radiate.

1929. January 21: Conference held at Ottawa, Canada, for the purpose of allocating certain high-frequency channels for the use of Canada, Cuba, Mexico, Newfoundland, Central American countries, and the United States.

March 4: The inauguration of President Hoover and Vice President Curtis, in Washington, was carried to 118 radio broadcasting stations in all parts of the United States, making the occasion the largest chain broadcast which has ever occurred. More than 30,000 miles of wire telephone program circuit were employed. Several high-frequency stations also transmitted the ceremonies primarily for the benefit of listeners in foreign countries.

April 16: International Safety of Life at Sea Conference held at London, England (April 16 to May 31).

May 1: There was a demonstration of 2-way telephone communication between an airplane in flight and telephones connected to the ordinary land telephone lines. Reporters of the New York metropolitan press flying in an airplane of the Bell telephone laboratories over northern New Jersey conversed with men at the city desks of their respective newspapers in New York.

May 6-7: A number of outstanding achievements in radio communication were made during the year in keeping the Byrd Antarctic Expedition in touch with civilization. On May 6 at 5 p.m., or 2 a.m. the next day at Greenland, the short-wave telephone station of the Byrd Expedition at Little America, Antarctic, communicated with the meteorological station of the University of Michigan at Mount Evans, Greenland, a distance of about 12,000 miles, on 34 meters. The signals were sufficiently strong at Little America that a loud speaker was used in receiving.

Programs during the year were regularly transmitted by a short-wave experimental station of the Westinghouse Electric & Manufacturing Co. at East Pitsburgh, Pa., on 25 meters to the Byrd Antarctic Expedition, a distance of approximately 11,000 miles.

Steamship *City of New York* (WFBT) of the Byrd Expedition relayed communications from a portable station regularly

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to the station of the New York Times located in New York City.

The plane *Stars and Stripes*, flying at about 3,000 feet above Commander Byrd's base, Little America, transmitted messages on 34 meters, using 50 watts power, to the New York Times station.

Station KDKA, East Pittsburgh, Pa., during the past three years has been broadcasting on schedule to the Royal Canadian Mounted Police post at Bache Peninsula, Ellesmereland, northwest of Etah, Greenland, located in approximately 75 degrees west, 78 degrees 30 minutes north (10½ degrees from the North Pole). This, according to reports, is the farthest north that regular broadcast programs have been received.

June 1: On June 1 and December 1 the third and fourth transatlantic radio radio-telephone circuits were put into operation between New York and London. This results in there being now in service one long-wave and three short-wave circuits. On the American side the short-wave transmitting station is located at Lawrenceville, N. J., and the receiving station at Netcong, N. J.

During the year further extensions of the transatlantic telephone service were made by wire to other points and countries in Europe, including extensions to the cities of Milan, Turin and Genoa in Italy, and to the entire telephone system of Czechoslovakia.

June 27: A demonstration of television in color was given by the Bell Telephone laboratories. Much of the apparatus employed was essentially the same as that used in the 1-color demonstration of April, 1927. Three channels were used for the transmission of the signals, one for each of the fundamental colors—red, green and blue. While transmission with this system may be by either wire or radio, transmission on the occasion of the demonstration of June 27 was by three pairs of wires.

Three interesting demonstrations took place during the year of the possibility of connecting together two radiotelephone links for the purpose of forming a through circuit. One of these was a connection made in London between the transatlantic radiotelephone circuit and a new short-wave radiotelephone channel which was being experimented with by the British General Post Office between Great Britain and Australia. This connection enabled speakers in America, using the regular telephone system, to talk, via London, to Australia over two short-wave links totaling some 15,000 miles in length. Conversations took place on September 25 at 4 o'clock in the afternoon, New York time, corresponding to 9 o'clock in the evening in London and to 6 a.m. on September 26 in Sydney. A second interesting trial was that of connecting in America the transatlantic telephone circuit with an airplane in flight near New York, enabling newspaper representatives in the plane to talk to people in London, via the radio link to the ground and thence the transatlantic radio link to London. This was on June 25, 1929. The third case on December 22, 1929, involved a radiotelephone circuit to an airplane flying over New Jersey and a separate radiotelephone circuit to the S. S. *Leviathan*, connections between the two being made through the long-distance terminal of the Bell system in New York.

August: The *Graf Zeppelin*, first dirigible to make a trip around the world, was equipped with radio transmitting apparatus which proved to be of inestimable value in its epochal flight.

September 19: The first meeting of technical consultative committee of the International Radiotelegraph Convention, Washington, 1927, was held at The Hague.

October: Work began on Department of Commerce (radio division) Grand Island, Neb., Central Monitoring Station, secondary stations being placed in each radio district and on six radio-test cars.

November 18: An earthquake in the bed of the North Atlantic Ocean snapped 12 cables and from that time until the end of the year a greatly increased proportion of the transatlantic communications were handled by radio.

December 8: Telephone service was inaugurated between land telephone lines and the S. S. *Leviathan*. The shore transmitting and receiving stations are located on the New Jersey coast and each is connected by wire to the long-distance telephone operating building in New York. The radio link between the ship and shore utilizes high frequencies (short waves). Here connections between the telephone subscribers on land and those with whom they converse on the S. S. *Leviathan* are handled as in the cases of telephone calls to various foreign points, such as Cuba, Mexico and Europe.

During the year there was continued growth in chain broadcasting. On September 1 about 34,000 miles of telephone circuit were in use for program transmission. One hundred and fifty-two broadcasting stations were provided with regular connections.

December 18: Radio act placing Federal Radio Commission on permanent basis approved.

Screen-grid tubes for radio receivers came into use during the year.

During the year the Riverhead, Long Island, receiving station of the Radio Corporation of America Communications (Inç.) picked up short-wave programs on foreign stations for rebroadcasting by regular broadcasting chains.

1930. April 3: Radiotelephone service between North America and South America was opened to the public. This service now interconnects 20,000,000 telephones in the United States as well as all telephones in Cuba and all the principal points in Mexico and Canada with the subscribers reached by the telephone networks in Argentina, Chile and Uruguay. The connection is made by means of a short-wave radio circuit covering a distance of 5,300 miles. The transmitting station in North America is located near Lawrenceville, N. J., and the corresponding station in South America is located near Buenos Aires.

April 27: A radiotelephone conversation lasting 15 minutes was carried on between a train running at 84 miles an hour between Toronto and Montreal, Canada, and London, England. The system broadcasts the voice from train to carrier-current telegraph wires which parallel the track, and vice versa. From these wires it is carried to pick-up stations and then transferred to the telephone office at Kingston, Canada, where it is placed on regular long distance telephone circuits. Connections from the train are made by an operator stationed on the train. Connections outside are made by placing calls with the long-distance telephone operator.

October 27: Regular commercial radiotelephone service between North America and Australia was inaugurated on this date. The service is provided through the linking together in England of the radiotelephone circuits from New York to London and from London to Sydney. A call over this system from Los Angeles by way of New York and London to Sydney covers a total distance estimated at about 21,000 miles.

December 7: Announcers on two submarines speeding along 10 miles off the coast of New London, Conn., depicted for listeners what they saw as one submarine (O-8) went below and the other (O-4) stayed on the surface. It was the first broadcast program from a submersible as it sank below the surface.

