EASY MEASUREMENT OF LOW RESISTANCES

RADIO WORLD

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The First and Only National Radio Weekly

609th *Consecutive Issue* *Twelfth Year*

NOV. 25 1933

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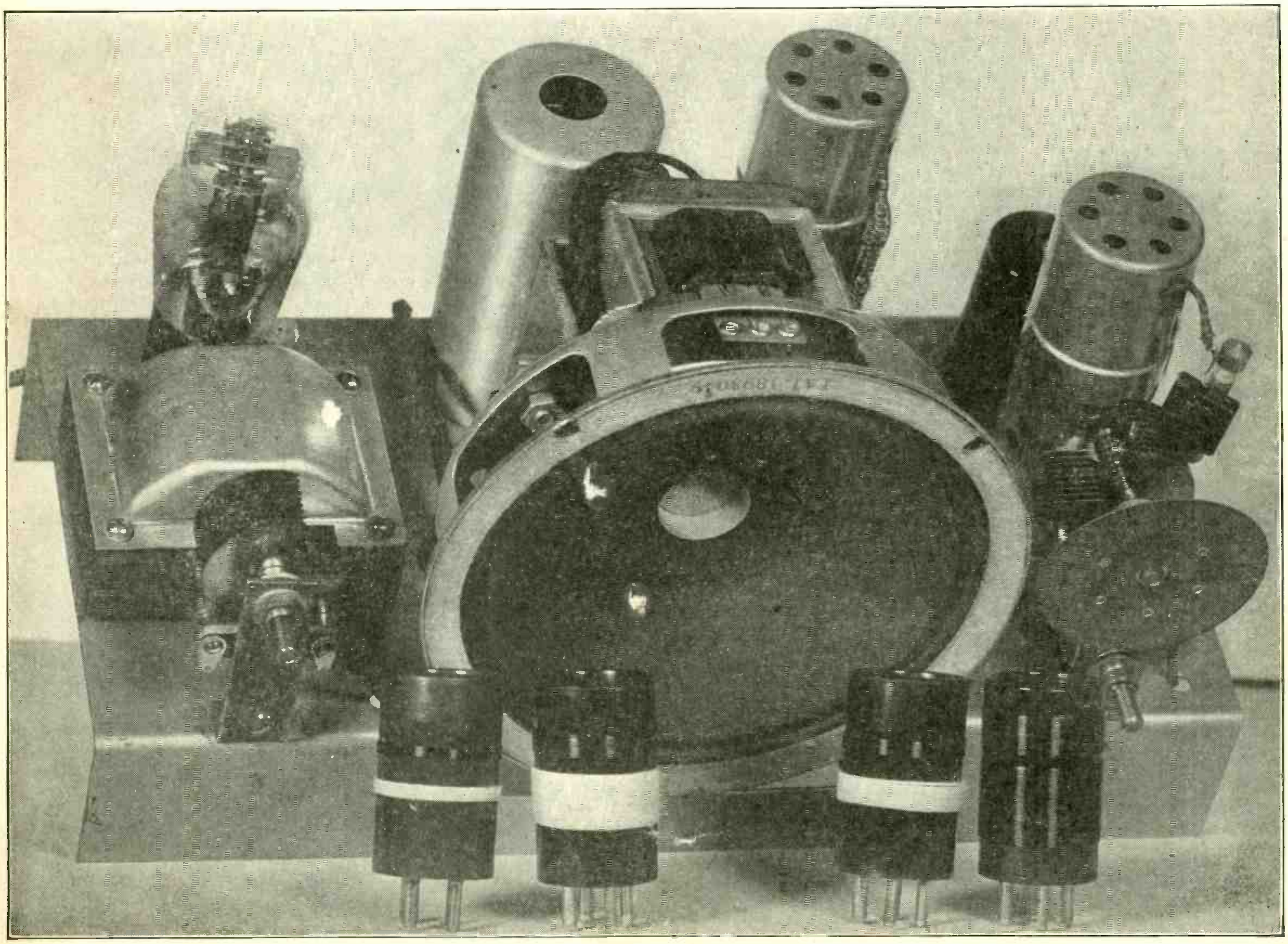
Vacuum Tube Voltmeter

Super Using 2-Volt Tubes and Pentagrid Converter



A four-tube short-wave a-c set. See pages 12 and 13.

ROLAND BURKE HENNESSY
Editor

HERMAN BERNARD
Managing Editor

RADIO
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J. E. ANDERSON
Technical Editor

J. MURRAY BARRON
Advertising Manager

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SHUNTING THE METER

To Enable Reading of Very Low Resistances

By Brunsten Brunn

THE USEFULNESS of a resistance meter can be extended to read very small resistances accurately by a very simple device. First let us show that the resistance meter ordinarily cannot be used for measuring small resistances. A common resistance meter has a 0-1 milliammeter as indicating instrument and this is used with a voltage of 1.5 volts. A limiting resistance is put in series with the circuit so that when the terminals provided for the unknown resistance are shorted the meter reads full scale. If the voltage is exactly 1.5 volts and the internal resistance of the meter is 27 ohms, the total external resistance is 1,500 ohms less 27 ohms.

This particular instrument has 20 divisions on the scale and it is possible to read to half a division. Hence the highest reading possible, short of full scale, is 39/40 of full scale. This will be obtained when the unknown resistance is 38.4 ohms, so that can be set as the lower limit by the ordinary resistance meter.

Using Shunt Method

For measuring low resistances the unknown is put across the instrument terminals and the terminals ordinarily used for the unknown are shorted. When this change has been made in the circuit it takes the form in Fig. 1. Rx is the unknown, Ro the external limiting resistance, and E is the voltage of the battery. Let the internal resistance of the meter be Rm. Ro should be adjusted so that when there is no shunt the deflection on the meter is full scale. Let the deflection be Im when some shunt is put across it. Then by solving the circuit we have the formula $Rx=RoRm/[E/Im-(Rm+Ro)]$. This formula is accurate and can be used for calibrating the instrument.

Now let us put in specific values in this formula. If we use the instrument previously described and also the same voltage, $Ro=1{,}473$, $Rm=27$, and $E=1.5$. Then if we express the current in milliamperes the formula reduces to $Rx=26.514/(1/Im-1)$. This formula is accurate, provided the adjustments have been made accurately and the voltage is just 1.5 volts. It can be used for calibrating the shunt type resistance meter having the specifications given above.

We found that the least value that 1/Im can have, short of full scale, is 40/39. Hence the highest value of resistance that can be measured with this particular instrument is 1,033 ohms. That is higher than the lowest value obtained by the series method. Hence we have ample overlap. The highest value that 1/Im can have, as we found above, is 40. Hence the lowest value of resistance that can be measured with the shunt method is 0.68 ohm.

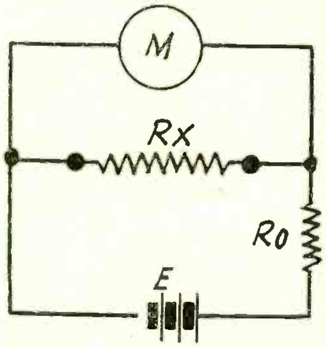


Fig. 1
This circuit illustrates how very low resistances can be measured with a resistance meter. The unknown is put in shunt with the meter to deflect a portion of the current

Limiting Values

This lowest value of resistance that can be measured is sufficiently low to test radio frequency tuning coils for shorts. If the coil is shorted the meter will indicate zero deflection when the coil is put across the meter, and if the coil is all right, there will be a definite deflection indicating a low resistance. It might amount to an ohm or more.

If a universal type 0-1 milliammeter is used, one that has an internal resistance of 50 ohms, the lower resistance limit is somewhat higher. Suppose in this case we make the voltage 10. The limiting resistance then will have to be 9,950 ohms and the formula reduces to $Rx=49.75/(1/Im-1)$. If the lowest current reading is, as before, 1/40 of full scale, the lowest resistance that can be measured is 49.75/39, or 1.276 ohms. If we used a voltage of one volt with this meter, the external resistance would have to be 950 ohms and the lowest resistance measurable would be 1.22 ohms. There is no difference in the accuracy and no great difference in the lowest resistance that can be measured.

It will be observed that when the series type resistance meter is used the deflection will be higher the lower the unknown resistor, while when the shunt method is used the deflection will be less the lower the resistance.

Resistance Standard

When using the shunt method of measuring resistance, the internal resistance of the instrument is the standard in terms of which the other is measured. Hence the internal resistance should be known accurately. If the true value of the resistance is not known by information from the manufacturer it should be measured. For this purpose a low resistance of accurately known value is required. Suppose that this resistance has a value of R ohms and that the resistance of the meter to be measured is Rm. Hook the meter in a circuit with very high resistance and adjust this resistance until the meter reads full scale. Then put the resistance of known value across the instrument. Read the deflection. It is much less now for a part of the total current has been deflected by the shunt.

The object of having a very high resistance in the external circuit is to insure that the total current will not change when the shunt is put across the instrument. When the shunt is across the voltage drops in the shunt and in the meter are the same. Hence if the deflection is Im milliamperes on the meter and I is the current through the shunt, we have $RmIm=RI$. Hence the resistance of the meter is $Rm=RI/Im$. It remains to find I, the current through the shunt. Well, the total current is equal to full scale deflection on the meter, for it was so adjusted before the shunt was connected. Let this current be Io. Then the current through the shunt is $Io-Im$, and we get for the resistance of the meter, $Rm=R(Io-Im)/Im$.

The determination is most accurate when the known resistance R is equal to the resistance of the meter. Hence a known resistor having a value nearly equal to the meter resistance should be selected. This assumes that the meter resistance is approximately known. At any rate, if the meter is a 0-1 instrument, the unknown should be between 25 and 50 ohms.

VACUUM TUBE VOLTMETER

for Measuring A-C in Peak and RMS Values, Also D-C Potentials

By J. E. Anderson

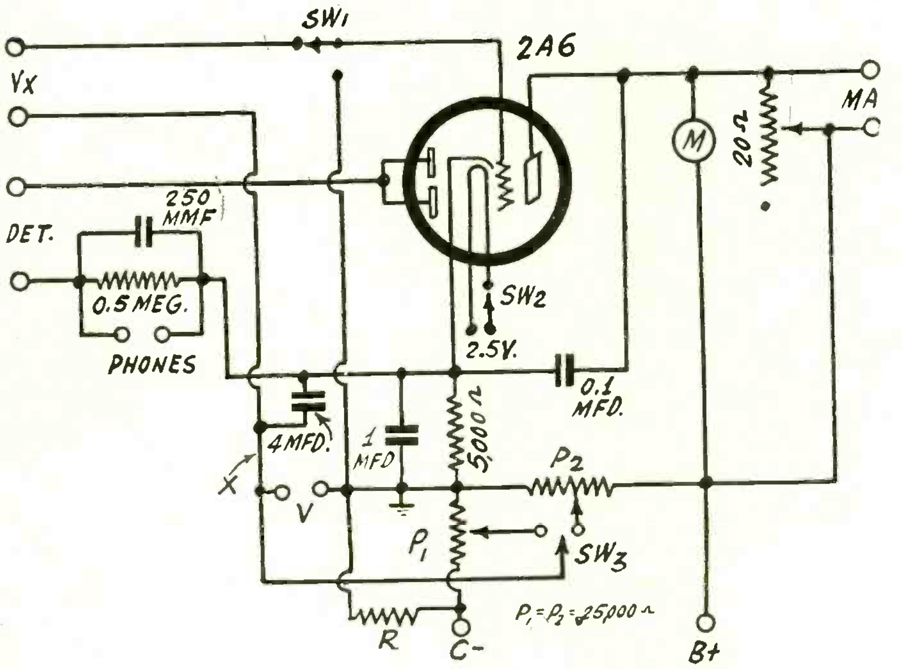


FIG. 1.

The circuit of a vacuum tube voltmeter and detector. It can be used for measuring alternating peak and direct voltages as well as root mean square. Besides the circuit can be used as a detector.

A VACUUM TUBE voltmeter is one of the most useful devices around a radio laboratory and it can be constructed very easily. The circuit of one such device is shown in Fig. 1. This is not only a vacuum tube voltmeter by which a-c peak voltages and d-c voltages can be measured but one that can be calibrated to read r.m.s. voltages and a circuit that can be used as a detector.

Let us first describe its use as a d-c voltmeter. A voltmeter having a range of the voltage to be measured is connected across the terminals indicated by V, the negative being connected to ground and the positive to the grid return lead. The voltage to be measured is connected to the terminals marked Vx with the negative to the grid and the positive toward that side which is conected to the positive of the voltmeter at V. A voltage of any convenient value is connected to the plate return, or between C minus and B plus.

Measuring Voltage

The first step is to switch the grid of the tube to ground by means of Swl. There will be a certain deflection on milliammeter M. Note the value. It is best to adjust the applied plate voltage, or the shunt rheostat across M, so that the pointer on the meter points to some division on the scale. This is a matter of convenience for that deflection will be used as a reference point to see that nothing has changed.

Now turn the switch Swl to the negative of Vx. If now the slider on P2 is near zero, that is, ground, there will be no plate current in the tube, or at least it will be lower than it was before. Move the slider on P2 toward the positive end until the current as indicated by M is what it was when Swl was on ground. The voltage indicated by V is now equal to the unknown voltage at Vx because the two have been balanced against each other.

The voltage that may be measured in this manner is limited only by the total voltage drop in P2. However, this is not the limit because if Vx is greater than the voltage across P2 an auxiliary voltage can be connected in series with Vx in the same direction as the drop in P2, and then the voltage at Vx will be greater by this auxiliary voltage than the voltage indicated by V. This auxiliary voltage can be measured first by the same method. It is most convenient to use a battery for the auxiliary voltage.

No Current Drawn

The advantage of measuring voltages by this method is that the meter does not draw any current from the source of the unknown voltage. In order, however, that no current is to be drawn the grid of the tube must be negative at the balance point, that is, when the switch Swl is on the ground position. It is the purpose of the 5,000 ohms bias resistance to insure that no grid current flows. This value is about right for a 2A6 tube. For tubes with lower amplification constants it may have to be lower. Its value is not critical in any case. Any value sufficient to prevent grid current is all right, but it should be large enough to insure a low plate current in the tube.

As an example of the voltage that may be measured with this arrangement we may mention the voltage drop in a resistance coupled circuit with a high plate resistance. The resistance may, for example, be as high as one megohm. If we were to connect a current-drawing meter across this resistance the voltage indicated would only be a small percentage of the actual voltage, but with this vacuum tube arrangement the voltage obtained would be correct. It would also be possible to measure the grid voltage when the grid leak resistance is of the order of several megohms.

Peak Voltmeter

The next application of the circuit is to the measurement of peak signal voltages. To do this the unknown alternating voltage is applied at the terminals Vx as before. A voltmeter is also connected across the V terminals, as before, but in this instance the meter is connected in the opposite direction because now we use potentiometer P1. Switch Swl is left as shown in the drawing. The first adjustment is to short the unknown and then slide P1 until the current in M is just zero. The shunt across M should be open so that the meter is most sensitive. At the point where the plate current is just reduced to zero note the voltage indicated at V. Now open the short on Vx so that the unknown voltage is active in the grid circuit. Once more slide P1 until the plate current is just reduced to zero and note the reading on V. The difference between the second value of V and the first is the value of the peak voltage applied at Vx.

The absolute error in the measurement is due mainly to the accuracy with which the current can be reduced to just zero, no more no less, and the reading of the corresponding voltages on meter V. Since this does not depend on the value of the unknown voltage, it is clear that the higher the unknown voltage the greater the accuracy with which a measurement can be made, that is, the greater the percentage accuracy.

The 2A6 tube is suggested because it has a high mu and therefore its plate current can be cut down to zero by a low voltage. Therefore a much lower total voltage drop is needed across P1 for a given peak value.

R. M. S. Measurements

It is also possible to measure r.m.s. values of alternating voltages by this instrument. The unknown is connected at Vx and Swl is left as in the drawing. With the Vx terminals shorted the potentiometer P1 is adjusted until the current in M is zero or some small value that can easily be returned to at any time. For example, the adjustment can be made until the current is such that the needle points exactly to the first division on the scale. When this adjustment has been made and the unknown voltage is applied, the current in M will increase, and the increase will be nearly proportional to the voltage applied.

The instrument must be calibrated by applying known voltages and noting the deflections. A curve giving the relation between the r.m.s. value and the current can be constructed, and this curve can then be used for measuring unknown voltages. After the circuit has been calibrated it is important that the filament current and the plate voltage applied to the tube be the same as they were when the calibration was done and it is also important to adjust the current when there is no input to have the low value used when the calibration was done.

There is no great need for calibrating the circuit in r.m.s. values because they can always be obtained from the peak values, assuming that a pure sine wave is applied. If the peak voltage is E the r.m.s. of this is 0.707E. This holds only for pure waves. The calibration of the r.m.s. scale holds only for the wave form that was used during calibration, and if this is to mean anything it should be a pure sine wave. Hence it is just as well to obtain the r.m.s. value from the peak by the formula given.

Use as Detector

If a 2A6 or any Duplex diode triode tube is used we have the rectifier available for detection. If we apply a signal voltage to the terminals marked DET there will be rectification and the detected voltage will appear across the 0.5-megohm load resistance. If the signal is modulated we may put phones across this resistance and the signal will be audible. If it is not modulated we can measure the d-c across the load resistance with a vacuum tube voltmeter.

