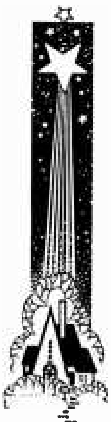
NATIONAL RADIO NEWS

IN THIS ISSUE

DEC.-JAN.
1941-1942

VOL. 9
No. 12



Christmas is a season of gaiety. We enjoy the good cheer, the friendly smiles of strangers. It is the season for kindling the flame of good will in the heart.

For those less fortunate our sympathies are thoroughly aroused. We enjoy the privilege of giving. We appreciate more deeply the warmth of each other's handshake. We are moved by a spirit of good cheer, of kindliness, understanding.

We live for a few days in a world as it should be.

It is a great satisfaction at this season of the year to have a little friendly magazine of this kind which is all our own—yours and ours—through which we have this opportunity to wish you, on behalf of our entire staff, a very Merry Christmas and the hope that the New Year will bring you new advancement, good health and happiness in abundance.

J. E. SMITH, President.

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VACUUM TUBE VOLTMETERS

Wm. Franklin Cook

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THE vacuum tube voltmeter, (v.t.v.m.) is not new; it has been used for years in laboratories. In recent years several manufacturers have made instruments of this type, designed for radio service work. They are still mysteries to many servicemen, however, including some who bought them. If the fundamental circuits and limitations of the device are clearly understood, servicemen would find many uses for this instrument.

Ordinary Voltmeters

First, let's learn just why we need a sensitive instrument of this type. As you know, an ordinary voltmeter requires current for operation. In other words, the current flowing through the meter movement causes a deflection of the meter needle. This current must be furnished by the voltage source and must flow through the circuit parts to the point where the meter is connected, causing a change in voltage drop across each part. If the circuit is of low resistance, then the small amount of current taken by the average meter does not greatly affect the voltages.

On the other hand, in a high resistance circuit, such as a resistance coupled stage, it is quite possible for this meter current drain to be appreciable, when compared with that normally flowing in the circuit. As a result, the voltage at the point where the meter is connected will be considerably different from the voltage at the same point when the meter is removed. This means such measurements are false as they do not give the actual voltages. (Of course, the voltages given in the set servicing data will in many instances be the *measured* value with a meter of a certain sensitivity. However, when *actual* values are given, or the serviceman's tester is of different sensitivity, then the readings may be quite different.)

Also, the current drain of the meter can change operating voltages so the meter cannot remain connected during receiver operation. This means voltages cannot be continuously checked, which is sometimes important when testing an intermittent set.

We think of a "voltmeter" as just a meter but it actually is a current meter in series with a set of multiplying resistances. The meter measures the current flow through these known resistances. This current depends on the applied voltage, so the meter is calibrated to read voltages. By measuring the resistance and dividing by the voltage range, we have the "ohms-per-volt" rating, which is an indication of the current drain or the sensitivity. The higher the "ohms-per-volt," the smaller the current flow through the meter. By making the meter more sensitive it will require a smaller amount of current so the multiplying resistors can be higher; the voltmeter then will have less effect on the measured voltages. However, there is a limit to this sensitivity increase, as the meter movement becomes very delicate. At the present time standard service instruments have sensitivities between 1000 ohms-per-volt and 25,000 ohms-per-volt.

In using ordinary instruments to measure A. C. voltages we find another draw back. These meters are useful on D.C. only, so the A.C. must be rectified. Most of them use copper oxide rectifiers for rectifying A.C. While these rectifiers do very well at commercial power line and low audio frequencies. They have the disadvantage of too much shunting capacity for measurements at the high audio frequencies and for R.F. measurements. In other words, as the frequency goes up the readings fall off, soon becoming zero. Special copper oxide rectifiers have been developed which have better characteristics, but even these are not entirely satisfactory above the low R.F. range.

Therefore, we would like to have available an instrument of high sensitivity, (drawing low current) and with an extended frequency range (small shunting capacity).

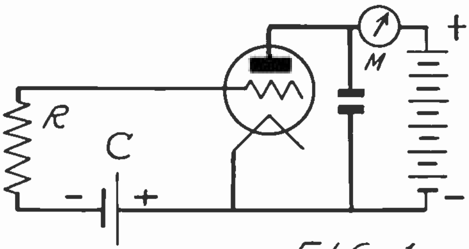


FIG 1

Now consider an ordinary radio stage, using a vacuum tube. Here we have a circuit to which we can apply a voltage and obtain a change in plate current. The ordinary grid circuit can be made to have extremely high resistance and but a small amount of capacity. Hence, if we can arrange this circuit so that it will cover the desired voltage range, we will have our desired instrument.

Although all vacuum tube voltmeters follow some basic radio tube circuit, there are many different arrangements of this circuit. Some types measure D.C. voltage only; some measure A.C. only; while some measure both. Some are not designed for R.F. measurements while others are. Some are calibrated to read r.m.s. voltages while others read peak voltages. Some are very simple in operation while others are more elaborate. Let us, now, take up several of the basic types and discuss some of the operating features of each one. This will help you understand just where and how they can be used.

Basic Vacuum Tube Voltmeters

In figure 1, we have a simple, basic tube circuit. Suppose we adjust the bias so the tube operates on the straight part of the characteristic curve; we have plate current flowing, causing a meter reading. Then, when a D.C. voltage is applied across resistor R, we get a change in plate current up or down, depending on the polarity of the applied voltage. By setting the initial plate current at a value giving a mid-scale meter deflection, we can thus obtain a reading regardless of polarity. This has the disadvantage of using only half the available meter swing, cramping the scale readings.

Also, this circuit does not work well with A.C. as the plate current would just vary about the same *average* value, with no meter change until the A.C. voltage exceeds the bias value. Then, grid current will flow, which will change the bias and cause a change in the plate current average. This means we have an insensitive and erratic A.C. indicator.

We need make but a simple change in this circuit, however, to have a much better A.C. instrument. Suppose the grid bias is increased to the plate current cut-off value. We now start with essentially zero meter indication. If a D.C. voltage is applied across R between A and B with the polarity indicated in Fig. 2, the grid is made less negative and the plate current increases accordingly. By proper tube and meter selection, we can now have a very sensitive instrument, using the full meter scale as a single range. We do have to watch polarity now, but this is a minor problem.

A.C. voltages are applied across R through condenser C (between A and C) which just serves to block any D.C. which may be in the circuit.

The negative half cycles of the A.C. voltage will not affect the grid as it is already biased to cut-off. However, the positive half cycles will cause an increase in average plate current proportional to the voltage and we can now calibrate our meter to read A.C. as well as D.C.

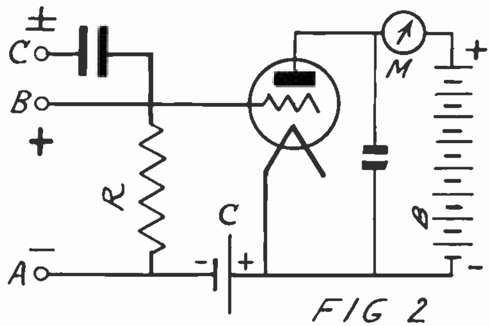


FIG 2

V.T.V.M. vs. Ordinary Meters

Now that we can measure both A.C. and D.C., how does the sensitivity and frequency range compared with ordinary meters?

The sensitivity can be made very high by proper design. The current drain from the voltage source depends on the value of resistor R and the input resistance of the tube. At normal negative bias values, the grid-cathode resistance is extremely high. (Naturally, if the input voltage exceeds the bias, this value will drop and thus shunt the input.) There is another input resistance factor in a tube but by proper selection of tube type and circuit values, this can be made unimportant.

Therefore, resistor R practically controls the ohms-per-volt or sensitivity. We might expect this value to be infinitely high, but actually it is limited by the convection or gas current of the tube grid. With a very high resistance, even a tiny grid current can cause a voltage drop which upsets the bias and hence the range and the original calibration of the device. This compels one to select tubes with low gas current. Quite often, 10 or more tubes may be rejected before a suitable one is found.

However, by proper choice of both the type and individual tube, resistance values of 10 megohms or higher can be employed for R. As the basic voltage range of a v.t.v.m. can be made low, this means that sensitivities of several megohms-per-volt can be obtained—many times that of the most sensitive ordinary meter, providing the input is kept within the negative bias range. I will take up multi-range meters later.

Although this instrument will respond from low power frequencies to high r.f. values, its usefulness depends on the impedance at the points where voltages are being measured and the capacity reactance across resistor R. Capacity reactance drops as frequency increases, hence this capacity lowers the input impedance as frequency is increased. For example, our 10 megohm input

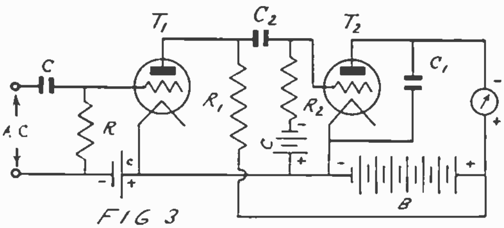


FIG 3

at D.C. may drop to well below 1 megohm at some medium R.F. frequency and continue dropping as the frequency is increased further. This means the ohms-per-volt rating drops with increases in applied frequency. If the point of measurement is of high impedance, such as across a tuned circuit, then the v.t.v.m. input may draw appreciable current. This loads the circuit, changing the voltage just like any low sensitivity meter.

On the other hand, if the point of measurement is of low impedance, (much below the v.t.v.m. input at that frequency) then the v.t.v.m. does not load the circuit appreciably and can successfully indicate R.F. voltages at high frequencies.

By proper design and layout, the circuit and wiring capacity can be made very small, hence, the internal tube capacity and external lead capacity are the important shunting values. The capacity between the grid and cathode is of course across R. There is another shunting capacity effectively across the input which depends on the grid-plate capacity, the plate load and amplification of the stage. This can be made smaller by choosing a tube with low grid-plate capacity or by using a screen grid tube.

In the screen grid or pentode, the control-grid to screen-grid capacity is across the input, so tube type choice is a problem where ultra-high frequencies are to be measured.

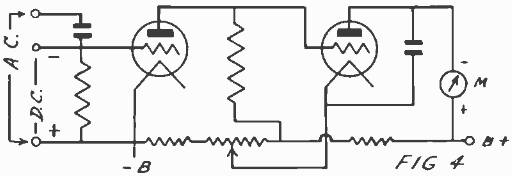


FIG 4

By proper tube choice, it is possible to obtain very good results well up into the R.F. range even using external leads of ordinary types. This lead problem will be discussed later. (Remember, however, the v.t.v.m. will indicate something, even when loading the circuit, which is better than ordinary copper-oxide rectifier types).