Direct radiotelegraph circuits were inaugurated during 1930 from New York, N. Y., to Santiago, Chile; Panama, Moscow; Prague, Czechoslovakia; and Santo Domingo on January 13, May 1, November 13, December 1 and December 24, respectively. Circuits were opened between San Francisco, Calif., and Panama on May 10, and between San Francisco, Calif., and Shanghai, China, on December 6.

During the year transatlantic radiotelephone service was extended through the provision of connections to a number of additional points in Europe. These extensions include practically the whole of northern Italy, the city of Rome, Vatican City, the cities of Warsaw, Poland, and Helsingfors, Finland, and the cities of Memel and Koxno, Lithuania. Service is now given to practically the entire telephone network of western Europe.

During the year ship-to-shore radiotelephone service in addition to being available to the steamship *Leviathan* was extended to the *Majestic, Olympic, Homeric* and *Belgenland*. This service is given through shore transmitting and receiving stations located at Ocean Gate and Forked River, N. J., respectively. Through connections with the land telephone system, this service is available not only to all points in this country but to most of the cities of Cuba, Canada and Mexico. Similar telephone service to the continent of Europe is available to passengers on these vessels through stations at Rugby and Baldock, England.

Television was employed for the first time as part of a regular performance in a theater, the television images being transmitted by radio from a studio about 1 mile from the theater.

The active images of the performers were reproduced upon a screen 6 by 7½ feet and were readily visible to those seated in the back rows of the balcony. The light impulses were transmitted on a wave length of 140 meters, and were accompanied by voice and sound effects. This increase in area of the projected image from the previous size of about 14 inches square to an area equivalent to about one-fourth that of the standard motion-picture screen was rendered possible by the introduction in the projection optical train of a light valve operating on the principle of altering the direction of polarization of a beam of polarized light by passing the beam from an electrostatic field. This light valve thus renders possible the use of more powerful rays of light than have heretofore been practicable in television projection.

A television picture which had traveled approximately 20,000 miles through space was received with a fair degree of accuracy, thereby establishing a distance record for television reception. The picture, a rectangular design in black on a white card, was transmitted by the short-wave station, W2XAF (31.48 meters) at Schenectady, N. Y., received in Sydney, Australia, by station VK2ME, rebroadcast by that section on 28.8 meters, and received back in Schenectady in about an eighth of a second.

The United States now leads the world in radio communication with circuits spanning every ocean and touching every continent on the globe.

During the year diversity in reception was improved upon. The method, as now used to a great extent and which is growing, is accomplished by the erection of three antenna spaced approximately 1,000 feet apart. Observations over a long period have shown that the strength of the received signal varies considerably within a radius of 2,000 feet and while the radio impulse at one of three antennae may be faint, the other two will be clear and strong. By connecting the three antennae with a central receiver a signal of uniform strength representing the composite level of the three antennae is obtained.

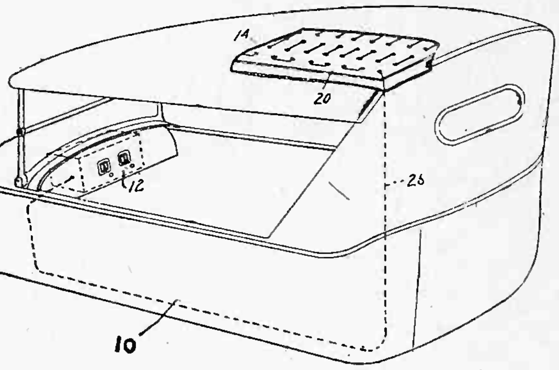
Experimental facsimile transmissions conducted during the year indicate the possibility that eventually a complete daily

(*Continued on next page*)

New Radio Patents

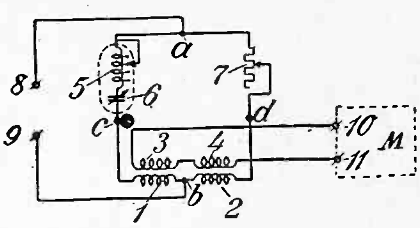
Illustrated Reports with Selected Claims

[Newly issued or reissued radio patents are recorded in this department. The number of the patent itself is given first. Usually only one claim is selected and the claim number also is cited. All inquiries regarding patents should be addressed to Ray Belmont Whitman, Patent Editor, RADIO WORLD, *145 West 45th Street, New York, N. Y.]*



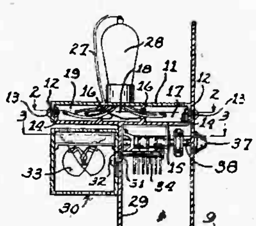
1,829,219. Portable Radio Apparatus. William M. Heina, Long Island City, N. Y., assignor, by mesne assignments, to Transitone Automobile Radio Corporation, Philadelphia, Pa., a Corporation of Delaware. Filed Jan. 15, 1929. Serial No. 332,620. 3 Claims. (Cl. 250—33.)

3. In combination with the collapsible top of a vehicle, a radio antenna comprising a wire carried by said top and arranged to form a plurality of spaced lengths extending back and forth in succession and transversely of said top.



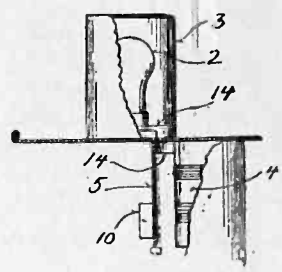
1,834,975. Radio Circuit. Wilhelm Scheppmann, Berlin-Tempelhof, Germany. Filed Jan. 27, 1927, Serial No. 164,020, and in Germany Feb. 3, 1926. 16 Claims. (Cl. 250—17.)

1. The combination in a radio circuit arrangement of the character described of an output circuit, an input circuit having two circuit paths that are in equal and opposite coupling relationship to said output circuit to produce opposite effects therein, only one of said circuits being a tuned circuit and comprising an acceptor circuit introduced into one of said circuit paths and tuned to the frequency of the current to be neutralized in the output circuit.



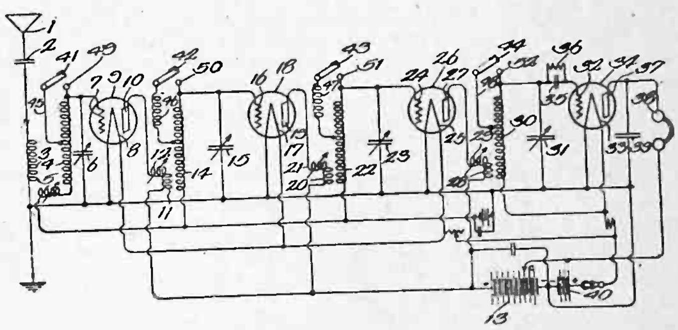
1,835,036. Radio Receiving Set. Frederick A. Gehm, Chicago, Ill. Filed Aug. 8, 1929. Serial No. 384,327. 4 Claims. (Cl. 250—14.)