Another way of using the circuit is to connect the grid of the triode to the negative end of the load resistance. The triode then becomes a diode biased amplifier. Thus we have a means of amplifying the detected signal whether it is unmodulated or modulated. The meter M will show the magnitude of the signal if it is unmodulated, and if it is modulated we can connect the phones in series with the B supply lead. There is a large number of possibilities of application of this instrument.

By-passing

A 250 mmfd. condenser is put across the load resistance of the diode. This is not too large for audio frequencies yet it is large enough to insure thorough detection when the circuit is used mainly for obtaining a d-c voltage across the load resistance.

A 4 mfd. condenser is connected between the cathode and the low potential side of the unknown a-c voltage. The object of this is to insure that the signal voltage is applied between the grid and the cathode and to keep it from straying into the potentiometers. The one microfarad condenser across the bias resistance has a similar object. The 0.1 mfd. condenser between the plate of the triode and the cathode is to filter the signal in the plate circuit. Without a large by-pass condenser here the meter M will not read much when alternating voltages are applied in the grid circuit. But a 0.1 mfd. condenser is adequate. It is too large for cases when a phone is put in the plate circuit, yet it is not so large that the audio signal will be shorted out of the phones entirely.

Purpose of Circuit

The switch Sw3 is for the purpose of switching the circuit for a-c and d-c measurements. For d-c the switch should be turned to P2 and for a-c to P1. It would be possible to measure d-c voltages by using P1 alone. It would only be necessary to apply the unknown voltage with the positive to the grid. If so arranged P2 could be a fixed resistance, Sw3 could be omitted, V would always have the same polarity, and the circuit would be simplified considerably. However, there are cases when it is desirable to apply the unknown with the negative to the grid, and for that reason the more complex arrangement is employed.

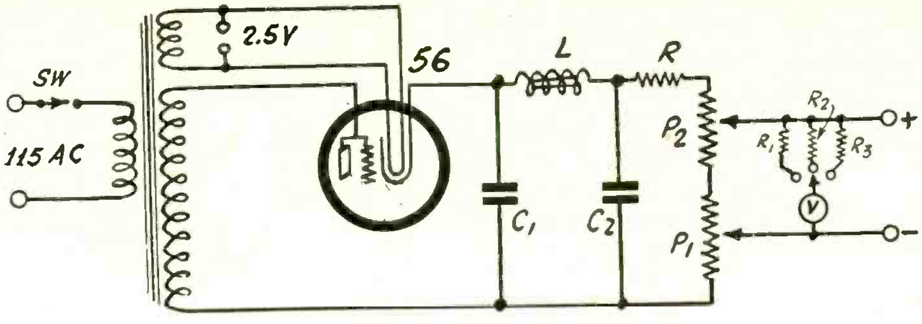


FIG. 2.

When using the vacuum tube voltmeter for taking grid voltage plate output voltage curves a source of adjustable grid bias is needed and this circuit is useful for this purpose

The circuit is a unit of a complete radio tester that is being constructed. It is for that reason that many of the devices are used which do not seem to be strictly necessary. Thus the two binding posts marked MA are for the purpose of making the milliammeter available for external use. One purpose of the rheostat is to make the range of the milliammeter wider. It is also useful in connection with the vacuum tube voltmeter, especially as a protection for the meter. The filament switch Sw2 is needed at times when the circuit is used in the general tester, but it is mounted on one of the potentiometers.

Resistance R depends on the rest of the circuit and the voltage desired across the potentiometer P1. If the plate voltage is taken from a B supply that is used for other purposes, R should be adjusted so that the drop across it is about 100 volts, although a lower value is all right if only low peak values are to be measured.

A Grid Voltage Source

In nearly all cases when the d-c vacuum tube voltmeter in Fig. 1 is used, a source of grid bias is needed, mainly for varying the bias on the tube that is being studied. For that reason a grid bias supply is included in the same box as that which contains the vacuum tube voltmeter. The circuit of this is shown in Fig. 2. It consists of a half wave rectifier using a 56 as the tube. It employs a small transformer with a one-to-one ratio so that the voltage applied in the rectifier circuit is about 115 volts. This will insure an output voltage of at least 100 volts. Besides the high voltage winding the transformer also has a 2.5 volt winding for the filament. In the tester circuit this winding will serve both tubes and the switch Swl, Fig. 2, will control the filament currents in both, as well as the grid bias.

The current drawn from the C supply will not be more than 10 milliampere. Hence two 2 mfd. by-pass condensers and a choke rated at 30 henries will suffice to filter the output voltage.

The resistance R is such that the voltage across the two potentiometers P1 and P2 is 100 volts. This should be adjusted when the voltmeter V reads 100 volts. that is, when it is connected across the total voltage divider.

P1 is a potentiometer of 25,000 ohms and is used for rough adjustments of the output voltage. P2 is a potentiometer of 400 ohms and is used for fine adjustment.

Voltmeter in Circuit

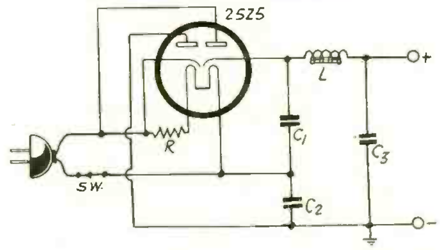
A voltmeter is always connected across the output terminals so that the bias applied is always known. The meter has three ranges, 0-1, 0-10 and 0-100 volts. and the three resistances R1, R2 and R3 are chosen with this object in view.

It is important that no part of the C supply be grounded or connected to any other point in the tester for it is to be available for connection anywhere without danger of short circuit.

When the vacuum tube voltmeter and the C supply are combined in the same unit, as they will be in the tester, the single switch Swl, Fig. 2, will control the filament current of both tubes as well as the grid voltage and it is mounted on P1 of Fig. 2. Sw2 in Fig. 1 will then not be needed. The plate voltage on the vacuum tube voltmeter can be left on permanently, as it will do no harm when the tubes are not heated. If, however, it is desired to open the plate supply it can be done by means of a switch placed in the B plus lead and mounted on one of the potentiometers in Fig. 1. When the vacuum tube voltmeter alone is needed, there is no harm leaving the C supply on, nor is there harm in leaving the vacuum tube voltmeter on when the C voltage alone is needed.

The voltmeter that is to go at V in Fig. 1 is a 1,000-ohms per volt instrument of the universal type which is another section of the general tester circuit. It is not necessary, however, to use such a sensitive voltmeter. Any voltmeter of reasonable sensitivity can be used.

Voltage Doubler



Voltage doubling is accomplished by means of two rectifiers and two large by-pass condensers. The essential connections of the circuit are shown in the diagram above. One of the anodes of the double rectifier is connected to the line. The cathode of the opposite rectifier is also connected to this line. The anode of the second rectifier is connected to the minus side of the output and to one of the condensers. The cathode of the first rectifier is connected to the positive side of the output and to one side of the other condenser. At the junction of the two condensers is connected the side of the a-c line heretofore not used. L and C3 are additional filtering devices for the rectified current.

How is a high-frequency transmission line constructed, one that operates on frequencies around 30,000 kc?

Usually the line consists of two concentric conductors, one of which is a copper or brass tube and the other a heavy wire in the center of that tube. Such a line has low resistance and practically no radiation. Another way of constructing the line is to have two equal parallel conductors always held at the same distance apart. They may be heavy copper bars or even tubes. Such a line would radiate considerably more than the concentric type of line. It is important that losses be as low as possible in a transmission line, and losses may occur as a result of radiation, resistance in the conductors, and no resistance due to losses in the insulators.

USES FOR THE NEW 79

Twin Tube Originally Brought Out for Class B Audio May be Circuited for Detector-Amplifier, Resistance Push-Pull or D-C Amplifier

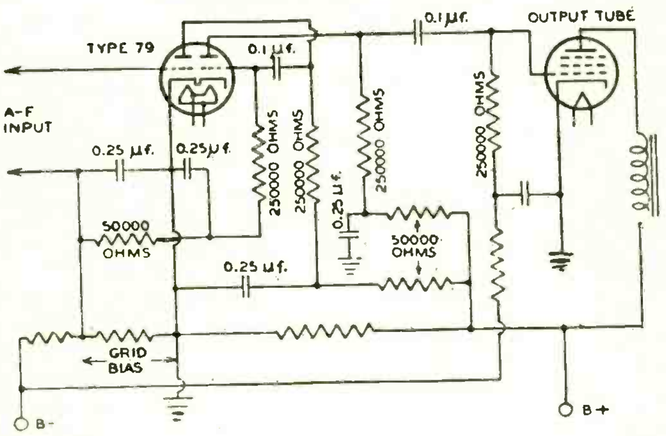


FIG. 1

A resistance-coupled audio amplifier, using the 79 for two stages, the second stage feeding the power tube. If the power supply is inadequately filtered, connect a resistor of 50,000 to 100,000 ohms in series with the grid return (a-f input at left) and increase the 0.25 mfd. condenser in this circuit to 10 or 15 mfd. or more.

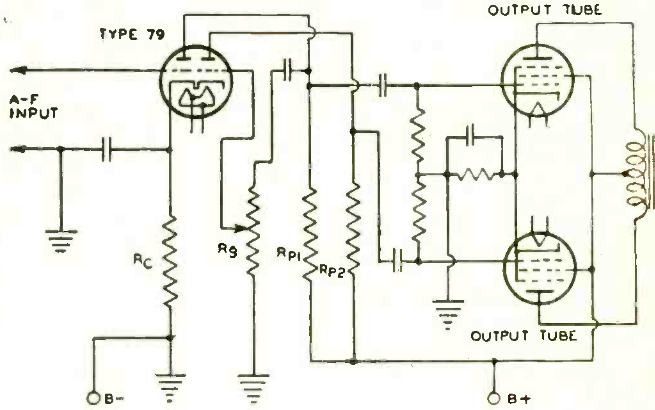


FIG. 2

For push-pull resistance-coupled audio, phase inversion may be adopted as shown. R9 is variable so that the voltages on Rp1 and Rp2 will be equalized. The values of the resistors correspond to those in Fig. 1. R9 may be 250,000 ohms. Unless careful balance can be established results will not be good.

THE type 79 vacuum tube, consisting of two high-mu triodes in a single bulb, although designed to be used as a Class B audio amplifier has many other applications.

The two triode units are identical and except for a common cathode are independent each from the other. This tube may be put to all the usual triode uses limited only by the common cathode. It may be used with both triodes in parallel, in push-pull arrangement, and in combinations where each triode unit performs a different function.

The ratings and characteristics for each triode unit are as shown:

Heater Voltage		6.3	Volts
Heater Current		0.6	Ampere
Plate Voltage ..	180	250	Volts
Grid Voltage. ..	—1.5	—2.0	Volts
Plate Current ..	1.25	1.75	Milliamperes
Amplification Factor.	80	80	
Plate Resistance.	50500	51500	Ohms
Power Output ..	30	57	Milliwatts

Resistance-Coupled Audio

As a resistance-coupled amplifier having its two units operating in cascade, the 79 provides exceptionally high voltage amplification, say RCA Radiotron Co., Inc., and E. T. Cunningham, Inc. The circuit of Fig. 1 is quite satisfactory for a resistance-coupled-amplifier arrangement when plate-supply voltages of low-ripple content are available. Because of the high gain of the 79 it is imperative that little or no hum voltage affect the grids. An inadequately-filtered supply voltage may be used, however, if a resistor of 50,000 to 100,000 ohms is connected in the grid return of the first unit and the capacity shown as 0.25 mfd. in Fig. 1 is changed to 10 or 15 mfd.

Measurement of the gain at 420 cycles with plate volts of 250 and grid volts of minus 2 showed a voltage amplification of over 2,000. The input voltage was limited to a value which just caused grid current in the second unit. With an input signal of 24 millivolts, the rms voltage measured across the 0.25-megohm plate load of the second unit is 50 volts. This is a gain of approximately 2,100. A curve of output voltage vs. input voltage shows the gain to be constant up to and including 24 millivolts input.

Fig. 3 shows a plate family of curves for a single unit with a 250,000-ohm load line for the 250-volt supply condition.

The question may arise as to whether the 79 or the 53 is more desirable for special applications such as the above since both are similar in having two triodes with a common cathode. A tabulation of their operating characteristics in a resistance-coupled amplifier (Fig. 1) follows:

	Type 79	Type 53
Filament voltage (volts)	6.3	2.5
Filament current (amperes)	0.6	2.0
Plate supply voltage (volts)..........	250	250
Grid voltage (volts)	—2.0	—3.0
Plate current (per unit) (milliampere)	0.32	0.5
Voltage amplification (per unit)	46.0	26.8
Overall voltage amplification	2,100	720
Max. A-F input voltage (RMS) (volts).	0.024	0.08
Max. A-F output voltage (RMS)(volts)	50.0	57.5
Plate load (megohm)	0.25	0.25
Distortion (negligible).		

Detector and Phase Inverter

The deciding factors in choosing between the two tubes are the available filament supply, the gain required, the available input for the stage, and the hum characteristic of the power supply.

As a biased detector, the 79 may be used as shown in Fig. 4. In comparison with the 53 in a similar circuit, the 79 will give approximately the same output with approximately one-half the input-signal voltage and approximately one-half the grid bias.

If it is desired to operate an output stage in a resistance-coupled push-pull arrangement, the 79 may be used as a pre-amplifier and phase inverter. The a-f voltage developed across the plate load of the second triode R_p2 in Fig. 2 is 180 degrees out of phase with the voltage developed across R_p1. The grids of the two output tubes can therefore be resistance coupled to R_p1 and R_p2, respectively. The variable tap on R_g is for the purpose of equalizing the voltages on R_p1 and R_p2. These two voltages must be equal for the proper operation of this amplifier.

The 79, due to its high gain, makes an excellent amplifier to build up phototube impulses for the operation of various devices. When it is desired that slowly-varying-voltage pulses be magnified, the use of a d-c resistance-coupled amplifier is advantageous. Such devices respond to low frequencies, in contra-distinction to usual audio amplifiers. The latter are ordinarily not effective below 25 or 30 cycles.

A suitable d-c resistance-coupled circuit is given in Fig. 5. With no signal voltage applied to the input terminals, each triode unit should operate at a suitable point on the linear portion of its grid-voltage plate-current characteristic. A voltage applied to the grid of the first unit causes a change in its plate current which in turn produces a change in the voltage drop across its plate resistor and alters the grid bias of the second unit. If the change on the grid of the first unit is in a positive direction, that on the second grid is in a negative direction. This fact may be an essential consideration in designing a d-c amplifier, i.e., as to whether it should consist of an even or an odd number of stages.

In the amplifier of Fig. 5 consisting of a phototube, the two units of a 79 operating as voltage amplifiers and a 43 operating as a current amplifier, it will be observed that a positive voltage change on the first grid causes a current increase in the plate circuit of the 43. A positive voltage change on the first grid due to light on the phototube is obtained when the phototube is connected as shown.

Voltage Doubler Used

A 25Z5 operating as a voltage doubler supplies plate voltage for the amplifier. A filter for smoothing the rectified voltage was found to be unnecessary, although in some applications it would be required.

The series-heater arrangement of this circuit requires shunt resistors across the 43 and 25Z5, since the heater of the 79 takes 0.6 ampere. The bleeder resistor should not take over 20ma. This is desirable to insure suitable output voltages from the rectifier.

Under the condition of average load, the following d-c voltages are applied to the amplifier:

Total Rectified Voltage (A to G)	220	Volts
Grid Voltage on No. 1 Unit (C to B)	—1.5	Volts
Phototube Supply Voltage to (B to D)	60	Volts
Plate-Supply Voltage for No. 1 Unit (C to E)	100	Volts
Plate-Supply Voltage for No. 2 Unit (C to E)	100	Volts
Plate-Supply Voltage for 43 (E to G)	80	Volts
Voltage to Balance Out Plate Current of 43 (G to F)	12	Volts

A fairly critical adjustment of voltage was found necessary for good operation. The tabulated voltages represent values found by experiment to be suitable.

Plate Current Balanced Out

Under the influence of light, the phototube resistance drops to a finite value so that current flows through R_1, thereby making the grid of the No. 1 unit less negative. The amplifier phase relations are such that the negative bias on the 43, caused by the drop in R_6 due to a change in No. 2 triode plate current, decreases and the 43 plate current increases. It is easily possible to reduce the 43 bias to zero so that the 43 plate current is limited only by cathode emission and plate voltage. Should it be desired to have no current through the indicating or recording device in the plate circuit of the 43 with no input signal, the diagram shows how the plate current can be balanced out. This is accomplished by returning the low-potential lead of the indicating device, in this case shown as a meter, through a suitable resistor to a point (F) on the bleeder. Thus, the voltage required to balance out the 43 plate current is equal in this instance to 12 volts and is obtained across G-F.

The high-current drain from the rectifier will effect the voltage regulation to some extent, but with the circluit of Fig. 5, no instability was apparent.

The voltages used on the test amplifier were sufficient to allow reasonably good performance. The approximate sensitivity of the amplifier was found to be such that a light flux of less than 0.02 lumen would cause a plate-current change for the 43 of 25 ma.