V.T.V.M. With Amplifier Tube

The demand for higher sensitivities as well as other considerations has resulted in many v.t.v.m. units with stages of amplification. This brings up other problems, some of which will now be covered.

In Fig. 3 we have a standard amplifying circuit connected ahead of the cut-off biased stage.

The use of coupling condenser C_2 makes this an A.C. amplifying stage, so this type will measure A.C. voltages only. In other words, if a D.C. voltage is applied across R it would change the plate current of tube T_1 from one fixed value to another. The *change* would result in a *pulse* passing through a condenser C_2 to the next stage, which would cause a momentary flicker of the meter needle but no steady reading. An A.C. signal would be rectified by tube T_2 (negative half cycles are cut off due to use of high grid bias) and an average plate current change would be obtained. An instrument of this type is thus designed for A.F., video and low frequency R.F. measurements only.

In Fig. 4 we have a basic direct-coupled amplifying circuit. This type will measure both A.C.

and D.C. voltages but is critical in adjustment and requires a very high voltage supply. Notice that the input voltage polarity is reversed. This causes trouble when measuring certain voltages where the grounding point may be different from the v.t.v.m.

In Fig. 5, we have another type of v.t.v.m., but this one is designed primarily for measuring A.C. voltages. At first glance, it would seem that the

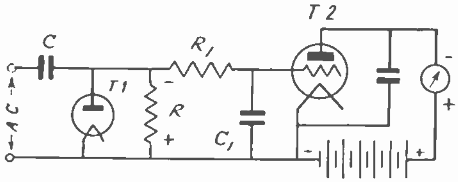
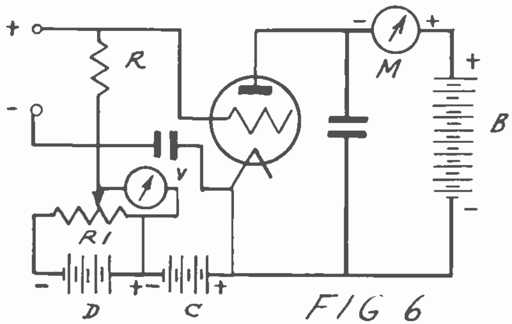


FIG 5

rectifier tube T_1 connected across resistor R would be a large load on the source of voltage. However, the condenser C and resistor R are chosen so that the voltage developed across R is maintained as a negative voltage on the plate of the rectifier, so that current flows only at the extreme tips of the positive peaks of the applied A.C. voltage. In other words, the time constant of R-C is high, maintaining the voltage for an appreciable period of time.

The filter circuit R_1-C_1 serves to keep A.C. voltages off the grid of tube T_2. Hence the D.C. voltage across resistance R changes the bias and thus the plate current of tube T_2, causing a meter indication. Notice the polarity of the voltage across the resistor R. In this case the plate current of tube T_2 is adjusted so that the meter reads full-

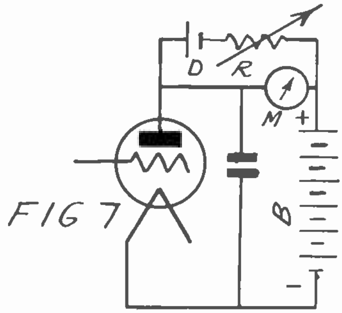


scale with no applied A.C. voltage. Then the negative voltage developed across R reduces the current, causing the meter to read in the other direction or down-scale. Thus it is calibrated in a reverse manner. The meter movement can be reversed so that maximum current causes the meter needle to move to the left, then the voltage will be indicated in the normal left-to-right manner.

Slide-Back V.T.V.M.

In Fig. 6, we have another basic type which is known as the Slide-back Vacuum Tube volt-meter. In this type the tube is biased close to the plate cut-off by battery C. However, a small plate current is allowed to flow. The voltage to be measured is applied to the grid circuit of the tube, causing a change in the plate current. Then another voltage is fed into the grid circuit with such a polarity that it bucks out the first voltage, causing the plate current to return to its original value. This additional voltage is measured by a voltmeter. As the plate current has returned to its original value both the input voltage and bucking voltage will be equal. Thus the measure of the bucking voltage gives the peak value of the input voltage.

For D.C. measurements, this circuit is exact but time-consuming. On A.C. measurements there is an error as the voltage becomes small. The peak



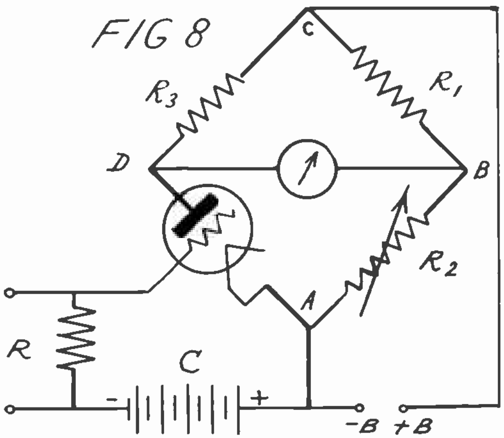
value of the A.C. input must exceed the bias enough to cause a change in the average plate current. This means that we are measuring less than the peak by some value close to .5 volt. At high voltages this is negligible, but below 10 volts, this error becomes increasingly larger. A correction chart is sometimes provided for low voltage readings.

Notice that in this case we must have a voltage D which is larger that the highest voltage to be measured, a means of varying it (R_1), and an additional meter. Furthermore, this type of circuit is hard to adjust if the input voltage varies considerably. There must be some means of changing the sensitivity of meter M, to prevent damage with large applied voltages, yet to have a sensitive indication of return to the original reading. Usually a shunting resistor is across the meter, or a large resistor is in series with it. Then, when a balance is approximately obtained, this resistor is disconnected or shorted by a push-button or similar switch, so the sensitive meter can be used to find exact balance.

Meter Zero Balancing

In several places, I mentioned the meter being set to zero, full scale, or some other value before measurements were made. We can always obtain this by varying the plate or grid voltage, but in many cases this is very undesirable. The scale on the meter is plotted with a certain particular tube characteristic curve in mind.

Now, after the calibration has been made, we must be careful not to change it if possible. If we change the plate or grid voltages, we shift the



tube operating point not only on the one curve, but frequently to another curve entirely. As this may be more straight or less straight than the original curve, we can thus destroy calibration.

(When the tubes in the v.t.v.m. must be replaced, this is frequently noticed. Sometimes we must then shift the B or C voltages to get the proper characteristic curve with the new tubes. With some types, many different tubes must be tried before tubes similar to the originals can be found.)

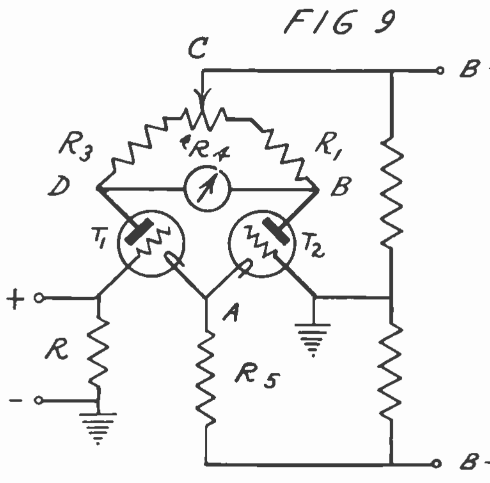
A better method of getting a particular meter reading is the use of a bucking voltage across the meter itself. Fig. 7 shows one arrangement of this type. The normal plate current of the tube flows through the meter. Another current from battery D flows through resistor R and the meter. This current can be made to aid or oppose the normal plate current, depending on the polarity of battery D. Thus, we can make the meter read some initial or starting value without regard to minor variations in the normal plate current. This causes the meter scale to at least start at the right point.

Bridge V.T.V.M.

Another method of obtaining a meter balance is to use a bridge type circuit. This is based on the Wheatstone bridge, where when the arms are balanced, the meter will indicate to zero. One form of this bridge is shown in Fig. 8. Here resistors R_1 and R_3 are of some particular fixed value. Resistor R_2 is made variable. Variations in the tube resistance, which is between A and D, will upset the balance of the bridge and the meter will indicate some current. Then resistor R_2 is adjusted to equal the tube plate resistance, thus restoring the balance of the bridge and the meter to zero. This circuit has the advantage over Fig. 7 of not requiring an additional battery.

Other undesirable tube characteristics can be balanced out by using the bridge circuit, using another tube as the balancing arm. If the two tubes used can then be chosen so that they are exactly alike, their characteristics will balance in many respects. Figure 9 indicates one type of this bridge circuit. Here the variable resistor R_4 permits an exact final balance.

This circuit is of particular interest in regard to the method of obtaining self-regulation. Notice that resistor R_5 is in the cathode circuit of both of the tubes. If there are variations in the plate current of the two tubes, the bias of both tubes will be affected. Hence, the tubes will both seek the same level, particularly if the amount of degeneration introduced by R_5 is high. This can be made so by choosing R_5 to have some high value. Then some voltage divider arrangement can be used as shown, so that the effective bias on the two tubes is at the desired level for starting conditions. Now, should either tube vary, it will af-

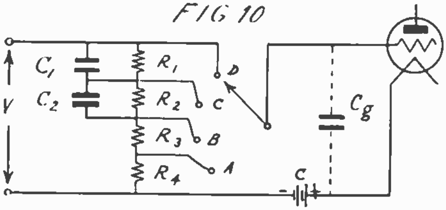


fect the other through the common coupling in R_5.

In this type circuit the degeneration reduces the sensitivity of the circuit, but some of this sensitivity can be gained back in another manner. Suppose we apply a D.C. voltage with the polarity indicated in Fig. 9 to the grid of tube T_1. This means the plate current of this tube will increase and the bias voltage developed across resistor R_5 will increase. This reduces the plate current in tube T_2. As a result, we have opposite changes in the plate current of the two tubes of such a nature that the voltage drops across resistors R_1 and R_3 add, giving a relatively larger change between terminals B and D of the bridge. The meter must, of course, be calibrated in terms of the input voltage.

From the foregoing, it can be seen that the vacuum tube voltmeter is basically a simple circuit, but must be properly designed for the measurements desired. Don't be fooled by the simple looking circuits; real engineering is required for a well designed unit. For instance, the plate voltage should be high for a straighter tube characteristic but must frequently be kept low to keep down the gas current trouble. The type of tube must be carefully selected, particularly when measurements are to be made at the higher radio frequencies. The points covered in the discussion of Figs. 1 and 2 apply also to the other circuits. Thus, the design engineer must compromise between desirable and undesirable characteristics to get a unit approaching the ideal.