1. In combination with a panel of a radio receiving set, a comparatively shallow casing removably secured to said panel, a plurality of compartments in said casing, one of said compartments separately receiving the alternating current energizing wires of said radio receiving set, another of said compartments receiving other wires leading to the electrodes of vacuum tubes removably and operatively secured in an upper section of said casing, and a downwardly projecting partition secured to another section of said casing, said partition providing a means for supporting a plurality of transformers on one side thereof, and a plurality of condensers on the other side thereof, said transformers being individually segregated and shielded by containers removably secured to said partition.



1,836,260. Radio Apparatus. William Turnor Lewis, Racine, Wis. Filed Apr. 26, 1929. Serial No. 358,230. 8 Claims. (Cl. 250—16.)

6. In a radio receiving system, the combination of a box-like metal body portion, a plurality of vacuum tubes mounted on one side of said body portion, tuning condensers mounted on the same side of said body portion, a shielding can for each of said tubes and each of said condensers, coupling devices mounted upon the opposite side of said body portion, and shielding cans for said coupling devices, the outline of said last mentioned shielding cans overlapping the outline of said first mentioned shielding cans.



1,836,461. Radio Receiving System. Henry C. Forbes, Chicago, Ill., assignor to Zenith Radio Corporation, Chicago, Ill., a Corporation of Illinois. Filed Dec. 26, 1925. Serial No. 77,834. 7 Claims. (Cl. 250—20.)

1. A radio receiving system including a primary radio frequency transformer winding; a winding in secondary relation to the aforesaid winding; a thermionic valve having an input circuit supplied from the second aforesaid winding; variable capacity means for tuning said input circuit to the signal frequency; and a local circuit exclusive of said valve, comprising a serial part of the second aforesaid winding, a resistance element, and a switch for opening and closing said local circuit.

The Chronology of Radio, An Epitomized History

(Continued from preceding page)

newspaper may be transmitted by this system of radio communication.

International broadcasting gained impetus during the year through the address of King George of England opening the London Naval Conference, the achievement of linking the World Power Conference in Berlin with the National Electric Light Association Convention in San Francisco by addresses broadcast from San Francisco, Berlin, London and Orange, N.J., and the broadcast of the ceremonies connected with the exchange of ratifications of the London Naval Treaty.

In developing synchronization of two or more stations operating on the same frequency without causing interference to each other, broadcasting station WTIC in Hartford, Conn., and WEAF in New York, N. Y., were granted authority to carry on this form of transmission. Station WBAL in Baltimore, Md., and WJZ in New York, N. Y., were also authorized to synchronize.

At the close of 1930, nearly 200 stations were embraced in the broadcasting networks of the National and Columbia chains. The length of permanent program telephone circuits used for this purpose was about 34,500 miles.

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. Answers printed herewith have been mailed to University Members.

Radio University

To obtain a membership in Radio World's University Club for one year, send $6 for one year's subscription (52 issues of Radio World) and you will get a University number. Put this number at top of letter (not envelope) containing questions. Address, Radio World, 145 West 45th Street, New York, N. Y.

Annual subscriptions are accepted at $6 for 52 numbers, with the previlege of obtaining answers to radio questions for the period of the subscription, but not if any other premium is obtained with the subscription.

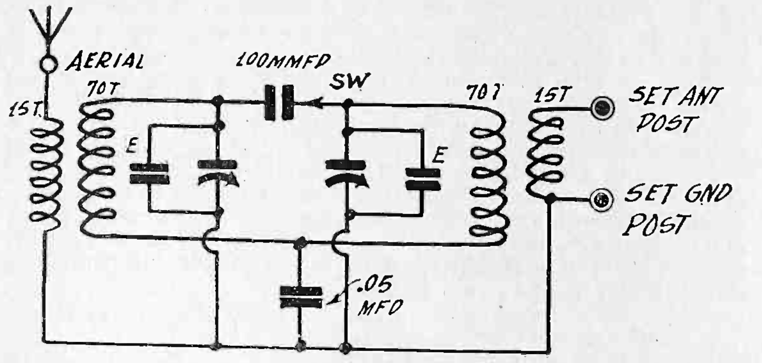


FIG. 981

A doubly tuned circuit that may be used either as a wave trap, to eliminate interference, or as a booster for a desired signal, since the tuning contributes a dual curve.

Band Pass Filter Rejector-Acceptor

Please show the diagram of a band pass filter wave trap, one that may be used for getting rid of direct interference from a broadcast station when receiving short waves on converter, and also for general trapping purposes. Can this also have an acceptance characteristic?—J. E. H., San Francisco, Calif.

Fig. 981 show sthe diagram. Two identical coils are used, primary 15 turns, 1/8 inch space, secondary 70 turns, diameter 1.75 inch, wire No. 28 enamel. The secondaries are tuned by a 0.00035 mfd. dual condenser, the equalizers, E, being adjusted once, preferably for some frequency around 1,000 kc. The 100 mmfd. condenser, with switch, may be omitted unless it is desired to increase the coupling by including them. The only object would be somewhat greater response on the higher wavelengths when using the device as an acceptor. A few degrees on the dial removed from the rejection point, or trap, will be found the acceptance point. The rejector position gets rid of interference in the usual trap manner, the acceptor position increases the response from a desired station. The 0.05 mfd. condenser may consist of two 0.1 mfd. in series. The connections are specified on the diagram.

* * *

Television Differences

Will you kindly explain the difference between lens and plain hole scanning discs for television, crater lamp and neon lamp, mechanical and electrical scanning? Is any one sending out electrically scanned pictures on high frequencies that the public experimenters may tune in?—E. R. T., Ventura, Calif.

The scanning disc has holes in it, usually square so as to permit more light to get through, and as the disc is rotated by the motor the scanning takes place. Under this system you either look directly at the neon lamp, to see a small picture, say about 0.6 inch, or put a magnifying lens in front of the viewing space to make the picture look larger, giving the semblance of a 3 inch picture. If, instead of holes only, there is a lens in each hode, then the picture may be projected on a small screen, provided there is enough illumination. The usual neon lamp does not provide enough illumination, hence a crater lamp is used. This, while also a neon lamp, is a point source of light, instead of an area source. If the point source is not confined the light thereform will diverge, as from a searchlight, hence the large picture. Mechanical scanning is scanning by mechanical means, such as a disc or drum, while electrical scanning applies principally to scanning with a tube. The cathode ray tube is used for this purpose, the electrons shot from the plate to the fluorescent screen being timed by an alternating voltage. W6XAO, Los Angeles, is sending out an ultra wave, as detailed elsewhere in this issue.

* * *

Television's Stage of Development

What is the present stage of development in television? Can the sound and pictures be sent simultaneously on the same wave?—K. D. S., Bangor, Me.

The present stage of television development is the transmission of pictures of limited interest, with the receiving apparatus enabling reproduction on a small screen. Sound and pictures can not be sent simultaneously on the same wave, in the sense that you probably mean. If there are two waves of high frequency, both can be modulated on a wave of much lower frequency, the low frequency wave transmitted, the two high frequency components being rectified in separate receivers.