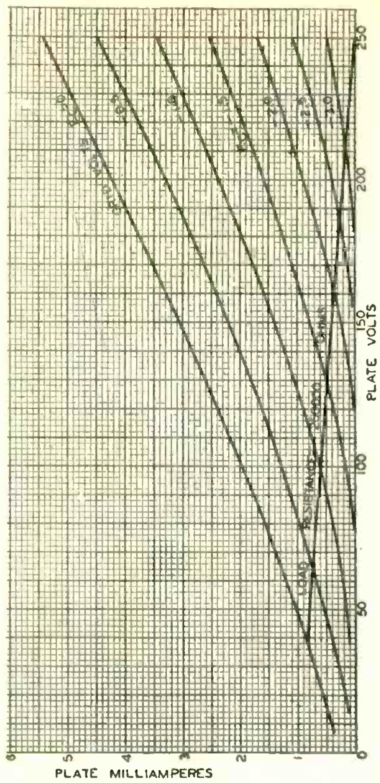
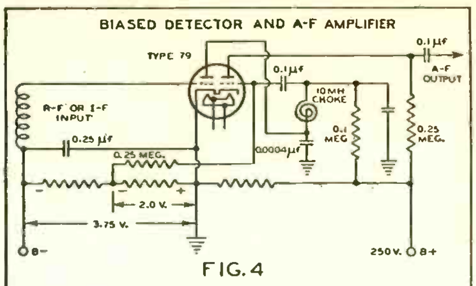


FIG. 3
Average plate characteristics, Class A operation, each triode unit of the 79. The heater voltage is 6.3 volts, the heater current 0.6 ampere.



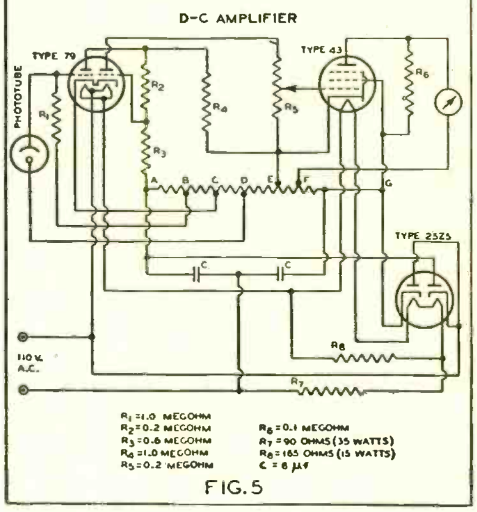


FIG. 4
The 79 as a biased detector and audio-frequency amplifier. The grid at left and plate above it are Unit No. 1.

FIG. 5
For photo-cell use a d-c amplifier, the 79 feeding a 43, may be used, with 25Z5 rectifier.

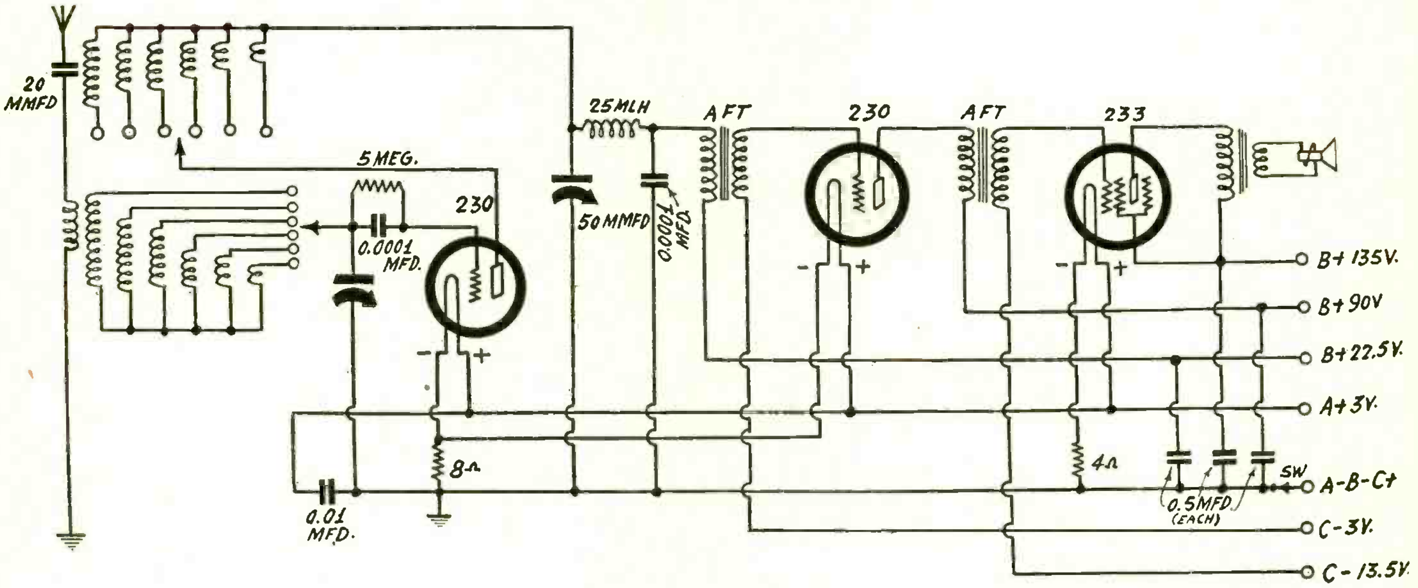
GETTING READY

Dealers are preparing for Christmas. Their orders are placed already and dressing-up the place is under way. Deliveries are slower this year.

WIND THE COILS

For This Short-Wave Battery Set

By Jack Tully



The use of a switch serves convenience in a short-wave set. This diagram is of a simple model, for battery operation, although it has plenty of pep. The grid of the detector may be returned to negative filament or positive filament, not to grounded A minus. The connection is left open in the diagram so that by test you may decide which way proves better. Usually sensitivity is higher when the connection is made to positive filament

THREE tubes will give speaker volume on a short-wave battery set, and switching may be used, instead of plug-in coils, and the inductances wound by the set-constructor.

The diagram herewith shows the circuit construction. The detector and first audio tubes are 30's, the output is a pentode 33, and for dry-cell feed to the filaments, in the absence of a storage battery, the speaker would be of the magnetic type.

A small series condenser is in the aerial circuit, and the grid leak is of high resistance, both precautions taken to assist oscillation at high frequencies. However, if one seeks to go above 30 mc (below 10 meters), oscillation may fail unless two tubes, both 30's, are in parallel in the detector circuit. This parallelism may be harmlessly retained for the lower frequencies. The 8-ohm resistor should be reduced to 5.5 ohms.

The detector is regenerative, as that is the only way of assuring sufficient sensitivity from a single-tube tuner, as well as good selectivity.

Making the Coils

The principal purpose of the present discussion is to provide the information on which the preparation of the coils may be undertaken.

Since the circuit is good only for short waves, and fails badly on broadcasts, there is little sense in attempting coils for the broadcast band.

The lowest frequency should be 1,500 kc or so, and if you will get a coil form of 1 inch diameter you may wind 40 turns of No. 30 enamel wire, or wire size somewhere near that, to constitute the tuned winding, and wind a tickler over the secondary, consisting of one-quarter the number of turns on the secondary. Insulating fabric should be placed between the two windings. With this coil the first test may be made, and therefore the frequency coverage confirmed.

If the tuning condenser is 0.00014 mfd. the ratio of frequency, high to low, in respect to this coil and the others, will be about 2.4-to-1, and if the condenser is 0.00035 mfd. the ratio will be about 3-to-1. Since it may be deemed expedient to use the larger capacity, because fewer coils are required, less room taken up, and relatively smaller reliance on the switch, the coil data so far have been given for 0.00035 mfd. and will be continued on that basis.

30-to-1 Vernier Dial

Any difficulty of moving the dial with proper fineness may be taken up by introducing a high-ratio vernier dial, say, 30-to-1, of which there are several on the market.

If the low-frequency setting is known, somewhere near or at full capacity of the condenser, the high-frequency end may be three times as great. So from 1,500 to 4,500 kc may be expected. Since the detector is a harmonic generator, if the test signal, say a 1,500 kc station, is strong enough, perhaps the second harmonic will be heard, disclosing where 3,000 kc is to be registered on the dial, as well as the third, so that 4,500 kc is located.

The circuit has to be used a while until something identifiable is picked up around 4,500 kc, or at least somewhere near the high-frequency end of the first coil. If it is code, and you can't read code, you can familiarize yourself with the characteristic of the keying and also the note, and then unwind turns from the secondary until you hear this same station with the capacity of the tuning condenser either maximum or nearly maximum. You know you put on 40 turns at first, now you may count the remaining turns, so even if you didn't keep track of how many were taken off you are still safe, and again you do enough listening until at or near minimum capacity you pick up a station.

Assuring Oscillation

Then take off more turns, until the condenser is at or near maximum, and you will have the third coil, as well as accurate data for the first and second coils, which will be carefully wound later, and ticklers proportioned.

With three coils the frequency range is 27-to-1, so already you have reached a frequency not much less than 30,000 kc, or 30 mc, or a wave not much longer than 10 meters.

As was stated, there may not be oscillation unless two tubes are used in parallel, as to the smallest coil, and also the tickler conditions are not just right. So wind the first coil as directed. Then wind the second coil, putting on an extra turn or so, and using larger diameter wire, say, No. 28 or 26 enamel, and put the tickler next to, not over this coil, and have it consist of half as many turns as the secondary, separation between adjoining windings ¼ inch.

The third coil is wound the same way, and as a precaution it has still larger wire on the secondary, because of necessity of reducing the radio-frequency resistance. Use No. 18 enamel, or bell wire. As a general proposition the number of turns should not exceed four, and you may accept four turns as correct in the absence of contradictory experience. The tickler for the smallest coil should have at least as many turns as the secondary, possibly even half again as many, although the tickler wire does not have to be so thick, and, again, the tickler is wound next to, not over the secondary, with ¼-inch separation between.

One Tubing or Three Tubings

Therefore with only three coils you have wide frequency coverage, the whole short-wave band, in fact, according to the present definition of what short waves really are. Still higher frequencies may be referred to as "ultra" frequencies, and yet higher ones as "quasi-optical" frequencies, but these you will scarcely aim for, and perhaps had better not expect to bring in on this receiver. If you are interested in making the trial, do

(Continued on next page)

What to Use When Calibrating

THE problem that seems to vex so many experimenters, that of calibrating a test oscillator that is outside the broadcast band, was discussed in detail in last week's issue, dated November 18th. Since it is true that the words alone do not convey a full picture, a little experimenting on the side will clear up the problem nicely.

Useful in Actual Work

Merely reading about calibration of the test oscillator is of scarcely any help, since fundamentals of both receiver and oscillator, and harmonics of oscillator, are discussed one after another, and the whole subject-matter sounds very confusing. Even when engineers talk to one another about oscillator calibrations or other matters pertatining to fundamentals and harmonics, the speaker usually is the only one that has the subject completely in mind, as it takes more concentration than one cares to devote to a merely conversational topic to make the necessary distinctions and follow the discourse.

When the problem is a practical one, the receiver at hand, and oscillator to be calibrated, the situation is quite different. The actual application is simple enough. At first one has to keep his mind closely on the subject, to be sure, but when the hands help the brain the work is facilitated.

The fundamental of the receiver can be well appreciated at all times, and receiver harmonics are not used ordinarily. The oscillator fundamentals constitute the unknown, and it is realized that by harmonics of the oscillator beating with fundamentals of the receiver the unknown is to be ascertained. It then becomes only a matter of applying the information already set forth, and that application will become so firmly fixed in one's mind after the first task is done that the next oscillator to be calibrated will constitute even an enjoyable work, requiring scarcely any headwork, due to the assistance of previous experience.

Use a T-R-F Set

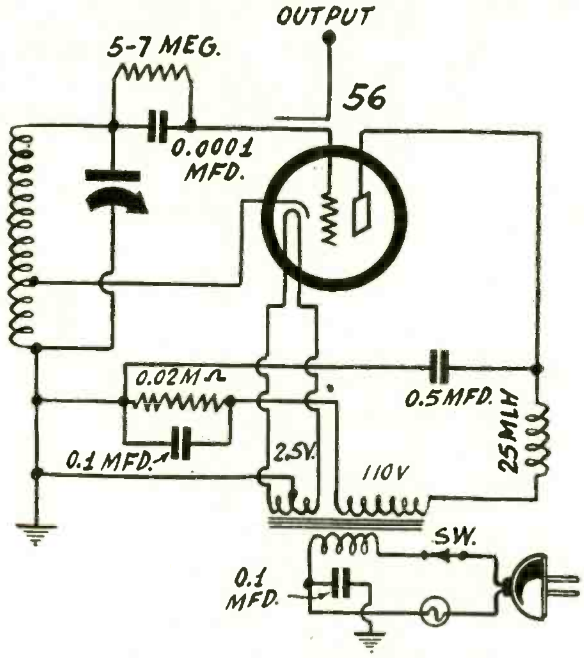
Preferably the receiver used should not be a superheterodyne, because of numerous responses in the set due to test oscillator and local oscillator harmonics, and to mixtures of off-resonant station carriers with local oscillator fundamental and possibly harmonics, as well as intermodulation of strong locals on their fundamental carriers, beats with local oscillation, and inexplicable results. A tuned-radio-frequency set does not give this trouble, and if the selectivity is not as great as it might be, looser coupling between test oscillator and receiver yields the equivalent of increased selectivity.

Unless the test oscillator is carefully and fully shielded, and the line blocked, as well as low-pass filtration introduced, it is quite possible that no other coupling between test oscillator and receiver is needed than the simple radiation from the test oscillator. If the intensity of the test oscillation is not high enough to give adequate coupling when the oscillator is a few feet from the receiver, bring the oscillator nearer to the set.

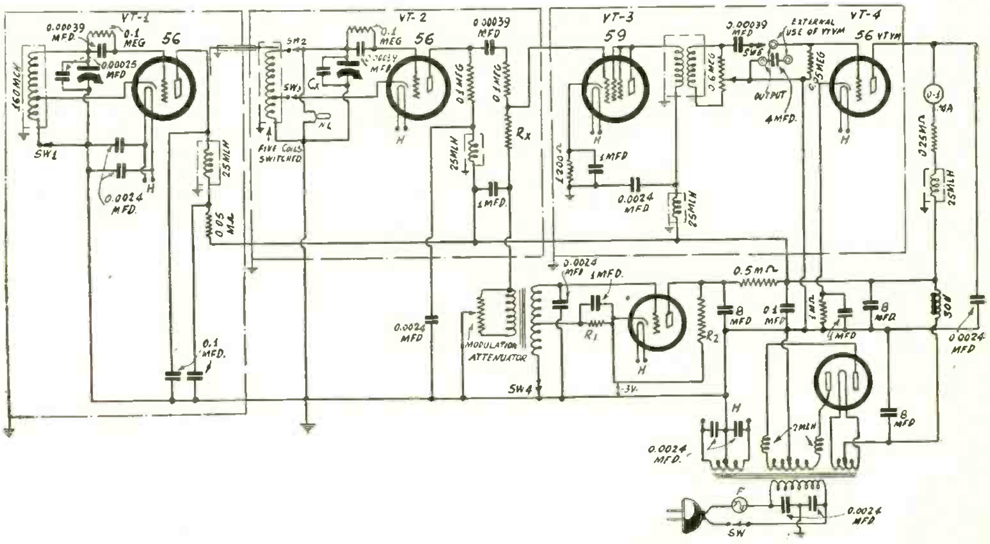
The exact resonance point, using a t-r-f set, can be found usually only by having loose coupling, so all conditions that cause response over a few degrees of the dial, with diminished intensity this and that side of resonance, should be avoided, since by loose coupling it is possible to reduce the response practically to zero except at real resonance.

Ear Suffices

The ear is a sensitive instrument in the light of these tests, and serves as well as a meter, since the speaker of the receiver will give the only indication really needed. However, any who desire to use a meter may put one in the detector plate circuit (d-c meter) or one across the output of the power tube (a-c meter). Or a neon lamp may be used across the output, and its glow noted as an aid additional to the ear's service. The meters and lamp are mere auxiliaries, rather fancy appurtenances, and not really needed for this work.



A simple a-c operated constantly-modulated test oscillator for low frequencies.



An elaborate modulated test oscillator. The calibration principle is the same.

Short-Wave Switch-Operated Set

(*Continued from preceding page*)

not be disappointed if not much, if anything, is heard.

The winding finally may be done on one long tubing, or on three separate tubings, and then the only uncertainty is the switch. To be any good at all the switch must be excellent, because contact resistance, capacity effects and other conditions, notorious in poor switches, put a terrific drag on the circuit. However, there are contact resistance and capacity effects in plug-in coils, and it is possible these days to get switches that do the work satisfactorily, since during the past year, with the greatest growth of short-wave popularity, switch makers, slow at first, were compelled to turn out a satisfactory product, or, to state it more accurately, the manufacturers of short-wave kits and sets were compelled to spend enough on the switch—and to them it was plenty—to get the kind of results that the public wanted.

A few local amateurs and an occasional foreign station at low volume no longer constitute a sufficient "thrill" in short-wave reception.

Returning to the circuit, the detector voltage may be somewhat less than 22.5 volts and give even improved results, but if there is no lower voltage available from your B battery supply, use 22.5 volts. Do not attempt to use the C batteries in some way to give low detector plate voltage while serving for C biasing, as these attempts are not sound and usually result only in short circuits.