FIG 10



Multi-Range Problems

The problem of obtaining different voltage ranges can be solved for D.C. and low frequency A.C. voltages by a voltage divider system. For instance, if R in Fig. 2 is tapped or made into sections as shown in Fig. 10, then the selector switch can be used to choose the desired range.

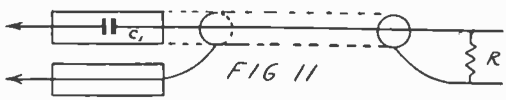


FIG 11

Resistors are chosen so that some desired fraction of the input voltage will be applied to the grid circuit. For example, if R_1 in Fig. 10 is 9 megohms, and the sum of $R_2+R_3+R_4$ equals 1 megohm (total is 10 megohms), then when the selector switch is moved to C, one tenth of the voltage V will be applied to the tube grid. This is the same as multiplying the range by 10, as 10 times the former voltage can now be applied and measured. The other taps are similarly figured out for other ranges.

When we get into R.F. measurements, we have another factor to consider. Remember the tube has a certain amount of input capacity C_g. When the selector switch is at D, this is across the total resistance. However, when we move the selector switch to C, notice that this places the capacity across resistors $R_2+R_3+R_4$. If the total of these resistors is high, then the capacity will affect the voltage division also. This is the same effect as lowering these resistances somewhat, while leaving R_1 fixed.

To correct this, we can connect a small capacity C_1 across R_1 so that the voltage division is corrected. The value of the (R_1-C_1) combination is thus made proportional to the ($R_2+R_3+R_4$—C_g) combination. In our example, where the range is increased 10 times, we just make the impedances have a 10 to 1 ratio and we again have a corrected scale.

At first glance, it would seem that C_1 across R_1 would be undesirable as it appears to be across at least a portion of the input. Remember that it is chosen to correct the impedance ratio, however, so it will be chosen inversely as the resistance ratio. This means it will be only 1/9 of C_g in our example, and thus will be but a *small* capacity.

When the selector is moved to position B, the capacity C_2 is then calculated. This is such a small amount that in many instances the wiring and selector switch capacity is enough. At A, the resistance R_4 may be so low that the tube capacity no longer is effective as a shunting reactance, so no further correction may be required.

External Lead Problem

The external leads or probes used to connect the v.t.v.m. to the point of measurement have long been a problem. The v.t.v.m. is very sensitive, so stray fields are readily picked up by unshielded leads. In most instances this effect will disappear when the leads are both connected to the point of measurement, as the impedance between the terminals is usually low enough to make the induced voltage of minor importance. However, there are cases where measurements, particularly in high impedance circuits, may be upset by this pick up.

Also, we have trouble with the capacity between the leads and between other parts and the leads. This is one of the reasons many have condemned the v.t.v.m. They did not realize the importance of this capacity. This capacity can not only result in loading the circuit, it can also detune it if we are measuring across a tuned circuit. Then when the leads are moved about, the readings will change with the capacity change. Furthermore, if a circuit is tuned with the v.t.v.m. connected to it, then it may no longer be resonant when the test leads are removed.

To cut out some of the stray field effect, shielded leads have been tried. Of course, this means the capacity between the leads (hot lead and shield) is greatly increased. For a long time, this meant the instrument could only be used for D.C. and low frequency A.C. By careful design and use of low capacity cable, measurements were extended into the audio and low R.F. ranges. Then, as pentode tubes having high amplification were developed the increased sensitivity permitted another means of reducing this trouble.

In Fig. 11, a shielded test lead is shown with a condenser C_1 right in the hot test probe. Notice that the capacity between the test lead and shield, as well as the input tube capacity, is effectively across resistor R. The circuit is therefore as shown in Fig. 12, where C represents the input and test lead capacity. We are interested in the capacity between terminals A and B, which represent the probe tips. The smaller we make C_1, the less effect condenser C will have, as there now are two condensers in series, where the total capacity is less than the smaller.

Of course, the capacities C_1 and C now act as a voltage divider, hence the lowest voltage range is changed. Instead of being a 0-1 voltmeter, for instance, we may now have a 0-5 or a 0-10 basic range. However, by using a pentode tube with high gain, or amplifying stages, we can compensate somewhat for this loss in sensitivity.

Notice that capacity C includes the input capacity of the v. t. v. m. Hence, if we use a voltage divider such as is shown in Fig. 10, we will have a different capacity as we vary the setting of the selector switch. This will again upset the voltage division. Therefore, in cases where multi-range instruments are required, a different voltage divider is usually used as shown in Fig. 13.

This type instrument is, of course, designed only for A.C. work and usually is designed for R.F. purposes.

In this system, we have a series of condensers with a selector switch. The range will depend on the ratio between condenser C_1 and the value of the shunting condenser C_2 to C_5 which is placed in the input circuit in parallel with C, the input capacity of the unit.

Now we have a voltage divider which is entirely a capacity divider. The resistor R is made high and is fixed in value, being used just to complete the grid circuit. This particular voltage divider is independent of frequency, as the reactances of condenser C_1 and whichever shunting capacity is in the circuit will vary directly with the frequency and in the same ratio. The capacity C also remains fixed.

Of course, condenser C_1 must be as small as possible, as the shunting condenser chosen for the highest voltage range will be fairly high in capacity. Otherwise, we would load our circuit if the source of voltage is of high impedance.

With this particular type of voltage divider, you will usually find stages of amplification. If this

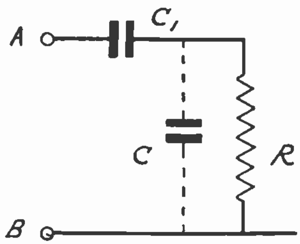
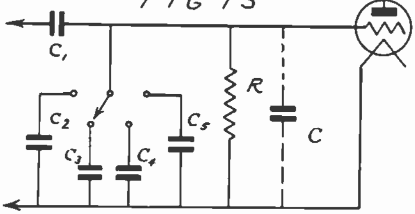


FIG. 12

amplification is of some constant impedance type, then our instrument can be used for making measurements at extremely low signal levels.

In some instruments, tuned circuits have been substituted for other methods of coupling the amplifying tubes together. This is entirely permissible where a particular frequency or range of frequencies is to be covered. This has the added advantage of indicating and selecting the frequency being measured—important in certain types of measurements. However, a tuned circuit has a different Q at various frequencies, and also its effective resistance changes according to moisture absorption in the coil and similar factors. As a result, in the types using tuned cir-

FIG 13



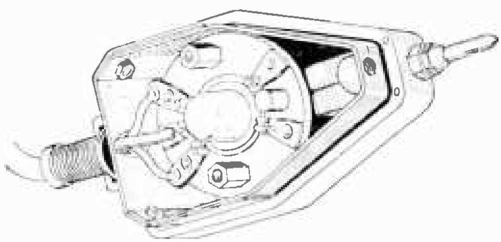
cuits, absolute measurements are not entirely reliable. This means that there may be considerable error when we try to measure the actual amount of voltage at some particular point. However, these instruments do have considerable usefulness in comparison work. That is, we might measure the signal voltage at the input of the stage and then that at the output. In both cases we might have considerable error, but the same error would exist in each case and the relative gain can be determined.

Another entirely different approach, used in instruments particularly designed for R.F. measurements, is to eliminate the effect of the test leads by moving the input tube right to the point of measurement. In other words, a tube is mounted on the end of a cable so the grid can be brought right to the circuit where measurements are to be made, thus eliminating all connecting leads between. There are several types, typical ones being shown in Figs. 14A and 14B. By having the tube rectify the applied voltage, only D.C. voltages need be fed down the cable to v.t.v.m., which is much less of a problem. Of course the tube supply voltages are fed up the cable to the tube, so the cable has several leads. Several instruments of this type use the basic circuit shown in Fig. 5, where everything to the left of T_2 is in the cable head.

This type has such a low input capacity that frequencies to 50 megacycles and higher can be measured, providing the tube or probe can be placed at the point of measurement without upsetting the circuit by capacity to other parts in the circuit.

Power Supply

Now, having covered most of the important problems in the tube circuit, what about the power supply? Naturally, if we have a sensitive circuit, any change in supply voltage will upset calibration and cause variations in meter readings. The most stable power supply is of course batteries. A battery operated unit presents fewer problems and can be made to maintain calibration over a considerable period of time. They do have a disadvantage when readings are to be taken over a period of many hours of continuous



Courtesy of P. R. Mallory & Co.

Fig. 14 A

Tube Probe of a General Radio 726-A V.T.V.M.

operation as the batteries may run down so rapidly that operation becomes uneconomical.

This fact, together with the desire of servicemen to have everything power line operated, has resulted in a number of A.C. operated units being produced. The power supply has to be of good regulation, so changes in the current drain and line voltage won't change the operating voltages appreciably.

In the case of plate and grid voltages, the power transformer, rectifier tube and choke coil are chosen with low resistance to have good regulation. High bleeder current values tend to mask small load current changes. Recently, several voltage regulating tubes have been brought forth and are now being widely used. These tubes have various voltage ratings and are connected across sections of the voltage divider which give the

Fig. 14 B

rated voltage. Fig. 15 shows a typical connection. The tubes are gas filled, so that the gas will ionize and pass a high current at some critical voltage, with large current changes with voltage variations. Hence, if the voltage varies between the tube connection points, the change in current flow, through a series dropping resistor R_1 "regulates" the tube terminal voltage back to the design value. These tubes can hold the voltage within a few per cent and have thus simplified the power pack problem greatly.

By using a degenerative type circuit, it is possible to obtain some regulation for voltage supply variation at the sacrifice of a certain amount of sensitivity. A self-biased tube arrangement is one form of this circuit. Remember, in Fig. 9, resistor R_5 has a degenerative effect. If the applied voltage changes somewhat, the plate currents would change, which would automatically correct the bias so that approximately the same results would still be obtained without greatly affecting the meter reading. In some instances where the basic circuits are used, you will sometimes find the meter itself connected in the cathode circuit. Here, it still, of course, measures the plate current but the voltage drop across the meter and any associated resistors will act as a self-biasing circuit.

Another power pack problem is the one of grounding. One side of the power line is grounded and the capacity between the power transformer primary and v.t.v.m. chassis has the effect of grounding the chassis whether desired or not. This upsets measurements where *both* test leads are to be applied to points different from ground potential.

This ground problem has worried many design engineers. A ground is almost essential to eliminate many stray field pickup effects and the v.t.v.m. must be shielded and grounded to eliminate hum from its own power supply. Also, if it is at a different potential with respect to the chassis where measurements are being made, other false readings may be obtained if there is any coupling between the two units.