* * *

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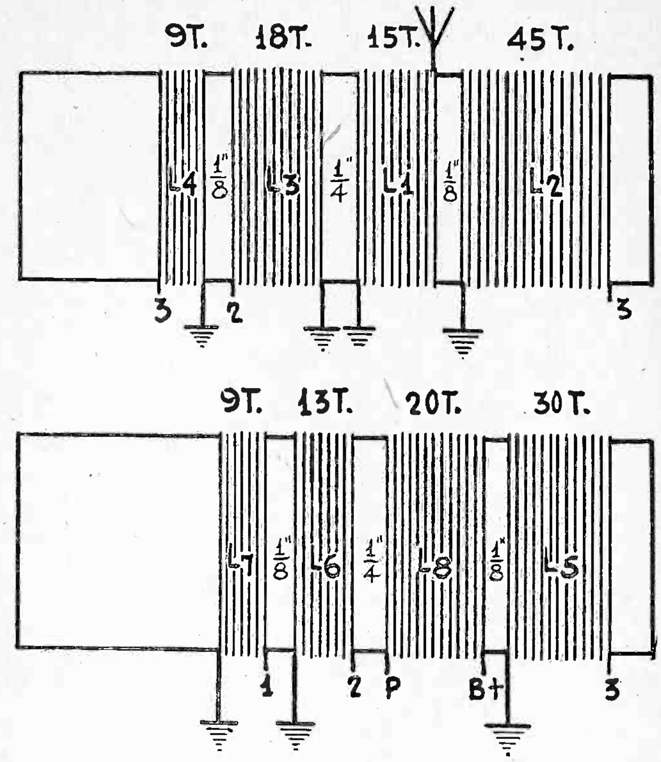

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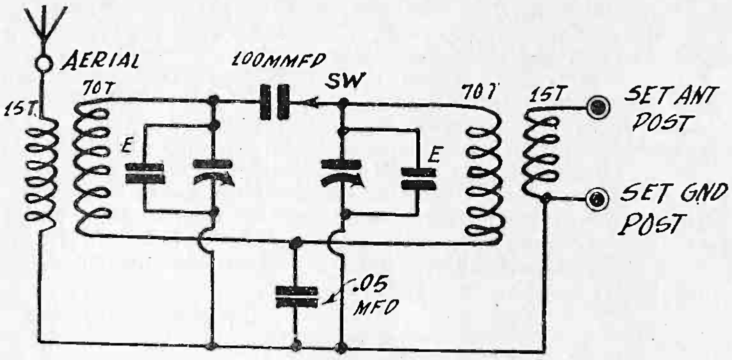

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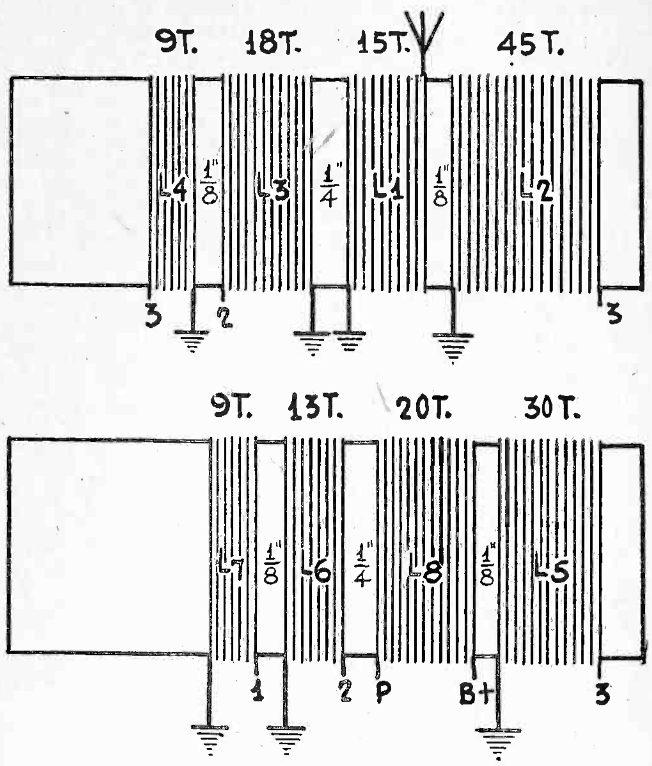

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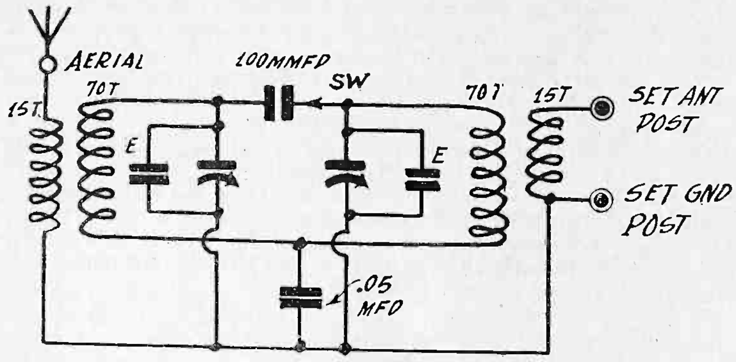

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N.B.C. on Ultra Waves

There has been some talk about the National Broadcasting Company being about to put on programs from their New York transmitter atop the Empire State Building, on ultra frequencies, preparatory to some company's entrance into television. Is such transmission imminent? What type of receiver would be used?—J. G. S., Jersey City, N. J.

The National Broadcasting Company has one of the finest television transmitters atop the Empire State Building and is doing experimental work constantly. There is a division of opinion among executives as to the present advisability of going into television transmission in a big way. At present the N.B.C. low frequency transmissions are purely experimental also, and usually without interest, placards being on the air for long periods. Persons who have seen demonstrations of the ultra wave transmission and reception are keen about it. There has been no definite announcement of when real program service will be instituted, but the statement has been made that when it is begun there will be receivers and scanning systems to permit reproduction in the homes of those who live within, say, 25 miles or so of the transmitter. What type of receiver will be used is not known but it is said to be a superheterodyne, carefully shielded, 22 tubes being involved all told, estimated selling price of all $600. Scanning is said to be of the cathode ray type. Executives believe that mechanical scanning systems would not prove popular.

* * *

Coil Data for Converters

Kindly give me the coil data for a short wave converter; individually tuned modulator and oscillator, for use of any intermediate frequency in the broadcast band.—W. O. D., Syracuse, N. Y.

Fig. 982 gives the data. These are applicable to the converter described in this issue, pages 12 and 13.