A FOUR-TUBE A-C SH

Regenerative Detector, 58 Audio Amp

By Herma

Try-Mo Ra

SPLENDID short wave results can be obtained with a simple four tube regenerative receiver utilizing a 58 for detector, another 58 for audio frequency amplification and a 2A5 for power amplification. Such a receiver, the Baird, is diagrammed in Fig. 1. Besides the amplifier and detector tubes it has an 80 in the power supply. Thus the circuit contains four tubes in all and it is entirely a-c operated.

For shortening the antenna to make the circuit more efficient on the short waves, a small condenser of 0.0001 mfd. is put in series with the antenna lead. This condenser is of the mica dielectric type since a condenser of this kind has a very low resistance to radio frequencies.

The coil system consists of four plug-in transformers, each having two windings, one for the tuning and one for the regeneration. The tuning coil plugs in so that it is between the antenna condenser and ground and directly across the tuning condenser. The tickler plugs in so that it is connected between the plate of the detector and the stator of the regeneration control condenser. The rotor of this condenser is grounded. For this reason the control of the regeneration is not subject to any body capacity effects. The regeneration is smooth and can be pushed to the oscillation point without any snapping. The approach to the oscillation point can be from either direction, thus making it possible to receive both modulated and unmodulated waves with highest efficiency.

Grid Leak Detection

Grid leak and condenser type of detection is employed because this can be combined more effectively with regeneration. For grid stopping a condenser of 0.0001 mfd. of the mica dielectric type is employed. Across this condenser is a leak of 3 meg., a value consistent with high sensitivity.

For stopping the radio frequency in the plate circuit a radio frequency choke is placed between the plate and the coupling condenser and plate resistor. The plate is fed through a resistance of 250,000 ohms from the highest voltage available in the circuit.

The screen of the detector tube is maintained at a suitable voltage by means of a voltage divider consisting of one 100,000-ohm resistor and one 7,500-ohm resistor, the lower resistor being placed between the screen and ground and the higher between the screen and the highest voltage available in the circuit.

Audio Coupling

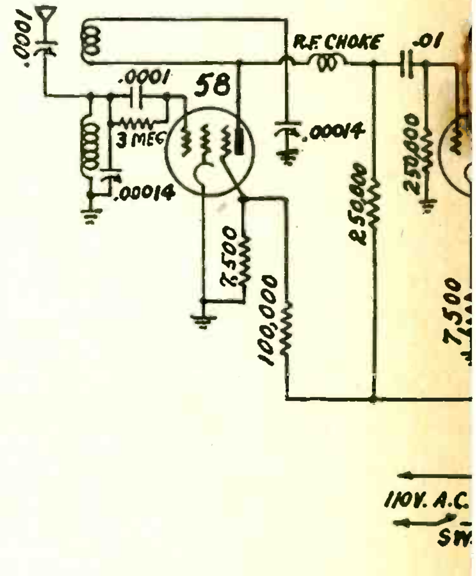
The first audio tube is coupled to the detector by means of a 0.01 mfd. condenser between the grid and the radio frequency tube. In the grid circuit is a grid leak of 250,000 ohms one end of which is connected directly to ground.

Following the 58 audio amplifier is a plate coupling resistor of 250,000 ohms, a stopping condenser of 0.01 mfd., and a grid leak of 250,000 ohms. The 58 audio amplifier is biased by means of a 7,500-ohm resistor in the cathode lead. This is not shunted by any condenser, the omission being for the purpose of stabilizing the high-gain amplifier.

The screen of the 58 is connected to the highest available voltage through a resistor of two megohms. This high resistance taken in conjunction with the 250,000-ohm plate resistance keeps the screen and plate voltages in their proper relative values and at the same time a comparatively large input is allowed.

The Power Stage

The power tube, which is a 2A5, is biased by the voltage drop in the 300-



FI

The circuit of a four-tube, a-c operat characterized by high radio se

ohm section of the speaker field coil, this section being placed between the ground and the grid return of the amplifier. In the lead to the grid is a 100,000-ohm resistor for the purpose of filtering out the a-c hum. There is also a condenser of 0.1 mfd. from the grid leak to ground and

Short-Wave Br

(We are indebted to the International Short-Wave Club, with headquarters at Klondyke, Ohio, U. S. A., for permission to publish this list, which includes stations authentically reported active.)

All times are given in Eastern Standard Time, add five hours for G.M.T. Wavelength only is given.

(Note—The following group of stations broadcasts musical programs. Commercial stations we listed separately.)

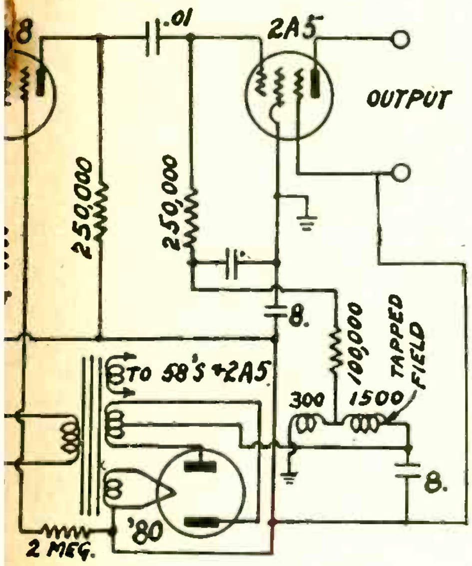
Wave Length Call	*Location*
14.47—LSY	Buenos Aires, Argentina. Near 4 P.M. Sundays.
15.93—PLE	Bandoeng. Java. Tuesdays 8:40-10:40 A.M.
16.87—W3XAL	Boundbrook, N. J. Week days. 7 A.M. to 3 P.M.
19.57—W2XAD	Schenectady, N. Y. 3 to 6 P. M. daily. Sat. & Sun. 1 to 6 P.M.
19.68—	Pontoise, France. 7 A.M. to 10 A.M. daily.
19.73—DJB	Zeesen, Germany. 8 A.M. to 12 noon daily.
19.84—HVJ	Vatican City. Broadcasts daily 5 A.M. to 5:15 A.M.
19.90—T14-NRH	Heredia, Costa Rica. Saturday 11 A.M. to noon, 4-5 P.M. and 10-11 P.M. Sun. and Mon., 11 A.M. to noon and 4-5 P.M.
20.60-HBJ	Geneva, Switzerland. Testing.
20.95—G2NM	Sonning-on-Thames, England. Sundays.
23.38—	Rabat, Morocco. Broadcasts Sunday, 7:30 to 9 A.M.
25.20—	Pontoise, France. 10.30 A.M. to 1:30 P.M. daily.
25.25—W8XK	Pittsburgh, Pa. 3 P.M. to 9 P.M. Daily.
25.34—W9XAA	Chicago, Ill. Relays WCFL, irregularly.
25.40—12RO	Rome, Italy. Broadcasts 11 A. M. to 12:30 and 3 to 5:30 P.M.
25.42—W1XAL	Boston, Mass. testing, irregularly.
25.53—G5SW	Chelmsford, England. Monday to Friday, 6:45 A.M. to 7:30 A.M. and 12:30 to 6:10 P.M. Sat. 7-8 A.M. and 12:30 to 6:10 P.M.
25.60—	Pontoise, France. 3 P.M. till 6 P.M. Daily.
25.60—VE9JR	Winnipeg, Canada. Daily exc. Sat. and Sun., 11:45 A.M. to 1:30 P.M.
26.83—CT3AQ	Funchal, Madeira. Tues.-Thurs., 5 to 6:30 P.M.; Sun. 10:30 A.M. to noon.
28.98—LSX	Buenos Aires, Argentina. Daily, 8 to 9 P.M.
29.26—D1Q	Zeesen Germany. Used irregular.
30-40—EAQ	Madrid, Spain. 6:30 to 8 P.M. daily. Sat. 1 to 3 P.M.
31.00—T14NRH	Heredia, Costa Rica. Daily exc. Sunday 9 to 10 P.M.
31.25—CT1AA	Lisbon, Portugal. Heard Tues., Thurs., Fri., 4 to 7 P.M.
31.28—VK2ME	Sydney, Australia. Saturday midnight to Sunday 2 A.M., 4:30 to 8:30 A.M. and 1:30 to 3:30 P.M.
31.30—HBL	Praquins, Switzerland. Testing near 4 P.M.
31.36—W1XAZ	Springfield, Mass. 3:30 P.M. to 11:30 P.M. Daily.
31.38—DJA	Zeesen, Germany. 2 P.M. to 6:30 P.M. daily.
31.40—VK3ME	Melbourne, Australia. Wed. 5 till 6:30 A.M., Sat. 5-7 A.M.
31.48—W2XAF	Schenectady, N. Y. Relays WGY daily 5 P.M. to 11 P.M.
31.51—OXY	Skamleback, Denmark. Broadcasts 2 to 6:30 P.M.
31.58—PRBA	Rio de Janeiro, Brazil. Heard between 6 P.M. and 8:30 P.M.
32.26—	Rabat, Morocco, broadcasts, Sundays, 3 to 5 P.M.
33.50—TGX	Guatemala City, Guatemala. Saturdays 10 P.M. till midnight.
34.68—VE9BY	London, Canada. Mondays 3 to 4 P.M. and irregular times.

ORT-WAVE RECEIVER

lifier, 2A5 Output and an 80 Rectifier

n Cosman

lio Company



G. 1

ed, short-wave regenerative receiver nsitivity and high audio gain.

this makes the filter effective.

Adequate filtering of the plate supply is obtained with the filter choke and two 8 mfd. electrolytic condensers, one being placed directly across the rectifier output and the other from the plate returns to ground.

The power pentode used is capable of a high undistorted output when operating with the voltage provided for in this circuit and the circuit is sensitive enough to load this tube up to the limits of its power handling capacity on most short wave stations ordinarily received.

Tuning

The tuning condenser has a maximum capacity of 140 mmfd. It is provided with a special slow motion vernier dial that makes close tuning easy. It is possible to tune any station "right on the nose" and thus to get the maximum sensitivity out of the circuit.

The spreading of the short wave band from 15 to 200 meters over four ranges also helps greatly to tune since there is a greater spread than if there were only three coils. The object of using a small tuning condenser, of course, is to bring this about. There is another advantage in using a small condenser, and that is that the sensitivity is much greater, for the sensitivity depends on the ratio of the inductance to the capacity.

The regeneration control condenser also has a capacity of 140 mmfd., but this condenser is turned with a simple knob of large size to make it easy to adjust the regeneration accurately.

The receiver is mounted on a steel chassis skillfully laid out to insure high efficiency of the tuner, absence of radio and audio frequency coupling, no hum, and convenience of assembly. The loudspeaker is in the center of the assembly, the detector with the tuner at the right, and the regeneration control at the left. The power transformer is also at the left, directly behind the regeneration condenser.

The receiver is housed in a beautiful crackle-finish wood cabinet.

A fifth coil is available for part of the broadcast band and sixth coil to complete that band.

LIST OF PARTS

Coils

One set of four plug-in coils to cover the band from 15 to 200 meters (Bruno or I. C. A.)
One radio frequency choke.
One electrostatically shielded power transformer.

Condensers

One 0.0001 mfd. fixed mica condenser.
Two variable 0.00014 mfd. tuning condensers (Hammarlund).
Two 0.01 mfd. fixed condensers.
One 0.1 mfd. condenser 400 volt rating.
Two 8 mfd. electrolytic condensers (500 volt rating).
One 100 mmfd. antenna series condenser.

Resistors

One 3-megohm grid leak.
Two 7,500-ohm resistors.
Two 100,000-ohm resistors.
Four 250,000-ohm resistors.
One 2-megohm resistor.

Other Requirements

One black crackled wood cabinet.
One drilled and punched metal base.
One A-C on-off switch.
One special slow motion vernier dial.
Two knobs.
Two 58-series tube shields.
One 2A5 tube shield.
One coil socket.
Two 58 sockets.
One 2A5 socket
One 80 socket.
One 6-inch dynamic speaker with 1,800-ohm tapped field coil matched to 2A5 tube.
One roll of hookup wire.
One kit of assorted hardware.
One a-c cable (cord and plug)
Assembly instruction sheet.

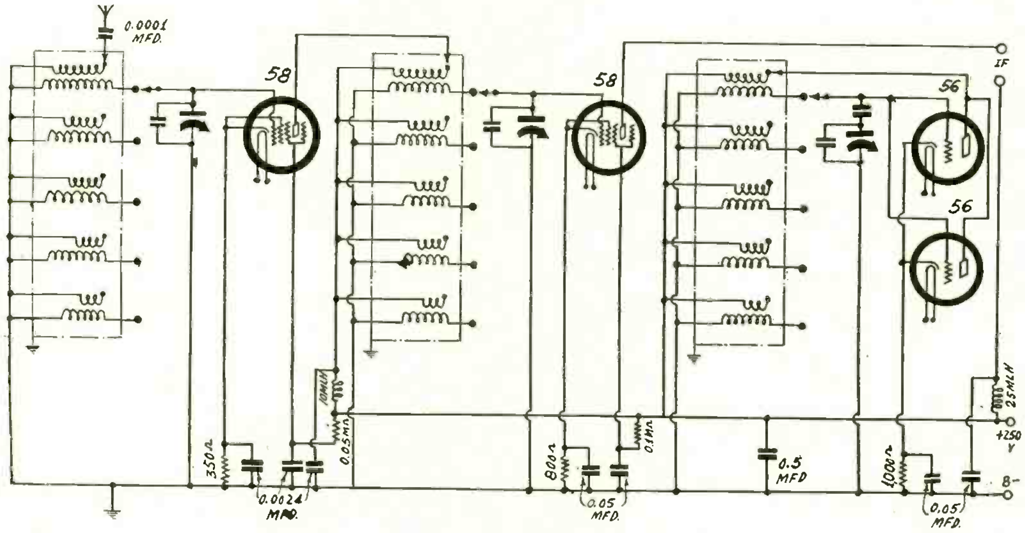
oadcast Stations

Wave Length Call	*Location*
38.60—HBP	Geneva, Switzerland. Testing.
39.40—HJ3ABF	Bogota, Colombia. 7 P.M. to 11 P.M.
40.50—HJ3ABD	Bogota, Columbia. Tues., Thur., Sat., 8 to 11 P.M.
41.00—CM5RY	Matanzas, Cuba. Saturdays 10:45 to 11:30 P.M.
41.60—EAR58	Teneriffe, Sat. and Sun., 4:30 P.M. to 6:00 P.M.
42.00—HJ4AAB	Manizales, Colombia. Thur. and Sat. 7-9 P.M. and 11-12 P.M.
42.20—HKN	Medellin, Colombia. 8 P.M. till 10 P.M. 8:30-10:30 P.M. Earlier Sun.
45.31—PRADO	Riobamba, Ecuador. Thursdays, 9 P.M. till 11 P.M.
46.60—REN	Moscow, U. S. S. R. Relays Moscow, 1 P.M. to 6 P.M.
46.67—VE9BY	London, Canada. Wednesday 8:30-9:30 P.M. Friday 7:00-7:55 A.M. and Saturdays 8-11 P.M.
46.96—W3XL	Boundbrook, N. J. No regular schedule.
47.00—HKS	Cali, Colombia. Irregular, near 10 P.M.
47.00—HCIDR	Quito, Ecuador. 8 P.M. till 10 P.M.
47.50—TITR	San Jose, Costa Rica. 10 to 12 A.M., 4 to 9:30 P.M.
48.00—HKA	Barranquilla, Col. 8 P.M. to 10 P.M. Daily.
48.85—VE9CL	Winnipeg, Canada. Daily except Sun., 6 P.M. till 8:30 P.M.
48.86—W8XK	Pittsburgh, Pa. 4 P.M. to 11 P.M., daily. Late Saturdays.
48.95—YV11BMO	Maracaibo, Venezuela. Broadcasts, 8 to 11 P.M.
49.18—W9XF	Chicago, Ill. 3:30 P.M. to 1 A.M. daily.
49.18—W3XAL	Boundbrook, N. J. Saturday 4 P.M. to midnight.
49.20—JB	Johannesburg, South Africa.
49.22—VE9GW	Bowmanville, Can. Week days, 3-9 P.M., Sun. 11 A.M.-7 P.M.
49.29—VE9BJ	St. John, N. B. Near 5 P.M. and 11 P.M.
49.34—W9XAA	Chicago, Ill. Relays WCFL, Sun. 11 A.M.-9 P.M.; Wed., Sat., 8:30 A.M. to 9 P.M.; Tues, and Thurs., 8:30 A.M. to 8 P.M.
49.42—VE9CS	Vancouver, B. C. Sun. 3:30 P. M. to Midnight. Fri. at 0 to 1:30 A.M.
49.50—W8XAL	Cincinnati, Ohio. 5 A.M.-9:30 A.M., 12:30-2:30 P.M. and 6 P.M. to 12:30 midnight.
49.50—VQ7LO	Nairobi, Kenya, Africa. Daily 11 A.M.-3:30 P.M. Tues. 3 A.M.-4 A.M. Thursday 8 A.M. to 9 A.M.
49.50—CMCI	Havana, Cuba. 9 P.M.-11 P.M.
49.51—ZL2ZX	Wellington, N. Z. Mon., Wed., Thur., Sat., 2:15 to 6:15 A.M.
49.59—VE9HX	Halifax, N. S. Mon., Tues., 6-10 P.M. Other days 6-7 P.M.
49.96—VE9DR	Drummondville, Can. Relays CFCF, 7 P.M. to 12 Midnight.
50.00—RW59	Moscow, U.S.S.R. 9 A.M.-11 A.M., 2 P.M.-5 P.M. Daily.
50.00—HKD	Barranquilla, Col. Daily 8-10 P.M.
50.26—HVJ	Vatican City. Broadcasts daily, 2-2:15 P.M., Sun. 5-5:30 A.M.
50.60—HKO	Medellin, Colombia. Mon., Wed., Fri. 8 to 10 P.M., Tues., Thurs., Sat. and Sun., 6 to 8 P.M.
51.00—HKB	Tunja, Colombia. Irregular near 10 P.M.
51.72—VK3LR	Victoria, Australia. Heard 2 A.M. to 6:30 A.M.
52.70—FIUI	Tananarive, Madagascar. Sat., Sun. 1-3 P.M. Other days 9:15-11:15 A.M.
58.00—PMY	Bandoeng, Java. 12:40 to 2:40 A.M. and 6:40 to 9:40 A.M.
62.50—W2XV	Long Island City, N. Y. Wed. and Fri. 8 till 10 P.M.
62.56—VE9BY	London, Canada. Saturday midnight on.
70.1—RV15	Khabarovsk, U.S.S.R., 3 A.M.-9 A.M.