This ground problem has been so troublesome that in most instances the instruments are just designed to make measurements with respect to ground and no other. It is fortunate that most of our R.F. and signal measurements can be made this way anyhow. There are instances where it may be desirable to measure A.C. voltages at some point different from ground potential, however, and therefore you will find that some designs use an ordinary A.C. meter, with a copper-oxide rectifier, to permit such measurements. In other words, the same meter movement may be used but the circuit is arranged in a different manner so that the meter is brought out individually through the proper multiplying resistors, and becomes an ordinary type A.C. voltmeter. Naturally, unless other provisions are made, this means that the instrument cannot be used on R.F. and A.F. voltages.

So far, we have covered a number of problems, most of which are solved by the design engineer, but which should be understood so that full use can be made of any particular instrument and many of the strange readings obtained at times can be understood.

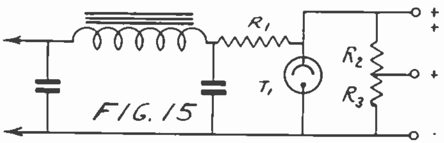


FIG. 15

Suppose we have a v.t.v.m. of any type. One of the first things to do is to become familiar with the use of the instrument. The instructions of the manufacturer should be thoroughly studied. Some are not designed for certain measurements, although they may serve excellently within their limits. Hence, make sure that the use and instrument match.

—————— *n r i* ——————

Scrambled Ads

WANTED—A place to show her wares by an antique lady with a Spanish chest and other odd things.

—Cold Spring (Ga.) Times.

———

WANTED—A salesgirl; must be respectable till after Christmas.

—Belen (N. M.) News.

Old Tubes Wanted

"Don't Junk Your Old Tubes" is the headline of an enticing invitation which General Electric is issuing to radio servicemen the country over.

Each serviceman is invited to bring old or obsolescent radio tubes of any brand which he has accumulated at home or in his shop, purchase at the regular dealer discount an equivalent number of new G-E pre-tested radio tubes, and receive for each tube so exchanged, a certificate having a definite intrinsic value.

These certificates in specified quantities will be redeemed by G-E radio tube distributors for any pieces of standard radio test equipment manufactured by the company, or, if the holder prefers, for any of a variety of premiums which include typewriters, clothing, cameras, furniture and the like.

The number of certificates needed to obtain a premium or a piece of test equipment may range from 50 to several thousand, depending upon what the redeemer desires to get.

Heap Big Chief Dowie meets Chief of Blackfeet Indians, while on vacation at Glacier National Park, Montana.

PUZZLING RADIO QUESTIONS FROM STUDENTS ARE ANSWERED BY N. R. I. EXPERTS

Iron Filings

QUESTION: *I have a dynamic speaker which has a considerable quantity of iron filings in the voice coil gap. What is the best method of removing these filings?*

ANSWER: It is usually possible to get the filings out of a loudspeaker gap by carefully cleaning them out. Use some very thin knife blade or cardboard to scrape them out. In some instances, however, there will be enough residual magnetism in the iron of the speaker to hold these filings.

In this case, it is possible to remove the filings by removing the residual magnetism. The easiest way of doing this is to apply some medium A.C. voltage to the field coil directly. In other words, disconnect the field coil from the radio and connect it to some A.C. voltage between 50 and 110 volts. Most speaker fields can be connected directly across a power line.

The A.C. voltage will remove the residual magnetism, and then by rapping sharply on the speaker, the filings will drop out.

Push Button Volume Level

QUESTION: *I have noted that in many instances the volume on push buttons will not be the same as that obtained by manual tuning. Why is this?*

ANSWER: The volume on push buttons may be either higher or lower than that obtained on manual tuning. If it is higher, this usually indicates that over-all alignment of the receiver is not as good as that obtainable with the push buttons, which are of course individually adjusted to each particular station and therefore usually better in alignment.

In some instances, however, you will find the volume is actually lower on push buttons. This is caused by the design of the receiver being such that a radio frequency stage is left out when the push buttons are used.

Testing A Power Transformer

QUESTION: *I have a receiver with a power transformer which smokes. How can I test the power transformer to see if it is defective?*

ANSWER: A power transformer will overheat when there is an overload in the set, such as would be caused by short circuited filter condensers.

Therefore usually by removing the overload, you can determine if the transformer has been damaged. In other words, if you will pull out all the tubes, particularly the rectifier tube, and turn on the set, you can observe whether the transformer still smokes. If it does, then the transformer has been damaged. Test the set to determine what else might be wrong, then replace the transformer.

Of course in some instances the transformer will be defective, and this will be the only trouble. As a more conclusive test of a damaged transformer, connect it to the power line with a lamp in series, but with no load on it. Again remove all the tubes from the set. Arrange a lamp socket so that it will be in series with one side of the power line connections. The lamp should be a standard 40 or 60 watt lamp bulb. Then, connect the power transformer to the A.C. line through the lamp, and turn on the switch. With no load on the primary the lamp should light but dimly, if at all. If it lights brightly, the transformer has short circuited turns and must be replaced.

By-pass Condenser Trouble

QUESTION: *I have a receiver using a small condenser connected between the plate of the output tube and set chassis. This condenser seems to burn out at rather frequent intervals. What is the matter?*

ANSWER: The condenser to which you refer is under a severe strain. Not only must it withstand the high plate voltage, but it has a considerable signal voltage across it. I would certainly use condensers rated at 600 volts for replacement purposes. Usually, this will clear up the trouble. If these condensers seem also to go out frequently, then use buffer type condensers or mica condensers rated at 1,000 to 2,000 volts.

It is also possible to use two condensers in series and obtain a high voltage characteristic. To make up a .02 mfd. capacity for instance, you would have to put two .04 condensers in series, preferably each being rated at 600 volts. Then, across each condenser place a resistor of about 10 megohms. These high resistances are for the purpose

(Page 20, please)

RADIO-TRICIAN
REG. U.S. PAT. OFF.
Service Sheet
Compiled Solely for Students and Graduates
NATIONAL RADIO INSTITUTE, WASHINGTON, D.C.

Philco Models 42-842, 42-843, 42-844

Alignment Procedure

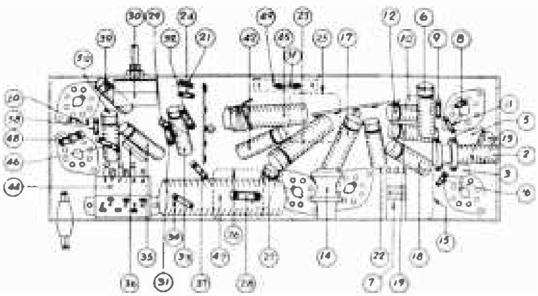
When adjusting the "I.F." padders the high side of signal generator is connected through a .I mfd. condenser to the loop tuning condenser stator lug which connects to grid of first detector tube. The ground or low side of signal generator is connected to chassis of receiver.

When aligning R.F. padders of portable models a loop aerial is made from a few turns of wire and connected to signal generator output terminals. Signal generator is then placed a few feet from set. The loop aerial of receiver should be assembled in the cabinet together with battery when adjusting R.F. padders.

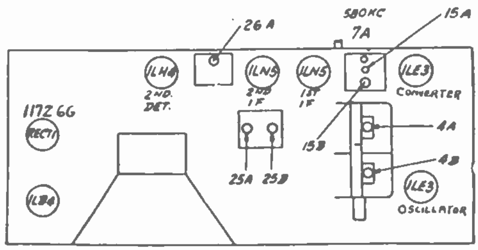
These models may be adjusted when operated by battery or 115 volts A.C.-D.C. power.

Operations in Order	SIGNAL GENERATOR		RECEIVER		
	Output Connections to Receiver	Dial Setting	Dial Setting	Control Setting	Adjust Compensators
1	See Paragraph on Signal Generator above	455 K.C.	540 K.C.	Vol. Max.	26A, 25A, 25B, 15A, 15B, Note A
2	Use Loop on Generator as above	1500 K.C.	1500 K.C.	Vol. Max.	4B, 4A
3	Use Loop on Generator as above	580 K.C.	580 K.C.	Vol. Max.	7A, Note B
4	Use Loop on Generator as above	Repeat Operation 2	Repeat Operation 2	Repeat Operation 2	

Note A: Dial Calibration—Before adjusting the R.F. padders the dial must be aligned to track properly with the tuning condenser. To adjust the dial proceed as follows: With the tuning condenser in the closed position (maximum capacity), set the dial pointer on the small dot below 540 K.C.

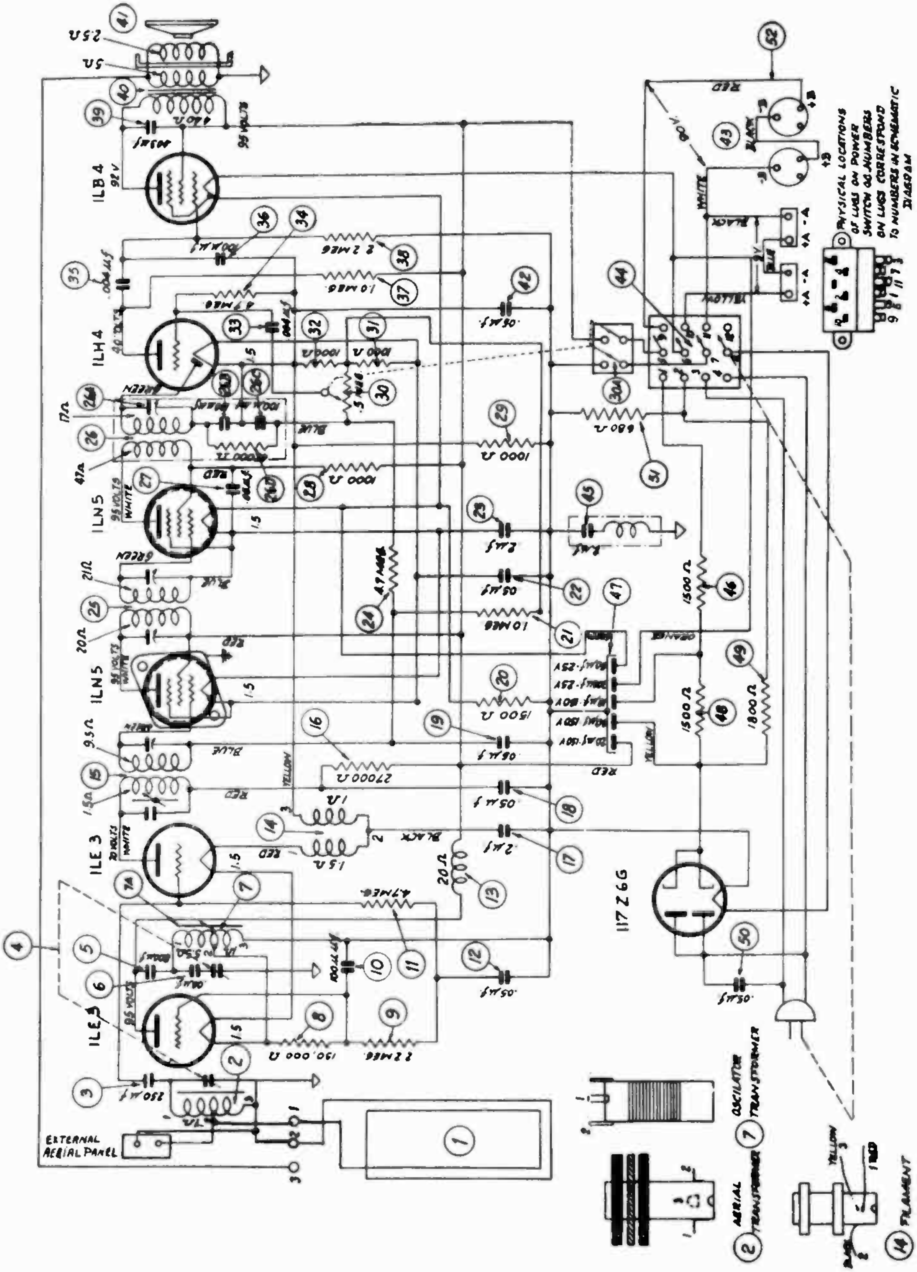


Note B—Roll tuning condenser as compensator 7A is being adjusted until maximum output is indicated on output meter.