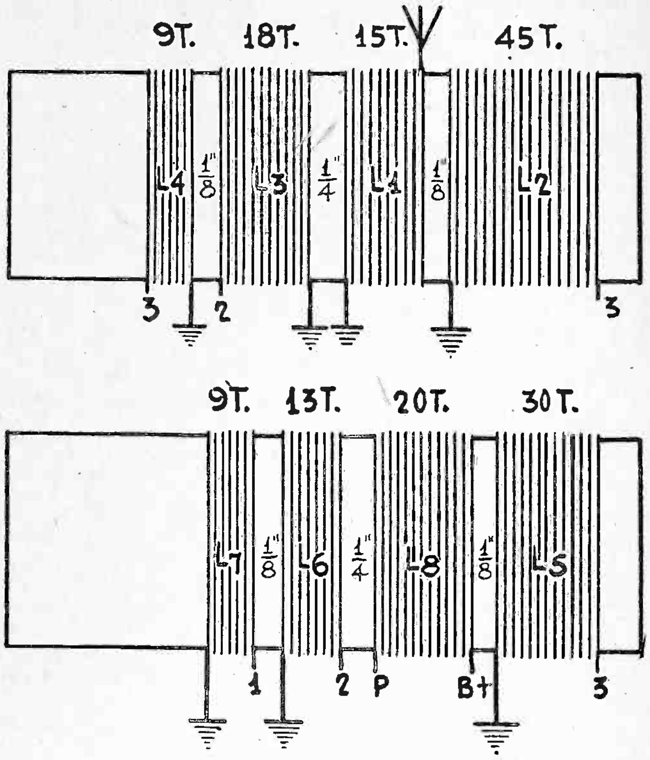


FIG. 982

The modulator coil data are given at top, the oscillator data below. All windings are in the same direction. The wire is No. 28 enamel, except that 28 may be any insulated fine wire. The diameter is $1\frac{1}{8}$ inches.

WORLD IS BUSY ON TELEVISION; PLANS VARIOUS

Work in television development is progressing in every major country, and the work is being conducted both by private enterprise and governmental agencies. In the United States work is being conducted by the Bureau of Standards, Bell Laboratories, General Electric Co., Westinghouse Electric, National Broadcasting Co., Columbia Broadcasting System, Philadelphia Storage Battery Co., Short Wave and Television Corp., Jenkins, Sanabria, and by a host of other organizations and individuals. In Germany work is being done by the German Post Office, Georg Seibt, Baron Manfred von Ardenne, Siemens and Halske, and by many other individuals, electric and optical companies. In Great Britain the work is mainly carried on by Baird Television Corporation.

Every form of scanning is being tried. Work is being done on disc scanners, both with simple holes and lenses. Cathode ray scanners are being explored thoroughly, as well as various arrangements of mirrors. Attempts are being made everywhere to project the pictures on a large screen so that several persons may view the pictures simultaneously, and this is a phase that is now receiving major attention.

Possibilities Explored

In order to explore the possibilities of the quasi-optical waves, the National Broadcasting Co. has erected a transmitting station on top of the Empire State Building, where on the eighty-sixth floor a complete television laboratory has been equipped. The transmitting antenna is located on top of the building 1,276 feet above the sidewalk and it consists of a fourteen-foot metallic rod.

Intensive work will be conducted in the laboratory during the coming year in an endeavor to learn the secret of the short waves and their possibilities as a medium of carrying television images to the people in territory surrounding the building. It is hoped that the development will have progressed sufficiently by next September to give the people a chance to look in on what is being flashed from the tall structure.

Quasi-optical waves are so called because they behave in much the same way as light waves. They travel only in straight lines, like a light ray, and for that reason their range is determined by the horizon, the distance of which is determined by the height of the transmitting antenna. The horizon from the top of the Empire State building is 60 miles, so that people living within this radius of the building would have a chance to look in. Beyond the horizon the waves will pass over the heads of those attempting to look in, and the only way they could intercept some of the signals would be to erect tall towers for their antennas. If the receiving antenna were placed at the same distance above the earth as the transmitting antenna, the possible distance would be doubled.

Problems to Be Solved

There are many problems to be solved in connection with the use of short waves. Ordinary tubes will not work satisfactorily and it will be necessary to develop new ones. Again, there is the problem of getting sufficient energy into the waves to make them of receivable strength a few miles away.

TRADIOGRAMS

By J. Murray Barron

W. H. Boderick, of 40 East 49th Street, New York City, has on demonstration a very compact unit to be used by those hard of hearing. For those who want to build their own, there is an essential kit with complete instructions.

* * *

A unique book department has just been opened on the eighteenth floor of the new McGraw-Hill Building, 330 West 42nd Street, New York City.

* * *

W. K. Skidmore, of 17 Warren Street, New York City, reports an increased interest in television. He deals in parts and condensers.

* * *

A lecture and demonstration on television were given at the School of Television, 360 Seventh Avenue, New York City, to 180 high school principals, instructors in physics and students. More than 100 high school boys had to be turned away owing to limitations of space.

After sketching the history of communication from its earliest development up to the perfection of radio, Mr. Rave said: "The development of television furnished the one example in the entire history of invention where public demand outstripped the ability of the laboratory to produce the desired result, namely, visual accompaniment to the sound message. In consequence we have today the spectacle of numberless technicians in laboratories all over the world, notably in the United States, working day and night to perfect this new instrument for an expectant public. Television did not have to overcome any obstacles for universal acceptance."

Following the lecture, Dr. Paul A. Kober, formerly of the General Electric Company, gave a demonstration consisting of the use of the television transmitter and the actual televising of objects to a receiver located at the school. Dr. Kober explained the component parts of both transmitter and receiver which had been perfected by him.

* * *

The Stuyvesant Electric Co., 53 Walker Street, New York City, is preparing for the increased pick-up in television and now lists various kits and parts. A catalog is available.

* * *

Harrison Radio Co., 189 Franklin Street, New York City, catering to the "ham," also has complete merchandise for the service man. Booklets and price lists are ready for the 1932 season.

* * *

Baltimore Radio Corp., 725 Broadway, New York City, has opened a retail counter carrying general parts, sets and television kits and supplies.

* * *

A. M. Flechtheim Co., 136 Liberty Street, New York City, has recently received some very good reports from their various representatives throughout the United States. Builders of television sets are helping in this respect.

* * *

Freed Television & Radio Corp., 22 Wilbur Ave., L. I. City (New York City), has put out a television kit. It is very simple, complete and attractive. There are full instructions, also a booklet and price list.

* * *

Harvey Sampson, proprietor of Harvey's Radio Shop, 105 West 43d Street, New York City, has put in a complete stock of See-All televisors and television receivers. A lens disc for projected images is the latest feature.

13 PUT OFF AIR DURING YEAR FOR OFFENSES

Washington.

During 1931 thirteen stations were ordered off the air for failure to maintain standards consistent with "public interest, convenience or necessity." The Commission acted more strictly with offenders than during previous years.

Besides, five stations were deleted as to identity when they consolidated with other stations, and two more stations combined to form a new station.

To solve a major problem of administration concerning the method and policy of handling applications for renewal of licenses, a plan staggering the license periods of all broadcasting stations was adopted. The 612 stations have been segregated into six groups, according to operating frequency, and each group has been assigned a fixed license term of six months.

New Incorporations

Canfield Refrigerator Co., New York City, refrigerating machinery—Atty., L. M. Wilson, 291 Broadway, New York, N. Y.

Jerome B. Mandel Radio Corp., New Rochelle, N. Y., musical instruments—Attys., Albany Service Co., 299 Broadway, New York, N. Y.

M. & S. Electric Co., New York, N. Y., electric machinery—Atty., R. Honigman, 2 Lafayette St., New York, N. Y.

Charles H. Maggs Electric Co., Long Branch, N. J., electrical equipment and machinery—Atty., Maurice A. Potter, Long Branch, N. J.

Electro Fire Detector Co., Inc., Newark, N. J., electro fire detectors—Atty., Israel B. Breene, Newark, N. J.