AN ALL-WAVE TUNER

To Go Ahead of 465 kc I-F Amplifier

By Herman Bernard



Circuit for constructing a calibrated all-wave tuner, going from 540 kc to nearly 40 mc. To insure oscillation at the highest frequencies, which approach the ultra frequencies, two tubes are used in parallel in the oscillator. There will be enough stray coupling, including that between adjacent switch sections, to make unnecessary any special external means of uniting oscillator with modulator.

THE construction of a tuner to feed a 465 Kc intermediate amplifier is diagramed in Fig. 1. The tuning ratio for the broadcast band is 3 to 1, which is applied also to the first shortwave band. After that, when the frequencies become more crowded, there are various methods that may be introduced, but none simpler than using only about half the dial displacement, so that, with the types of tuning condensers now popular, there is straight frequency line distribution over this plate area. By this method, also, the frequency ratio is reduced to 2 to 1, as a compromise for the benefit of the high frequency bands, for all methods of wide-band coverage introduce some compromises.

Ratio of Dial

It is advisable that the dial have a high reduction ratio, say around 30- to 1, and then the use of only 90 degrees of the dial rotation, instead of 180 degrees, does not become a serious handicap. While electrical considerations govern the spreadout or crowding of high frequencies on the dial, mechanical considerations can take care of sufficient dial separation to make the tuning seem less congested.

After all, ease of tuning is what matters, and the frequencies would be fairly well spread out.

On this basis computations have been made, allowing for a condenser with maximum of 400 mfd., which is close to the real maximum of the so-called 350 mmfd. group, since the trimming capacity must be added, and besides the run of condensers is around 360 mmfd. without the trimmer.

Table Explained

In the preparation of the following table it will be noted that the minimum capacity of the signal level is lower than that of the oscillator level, which is necessary for good tracking in the broadcast band, and to carry out the tracking at the higher frequency bands the inductance is chosen accordingly. The respective capacity minima are 44.4 and 53 mmfd.

The maximum capacity at the signal level prevails for the broadcast band and the first short-wave band, since the 3-to-1 frequency ratio is maintained in both these instances. However, for the higher frequency bands the maximum selected is 177.6 mmfd., which is approximately the capacity at which such condensers stop yielding a straight frequency tuning line and become something more crowded. So for this band the dial would be turned only to, say 50, instead of all the way to 100, as which was true in the two previous bands.

Of course, if one so desired, he could tune to lower frequencies, considerably overlapping the next lower band, simply by going to higher numbers than 50, but better results are obtained by using each band only for the frequencies intended, because the primaries and ticklers have been selected on that basis.

Tabulation of Constants

Here is the table:

kc	Signal Level mmfd.	L
540-1,620	44.4-400	220
1,620-4,860	44.4-400	23.1
4,860-9,720	44.4-177.6	4.8
9,720-19,440	44.4-177.6	1.1
19,440-38,880	44.4-177.6	0.3

kc	Oscillator Level mmfd.	L	Cp
1,005-2,085	53-230	110	520
2,085-5,325	53-260	17	730
5,325-10,185	53-177.6	4.7	0
10,185-19,905	53-177.6	1.0	0
19,905-39,345	53-177.6	0.3	0

The signal level refers to the carrier frequencies of the stations to be tuned in at that level. The capacity of the condenser is in micro-microfarads. L, under Signal Level, refers to the inductance for the first and second coils from left in the diagram. The frequencies actually covered by the combinations of coils and condensers are noted both at the signal level and at the oscillator level. Of course, the oscillator level is simply higher than the signal level by the amount of the intermediate frequency. Thus, add 465 kc to the signal level and you have the oscillator level. The minimum capacity for the signal level remains unchanged throughout, at 44.4 mmfd., and the minimum capacity of the oscillator level remains unchanged likewise, at 53 mmfd. However, though the signal level capacity is reduced from 400 to 177.6, throughout, the oscillator effective capacity is reduced for two bands by a series or padding condenser, hence the maximum oscillator capacity cited is the effective result, obtained when the 408.6 mmfd. oscillator condenser's maximum has the padding condenser in series. Actually this maximum for the oscillator, without padding is, 408.6, because the trimmer is 8.6 mmfd. greater than at the signal level. The padding capacity in the righthand column is approximately correct, so that any adjustable means will strike the exact point. A fixed mica condenser and a small adjustable condenser could be put in parallel to accomplish the result.

Calibration Ideas

The method of using the full dial and full capacity spread for two bands, and halve the mechanical displacement of the dial for the next three higher frequencies, has its advantages, principally in that straight frequency line tuning is introduced, and no series, parallel or other special capacities have to be cut in.

Besides, since there are only two ratios, if the dial is to be frequency-calibrated, this may be done on the basis of two calibrations, one for each ratio, with the proper frequencies written in.

For the two lower frequency bands this would amount merely to putting the right numbers on top and on bottom of a division bar, while in the other instance the same procedure would be followed, except that another tier of numbers would be introduced. However, it should be remembered that the two low-frequency bands would be directly and evenly related to each other, the higher frequencies being three times as great, whereas the third band would not be related to either of the lower ones, but the two remaining higher bands would be related to the first 2-to-1 ratio band by the factors 2 and 8.

Coil Information

All the coils for a given stage are shown as being in one shield can. If the shield is 3" diameter aluminum, and the coils for the two or three lower frequencies are layer-wound on dowels that have circular pieces at the ends to hold the wire in place as it is wound, the total result can be compactly accomplished. The two smaller coils may be solenoids.

For the low-frequency coil (broadcast band), the r-f secondaries may consist of 225 turns of wire of the approximate size of No. 29. If the primary is wound on the same basis, as a separate coil to be related to the other by location, then since the insulating rings will have a thickness that produces a considerable space between the windings, the primaries should have more than the usual one-quarter of secondary turns, and primaries of half the number of secondary turns would be satisfactory. The broadcast oscillator coil would have 125 turns. The tickler would have 60 turns.

The data given will be sufficient for the broadcast band coils.

With such information the first coil may be wound, and the two separate parts held together by a rod through the central hole in the round pieces. This preferably should not be metal, so bakelite may be used, or other insulator, although the loss in the broadcast band is small if a brass screw is used. An iron screw is more loss-provoking.

The coils are wound in layer fashion, the wire simply being turned on the bobbin-like form until enough turns are on, as described, to accomplish the result.

With that much information the set may be built, the intermediate channel lined up with a modulated test oscillator, at 465 kc, and then the other coils may be wound experimentally. For instance, the first tube may have the a-c line connected to plate, instead of the rectified and filtered B voltage, and may be turned into an oscillator, by using primary as feedback coil. The modulated oscillation will come through if the condenser is removed from the second stage. Then harmonics of the test oscillator (an extra instrument, the one used for i-f lining-up) may be used for determining the number of turns on an experimental coil, and the coil for the succeeding stage duplicated, with a special oscillator coil only for the second band. After that all coils for a given frequency level are made alike, except that slight turns-removal may be necessary to make up for the difference in minimum capacities.

The Paralleled Tubes

The mutual conductance of the local oscillator in the receiver is too low for any considerable response at the very high frequencies unless two tubes are used in parallel, and since they may as well be included for the broadcast band and between-bands, that is done, and convenience served without any impairment of results whatsoever.

Thus the coils are stacked up in the same cans for the same stage, three shields are used, fifteen coils (counting primary and secondary as one coil) and accurate calibration will be possible.

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Accurate Settings of Oscillators

AFTER an oscillator has been calibrated accurately how is it possible to return to the same frequency by setting the dial? What sort of dial should be used? Are there any special dials or arrangements by which the accuracy can be increased?—B.Y.

If we assume that the circuit has been stabilized so that the frequency does not change with filament and plate voltages, and also if we assume that the temperature has no effect, the accuracy with which the frequency can be set depends on the dial of the condenser. We can get a dial that can be read directly to one part in 1,000, full scale, and that can be estimated to one part in 2,000. If the capacity range is C and if it is a linear condenser, we can read the capacity to C/2,000. The frequency change due to a small change in the capacity is $dF=FdC/2C$, where C now is the total capacity in the circuit. If we assume this to be equal to the range of the condenser we can substitute C/2,000 for dC. Hence dF is equal to F/4,000. If the frequency is 1,000 kc, we can set the oscillator to within 250 cycles. We could use a scale on the condenser such as is used on transits or spectroscopes where it is possible to read at least one part in 7,200. That would increase the accuracy of the setting in direct proportion to the accuracy of reading the scale. Or it would be possible to use an optical arrangement to increase the accuracy still more. For all practical purposes a dial that can be estimated to one part in 2,000 of full scale is good enough, and such a dial need not be more than 4 inches in diameter, or at most 6 inches. It is always possible to have a high minimum capacity in the oscillator and therefore a narrow range for each coil. The accuracy of the setting can then be greatly increased. Suppose, for example, that the oscillator only goes from 900 to 1100 kc and that the condenser used for tuning has a range of 500 mmfd. This condenser could be arranged so with other condensers that the whole range would have to be used to change the frequency by 200,000 cycles. An accuracy of better than 100 cycles would be possible, or one part in 10,000.

* * *

Effect of Suppressor

WHAT IS the purpose of the suppressor element in a screen grid vacuum tube and in what way does it help to improve the operation of an amplifier?—T.H.M.

If electrons strike the plate at a sufficient speed they release other electrons from the plate and cause what is called secondary emission. The electrons will have sufficient speed when the screen voltage is high and especially when the plate voltage is much lower than the screen voltage. These electrons may flow from the plate to the screen and thus cause a negative plate current. At any rate they retard the flow of electrons in the proper direction. The function of the suppressor is to prevent these electrons from interfering with the normal flow. The effect of the suppressor in an amplifier is to allow a much higher plate swing and hence a greater output and a greater amplification. In the 24, which has no suppressor, the plate voltage cannot fall below about 100 volts when the screen voltage is 90 volts. In the 34, which has a suppressor, the plate voltage can fall to about 40 volts, when the screen voltage is 67.5 volts. That is, when the tube has no suppressor the plate voltage cannot even be allowed to become equal to the screen voltage, while in the 34 it can be allowed to fall much below. A tube with a suppressor grid cannot be used as a dynatron oscillator for it functions because of the effects of secondary emission. However, if a tube has a suppressor that is brought out to a separate pin, it can be given a voltage that will give the required characteristic.

* * *

Small Variable Condenser

WOULD IT BE practical to make a small variable condenser by attaching a circular metal disc to the end of a screw and then mounting a stator plate so that when the screw is turned the plate attached to the screw would move toward or away from the stator plate? It seems to me that a very fine gradation in capacity could be obtained in this manner. Are there any difficulties?—W.E.M.

The difficulties are mainly mechanical. First of all it is difficult to attach the plate to the screw so that it will not wobble. It must be accurately at right angles to the axis of the screw. In the second place it is difficult to keep the screw itself from wobbling. If the machining has been done well, it will work out all right. A very fine gradation in capacity is possible, first by making the pitch of the screw fine and second by making the mean distance between the two plates large. Perhaps an easier construction is to have the movable plate in the form of a book leaf and make the screw move one edge of it.

* * *

Dynatron Oscillator

IN WHAT MANNER does the plate current vary with the bias on the control grid in the region where a screen grid tube works as a dynatron oscillator, that is, in the region where the resistance characteristic of the plate circuit is negative? Or, how does the negative resistance characteristic vary with the control grid bias?—R.L.

The slope of the plate voltage plate current characteristic increases as the grid bias decreases, that is, the negative resistance decreases as the bias decreases. For the 24A tube the plate current is zero when the plate voltage is about 20 volts, the screen voltage being constant at 90 volts. For any given plate voltage the negative plate current increases as the bias decreases. The positive plate current, where it is positive, also increases as the grid bias decreases. These variations are consistent with the increasing slope as the bias decreases. These facts indicate that the output of a dynatron oscillator can be modulated by impressing an alternating voltage on the control grid.

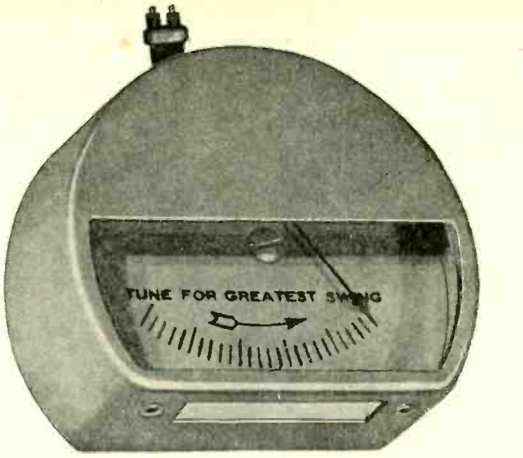
* * *

Variation of Capacity of Condenser

DOES THE CAPACITY of a condenser vary when the rotor plates are moved in the direction of the axis with respect to the stator plates? It seems to me that there should be no change, for there is no change in the areas of conductors facing each other. Yet we are told that to make adjustments in the capacity we

(*Continued on next page*)

If one has a tuning meter, and the needle moves in the direction opposite to that marked "tune for greatest swing," putting the meter in a reversed-phase circuit will make the action correspond with the directions on the meter. Some suggestions for the new location are contained in answer to a question on this page. Readrite's tuning meter is illustrated.



(Continued from preceding page)
should move the rotor plates in this manner, and usually there is a provision for making the change.—W.C.B.

The capacity of a condenser having plates of areas A and a separation d may be expressed by A/d. That is, the capacity is proportional to the area and inversely proportional to the separation. Now suppose that the total distance between two stator plates is D and that the thickness of the rotor plate between them is negligible, or rather let us assume that the distance between the two stator plates exclusive of the space occupied by the rotor is D. Now let us assume that the rotor plate is not in the center and that the distance between one stator and the rotor is d and that the distance between the other stator and the rotor is D—d. We then have two capacities, one proportional to A/d and the other to A/(D—d). The sum of these two capacities is proportional to AD/d(D—d). If this expression remains constant as d is varied, the capacity does not vary as the rotor is shifted in the direction of the axis. It is obvious that it does not remain constant, for as d becomes zero the capacity becomes infinite and again as D—d becomes zero the capacity becomes infinite. We suspect, therefore, that there is one value for d which makes the capacity minimum, and from the nature of the case it would appear that the capacity is minimum when d is one-half D, that is, when the rotor plate is half way between the stator. This suspicion is verified by minimizing the expression. The minimum occurs when D=2d. If the displacement is 10 per cent. of d, the increase in the capacity is only one per cent. But if the displacement is 50 per cent. of d, the increase is 33 per cent. For greater displacements the capacity increases very rapidly.

* * *

Use of Tuning Meter

HOW CAN I use my tuning meter so that it corresponds correctly to the directions on the meter? Instead of tuning for greatest swing for resonance it tunes backward, that is, for least swing.—J. W. D.

That has nothing to do with the meter but with the way you use the meter. If greatest swing, as indicated on the needle, means most plate current, then the meter should be in a circuit that modulates upward. If greatest swing means least current, then the meter should be in a circuit that modulates downward. Whichever way it is, if it is wrong now, putting the meter in a phase-reversed circuit will cure the trouble. Suppose you have the meter now in series with a B plus lead. Suppose you haven't automatic volume control, although tuning meters are recommended only for such circuits. Then as the signal increases, the plate current increases (upward modulation), and, as you say, the meter works backwards. But if you will insert a series resistor of a few thousand ohms, connected one side to B plus, other side to the common B lead to the tubes previously measured by the meter, and now connect the meter from this common lead to ground through a resistance large enough to prevent full-scale deflection, the meter acts as a voltmeter, measuring the change in voltage applied to the plates, and this voltage is less, the larger the signal (downward modulation). This will correct your trouble. If you have a 55 or other duplex diode type tube, the meter in the plate circuit, if diode-biased grid is used, will modulate downward, or, to reverse the situation, used fixed bias, and it will modulate upward.

* * *

Input to 2A6

WHAT should the operating bias of a 2A6 duplex diode high mu triode be when used as a resistance coupled amplifier? How much signal voltage can be safely used on the tube? If it is diode biased is there danger of overbiasing the tube so that there is no output?—W.R.B.