Courtesy, Philco Radio & Television Corp.

Readers who file Service Data in separate binders remove page carefully, trim on dotted line for same size as data published heretofore.



Courtesy, Philco Radio & Television Corp.

Novel Radio Items

—BY L. J. MARKUS—

MERRY Christmas to you, N.R.I. students and graduates. And here's a prophecy for the New Year: It's gonna be the biggest and busiest in history for you radio men. So-o-o, keep right up on your toes, and remember that you're playing a pretty important part in the National Defense Program no matter what kind of radio work you will be doing.

—————n r i—————

ECHOES can be produced artificially for radio dramas by a new magnetic sound recorder which records an audio signal on a flexible iron tape by a magnetizing process, then plays back the signal a second or so later, amplifies it, and mixes this artificial echo with the original program signal. By speeding up the process and adding additional pick-up units, artificial reverberations can be created for programs, to make studio actors sound like they were outdoors, in a tunnel, in an auditorium, or anywhere else.

—————n r i—————

RURAL areas will get improved radio service if the Federal Communications Commission decides to authorize super-power broadcast stations as a defense emergency measure. Stations applying for increases from the present 50,000-watt limit are: WOAI, San Antonio—750,000 watts; WLW, Cincinnati—670,000 watts; WSM, Nashville—500,000 watts; KSL, Salt Lake City—500,000 watts; WHAS, Louisville—750,000 watts; WHO, Des Moines—500,000 watts.

—————n r i—————

RADIO stations on the air at any particular time are indicated visually by the panoramic oscillograph unit, one of the many instruments used by the F.C.C. for policing the air waves. It automatically tunes over a given portion of the radio spectrum, and gives a visual record of the number of radio stations on the air at that time. This greatly simplifies detection of the presence of "outlaw" radio stations.

—————n r i—————

YARN of the month comes from *The Broadcast Engineers Journal*, which tells how army pilots regularly use the transmitting antenna of station WCOV in Montgomery, Alabama, as a sort of pylon on a course marked out for practice flying. The big question among the radio ops down there is how many months the station would be off the air if one of the embryonic pilots cut a little too short on his turn.

CEILING projectors, essentially searchlights used at airports to determine the ceiling or height of clouds at night, will now work in the daytime too. U. S. Weather Bureau men have found a way to modulate the light beam, and pick up the reflected modulated light from the clouds with a photoelectric cell.

—————n r i—————

HAMMOND electronic organs, 555 in all, have been ordered by the U. S. War Department for camps. Electronic specialists who get drafted may have to service the organs.

—————n r i—————

RADIO is being used to balance automobile crankshafts. The radio balancer tunes in a vibration, then automatically drills metal from the right spot to eliminate the vibration.

—————n r i—————

INSULATORS which support transmitting antenna towers have supported loads of 3,000,000 pounds, yet the walls of these porcelain cone insulators are only 2½" thick.

—————n r i—————

SAHARA Desert bus and airplane traffic maintains permanent contact with a broadcasting station in the heart of the desert.

—————n r i—————

TRANSMITTING antenna towers 900 feet high bring to stations WNAX of Yankton, South Dakota, and WKY of Oklahoma City the dual honor, share and share alike, of having the highest antenna towers in the western hemisphere.

—————n r i—————

MEXICO gets its first radio network, with key station XEW in Mexico City tied together with nine other stations.

—————n r i—————

ARMY "walkie-talkie" two-way radio sets were used by one West Coast soldiers' football team so the assistant coach spotting plays from the roof of the press box could immediately pass on his observations to the coach pacing up and down the sidelines during the game. These knapsack-type sets weigh only about 20 pounds.

—————n r i—————

SABOTEURS are being balked in many defense plants by invisible light rays which zig-zag across protected areas. A. D. T. invisible photoelectric alarms will now cover distances up to 1,000 feet.

Circuit Analysis of an A. C. Superheterodyne Receiver

By J. B. STRAUGHN

N. R. I. Service Consultant

General Description. An a.c.-powered superheterodyne receiver employing five tubes, an 80 rectifier, a 6A7 frequency converter, a 6D6 i.f. amplifier, a 6B7 detector-a.v.c. and audio amplifier, and a 41 power output amplifier; this circuit is conventional in most respects, as the "usual kind" of circuits are employed.

Signal Circuits. In considering this circuit it will be best to consider the important sections of a superheterodyne, namely, the preselector, frequency converter, i.f. amplifier, detector, and audio amplifier.

Preselector. A simple circuit is used, consisting of a tuned transformer and i.f. interference rejector which is essentially a wave trap. The antenna signal sets up a current in the primary coil L_1. (See diagram on page 19). Should interference at the i.f. value be present, the wave trap consisting of L_{15} and C_{47} will present a high resistance and thereby reduce the interference current intensity in L_1. The i.f. value for the receiver is 460 kc., as mentioned in the service manual. In actual servicing, this wave trap can be ignored if no i.f. interference is encountered.

The r.f. current flowing in L_1 induces a voltage in coil L_2. Now observe that trimmer condenser C_{45} in shunt with tuning condenser C_6 is connected to coil L_2 through condenser C_5. C_{45} has a capacity of 3-25 mmfd. and hence is a trimmer while C_6 has a capacity of 16-410 mmfd. the arrow indicates it is a tuning condenser. Condenser C_5 has a capacity of .05 mfd. or 50,000 mmfd., or more than 100 times that of C_6. For this reason we may say: the reactance of C_5 is negligible with respect to C_6 and L_2-C_6 is the basic tuning circuit. As we shall see later, the grid return of L_2 is not directly grounded in order that the a.v.c. can feed through it to the grid of the 6A7 tube. As far as r.f. currents are involved, the grid return of L_2 as well as the rotor of C_6 are grounded.

At resonance the voltage in L_2 is stepped up, presenting to the grid-cathode of the first tube, an r.f. voltage substantially greater than the voltage across L_1 in the antenna circuit. Voltage gains of 10 times may reasonably be expected.

Frequency Converter. A pentagrid tube (one with five grids, penta meaning five) is used as an oscillator, mixer-first detector—the frequency converter of a superheterodyne receiver. Its first grid connects through condenser C_8 to coil L_4 and to chassis (or r.f. ground) through C_{11} in shunt with C_{40}. Coil L_4, C_{11} and C_{40} are shunted by tuning condenser C_9 and its associated trimmer, C_{44}, to form a resonant circuit in the grid. This arrangement is widely used in super receivers in order to make the oscillator frequency follow (or track) with the preselector frequency. (The preselector resonant circuit is L_2-C_6). Usually the oscillator frequency is above the desired signal frequency tuned in by the preselector, by the i.f. value. That is, C_6 and C_9 are ganged together, so that when C_6 tunes in a 1,000 kc. signal, C_9 will cause the oscillator to generate a 1,460 kc. signal and this difference will exist over the entire tuning range of C_6 and C_9. At the very high frequencies, C_{44} is adjusted to give the desired i.f. difference and is called the high frequency trimmer; at low frequencies C_{40} is adjusted and is called the low frequency trimmer or padder.

From the second grid, trace through L_3, then through R_5 to the voltage supply (to be considered later) and through C_{16} to ground. Coil L_3 inductively links to L_4 and thus produces feedback from the second grid to the first grid circuit. If you consider that the second grid of the 6A7 tube is an anode, or oscillator plate, you will see that we have a tuned grid, tickler type feed-back oscillator circuit. The intensity of oscillation is automatically controlled by the grid bias produced by grid current flow in R_3. Condenser C_8 serves as the grid resistor filter condenser and helps to reduce the r.f. ripples of the grid bias voltage.

The cathode, the first and the second grid with their associated circuit components set up beyond the second grid an electron cloud that is varying in intensity in accordance with the oscillator frequency; technicians call this cloud the "virtual" or actual cathode for the remaining tube elements because the electrons flowing to these elements come from this cloud. These electrons are speeded towards the plate by the third and fifth grids (screen grid) since these electrodes are at a positive potential with respect to the virtual cathode. At the same time the signal from the preselector is "injected" into the tube by the fourth grid and introduces a new variation in the electrons flowing from cathode to plate. Thus both the preselector and local oscillator signals are mixed in the 6A7 tube. Detection takes place because of the operation of the tube and a strong beat signal (the i.f. signal) appears in the plate circuit.

Coil L_9 and adjustable condenser C_{17} form a parallel resonant circuit in the plate circuit, absorbing power at its resonant frequency and acting as a low reactance path for all other signal frequencies. The plate r.f. and i.f. current then returns to the cathode through C_{38}, C_{36} and C_{10}.

I.F. Amplifier and Detector. In a parallel resonant circuit a large current flows in the coil-condenser circuit, hence in L_9 a large current induces in L_{10} a corresponding i.f. signal voltage. L_{10} and C_{18} form a resonant circuit which boosts this induced voltage and a larger voltage appears across C_{18} than that induced into L_{10}. However the voltage across L_{10} is slightly less than that across L_9, as some energy is lost in the primary and secondary resonant circuits. By means of a direct connection to the grid of the 6D6 tube and by a cathode connection through C_{19} and C_{20}, the voltage across C_{18} is applied to the input of the 6D6 amplifier tube.