Storm King Corporation of America, New York, N. Y., radios, radio parts—Attys., United States Corporation Co., 150 Broadway, New York, N. Y.

Richard Larkins Corp., New York, N. Y., electrical apparatus—Attys., Flatow & Taflowe, 17 John St., New York, N. Y.

Jacob C. Schuff, Inc., Ocean City, N. J., radios, automobile accessories—Atty., George R. Greis, Ocean City, N. J.

Multivix and Television Industries, Inc., Wilmington, Del., mercantile manufacturing and trading—Attys., Corporation Service Co., Wilmington, Del.

Kovalite Co., Dover, Del., electrical fixtures, lamps—Attys., Capitol Trust Co. of Delaware.

Brotherhood of Electrical Workers of America, Inc., Pittsburgh, Pa., maintain a social, beneficial and protective order—Attys., Capital Trust Co.

Literature Wanted

Charles Cordy, 1101 13th Ave., Columbus, Ohio.
Charles Cabana, 820 Outremont Ave., Outremont, Montreal, Can.
Elwood Hartzell, 2243 Bridge St., Philadelphia, Pa.
Andrew Sobczyk (W9GOT), 6705 Grand Ave., Duluth, Minn.
Wm. A. Post, 2255 West 25th St., Los Angeles, Calif.
Boyd Betts, 914 Harlan St., Indianapolis, Ind.
Lewis Beuthel, Rt. 2, Box 742, Fresno, Calif.
Fred Santschi (on short waves), 715 S. Hope St., Los Angeles, Calif.
Fructuoso Taylona, 1503 General Luira, Paco, Manila, P. I. ¼
F. L. Johnson, Cor. 5th and Chestnut Sts., Gadsden, Ala.
Fred C. Balz, 157 Esperanza Ave., Sierra Madre, Calif.
George E. Eck, 3016 Lloyd Ave., Chicago, Ill.
J. Kleinman, 1494 Brook Ave., Bronx, N. Y. City.
Irin L. Dellinger, Wardensville, W. Va.
J. C. Miscera, 316 Goodhue St., St. Paul, Minn.
C. H. Miller, 106 E. 5th Ave., Cheyenne, Wyo.
Adolphe G. Stofferan, 1312 Wellington St., Chicago, Ill.
Leslie Card, Caryville, Tenn.
Walter A. Stewart, Jr., 232 So. "G" St., Lompoc, Calif.
Carl Tretinyak, Hotel Edward, Apt. 3, Rochester, Minn.
Wm. R. Shannon, 155 Cottage St., Rochester, N. Y.
Joseph Miles, 11 Larch St., Toronto, Ont., Can.
John Beck, 47 Lake Side Ave., Burlington, Vt.

A THOUGHT FOR THE WEEK

HOORAY for the downtrodden musician! The Chicago Broadcasters' Association was threatened with a strike by the station musicians. A compromise was effected, by the terms of which the studios must engage a minimum each of fifteen musicians instead of ten, for six days of labor instead of seven and a maximum of thirty-five hours a week. The minimum wage scale is $90 a week. How our plumbers, carpenters and bricklayers must be scolding themselves for not having learned to play the tuba, sax or drums when they started out on their careers!

RADIO WORLD

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; J. Murray Barron, advertising manager.

The Economic Situation

In view of the world-wide economic situation it is pertinent to peruse the following, taken from another magazine:

"It is a gloomy moment in history. Not for many years—not in the life time of most men who read this paper—has there been so much grave and deep apprehension: never has the future seemed so incalculable as at this time. In our own country there is universal commercial prostration and panic, and thousands of our poorest fellow citizens are turned out against the approaching winter without employment, and without the prospect of it.

"In France the political cauldron seethes and bubbles with uncertainty: Russia hangs, as usual, like a cloud, dark and silent, upon the horizon of Europe: while all the energies, resources and influences of the British Empire are sorely tried, and are yet to be tried more sorely, in coping with the vast and deadly Indian insurrection, and with its disturbed relations in China.

"It is a solemn moment, and no man can feel an indifference (which happily, no man pretends to feel) in the issue of events.

"Of our own troubles no man can see the end. They are fortunately, as yet, mainly commercial: and if we are only to lose money and by painful poverty to be taught wisdom—the wisdom of honor, of faith, of sympathy and of charity—no man need seriously despair. And yet the very haste to be rich which is the occasion of this wide-spread calamity, has also tended to destroy the moral forces with which we are to resist and subdue the calamity."

For credit for this quotation, see bottom of page 23.

W6XAO SENDING 80 LINES, USING AN ULTRA WAVE

Los Angeles.

The intense public interest in television is indicated in Southern California by inquiries since the opening of regular television service on W6XAO television station of the Don Lee Broadcasting system. Radio supply houses have their telephones tied up by calls, while the wires at KHJ, where W6XAO is situated, are likewise kept busy.

The beginning of this television service, the first regular broadcasting with electrical scanning in the United States and probably the world, has indicated the vast number of amateur experimenters who are now eager to adjust their receivers. The prevailing inquiry concerns the frequency used. Not a short wave, but an ultra-short wave receiver is required, the signals being sent out on a frequency of 44,500 kilocycles, corresponding to a wavelength of 6¾ meters. This is in the new "quasi-optical" region recently allocated to television by the Federal Radio Commission.

Invites Public to Look In

Harry R. Lubcke, director of television at W6XAO, made the following statement:

"While it is gratifying to note the large public response to our efforts, we do not wish to represent these as the finished product of our experiments. Having arrived at a point where we were transmitting television images, we felt it appropriate to inform the public and allow others to pioneer with us.

"It has been erroneously stated that we inaugurated the first television service in the United States. This is untrue. Television broadcasting with mechanical scanning discs has been a fact for over a year in the East. Our broadcasts represent the first regular transmissions using electrical scanning equipment in the United States and perhaps the world.

KHJ to Send Sound

"As we have continuously maintained, the standard radio broadcast receiver is not obsolete, although we are transmitting voice announcements of call letters and frequency over our ultra-short wave transmitter, as required by the Federal Radio Commission. The sound component of future synchronized sight and sound broadcasts will undoubtedly employ KHJ and the broadcasting stations of the Don Lee network."

Signals are being sent out from W6XAO between 6 and 7 p.m. daily. (P.S.T.) These usually consist of several vertical lines, allowing experimenters to adjust and synchronize their receivers. Voice announcements of frequency and call letters are made every fifteen minutes during the broadcasting. This is preparatory to the transmission of other images, which will be those of actors and actresses on special television film.

80 Lines, 15 Frames

Eighty lines are used in an image repeated fifteen times per second. The system employs cathode-ray beams at both transmitter and receiver, and is a development of M. Lubcke. With this system receptability is possible on a scanning disc as well as on electrical receivers especially adapted thereto. A single spiral disc of eighty holes revolving at 900 revolutions a minute is required.

40 Mile Area

The receiving area extends approximately forty miles from the point of projection. Already a portion of Los Angeles and environs has been mapped for television waves with the aid of an especially equipped automobile. It was found that the City Hall cast a pronounced shadow on the waves, making reception difficult on the north east side, which is opposite the Don Lee Building. Reception is also weakened by intervening hills.