The operating bias on this tube when the voltage in the plate circuit is 250 volts should be 1.35 volts. This does not change when the value of the plate load resistance is changed because it depends only on the voltage in the plate circuit. The peak of the signal voltage should not exceed the bias, that is, 1.35 volts. Yes, there is danger of overbiasing the grid when the tube is used in a diode biased amplifier. The drop in the load resistance on the diode should not exceed a peak value of 1.35 volts, measured at the highest percentage of modulation. When it is used in this manner there should be thorough control of the amplification ahead of the tube or else there should be a potentiometer load resistance on the diode so that the input to the triode may be varied at the grid. That is the maximum peak of a modulated wave that controls the overloading is often forgotten and it may be for that reason that tubes often overload when the signal voltage peaks are less than the bias, when the unmodulated peaks are measured.

* * *

Measuring Small Resistances

IS IT POSSIBLE by means of a resistance meter to measure accurately resistances less than 10 ohms? If so, please outline the method.—K.D.C.

Yes, it is possible. Connect the resistance in shunt with the meter terminals and obtain the resistance in terms of the meter resistance. If the external resistance is large it is only necessary to consider the unknown across the terminals and the meter resistance. A detailed explanation of this method will be found elsewhere in this issue.

* * *

Low Frequency Oscillator

CAN YOU SUGGEST a design of an oscillator that will generate a frequency of the order of 10 cycles per second? I presume that such an oscillator is possible.—W.B.J.

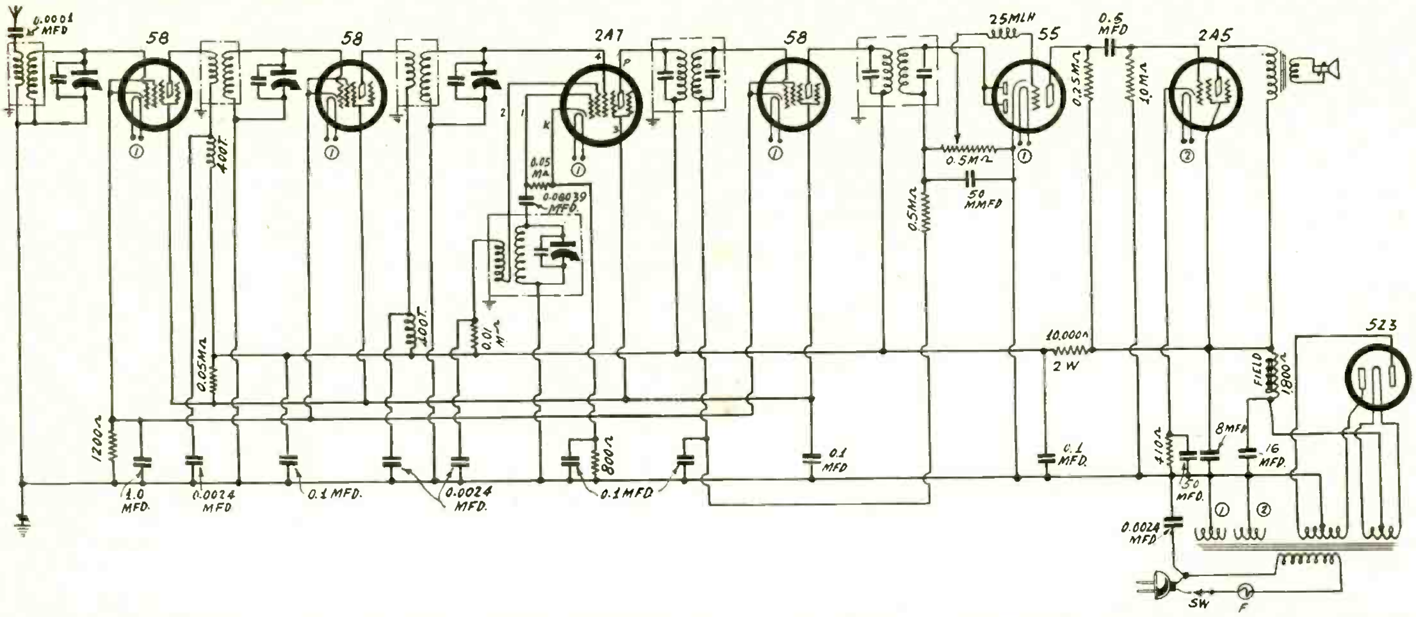
Hook up a Hartley type oscillator with two 30-henry choke coils in series. Connect the junction between the two chokes to the cathode, one free terminal to ground and the other to the stopping condenser in the grid circuit. Use a stopping condenser at least 4 mfd. and a grid leak of about 10,000 cycles. Connect a large condenser across the two chokes, that is, from the grid end to ground. A condenser of between 4 and 5 mfd. should give a frequency of 10 cycles per second. There is no guaranty that it will oscillate, for that depends on the coils used. Do not use electrolytic condensers.

* * *

Measuring Capacity

HOW CAN an a-c voltmeter be used for measuring the capacity of a condenser? I have a voltmeter that measures up to 500 volts a-c and it is an instrument that takes one milliampere full scale.—W.C.B.

First measure the line voltage with the voltmeter. Call it E. Then put the condenser in series with the line and measure it again. Call the new value of voltage, as read on the meter, V. Find E/V. If you call this ratio r, the formula for obtaining the capacity, assuming that the line frequency is 60 cycles per second and taking account of the fact that the resistance in your meter is 500,000 ohms, is $C=0.00265/(r^2-1)^{1/2}$. This formula covers a rather wide range of capacities for with the meter in question r can be any value between about 1.01 to 23. That is, the measurable range would be from 0.000115 to 0.0265 microfarads. If a lower voltage is available one of the



Grid bias questions are answered herewith and illustrated in the diagram. Self-bias applies to the 58 and 2A5 tubes, while grid-leak bias applies to the oscillator of the 2A7 and diode-bias to the amplifier of the 55.

lower ranges could be used for measuring larger capacities.

* * *

Manual and Automatic Control

WOULD IT NOT be possible to combine the automatic and manual volume controls so that the drop in the diode load resistance could be applied in part or in full to the controlled tubes. It seems to me that this can be done by connecting all the grid returns from the controlled tubes to a slider on the potentiometer used as load resistance on the diode? Let us hear your comments on it. —F.W.R.

There is no reason why this could not be done. When the potentiometer slider is set at the negative end of the resistor the control is full and when it is set at an intermediate position there is little control. On weak signals it could be moved over toward the cathode and then there would be very little a.v.c. On strong signals it could be moved to the other end and then there would be all the a.v.c. available. But as a manual control it would not be much good. If the volume were too great when the slider is over on the negative end there would be nothing that could be done to reduce it. This would have to be manipulated with another control in the audio end, perhaps with a potentiometer connected in parallel with the first, the slider of the second going to the grid of the triode in the detector.

* * *

Measuring Resistance with Voltmeter

IS IT possible to measure resistance by means of a voltmeter and a battery? If so, will you please describe how it is done? The reason I ask is that an ordinary resistance meter is nothing but a voltmeter.—N.J.

Yes, it is possible if the resistance inside the meter is known, and it is known when the sensitivity of the instrument is known. Let us assume that the highest voltage readable with the meter is V volts. Also let us assume that we have a means available for getting a voltage equal to this, so that we can get a full deflection on the meter. Now let us connect an unknown resistance in series with the voltmeter and measure the same voltage again. Let us say this time the meter reads Vx volts and that the resistance we have inserted is Rx ohms. We have then $Rx=Ro(V/Vx-1)$, in which Ro is the internal resistance of the meter. If the full scale reading of the voltmeter is 100 volts and the instrument has a sensitivity of 1,000 ohms per volts, $Ro=100{,}000$ ohms and $V=100$ volts. Hence in this particular case the formula reduces to $Rx=100{,}000(100/Vx-1)$, and we have the unknown resistance in terms of a single quantity which we read.

* * *

Definitions of Bias

PLEASE EXPLAIN what is meant by (a) self-bias, (b), diode-bias, (c) leak-bias, (d), leak detection.—O. L.

The circuit diagram on this page should be consulted. Self-bias is the bias arising from the potential difference across a resistor through which flows the plate current of the biased tube, which is true of the 58's and the 2A5 in the diagram. Diode-bias is the biasing of the grid of an amplifier by the rectified signal voltage obtained from a diode. Thus in the 55 the input to the grid of the amplifier (one of the units in the same envelope) is equal to the rectification of the signal, when the potentiometer is at extreme left, but as the potentiometer is used as volume control, values of voltage from maximum to zero may be taken off. Leak-bias is such bias as results from the flow of grid current and is desirable only in detector circuits, as it introduces unwelcome distortion in amplifier tubes and runs up the the plate current. In the amplifier there is no stopping condenser between the grid and the grid load to accumulate electrons so that the plate current would decrease instead of increase. Leak detection is intentional leak-bias and is illustrated in the oscillator section of the 2A7. Between the grid and the tuned circuit is a fixed condenser. The grid would be open unless a resistor were interposed, and besides this resistor establishes a potential difference proportionate to the grid current flowing. In this case the higher the grid current, the more negative the grid, and this is really diode-bias, where grid to cathode is diode and grid to plate is amplifier anode.

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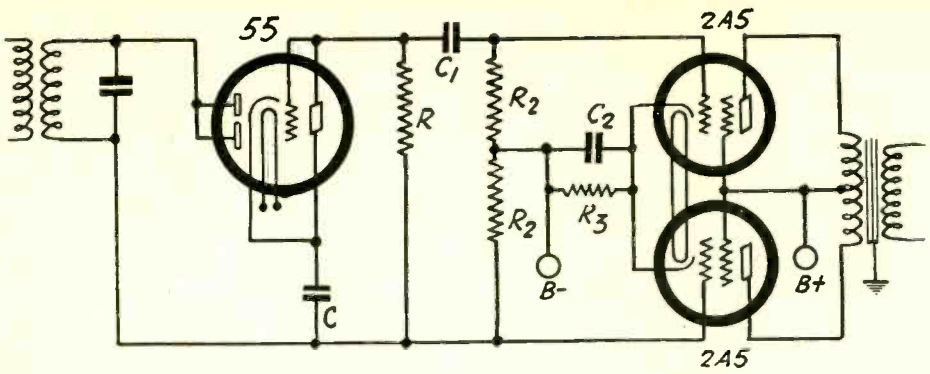


The 55 used as a single diode, instead of as a diode combined with triode, or two diodes combined with one triode. In the illustrated example the voltage that may be put in, assuming R is 500,000 ohms, may equal 100 volts, without danger of overloading the tube. This is of course much more than would be put in actually, and besides the bias on the 2A5's should not be more than 20 volts. Diode feed to push-pull output, using resistance coupling, is illustrated.

(*Continued from preceding page*)

Push-Pull Resistance

AS I WOULD LIKE to have a diode detector that would stand a good input, please show a way to couple to 2A5 output, single or push-pull. The rectified voltage may be constantly around 20 volts, or rise a bit more on occasions.—T. N.

The 55 used as a single diode is illustrated. It is preferable to tie grid and plate to the cathode, and use the two anodes united for a single anode. As thus constituted, of course, the result is a single operating anode and a single operating cathode. The load resistor, R, is between return of the carrier input circuit and cathode. So in respect to a midpoint on R the voltages at opposite ends of this resistor are equal but opposite, which is the push-pull requirement. The midpoint is in the next circuit and reflected back. By using stopping condensers C and C1 we avoid d-c potential conflict. Thus we feed push-pull 2A5's by resistance coupling. If a voltage greater than the equivalent of the bias on the 2A5's is put into the grids of those tubes, of course the output will be overloaded. But the diode detector will stand considerable, up to say 100 volts, if R is 500,000 ohms.

* * *

Use of 53

DURING the last few months I have been experimenting with the 53 tube, trying to use it as an audio amplifier, both for power and for voltage. So far I have had very little luck. It seems to distort the signals very much. Can you explain why this might be so?—W.E.B.

The 53 is a high mu tube and it will not stand much signal voltage. If it is used as a driver or as a power amplifier in a Class A hook-up it takes a bias of 5 volts, the plate supply voltage being 250 volts. If the peak of the signal is equal to the bias the power output is 400 milliwatts. Beyond that the distortion is great. As a Class B amplifier with 300 volts applied in the plate circuit the output is 10 watts, but to obtain this a driver must be used. The tube has also a high plate resistance so that if it is not loaded up adequately there will be much distortion even when the output power is much less than 400 milliamperes.

* * *

Time Constant of a Coil

WHAT IS meant by the time constant of a coil and on what does it depend?—F.W.V.

The time constant of a coil is the inductance divided by the resistance, henries and ohms being the units. It is a measure of the rate at which current builds up in the circuit containing the coil after a steady voltage has been applied. The larger the time constant is the more slowly will the current come up to its final value. There is a similar quantity for a condenser, the time constant in this case being the product of the capacity and the resistance, farads and ohms being the units. It determines the rate at which the condenser will charge after a voltage has been applied. The time constant of a coil multiplied by the angular frequency is what has been called the Q-factor of a tuning coil. The higher this is the better is the coil in a tuned circuit, that is, the more selective is the circuit and the higher the resonant voltage.

* * *

Self Bias Versus Fixed

IN TUBE and circuit discussions different operating conditions are specified according to whether the amplifier tube is self biased or has fixed bias. Why is this difference? Does not a tube take the same bias regardless of how that bias is produced?—B.W.

It is customary to prescribe different external grid resistances according to the method of biasing the tube. When fixed bias is used a lower resistance is usually specified than when the tube is self biased. The reason for this is that when the bias is fixed the grid may go positive on strong signals and draw grid current. This would cause distortion if the resistance in the external grid circuit were high. When self bias is used the bias increases directly as the plate current, and that increases as the signal increases. If the signal tends to drive the grid positive the self bias increases to prevent this. Hence there is little chance that grid current will flow, and therefore a high resistance is permissible in the external grid circuit. The self bias does not increase in this manner when the by-pass condenser across the bias resistor is very large unless the tube detects in the manner of a biased detector. A very good way of operating a tube is to have fixed bias and a high resistance in the grid circuit and then confine the signal to such values that no appreciable grid current flows. When distortion appears it is a signal that the voltage on the grid is exceeding the permissible value, and then the volume control should be brought into play.

* * *

Constant Coupling

YOU MENTIONED something about constant coupling effect in answer to a question recently, but you did not show the circuit. What is it?—W. D. C.

The diagram herewith shows one constant-coupling arrangement. For a given band, say the broadcast band, the mutual coupling between L1 and L2 is so selected, in respect to the mutual capacity Cm, that the load has a constant coupling value. The input voltage Eg has no effect on the constancy of the transformer action, but of course what the input voltage is may depend on the effect of C upon the circuit, as when the resistance of C at small capacities is high to the high frequencies concerned, and of course the tube introduces a small difference whereby exactly constant gain is not practical, without special extra compensation.

* * *

Auto Tube Oscillator

WHICH tube would you recommend for an oscillator out of the 6.3-volt series? Would one of the screen grid tubes be satisfactory? —M.M.

The most suitable tube for an oscillator out of this series of tubes is the 37. Another that is all right is the 85, which would be selected if there is any need for the diode built into it. For example, if the purpose of the oscillator is to generate a voltage to be rectified for a steady unidirectional voltage, the 85 would be the most suitable.

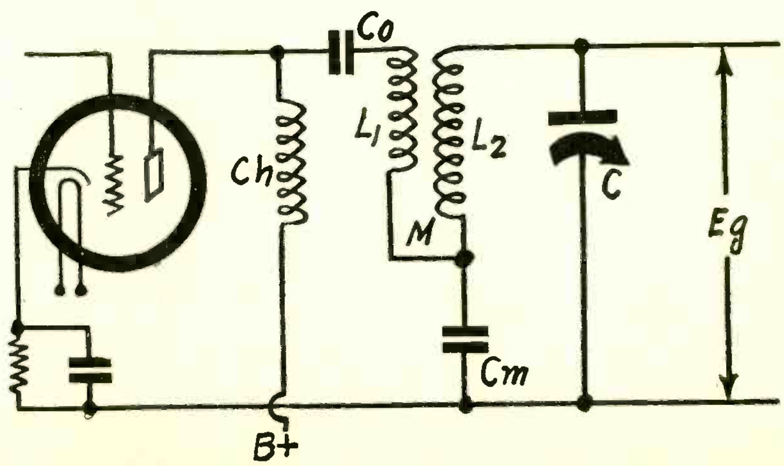
* * *

Measuring High Resistance

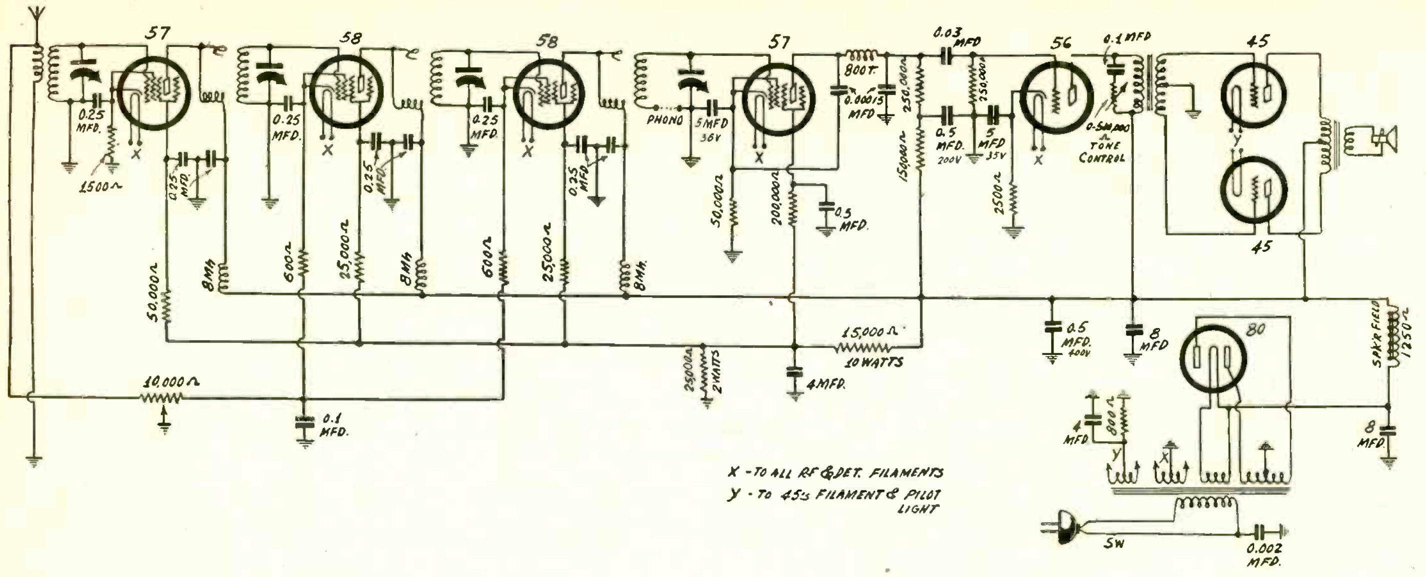
PLEASE suggest a method of measuring very high resistances, say of the order of 10 megohms and higher. As you know, these cannot be measured with ordinary resistance meters.—P.L.A.