As the 6D6 is a high gain amplifier, a large i.f. voltage is developed across the plate parallel resonant circuit, L_{11}-C_{48}. The return i.f. path to cathode for this resonant circuit is through C_{38}, C_{36} and C_{20}. The i.f. current in L_{11} induces an i.f. voltage in L_{12} and by tuning C_{49} to resonance a large i.f. voltage appears across C_{49} which is less than the voltage across L_{11} but *many times greater* than the voltage existing across L_{10}. Because of the voltage step-up arising from the preselector, frequency converter and i.f. stage, the voltage across C_{49} is high enough for demodulation. This voltage is now rectified by one of the diodes in the 6B7 tube. The other diode is not used, for as you see, it is connected directly to the chassis.

Trace the used diode circuit by starting with the lower diode plate; trace through L_{12}, R_8, R_9 and then to the cathode of the 6B7 tube. Because of rectification a pulsating d.c. current flows through this circuit with its amplitude following the original modulation. In the detector circuit R_9 is the diode load across which the a.f. voltage is produced. Condenser C_{23}, resistor R_8 and the capacitor formed by the shield over the lead which connects R_8 and R_9 act as an i.f. filter so that across R_9 only the a.f. voltage and a d.c. voltage appears.

Audio Amplifier. It should be realized that in addition to the a.f. voltage a d.c. drop exists across R_9. Hence a direct connection to the input of the first a.f. amplifier cannot be made and a d.c. blocking condenser is required. Note that the movable contact of R_9 connects to the grid of the pentode section of the 6B7 tube through the d.c. blocking condenser marked C_{25}. The grid also is connected to the chassis through resistor R_{11}. For all audio frequencies except the very lowest, little of the a.f. voltage is dropped in C_{25} but is developed across R_{11} being available for audio amplification. Varying the position of the movable contact of R_9 controls the amount of a.f. voltage fed to the audio amplifier and therefore serves as the volume control.

The connecting lead from C_{25} to the grid is shielded so that stray electrical field pickup will be kept out of the audio amplifier. The signal at this point is at a very low level and therefore stray signals entering at this point will give the greatest interference.

From the grid of the 6B7 tube, trace through R_{11} to chassis and from chassis through R_{12} to the cathode, thus establishing the grid to cathode path. Actually, however, the a.f. will take the C_{26} path from chassis to cathode instead of going through R_{12}.

A pulsating d.c. current (a.f. on d.c.) will flow in the plate of the 6B7 tube. The d.c. current will be forced to take the path through R_{13} and R_{15} to the +B supply as all other paths are blocked by condensers. A.f. currents will flow through C_{28}, R_{14}, C_{30}, and R_{17} to chassis, and from this point through C_{26} to the cathode of the 6B7 tube. Another path for a.f. currents will be through R_{13}, C_{29}, R_{17}, C_{26} to the cathode of 6B7. It is the a.f. voltage developed across R_{14} that excites the grid cathode of the 41 tube since the reactance of C_{30} is negligible with respect to the resistance of R_{14}.

Any r.f. signals getting into the plate of the 6B7 are by-passed from the plate load circuit by condenser C_{27}.

In the plate circuit of the 41 pentode output tube we find the output transformer T_2 coupling the pentode tube to the loudspeaker. Condenser C_{32} is shunted across the primary to prevent parasitic oscillation in the output stage, by making the plate load substantially capacitive for high frequencies. The condenser reduces the high frequency response, but when more bass emphasis is desired C_{31} is shunted into the circuit by switch S_6, thus giving the output a boomy or predominantly bass response. S_6 is hence the tone control switch.

Now let us trace the a.f. signal path from the primary of T_2 to cathode. Follow the lead connecting T_2, C_{32} and the screen grid to C_{38} and C_{38} to the chassis and from chassis through R_{17} to the cathode.

Power Supply Circuits. A full wave type 80 rectifier is used in the power pack. Power transformer T_1 may be designed for either 60 c.p.s. or 25 c.p.s. but not for both, as you should know. Note that the 25 c.p.s. transformer has higher primary and secondary resistance, the result of more turns in each section; because of the low frequency, more core flux must be obtained with more turns to provide normal induced voltage. You will find that the 25 c.p.s. transformer is larger and heavier than a 60 c.p.s. transformer with the same voltage rating.

One low voltage secondary supplies power to the filament of the 80 rectifier tube, the other low voltage secondary feeds all other tube filaments in parallel. Note the usual method of leaving out the filament connections, but *indicating* connections by ending short leads in arrows. The ends of the high voltage secondary go to the plates of the 80 rectifier tube, while the center tap is connected to the chassis.

Choke coil L_{14} (the field of the loudspeaker), and condensers C_{35} and C_{36} are the power pack filter which terminates in the voltage divider R_{18}, R_{19} and R_{20}. Note that condenser C_{36}, an electrolytic condenser, is shunted by a .25 mfd. capacitor which is a paper condenser. Electrolytic condensers lose effectiveness as the frequency goes up. At high audio and radio frequencies C_{36} may not be a good capacitive shunt on the voltage divider. Including a paper condenser insures low reactance at these frequencies. The voltage divider serves to furnish the lower electrode voltages, but the plate-chassis voltage supply for all tubes terminates across the total voltage divider, terminals *1* and *2*. Let us trace the d.c. supply voltages.

6A7 Converter. Starting with the plate, trace through L_6 to point 1 in the power pack output. From point 2, the chassis, continue through resistor R_4 in the cathode of the 6A7 to the cathode of this tube. The voltage drop across R_4 is used to bias the detector section of the 6A7 tube, the grid connection made from the chassis end of R_4 through R_{12}, R_9, R_{10}, R_2, L_2 to the fourth grid of the 6A7 tube. In addition to the d.c. voltage developed across R_4 the a.v.c. voltage across R_9 is added to the normal C bias voltage of R_4 to give a.v.c. The voltage across R_{12} is in the opposite polarity, hence the bias of R_4 must be made great enough to compensate for it and give the fourth grid a net negative bias with respect to its cathode. Thus the grid and plate of the 6A7 tube obtain their operating d.c. voltages.

Grid No. 2 is the anode for the oscillator section of the 6A7 tube. Trace through L_4, through R_5 to point *3* in the power pack. At point *3* the voltage is positive with respect to chassis and higher than point *2* by the drop in coil L_{14}. However, considerable ripple exists which is eliminated by the filter R_5-C_{16}; while resistor R_5 also reduces the oscillator anode voltage to the desired value. Grid d.c. voltage is secured by self-rectification of the grid current, the current building up the d.c. voltage across R_3. The ripple is filtered out by C_8, which connects back to the cathode end of R_3 through L_4, C_{11} and C_{10}. Thus, the grid-cathode of the oscillator section receives its C bias. Since there is no conductive path for the voltage developed across R_4, being blocked by C_8, this voltage in no way influences the operation of the oscillator.

6D6 I.F. Amplifier. Here the plate connects directly to point *1* through coil L_{11}. Point *2* connects to the cathode through resistor R_7 which supplies the minimum C bias for the i.f. amplifier. The grid return is through L_{10}, R_6, R_9 and R_{12}. Again the bias established by R_1 must be large enough to overcome the opposing voltage across R_{12}.

Since the screen grid voltage should be less than the plate voltage, it is connected directly to a tap on the voltage divider, which is the junction of R_{18} and R_{19}. (The screen grid of the 6A7 tube is likewise connected to this point in the voltage divider.) C_{34} serves as the screen by-pass and prevents any ripple voltage from being applied to the screens.

6B7 Tube. From the plate trace through resistors R_{13} and R_{15} to point 1 of the power pack. Naturally, with 260,000 ohms in the plate circuit, the net plate-cathode voltage is lower than the power pack d.c. voltage. Resistor R_{12} in the cathode circuit furnishes the C bias for the pentode section of the 6B7 tube. The grid return is through R_{11}.

Screen grid voltage for the 6B7 is obtained by a direct connection to the voltage divider in the power pack, the point between R_{19} and R_{20}.

41 Power Output Tube. The plate connects to point *1* the positive terminal of the power pack through the primary of the output transformer T_2. Its screen grid connects directly to point *1* in the power pack. Resistor R_{17} develops the C bias voltage as the result of screen and plate current flowing through it; its negative potential with respect to cathode is applied to the control grid through resistors R_{11} and R_{15}.

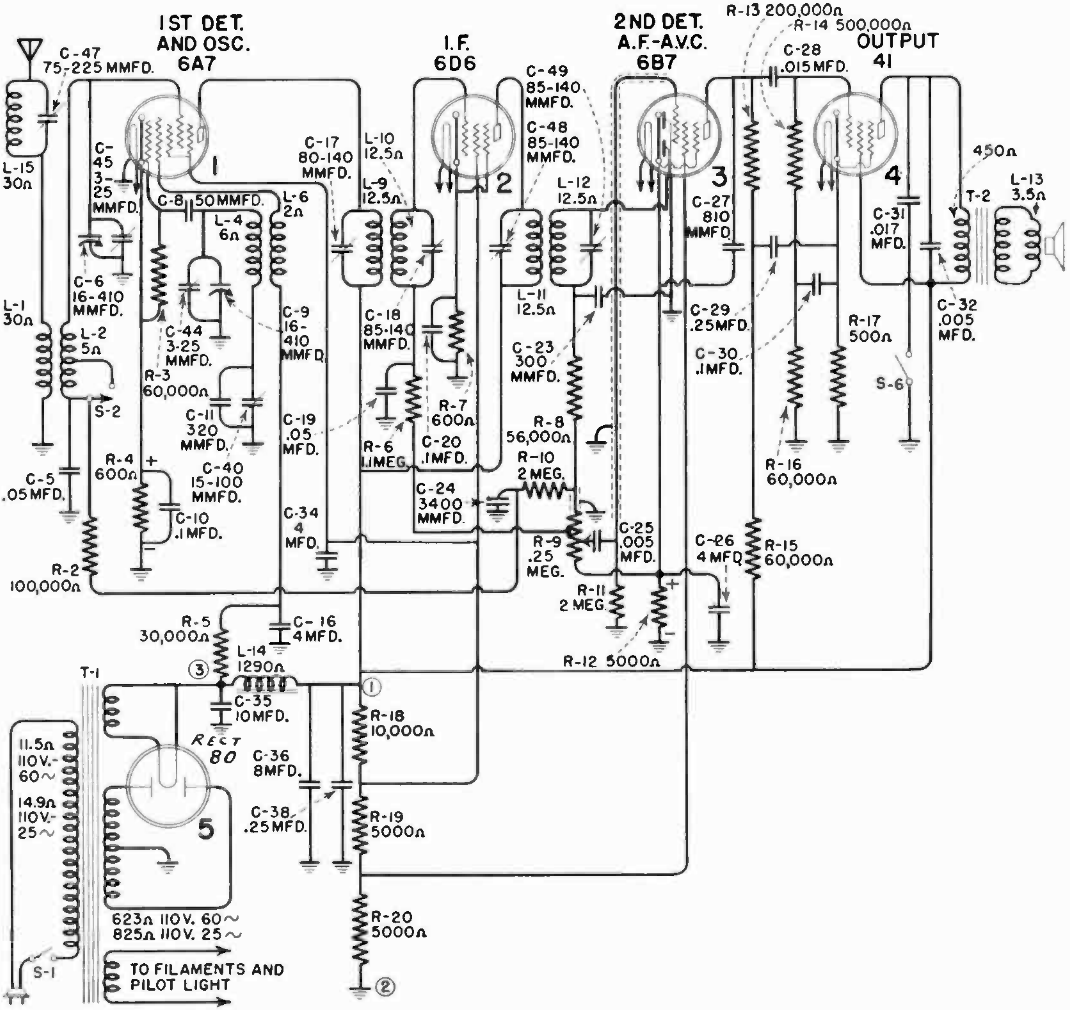
CIRCUIT CONTINUITY. Should you wish to check continuity in any of the electrode circuits, bear in mind these rules:

1. All positive electrodes should have a conductive path to the filament (or cathode) of the rectifier tube.

2. All negative electrodes should have a conductive path to a plate of the rectifier tube.

Let's prove this by tracing a few circuits.