Electrical scanning is the newest type of television, differing from that of the ordinary scanning disc. The receiver is operated entirely from a 110-volt light socket, with either 50 or 60 cycles. A new principle makes possible synchronization from the image pulse itself, making it immaterial which one of the power systems of the city serves the user. The use of eighty lines exceeds in number those employed by any other television broadcasting station.

The transmitter at W6XAO is situated adjoining the television laboratory and is shielded to keep the currents isolated. Across the hall in a thick-walled room is the projector, especially made with a suspended amplifier and a switch for vocal signals. No alternating current lights can be allowed in this operating room as they would introduce a 60 cycle interference in the image.

Peek at Studio

In a studio 100 feet distant is a receiver, in a cabinet outwardly similar to that of a radio receiver, save for a circular flourescent screen upon which the images appear approximately 10 inches in size. There is a switch, a tuning knob and a synchronizing knob. Upon making the connection a tiny blue spot appears, which resolves itself automatically from an irregular pattern into the proper image, locked in synchronism. A ground connection, an aerial connection and a 110 volt power connection are all that are required for operation. The component parts of this receiver may be enumerated as follows: the receiver which picks up the signals from the air, a high frequency source, a low frequency source, a synchronizing amplifier, a cathode-ray tube, and the power supply unit.

Vertical Auto Antenna

The automobile used for testing is equipped with a vertical rod for an aerial elevated above the back tire. The experiments by automobile have determined which areas in greater Los Angeles are best served and have advanced technical information on transmission in this as yet virgin field.

STATION SPARKS

By Alice Remsen

* * *

Moonlight Sonata

(For the Slumber Hour, WJZ, every week-night, 11:00-11:30 p.m.)

A WHITE witch is dancing on the water,
A witch with silvery arms;
Spray is dripping from her moon-drenched fingers.
O white witch cast your spell upon me!

Bewilder my senses with your beauty
Before the dawn breaks my enchantment.
Kiss me, O white witch!
Shower me with silver diamonds from your hair.

Lead me up the shimmering path that burnishes the water;
Lend wings to my feet,
That I may catch the fringe of your ecstasy
Before it passes beyond my reach.
—A. R.

* * *

Ludwig Laurier Is Still Charming His Listeners with the soothing music of his "Slumber Hour" period. The spirits of the old masters preside over the witchery of Director Laurier's magic baton, as he directs his miniature symphony group during the broadcasting of the world's greatest musical classics. This is a period that should never be missed by music lovers.

* * *

Alice Joy, The Prince Albert "Dream Girl," does nothing by halves. During a recent broadcast Alice sang an all-Irish song group—and she was dressed gayly from head to foot in emerald green!

* * *

A Program Well Worth Your While is that of the "Danger Fighters," Saturday nights, 8:00 to 8:30 over WJZ. It is sponsored by the Health Products Corporation, and produced by the McCann-Erickson Agency. This program brings scientific discoveries in dramatic form to the radio listener. Interesting, educational and entertaining.

* * *

According to Judge Gordon, food news expert on the N.B.C. "Our Daily Food" program, American people eat 272 bushels of apples each time the clock ticks off a minute; which means a bushel of apples a year for every man, woman and child. Of course this includes apples eaten straight, in pie, baked, sauce and in mince-meat. Of apple pie alone approximately 1400 pieces are eaten every minute, New England topping other states by a wide margin; mince-pie and Indiana come a close second.

* * *

B. A. Rolfe Is Back From His Vacation. During his absence he studied the dance demands of radio listeners, and discovered that slow music, by orchestras composed predominantly of stringed instruments, is gaining favor very rapidly.

* * *

David Guion, Texas Composer, who came into prominence through his broadcasts over WOR, has gone N.B.C. He and his orchestra, with Paul Ravel as soloist, is now heard every Wednesday, at 10:30 p.m., E.S.T., over WEAF.

A New Two-Piano Team, consisting of Sandra Phillips and Peggy Keenan, may now be heard each Tuesday morning, from 9:00 to 9:15, over WABC. The program is known as "Piano Pictures" and embraces both classical and popular music.

* * *

From Choir Boy In A Venezuelan Church to Opera, then concert and now radio, outlines the career of Tito Coral, South American baritone, now featured on WJZ each Monday, Wednesday and Saturday, at 11:30 p.m.

* * *

The Pillsbury Pageant, featuring the Street Singer and Toscha Seidel, will be heard from 9:00 to 9:30 p.m., on Fridays, over WABC, instead of changing to Thursday, as before stated.

* * *

Buddy Rogers Has Deserted the Screen to organize and conduct his own orchestra and sing over the N.B.C. networks, according to an announcement sent out by George Engles, N.B.C. vice-president in charge of Artists Service. Rogers has signed a contract placing him under the exclusive management of N.B.C.

* * *

The Boswell Sisters have a commercial program again. They are heard three times weekly, on Monday, Wednesday and Friday, from 7:30 to 7:45 p.m., E.S.T., on the Pompeian Make-Up Box program. Jeannette de Cordet will be retained as Mistress of Ceremonies.

* * *

Nelson Eddy, WOR Baritone, has been playing a series of out-of-town concerts, but manages to return to New York for his Friday night radio program.

* * *

Willard Robison and his Deep River Orchestra, one of the few combinations with which I would care to broadcast, are heard three times weekly over WOR on Mondays at 8:30 p.m., Tuesdays at 11:03 p.m., and Wednesdays at 8:00 p.m. Don't miss hearing this delightful program.

* * *

Many Lew Conrad Fans will be glad to know that "Our Lew" will be guest conductor for a week at the Metropolitan Theatre in Boston. He will conduct the Metropolitan grand orchestra through the N.B.C. Artists Service in New York.

* * *

And Still Another Matrimonial Venture has been announced. Miss Kathleen Stewart, charming N.B.C. pianist, and Everett Martine, of Nyack, N. Y., will wed in May. Congratulations, Kathleen and Everett!

* * *

Biographical Brevities

All About Gladys Rice

Gladys Rice was born on Thanksgiving Day in Philadelphia, the daughter of Sally Cohen and John C. Rice, whom veteran theatregoers will remember as one of the country's leading vaudeville teams of a generation ago. For the first few years of her life Gladys trouped with her parents. She made her stage debut in an impromptu manner one day, when she broke away from her nurse behind the scenes, rushed onto the stage and cried, "Daddy! Daddy!" to her father, who was in the midst of a love scene. She brought down the house.

Sally Cohen and John Rice decided that their daughter should escape the hardships of the theatre. So as soon as Gladys was old enough, they sent her to private school. She was never allowed near the theatre.

The parents appeared on Broadway and on tour for years. John Rice starred with such favorites as Tom Wise, Marie Dressler, and May Irwin. He appeared in Edison's first motion picture, "The Kiss." It is notable that years later Gladys also got her first real professional job from Mr. Edison by singing for the records.

In school Gladys participated in amateur theatricals. When her parents had vacations from the stage, the three of them gathered at their home in Mt. Vernon, N. Y. As a child Gladys would go for long walks with her father. He would talk to her in the dialects which he used on the stage. This delighted her and she would imitate his speech. She even learned five dialects. In school also she learned several foreign languages. The singing voice showed promise and she went through a strenuous course of training. She sang in school concerts and operettas—then she asked to go on the stage.