One way of measuring high resistances is to construct a resistance meter according to the ordinary pattern but using high voltage and high limiting resistance. As an illustration of how high resistance might be measured, assume that a 0-1 milliammeter is used and that the voltage in the circuit is 250 volts. The limiting resistance will have to be 250,000 ohms. If the meter scale has 50 divisions and it is possible to read accurately to half a division we can read a current of 1/100 milliampere. To reduce the current to this value we would have to put a resistance of 24.75 megohms in series with the circuit, and that would be the highest resistance measurable with reasonable accuracy.

CONSTANT-COUPLER CIRCUIT



A constant-coupling transformer, consisting of L1 and L2, with a mutual capacity, Cm, Ch would be very large in inductance, and the stopping condenser Co small.



Here is an 8-tube tuned-radio-frequency set. The question raised concerns the quality. Is it good? Is it so good that low notes are well amplified? What effect could such a condition have on hum? What precautions are taken against hum amplification? The questions are answered below.

The Review

Questions and Answers Based on Articles Printed in Last Week's Issue

WHEN a broadcast wave is modulated by an audio signal of 5,000 cycles per second, does the carrier frequency vary by 5,000 cycles plus and minus the assigned frequency? If it does, how is this fact reconciled with the limitation that a station carrier must not deviate by more than 50 cycles plus or minus? If it does not, then how can the side band frequencies be 5,000 cycles plus and minus the carrier frequency?

A good station now has crystal control of the frequency and it is arranged so that the modulation cannot in any way affect that frequency. A good station stays much closer to the assigned frequency than the limit set by federal regulation. Only the amplitude of the carrier varies at a rate 5,000 cycles per second. That is, the carrier amplitude rises and falls in value once in every 1/5,000th of a second. The theory of modulation is such that a wave modulated by 5,000 cycles is equivalent to three waves, one having the frequency of the carrier, one having the frequency of the carrier less 5,000 cycles, and the other carrier frequency plus 5,000 cycles. Sure, the station does send out the two side frequencies as well as the carrier. But it does not allow its frequency to vary.

* * *

STATE a method of getting a good estimate of the low-frequency level of a test oscillator.

A good estimate of what the low frequency of the test oscillator actually is may be obtained. Since the receiver frequencies must be known, either because the frequencies of stations tuned in and beaten against are known, or because the receiver is frequency-calibrated with accuracy, if the lowest oscillator frequency beats with a station then the test oscillator's low frequency is a sub-multiple of the receiver's low frequency. It is easier to do the examples than to get a good idea from the words, therefore:

$$\text{LFTO} = \frac{\text{LFR}}{2 \text{ or } 3 \text{ or } 4 \text{ etc.}}$$

where LFTO=low frequency of test oscillator, and LFR=low frequency of receiver.

* * *

WITH transformer in the 85 plate circuit, should the bias be self or diode type? For a battery set, what bias and how obtained?

Since a transformer is used in the plate circuit of the 85 triode, a fixed bias is essential on this tube. It is obtained by means of a battery and its value is 13.5 volts. In case the circuit is powered by a rectifier B supply it is possible to insert a resistor in the negative lead of the rectifier and making its value such as to give the proper bias. The grid return then would be connected to the most negative point and the rectifier would be grounded at the positive end of the bias resistor. The reason self bias is not used on the triode is that this could not be done without putting a voltage handicap of 13.5

* * *

WHAT INTERMEDIATE frequency would you recommend for a short-wave superheterodyne that is to tune down to the 20 meter region? Is it better to use 175 kc or frequency more nearly equal to the broadcast frequencies?

Just what intermediate frequency is selected is not of great importance, but it may be better, all things considered, to use a frequency around 450 kc. This is not too high for the frequencies immediately above the broadcast band and it is not too low for those of the 20-meter region. If, however, the frequencies immediately above the broadcast band are not to be received, the intermediate may be as high as 1,500 kc. When a low intermediate frequency is used there is not so much difficulty to make the radio frequency tuner track with the oscillator. But then there is not so much radio frequency selection, either. The latest broadcast superheterodyne frequency, namely, 456 kc, is all right for a shortwave receiver, and it has the advantage that suitable intermediate frequency transformers can be obtained easily.

CONCERNING the circuit reprinted at top of this page, is the low-note response good, and what relationship does this bear to hum, and what precautions are taken?

The response on the low notes is excellent and for that reason some have encountered hum. This tendency to hum has been reduced, without at the same time reducing the low note response, by increasing the filter resistor in the plate circuit of the 57 to 150,000 ohms, or even to 250,000 ohms when necessary. If this does not remedy the hum in some instances, the 56 plate circuit may be treated in the same manner, that is, by putting a resistance of 10,000 ohms in series with the plate and then putting a condenser of 0.5 mfd. from the plate end of this resistor and the cathode, or ground, whichever gives less hum. This resistor would go between the B plus terminal, of the transformer and B plus, and the condenser would go from the transformer to ground. The tone control consisting of a condenser and variable resistance in series, should be left across the transformer primary.

* * *

IS IT satisfactory to put the volume control in the grid circuit of the output tube, if so, when, and with what precautions?

The volume control, located in the grid circuit of the output tube, is well positioned from the viewpoint of overload, as the last tube will overload the first, but sometimes there will be hum when the control is turned to low volume levels. This would require that the 0.1 meg. in series with the grid leak proper be increased considerably, to the order of megohms, or that the capacity from juncture of the two resistors to ground be increased, and such a capacity increase would have to be considerable. Sometimes a combination of both remedies is necessary.

* * *

WHAT is the simplest way of measuring a resistance when a milliammeter and a variable voltage are available?

Connect the resistance to be measured in series with the milliammeter and with the variable voltage. Also connect a voltmeter across the voltage so that the voltage is known at all adjustments. Vary the voltage until the milliammeter reads just full scale. The resistance is then read on the voltmeter in thousands of ohms per milliampere. For example, if the milliammeter is 0-1 instrument the resistance is 1,000 times the voltage that gives just full deflection. If the adjustment is made to 1/10 scale of the same milliammeter the resistance is 10,000 times the indicated voltage.

INCREASING THE SENSITIVITY

Bucking Out Meter's Steady Current

By Graham Ballington

SOMETIMES it is necessary to measure small current changes when that current is so large that the changes are minute in comparison. If the instrument indicating the current is insensitive enough to show the total current, the changes will be so small that they cannot be read, if even detected, and if the instrument is sensitive enough for the changes the entire current will burn it out.

To overcome this difficulty a method of bucking out the steady current is available, thus enabling the use of an instrument sensitive enough to give the changes. How this is done when the changes are those in the plate current of a vacuum tube is shown in Fig. 1. A circuit composed of a battery E and a high resistance R is put across the meter with the polarity of the battery such that the current in the auxiliary circuit flows through the meter in the opposite direction from that of the plate current.

If the internal resistance of the tube is r and the internal resistance of the meter M is Rm, then the current through the meter is given by $(EbR - Er)/(rR + rRm + RRm)$. But since Rm is very small compared with r or R, the current through the meter can be written very closely $(EbR - Er)/rR$, or as $Eb/r - E/R$. That is, the current through the meter is the difference between the currents that would flow in the two circuits that would be formed by shorting the meter.

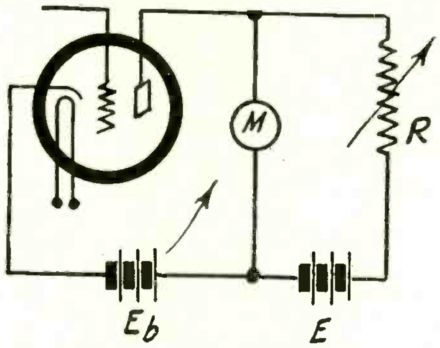


FIG. 1

An arrangement for measuring the difference between two currents with a sensitive current meter. Small variations in the plate current can be measured accurately.

Adjusting to Balance

At a given value of the plate current we can select values of E and R such that the current through the meter is zero. This would be done at some value of the plate current about which the variations in the plate current are to be studied. Then if the plate current is varied, either by varying the grid voltage or the plate voltage, leaving E and R fixed, the current through the meter will vary, and the variation will be the variation in the plate current. Since either current may be larger, the current through the meter will flow in either direction. Hence there should be a reversing switch in the meter circuit or the instrument should be one that will read current in both directions. That is, if there is no reversing switch the meter should be one that has the zero in the middle of the scale.

Applications

The arrangement can be applied for measuring the variation in the plate current of a screen grid tube when the plate voltage is low compared with the screen voltage. Take the 36 tube, for example. If the grid voltage is zero and the screen voltage is 90 volts, the plate current varies between about 3.1 and 2.7 milliamperes as the plate voltage varies between zero and 80 volts. There is not much chance of reading the variations accurately if a milliammeter having a range of 0-5 milliamperes is used since the amplitude of the change is only 0.2 milliampere.

However, if we adjust the auxiliary circuit constants so that E/R equals 2.9 milliamperes we can use a milliammeter with a full scale deflection of 0.5 milliampere, and the accuracy has been increased ten-fold. We could even do better in this instance for the amplitude of the change is only 0.2 milliampere. We could therefore use a microammeter having a range of 0-200 microamperes. The accuracy would therefore be increased 25-fold as compared with the original. That is comparing under conditions of equal scales on the meters. Perhaps the scale on the microammeter would be much longer and that would increase the accuracy still further.

The Object

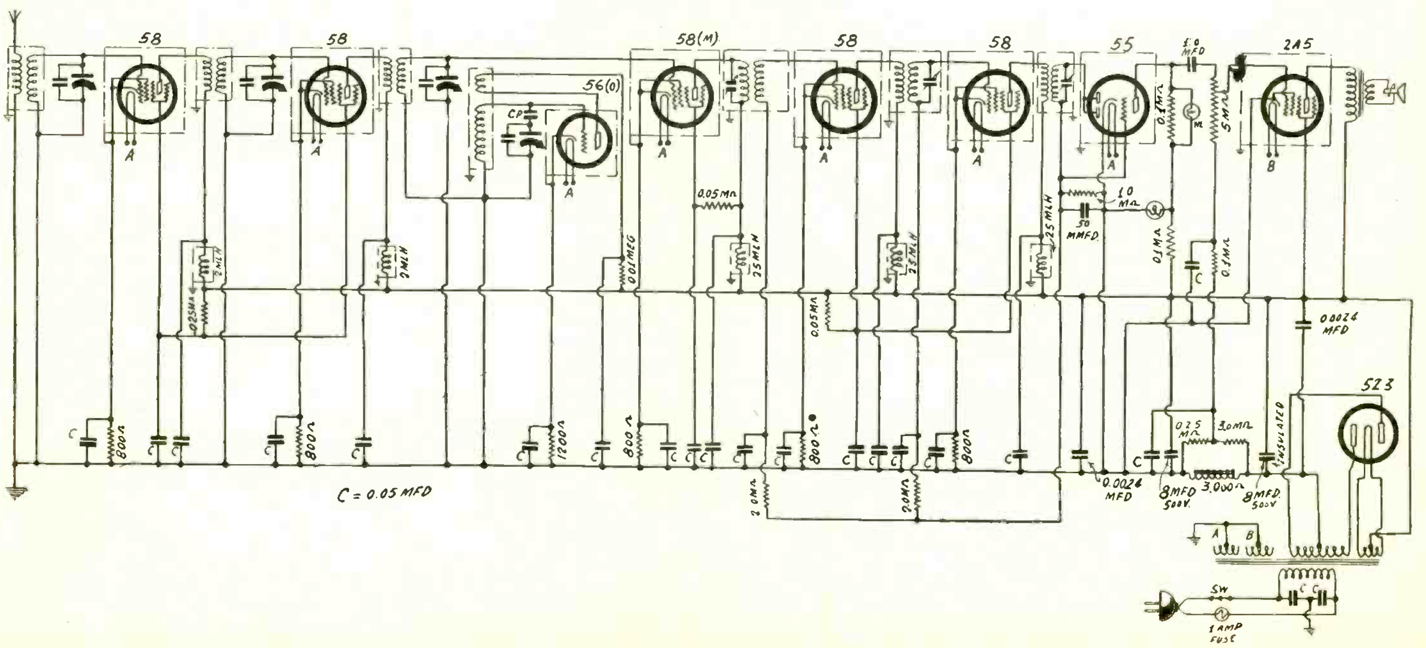
The object of measuring the plate current of a screen grid tube in this region of voltage is to get the value of the negative resistance and hence to determine the likelihood of oscillation when the tube is used in a dynatron circuit.

In a test of this type on the 36 under the conditions stated the resulting negative resistance was 67,000 ohms. In a test on the 24 under similar conditions gave about 73,000 ohms. Therefore both these tubes are about equal as far as the negative resistance is concerned.

Will they oscillate when they are connected in a dynatron circuit, assuming that the resistance of each is 70,000 ohms? The condition for oscillation is that $r = L/RC$, in which r is the absolute value of the negative resistance, L the inductance of the tuning coil, C the capacity across it, and R is the radio frequency resistance in the coil. This equation holds when the oscillation has settled down to the steady state. That condition that oscillation shall start is that r be less than L/RC.

Oscillation Condition

Obviously what determines whether the circuit will oscillate, for a given value of the negative resistance, is the value of L/C, or on the effective resonant resistance of the parallel tuned circuit. Assuming that R is 10 ohms, what is the limiting value of the L/C ratio? It is 700,000 ohms. It is not likely that such a high ratio will be obtained over a wide frequency range. If the inductance is 250 microhenries, the value ordinarily used in a broadcast tuner, the limiting value of the condenser is 358 mmfd. With the inductance and resistance assumed, oscillation is likely over the entire broadcast band, but the circuit may stop oscillating before the frequency reaches 550 kc.



In a circuit like this the bucking method explained above comes in very handy

Station Sparks

By Alice Remsen

BIG DAYS AND NIGHTS AT NEW N.B.C. STUDIOS

The National Broadcasting Company has moved bag and baggage to Radio City, and what a wonderful place it is. Seventy stories high and covering four full city blocks, containing within itself theatres, office buildings, shops, studios and executive offices. It was over two years in the making and now it is finished and houses the last word in furnishings and technical equipment, including even space for the special needs of television when that eagerly awaited art becomes really practical enough to make a part of our everyday life, as radio is today. The NBC has appropriated nine floors for its special use in the center building constructed for the needs of broadcasting. It is extremely spacious. I lost myself three times the first day I tried to find the program department, Artists Bureau and music library. One must get used to it all over again.

The most interesting part of the dedicatory program on November 11th was the transatlantic conversation between David Sarnoff from London and Owen D. Young and others here in New York—a really amazing piece of work.

WRITERS COMING INTO THEIR OWN.

A matter for rejoicing among scribes is the fact that radio is at last recognizing the extremely important part played in the broadcasting field bv writers. Peter Dixon has pointed out, time and time again, in his column in the New York *Evening Sun* the need for using experienced writers in radio instead of using slapdash continuity, badly constructed dialogue, and poor rhyme, rhythm or reason in plot and story. At last the eyes of sponsors are open and they are calling in men of action and experience to take care of their writing needs; and authors are being given due recognition of their work. A short while ago writers seemed to be ashamed of their radio activities; one reason for this sense of shame was the ridiculously low price paid for radio material, fifty dollars being considered a very high price per script; that is changed now, writers, particularly the comedy variety, are being paid famulous sums and keeping the rights to their scripts also in some instances. Jolly good thing, too! . . .