Starting with the plate of the 6A7 tube trace through L_6 and L_{14} to the filament of the 80 tube.



When switch S-2 is closed, the preselector is tuned to the Police Band. The second harmonic of the oscillator then beats with the Police Band stations to form the I.F. frequency.

Starting with the second grid of the 6A7, the anode for the oscillator section, trace through L_6 and R_5 to the cathode of the 80 tube. Starting with the third or screen grid of the 6D6 tube trace to the junction of R_{18} and R_{19} and then through R_{18} and L_{14} to the filament of the 80 rectifier tube.

Turning now to a negative electrode, for example the control grid of the 6D6 tube, trace through L_{10}, R_8, R_9, R_{12}, to the center terminal of the high voltage secondary of the power transformer, to either plate of the 80 rectifier tube. Another example: starting with the control grid of the 41 tube, trace through R_{14}, R_{15}, to chassis and through the high voltage secondary to either plate.

Performance. This is an average receiver with respect to sensitivity and volume. Reasonably good fidelity is to be expected. An antenna 50 to 75 feet long is advisable in rural areas, short antennas in metropolitan districts. Noise reducing antennas of the doublet variety may be advantageously utilized in communities where electrical noise is a problem.

Service Hints. Since this receiver is quite conventional in design, most of the defects are isolated by basic methods discussed in the regular course. A few hints may prove helpful.

It is possible for this receiver to develop hum modulation without a defect in the main power pack filter. Should C_{16} open or lose its capacity, filter R_5-C_{16} will no longer remove the a.c. ripple in the supply to the local oscillator and as a result hum will be heard when a station is tuned in.

Here is a power supply system in which voltage distribution is controlled by a power pack voltage divider. Should R_{20} open, the screen grid of all tubes except the output tube will receive excessive voltage; as a result oscillation and perhaps distortion alone will set in. If more than one stage goes into oscillation, a likely condition, intermittently blocked oscillation may occur giving rise to a motorboat sound. Opening of condenser C_{34}, across the voltage divider can give the same trouble.

Should R_{19} open, the screen grid of the pentode section of the 6B7 will not get its d.c. voltage. As a result the tube will probably not amplify and a dead receiver will be the result. It is possible that a weak signal will get by (quite distorted) and with some oscillation present, since the previous tubes will have excessive screen grid voltage and the signal may jump through the G-P capacity of the 6B7. Leakage in C_{28} will bias the 47 tube abnormally positive and thus give rise to distortion. Leakage in C_{29} which is connected to the +B supply terminal drives the grid more negative and will cause serious distortion, more noticeable on weak signals.

n r i

Puzzling Radio Questions

(Concluded from page 12)

of regulating the voltage drop so that they will be equal across the two condensers. With this arrangement, you should have no further trouble providing the set is otherwise in good condition.

Changes In Receiver Wiring

QUESTION: *I have a set in for service which has been changed by some serviceman. How can a set in this condition be properly serviced?*

ANSWER: First, it is important to determine whether the change in the circuit was with the idea of improving the receiver, or whether it was done by some serviceman who did not know any better.

Once in a while, a receiver will come in that has its circuits considerably changed, because there was some trouble which the serviceman did not properly locate, but covered up by making some change. When the original trouble is cleared up, the set still will not operate properly until the circuit has been restored to its original type.

Of course, where the circuit has been changed definitely, such as for different types of tubes or for higher fidelity operation, then usually the changes are made in an acceptable manner. In such cases, just remember that you can service the set without wiring diagrams. The tubes must have operating voltages just as before. Therefore, check operating voltages. A quick check of the control grid and plate circuits will show just how the tubes are connected in the circuit and their proper order. Once this is determined, you can perform the usual circuit disturbance test to find the trouble.

As a practical pointer, should you ever change a receiver at all, be sure you make complete notes of this change and file them somewhere. Should you ever have to service this receiver again, it is surprising how complicated a simple change can sometimes make the service operation, if you have forgotten just what was done before.

Bias Supply

QUESTION: *I have noticed on several recent receivers that there appears to be no bias on the first audio tube. How is tube operation properly obtained?*

ANSWER: An examination of the circuit in this case will usually show that the grid circuit has a very high resistance in it. The value is usually somewhere between 3 and 15 megohms. As you know, the grid is in the electron stream within the tube. Some electrons are bound to strike the grid. Even this small amount of current flow through this high grid resistance value results in a voltage drop which serves to bias the tube. This is known as convection bias. It proves very satisfactory for ordinary tubes which are not gassy. It does not work at all with gassy tubes. In fact it is the worst type of bias for tubes that are gassy, because the gas current causes the grid to become positive instead of negative, thus causing distortion.

Therefore, if you ever have trouble with the first audio stage using such a resistor, be sure to try another tube. The ordinary tube tester does not show up gas with sufficient accuracy for this purpose.

The value of this resistor is not ordinarily critical, and if you find one burned out, practically any value above 3 megohms can be used.

KNOW YOUR RADIO DOCTOR BETTER

By JOHN F. RIDER

An Address Broadcast Over WABC, New York

IN this day of national emergency, radio is more than just a medium of entertainment and education. It is the only communication link of instantaneous action between the Federal Government and the people of this nation. It is the only means whereby with the flip of a switch, those who are responsible for the functions of this government and the proper protection of its people, may speak and convey their message to the entire population. Since we do not know what the future has in store,—national preparedness requires that every radio receiver in the home—factory—automobile—or wherever it may be, function properly.

For many years past, manufacturers of radio receivers produced a new crop each year. Because of defense requirements, there will be a definite curtailment in the production of new receivers during the remainder of this year and next year. This means that the public at large will find it more and more difficult as time goes on, to procure new equipment to replace their old receivers. . . . Defects in radio receivers are, however, not controlled or determined by international policies, the declaration of war, or shortages of materials. . . . Radio receivers fail and will continue to fail because of the deteriorating actions of the electric currents which course through them—because of humidity—because of improper handling. . . . Since replacement of a defective receiver will become more difficult, it is inevitable that there should be an increase in the amount of radio servicing, therefore a closer association between the public and the radio repair industry.

Under the circumstances, it becomes valuable to the welfare of the people of this nation to know something about what radio repairing really means. . . . This does not require that Mr. and Mrs. America become technical people and make it their business to learn what is in a radio receiver. . . . What is necessary, however, is that people realize that the repair of a radio receiver is not as simple as many believe. . . . The modern radio receiver is a complicated affair. . . . There is no device with which the public comes in daily contact which is comparable in the nature of its complexities to the radio receiver. Strange as it may seem, about the only parallel is the human body. . . . The automobile, which so many people view with awe and consider a complicated device, is relatively simple, when compared to a modern radio set.

The average listener becomes annoyed because a slight amount of noise, crackling or sputtering develops in his radio receiver. To all appearances, the receiver is perfect—except for that little noise. . . . After listening to the crackling for a week or so, a radio repairman is called. . . .

As far as the public is concerned, this specific problem of repair is very simple. . . . It's just a matter of removing that crackling or sputtering. . . . What the public fails to realize is that of all of the possible defects, and they are myriad, which may develop in a radio receiver,—the most difficult of all to locate—is that of noise. . . . Every single part—every tube—every wire—every connection—in fact everything in the radio receiver is a possible source of this trouble. . . . It is true that once the defect has been located, the actual operation of repair may be but a moment's work. . . . But the locating of that simple defect is an entirely different matter. . . . It may take hours and even consume days! . . . It may take many hours even in the finest of equipped radio shops—operated by men who have spent years securing their technical education.

The locating of noise—that very slight crackling or sputtering—is in reality the most difficult problem which can face the radio serviceman. About the only parallel which can be found is an ache or pain in the human body. . . . As every man and woman well knows, many aches and pains which may appear to be centralized, are after much investigation and experiment found to be due to something far removed from the actual location of the pain. . . . Strangely enough, the public has become accustomed to accepting such conditions and to paying the doctor for each and every visit made,—for each and every experiment, although, it may not be until after the fourth or fifth visit that the real root of the trouble is located and the remedy is effected.

But when working with the radio repairman, the public, unfortunately, is not cognizant of the fact that the radio repairman too, is working with invisible forces—electrical currents. . . . Because of the nature of the fault, few radio repairmen, if any, are paid in full for all of the time they must spend to cure noise troubles in radio receivers. . . .

The public at large expects the radio repairman to be able to diagnose a fault the moment he looks at or listens to a radio receiver. Just as a medical man often finds it impossible to arrive at a clear-cut diagnosis of an ailment by a superficial investigation in the home and requests that the patient go to his office for a more thorough analysis by means of proper apparatus, just so does the radio serviceman find it impossible in most instances to diagnose a defect properly in the customer's home. . . . It is because of this and because the necessary equipment is located in the repairman's service shop, that it has become common practice to remove the radio receiver from the home to the shop. . . . It is only after critical examination in the repair shop that it is possible for the serviceman to render a decision as to the nature of the fault and the cost of its repair.