The parents pondered. They had hoped to keep her from the stage, but relented enough to allow the aspiring child to play with a stock company in Mt. Vernon. Perhaps, they thought, she will find the work irksome and undesirable, but the contrary happened. Gladys sought concert work. One day she met S. L. Rothafel, the "Roxy" of the show world. He gave her an audition and was favorably impressed. Finally she joined his "Gang" and her real work commenced.

Since then the name of Gladys Rice has been associated with radio. She is known from Coast to Coast. She sings in several different dialects and gives her own original interpretation of old and new ballads. Her voice is soprano. She is tall, inclined to be stately. Has black bobbed hair and large dark eyes. She still studies conscientiously, attends the theatre religiously, reads murder stories a great deal and is learning to play bridge. Never goes to night clubs, is a devotee of water sports and swims well, but doesn't care for boats, even ferries. She lives with her mother.

* * *

ANSWERS TO CORRESPONDENTS

W. P. COUCH, Cromwell, Conn.: The address of Radio Guide is 475 Fifth Ave., New York, N. Y.

* * *

JEAN GORDON, New York, N. Y.: (1) Do not know of a Scotch comedian broadcasting permanently on any New York station. (2) Death Valley is the name of the program to which you refer. Yes; it is an excellent dramatic presentation. John White is the name of the man who sings the cowboy songs.

* * *

SUNDRY SUGGESTIONS FOR WEEK COMMENCING JANUARY 17.

Sun. Jan. 17..Footlight Echoes....WOR 10:30 p.m.
Mon., Jan. 18..Vaughn de Leath.WABC 6:15 p.m.
Tues., Jan. 19. THE JARR Family.WOR 7:45 p.m.
Wed., Jan. 20. Big Time ....WEAF 8:00 p.m.
Thur., Jan. 21. Weaver of Dreams..WOR 10:15 p.m.
Fri., Jan. 21—Ada Patterson. Interesting People I Have Met.....WMCA 10.45 a.m.
Fri. Jan. 22..Friendship Town.....WJZ 9:00 p.m.
Sat., Jan. 23.. Little Symphony. Philip James..............WOR 8:00 p.m.

(If you care to know something of your favorite radio artists, drop a card to the conductor of this page. Address her: Miss Alice Remsen, care RADIO WORLD, *145 W. 45th St., New York, N. Y.)*

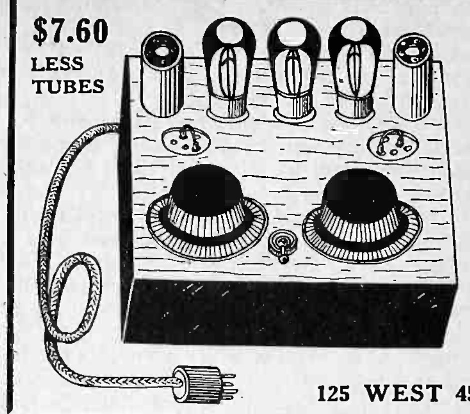
THE ECONOMIC SITUATION

The quotation on page 22, under the heading "The Economic Situation" is taken from "Harper's Weekly," issue of October 10th, 1857—remarks made only 74 years ago!

Excellence of Set Boosts Polo Sales

Polo Engineering Laboratories, 125 West 45th Street, New York City, report that 75 per cent. of their present business in the sale of Polo midget sets consists of repeat orders and orders obtained on the recommendation of highly satisfied customers.

The Laboratories, it is well known to the trade, have one of the best 5-tube midget t-r-f sets made, with multi-mu r-f and pentode output, for a-c operation. Factory production has been again increased, for the third time in four months.



$7.60 LESS TUBES

BUILD THIS SENSITIVE CONVERTER FOR ONLY

Complete parts for the Polo Economical Short-Wave Converter, 15-200 meters, with built-in power supply, completely self-operated, and including cabinet, sell for only **$7.60**. This converter works on supers as well as on t-r-f sets. *No user has ever reported failure to get results!* And you get *real* results. No plug-in-coils. Costs only 1/10c per hour to run. Clear picture diagram makes 2-hour wiring easy. **$7.60**

Order Cat. ECC @ **$7.60**. Tubes used are three 237, @ **$3.15** extra for all three.

Polo Engineering Laboratories
125 WEST 45th STREET NEW YORK, N. Y.

BLUEPRINTS

627. Five-tube tuned radio frequency, A-C operated; covers 200 to 550 meters (broadcast band), with optional additional coverage from 80 to 204 meters, for police calls, television, airplane, amateurs, etc. Variable mu and pentode tubes. Order BP-627 @ ....25¢

628-B. Six-tube short-wave set, A-C operated; 15 to 200 meters; no plug-in coils. Intermediate frequency, 1,600 kc. Variable mu and pentode tubes. Order BP-628-B @ ....25¢

629. Six-tube auto set, using automotive tubes, with pentode push-pull output. Order BP-629 @................25¢

RADIO WORLD
145 WEST 45TH ST., NEW YORK, N. Y.

1,000 PAGES! 2,000 DIAGRAMS! IN RIDER'S NEW 7-POUND MANUAL

JOHN F. RIDER'S PERPETUAL TROUBLE SHOOTER'S MANUAL is the book you need if you want to do profitable servicing. This loose leaf volume contains every bit of radio service information of all popular commercial broadcast receivers manufactured since 1920 and includes the latest diagrams. In addition to the wiring diagrams of the receivers the Manual contains chassis layouts, color coding, electrical values, chassis wiring diagrams, and the wiring of units sealed in cans. It also contains a course in Trouble Shooting, the use of set analyzers, data upon Superheterodynes, automatic volume control, etc. Page size is 8½x11, bound, 1,000 pages, index and advertisements on additional pages. Order CAT. RM-31 and remit $4.50. We will then pay postage. Shipping weight 8 pounds. Ten day money back guarantee.

RADIO WORLD
145 WEST 45th ST. NEW YORK CITY

THE FORD MODEL—"A" Car and Model **"AA"** Truck — Construction, Operation and Repair — Revised New Edition. Ford Car authority, Victor W. Page. 703 pages, 318 illustrations. Price **$2.50**. Radio World, 145 W. 45th St., New York.

Quick-Action Classified Advertisements

7c a Word — $1.00 Minimum
Cash With Order

HANDY 4 FT. FLEXIBLE TEST-CORDS WITH UNIVERSAL CLIPS—25c postpaid. Five for $1.00. Tele-Dyne Electrical Laboratory, 2935 Walnut Street, Chicago, Ill.

PRINTING: 1000 BUSINESS CARDS, with Card Case, $1.50 postpaid. Other printing reasonable. MILLER, Printer, Narberth, Pa.

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

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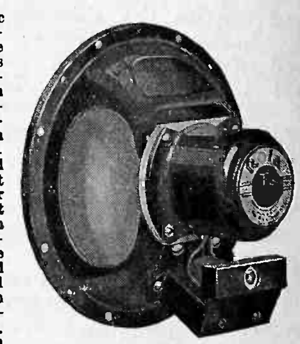

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