MARIE ON AGAIN

"Marie, the Little French Princess," has been renewed over WABC for another thirteen weeks. This is a four-a-week script series sponsored by Louis Philippe, Inc., portraying the adventures of Princess Marie, who has come to America incognito, as Marie Bertrand, in order to escape the tedium of court life. Tuesdays, Wednesdays, Thursdays and Fridays, WABC and network, 1:00 p. m. . . . The "Conclave of Nations" series started over Columbia on November 19th. This series, which takes the form of a tribute to an individual nation on each program, will be heard each Sunday at 10:30 p. m., at which time the Ambassador or Minister of the country being saluted will speak to the radio audience; Channon Collinge will supply the musical background with his orchestra. . . . Frank LaForge, internationally known concert pianist and teacher, will resume his weekly chamber music concerts over WABC and chain, each Wednesday at 3:30; Mr. La Forge will present outstanding pupils of his in song and instrumental recitals. . . . Olsen and Johnson are what might be called "commuting comics," for while they are playing with their stage show, "Take a Chance," through the Middle West they must dash back each week for their "Swift Revue" broadcast on the stage of the Civic Theatre, and then dash back again for a Saturday matinee with the show, playing such towns as St. Paul, Milwaukee, St. Louis, Cincinnati, Cleveland and Detroit; of course, they have a private plane at their disposal all the time. . . .

MAY SINGHI BREEN IS SAD

I was listening to May Singhi Breen and Peter de Rose one morning recently and wondered what on earth was wrong with May, who usually is so fine; she seemed to have the "sniffles"; I called the studios after their broadcast and condoled with May, telling her what to get for her cold. May answered, "Why, Alice, I haven't got a cold!" I said, "Well, there was something wrong with you this morning; what's the trouble?" Then May began to cry in earnest; it appears that her daughter, Rita Lherie Breen, had been married the day before to Lieutenant Byram Bunch, U.S.A., and had left immediately for Hawaii, as the bridegroom had been ordered there for two years; poor May misses Rita; they had never been separated since Rita's birth. . . . Alois Havrilla was responsible for the first broadcast of Ethel Merman, in 1924; Ethel admits she was scared to death, but has never forgotten the debt she owes Alois Havrilla, for at that time she was not sure she could sing, and the encouragement of Mr. Havrilla meant a lot to her. . . . Alice Davenport, who plays the feminine lead in Ray Knight's "Wheatenaville" program, is the daughter of Dr. and Mrs. William Billings Davenport, who formerly were stage people; Dr. Davenport played for a time with William Faversham, and also E. H. Sothern; in spite of her theatrical background, Alice admits that she went through the most agonizing stage and mike fright at the beginning of her career. . . . Smilin' Ed McConnell has a tremendous audience of farmers who claim that Ed puts on the best farm relief programs in the country; prices may "faw down and go boom," but old Ed's smile seems to go on forever; his intimate manner gets under the skin; he can pick up almost any song and put it over until it sticks, and between numbers his conversation draws the family just a little bit nearer to the loudspeaker than do a good many other radio artists; however, Ed does not exactly prefer to be called an artist; he claims he's just got a world of friends and that he likes to talk and sing to them; he draws a tremendous amount of mail through his Early and Daniel Tuxedo Foods program, which is broadcast from WCKY, in Cincinnati, through the Center of Population Group, which includes WHAS, Louisville, and WSM, Nashville, Tenn.; this program goes on each Tuesday evening at 7:15 p. m.

THE BOSWELLS ARE BACK

The Boswell Sisters, Connie, Martha and Vet, have returned to New York, after a triumphant visit to the scene of their struggling start in Hollywood, and will once more be heard over a nation-wide network, via WABC-Columbia, each Monday and Friday at 11:15 p.m. EST.; a twist of fate and the twists of millions of radio dials throughout the country were responsible for the fact that the Boswells, while taking a five weeks' rest on the West Coast, were asked to interrupt their vacation to appear in the Constance Bennett motion picture "Moulin Rouge" several years after they had made a quite futile effort to crash the gates of Hollywood studios—but this time they were sent for—went—and conquered! . . . Abe Lyman has a new series of late dance programs over WABC and the Columbia network from the Hotel New Yorker, Mondays and Thursdays from 12:30 to 1:00 a. m. and on Saturdays from 12:00 midnight to 12:30 a. m. . . . Julius Tannen, glib comic of the Seven Star Revue, in addition to being a funny man is also a "discoverer"; it came out during a recent "Meet the Artist" interview, that the sad-faced joker discovered a young fellow playing the violin in 1912, during his engagement at a vaudeville house in Dallas, Texas; the young fellow was a "number two" act, and his violin playing was not so hot, but Tannen was very much intrigued by the chap's personality; and so he offered to write the young man some material and coach him in speaking them from the stage; he did so, and after a few days the young man was doing a swell job, and Ben Bernie, for he was the young man, has been doing a swell job ever since. . . . And my editor will think I'm doing a swell job if I hop on a train right away and get this in to him, so here goes!

A THOUGHT FOR THE WEEK

WILLARD ROBISON paid off a mortgage against his home with his royalties on "Cottage For Sale," one of last year's big song hits over the radio. You can't tell Mr. Robison—and get away with it—that radio repetition of a number will kill it before the sales reach a profit for publisher and writer. He knows better.

"Spotlight on Universe" Daily Feature at WHOM

A question and answer service covering the whole scope of human knowledge, with facts verified by a directed staff of specialists, has been begun as a daily feature at WHOM, Jersey City, N. J., 1,450 kc. The station has New York City studios in the Hotel President, from which the broadcasts are wired to the transmitter in Jersey.

This is one of the most comprehensive of question and answer services instituted by any station, and differs from all others in its unlimited scope. Listeners are invited to send in questions for possible inclusion of answers in broadcasts, on any topic whatever.

The present schedule, entirely p.m., follows: Sunday, 6:30; Monday, 9; Tuesday, 5; Wednesday, 4:45; Thursday, 9; Friday, 3:15; Saturday, 6:30. The questions are answered over the air by Herman Bernard. The feature is called "Spotlight on the Universe."

TRADIOGRAMS

By J. Murray Barron

United American Bosch Corporation announces the appointment of the Dickel Distributing Company as its radio wholesalers serving Pennsylvania, New Jersey and Delaware dealers. This organization is one of the largest wholesaling from the Philadelphia district and is headed by G. W. Dickel, who for four years served as treasurer of the Philadelphia Radio Distributors Board of Trade.

* * *

Aaron Lippmann Company, of Newark, N. J., has co-operated with the National Union Radio Corporation and the Newark section of the Institute of Radio Servicemen in organizing an advanced study course for professional radio servicemen. A series of thirteen meetings will be held every Tuesday evening from 8 to 9 at the Robert Treat Hotel in Newark. The course takes up a study of the theory behind each part of the radio receiver with illustrations of practical application of the theory.

* * *

An ac-dc hearing aid device has just been put on the market by the Universal Microphone Co., Inglewood, Cal., as an item in its new list of such equipment. The item weighs 5 pounds with measurements of 11 inches long, 5½ wide and 7½ high. This new model is a two stage amplifier using two 237 tubes, and the new 25Z5 rectifier, which also supplies microphone current. Universal also announces a two lapel microphone combination corded together with a special line, one of the tiny instruments goes on each lapel, which aids greatly as the speaker or announcer turns or twists his head.

* * *

Everywhere one turns nowadays are to be found short-wave and short-wave broadcast combinations. What is probably the largest or most complete display along these lines can be seen in the downtown Cortlandt Street district in New York City. The demand has been for these outfits and many of the leading manufacturers are supplying the combinations. Judging from the report of the stores and mail order houses, the short-wave sales will be the largest in any year since radio entered the home as a part of one's daily life.

It is announced from Postal Radio Corp., 135 Liberty Street, N. Y. City that their nine-tube short-wave receiver, the professional model, designed especially for the "ham" and short-wave fan, was demonstrated at the last meeting of the New York Chapter of the Short-Wave Club in New York City. At a very early date a printed record of the world-wide reception will be available for those interested in good catches on short waves. This should be real news for the fan who wants the best in short-wave receivers and desires a multiple-tube outfit, laboratory-wired and tested.

* * *

Try-Mo Radio Co., Inc., of 85 Cortlandt Street, N. Y. City, announces it is in production on a new 4-tube a-c Baird short-wave receiver. This comes in kit form or wired and tested and includes an enclosed speaker. There is also a broadcast coil.

* * *

Harrison Radio Co., 142 Liberty Street, New York City, report a considerable increase in the demand for small short-wave outfits and a goodly increase for the larger sets over last year's business. There is an illustrated circular now ready for free distribution.

* * *

An unusual and attractive window display, showing several types of broadcast radio receivers in modern cabinets, is now featured at Federated Purchaser, 25 Park Place, New York City.

* * *

The North Radio Company, at Washington and Cortlandt Streets, New York City, has what is considered one of the largest and most complete stocks of ac-dc and exclusively a-c receivers and midget and mantle type sets. In addition there is a complete line of short-wave outfits, including a number of short-wave converters.

* * *

The many friends of George Modell will be glad to learn he is back once more on Cortlandt Street, right next to the old place, holding forth as active manager. As of old, he always is ready to give a good buy in the latest and livest numbers of the auction field.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor, Radio World, *145 West 45th Street, New York, N. Y.*

M. C. McMillan, 3515 S. Sheridan, Tacoma, Wash.
Glen Woodard, Box 1442, Billings, Mont.
M. V. Sperry, Hamilton, Mont.
Universal Radio Service, 4211 Grenshaw, Chicago, Ill.
Jas. E. Brown, No. 302 N. 35th St., Louisville, Ky.
F. M. James, 307 Montclair Ave., Ludlow, Ky.
Jos. Belick, 65 Front St., Box 133, Coplay, Pa.
D. Boillotat, 5105 Hillsboro Ave., Detroit, Mich.
George D. McCaughey, 3507 N. 8th St., Philadelphia, Pa.
O. Anderson, 819 Weller St., Seattle, Wash.
J. H. Whitcomb, Essex Junction, Vt.
Alvin F. Braeking, 749 N. 21st St., Milwaukee, Wis.
Jim Richesin, Box 724, Lefors, Texas.
Orval V. Kahl, Reliable Radio Service Co., 1410 Upper 11th, Vincennes, Ind.
C. J. Snyder, C. J. Snyder Co., 114 Arch St., Little Rock, Ark.
Eugene A. Gordes, Box 64, Frontier, Wyo.
Harry W. Raymond, Raymond Radio, Riverside, R. I.
C. Elmer Pride, Sec'y & Treas., Gilbert & O'Callaghan, 703 Walnut St., Philadelphia, Pa.
John L. McGinnis, 310 E. Wishkah St., Aberdeen, Wash.
F. D. Dempsy, The Charles Sexauer Co., 1464 Sherman St., Detroit, Mich.
M. B. Lamont, Radio-Electronic Service, 423 East Market St., Warren, Ohio.

CORPORATION ACTIVITIES

CORPORATION REPORTS

Keith-Albee-Orpheum Corporation (controlled by RCA)—Quarter ended Sept. 30, 1933, net loss $197,097 before subsidiary preferred dividends, compared with net loss of $278,953 in the preceding quarter and net loss of $74,231 in the quarter ended Sept. 30, 1932. Net loss for the nine months ended Sept. 30, 1933, $552,792, against net loss of $1,044,820 for the same period of 1932.

ASSIGNMENTS

Dependable Radio Service Corp., 4,910—13th Ave., Brooklyn, N. Y., repairing and selling radios, assigned to Hyman Artz, 2,044 Sixth St., Brooklyn, N. Y.

BANKRUPTCY PROCEEDINGS

Petition Filed Against

Paramount Radio Manufacturing Co., Inc., of 34 E. 12th St., New York, N. Y., by the following: Brumberger Co., for $349; DeJur-Amsco Corp. for $315; Solar Mfg. Corp., for $90.

BANKRUPTCY SCHEDULES

Suburban Electrical Supply Co., Inc., Pearl River, N. Y.—Assets, $20.593, main item being accounts, $13,743; liabilities, $20,751.

RADIO WORLD

The First and Only National Radio Weekly

Twelfth 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; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.

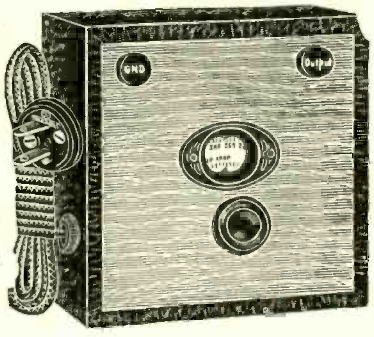
Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager; J. E. Anderson, technical editor; J. Murray Barron, advertising manager.

Valuable Gifts with Subscriptions for RADIO WORLD

A *NEW* TEST OSCILLATOR

That Works A.C., D.C., or Batteries!

SHOWN ONE-THIRD ACTUAL SIZE



Over-All Size Is Only 5x5x3"! Dial Reads Frequencies Directly!

A NEW TEST oscillator, Model 30, has been produced by Herman Bernard, so that all the requirements for lining up broadcast receivers, both tuned radio frequency and superheterodyne types, will be fully and accurately met. This device may be connected to 90-120-v a.c., any commercial frequency, without regard to polarity of the plug, and will function perfectly. It may be used also on 90-120-volt d.c. line, but plug polarity must be observed. One of the plug prongs has a red spot, denoting the side to be connected to positive of the line. If you don't know the d.c. line polarity, you may connect either way, without danger. The oscillator will work on d.c. only when the connection is made the right way. Moreover, 90 volts of B battery may be used instead of either of the foregoing, simply by connecting two wires between the plug at the batteries, observing polarity. No separate filament excitation is required. The oscillator is modulated with a strong, low note under all circumstances. It uses a 30 tube.

THE dial of the Bernard Model 30 Test Oscillator is directly calibrated in kilocycles, so there is no awkward necessity of consulting a chart. The fundamental frequencies are 135 to 380 kc, so that nearly all commercial intermediate frequencies as used in present-day superheterodynes are read on the fundamental. The points for other intermediate frequencies, e.g., 400, 450, 456 and 465 kc, are registered on the dial also, two harmonics, with which the user need not concern himself, being the basis of these registrations. Besides, the broadcast band is taken care of by the fourth harmonic and the dial is calibrated for that band, also.

The divisions on the dial for the fundamental band, 135 to 380 kc, are 1 kc apart from 135 to 140 kc, 2 kc apart for 140 to 180 kc and 5 kc apart for 180 to 380 kc. For the broadcast band, 10 kc apart from 550 to 800 kc, 20 kc apart from 800 to 1,500 kc.

The test oscillator may be used also for short waves, by resorting to higher harmonics.

Send $12 for 2-year subscription for RADIO WORLD and order Cat. BO-30 sent free, with tube (prepaid in United States and Canada).
Another model, BO-30-S, same as above, except frequencies are ten times as high, hence instrument is for short-wave work only, is available on same basis.

540-4,500 kc Tuning Units

The Tuning Units consist of a four-gang 0.00046 mfd. condenser, with trimmers on it, ⅜-inch diameter shaft, 1⅛ inches long, mounting spades, condenser closing to the left; and a set of four shielded coils. The condenser is the same for tuned radio frequency sets or superheterodynes, but for superheterodynes a series padding condenser is supplied also. For t-r-f sets the four coils are alike. For supers three coils are alike and there is a different coil for the oscillator, with a selection for 175 kc, 456 kc or 465 kc intermediate frequency.

For t-r-f construction, three stages of t-r-f and tuned detector input, four equal shielded coils, tapped for the police band and properly matched to the tuning condenser which is supplied also. Order Cat. TRFTU, which will be sent free, postpaid, on receipt of $10.00 for 86-week subscription for RADIO WORLD (86 issues).

For superheterodyne construction, two stages of t-r-f, tuned oscillator and tuned input to modulator, three identical coils and an oscillator coil, with the proper padding condenser and the four-gang condenser, are supplied as noted below:

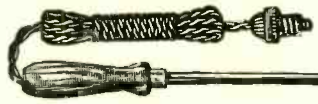
175 kc—For use with 175 kc intermediate frequency. Unit includes four-gang condenser, three r-f coils, the proper oscillator inductance and 800-1,350 mmfd. padding condenser. Send $12.00 for two-year subscription and order Cat. SUTU-175, which will be sent postpaid.

456 kc—For use with 456 kc i.f. order Cat. SUTU-456. Padding condenser is 350-450 mmfd.

465 kc—For use with 465 kc order Cat. SUTU-465. Padding condenser is 350-450 mmfd.

Those desiring to use the short-wave feature will want a switch, which is sold outright and separately. This is a long switch that has sections very close to where the wiring would have to be, and thus insures short leads. The switch is Cat. 4GSW @ $2.25 postpaid.

SOLDERING IRON



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From the tri-relationship chart (either one), the required inductance value is read, since frequency and capacity are known by the consultant. The size and insulation of wire, as well as the diameter of the tubing on which the coil is to be wound, are selected by the user, and by referring to turns charts for such wires the number of turns on a particular diameter for the desired inductance is ascertained.

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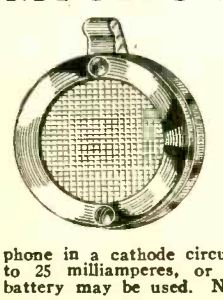

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