The public should appreciate that the radio repairman is not a miracle worker—that he is just another human being, who can be trusted to do an honest job and render an honest bill for work done. . . . I say this with full realization that there have been times in the past when a repairman practiced subterfuge. But to condemn the majority because of the occasional practices of a few is not right. The radio repairmen of America are honest people and serve the national requirements faithfully and justly. . . . The very growth of radio during the past twenty years is testimony to this fact.

It is of value to the public at large—for their own protection—for the protection of the investment that each and every person makes in his radio receiver, to understand that the repair of a radio receiver is not just the substitution of a defective part. . . . There occurs in a radio receiver, over a period of time, a gradual wearing away of the parts. This is similar to that found in the human body as people grow older. . . . Listening to a radio receiver day after day, it is indeed difficult to realize the changes taking place, for they occur little by little until that day arrives when the major defect develops. When such a receiver is sent to a radio shop for repair, replacing the defective part is not all that the radio serviceman must do.

After having put in a new part or parts as the case may be, and the receiver again is in an operative state, he then must check the entire receiver, for while it may be in an operating state, he still is not certain that the receiver is performing as it should. There is a great difference between a receiver which is in an operating state and a receiver which is performing as efficiently as it should and was intended by the set manufacturer. It is the obligation of every reliable radio serviceman to make certain that the receiver, before it leaves his shop is as close to perfection as it is possible to make it. An individual who is not familiar with radio would consider such a final check-up as being something superficial and unnecessary. This is absolutely incorrect, for we doubt if one receiver out of a thousand is in such condition when it is brought into a repair shop, that after repairing the fault the serviceman may return the receiver to the customer without any further checking.

Such supplementary and final checking consumes time, and while it is true that the customer may not have specifically asked for such a final test, he should look askance at the man who does not make it, rather than consider the serviceman who charges for such a final check-up as making unnecessary charges.

The major portion of a charge made for a repair by a radio serviceman is mostly for work done other than the actual correction of the defect. It is for the time spent in pick-up and delivery of the receiver,—for the time spent making the inspection—for the time spent making the actual diagnosis and locating the defect—for the cost of the new parts, some of which may be expensive—it is for the time involved in making the final overall check-up of the receiver. . . . Every service job must bear its share of the over-all expense of running the service shop—the rent, the light, power, advertising, cost of equipment and so on. . . . Failure to recognize this condition is due to no deliberate fault on the part of the public. . . . They just never have been told! . . . It is this that has made the public feel that oftentimes they were overcharged for a radio repair.

Most certainly it is hoped that in the future a greater understanding will develop between the public at large and the American radio serviceman, for he is entitled to as much consideration as everyone else who renders a service to the people of this nation.

The Service Forum

Conducted by

J. B. Straughn, N. R. I. Service Consultant

Send in your service notes. We will re-word them for publication. To qualify your note for the NEWS you must have observed the same trouble on two or more identical receivers.

PHILCO 29, 29X, 45 — **WEAK**

If these models lack the sensitivity they should have, but still play with good tone, check the secondary of the second i-f transformer. The main sympton of this will be found as a lack of sharpness in the trimmer (nut) on the 2nd i-f can. (Screw is Primary trimmer).

—— *n r i* ——

PHILCO 118 — **INTERMITTENT**

An intermittent drop in volume, accompanied by a noticeable reduction of the high-frequency response is usually caused by the tone compensating condenser which is connected to the volume control slider, intermittently open-circuiting.

—— *n r i* ——

PHILCO 800 — **INOPERATIVE OR RATTLING SOUNDS**

Inoperative or rattling sounds, caused by an open or short-circuited buffer condenser, often causes continued arcing of the vibrator points. Replace with a new unit. Another source of trouble is loose rivets; check these carefully and if impossible to re-rivet solder same firmly to the chassis.

—— *n r i* ——

PHILCO 59 — **OSCILLATION**

Over-all oscillation in this model is often due to open by-pass from "-B" to chassis. This is a 0.015 mf condenser, part of a dual unit, located next to the wire-wound resistor in the corner.

—— *n r i* ——

PHILCO 59 — **OSCILLATOR**

When oscillator frequency shifts, detuning the signal, replace the bypass condenser on the screen grid of the det.-osc. with a 0.1 mf., 600 volt unit. This condenser is located in the back of the type 42 tube, and is the bottom terminal on the second one from the side.

—— *n r i* ——

PILOT 1451 3 WAY — **HUM WHEN OPERATED ON AC LINE**

Leads in filter choke short after heating. Remove outer insulation, separate, tape and secure leads and rewrap entire choke.

—— *n r i* ——

RCA VICTOR U-44 — **SET DEAD**

Power line ammeter will indicate 2 amps in place of ¾ amps. Check for short from 6F6 plates to chassis through .005 condensers. Use 600 volt replacements.

—— *n r i* ——

RCA VICTOR U-9 — **HOWLS**

Set howls at high volume levels. Microphonic 12SA7. Distortion; short in 50L6GT output tube.

—— *n r i* ——

RCA VICTOR TT5 — **PICTURE HALF SIZE IN WIDTH**

Replace condensers C81 and C82 which usually open circuit or develop broken leads.

—— *n r i* ——

RCA VICTOR TT5 — **IMPOSSIBLE TO CENTER PICTURE VERTICALLY OR HORIZONTALLY**

Replace resistor R93, breaks at soldered lug. Other troubles may be located by close inspection of resistors and condensers mounted on fibre terminal board. Vibration in shipment may break these off.

—— *n r i* ——

RCA VICTOR TT5 — **BLACK HORIZONTAL STREAKS ON PICTURE**

Audio signal getting into picture channel. Readjust fine tuning control in front center of set.

—— *n r i* ——

RCA VICTOR 97R2 — **CRACKLES REGARDLESS VOLUME CONTROL SETTING**

Noise apparently in 6F5 audio stage but caused by faulty 390 ohm cathode resistor of 6F6 power stage feeding back to 6F5 cathode.

—— *n r i* ——

RCA VICTOR R-10 — **NOISE SIMILAR TO LOOSE TUBE ELEMENTS**

May be caused by loose metal grommet rattling on chassis. The control grid lead of the first detector passes through this opening and picks up the small induced voltage thus generated and amplifies it greatly.

—— *n r i* ——

RCA VICTOR 8M3, 8M4 — **NOISE-FILTER CHANGE**

It is occasionally advantageous on the auto radio models 8M3 and 8M4 to have the 22mmfd antenna shunt capacitor C-1 connected between the output

(Page 26, please)

Police Radio Network Safeguards a Community

THIS story is about Captain Roy E. McConnell of the Evansville, Indiana Police Department who probably has done more than any other individual toward the creation of an ether "net" to foil criminals in the Hoosier and Blue Grass States. We are proud of Captain McConnell, our graduate.

His road was not an easy one. He came up the hard way. But hard or not he kept hustling, always reaching out for bigger things to do, always quick to seize an opportunity to be of service to others.

At the age of thirty-two he was an Accessory Salesman. He was doing very well too but selling was not the kind of work Roy McConnell was cut out for. He had Radio in his blood. He read everything about Radio he could get his hands on. Eventually he enrolled with N. R. I.

Just a few days after completing the N. R. I. Course he took the amateur operators' examination and passed with a grade of 92%. He was assigned the call of W9HBS. Shortly after this he was teaching Radio at the old Louisville Institute of Technology. While a teacher at this Institute he was asked to go to Evansville, Indiana to act as adviser in the installation of a police Radio system. This job was completed in January, 1935.

Captain McConnell with his associates at Police Radio Station WQKB, Evansville, Indiana.

The equipment included a 50-watt main station transmitter operating on a frequency of 30,100 kc. under the experimental call W9XEH, two two-way mobile units and twelve car receivers. Captain McConnell was made Chief Engineer.

There was a rapid extension of the system in 1936. Another two-way unit was installed for the city police, while receivers were placed in three county cars. Then Captain McConnell, with his assistants, designed and built a fire alarm Radio system providing communication between the Headquarters Building and the City's Thirteen Station Houses. A two-way unit was installed in the Fire Chief's car and receivers were installed in the machines of the two Assistant Chiefs.

This system was installed hardly a day too soon because Captain McConnell recalls with rightful pride how the surly Ohio river went on a rampage and the Bell Telephone Company Officials publicly credited the Radio system with saving the flooded city's telephone communication.

Into the police station came an excited telephone call that the muddy water was pouring into the basement of the Telephone Company building. Although the Fire Chief was on the west side of the city, a Radio message immediately apprised him of the situation. He flicked a switch, gave an order, and within minutes city pumpers were on the scene. The threatening waters were quickly stemmed. Officials later stated that $100,000 worth of telephone equipment was saved.

With the flood fresh in their minds, and its prophecy of the necessity for communications with neighboring cities in times of emergency made manifest, the Evansville Police Radio men set about to build a 500 watt transmitter. The equipment was placed in operation in October, 1937 on a frequency of 30,700 kc. and under the permanent call WQKB.

Then Captain McConnell cast his "radio-eye" toward Kentucky. He was especially interested in Henderson Police because of the amount of traffic between Evansville and Henderson. Equipment was installed in Henderson and the results were immediately apparent from both technical and law enforcement points of view.

Because of outstanding results other cities became interested in joining the embryo net. The first city to do so was Hopkinsville, then Bowling Green and then Owensboro, then Madisonville joined the network followed by Paducah.

As time passes the net continues to grow. There are now receivers at Boonville and Princeton, Indiana and Mount Vernon, Indiana is trying to put a 25 watt transmitter and install two-way units in city cars. And Captain McConnell is hoping that Carmi and Mt. Carmel, Illinois will soon join the net, providing direct contact with Illinois.

The stations are joined in an association known as the Southwestern Kentucky-Indiana Police Radio Association. Captain McConnell has been elected a Director of this Association.

Captain McConnell is a modest man who does not like publicity. He prefers to give credit to the "boys" who are working with him. But this story would not be complete without some direct word from Captain McConnell who writes as follows:

"Dear Mr. Smith: The years are passing by and the world of Radio moves rapidly forward opening up new and greater possibilities for the trained Radio man. In looking back over the past years I can credit each month and each year with some personal advancement in the field of Radio but the one day, of all these years, that stands out and becomes more precious to me is the day I enrolled for the N. R. I. Course. On that day I started laying my Radio foundation that has made possible the advancement I have made. I am enclosing a recent photograph taken of the station here. In the center is the original 50 watt W.E. transmitter which we now use as a standby unit. On the left is a 500 watt unit that we built here at the station by myself and associates. On the right is a control cabinet housing receivers and control relays. Standing at the right of the desk is Sgt. N. D. Covert, at the left, Ralph Barnett, operator, and in the center is Sgt. E. L. Harper, who taught Radio with me in Louisville before coming here.

"Within the past several years I have come in contact with many of your students and graduates. You deserve the success you have obtained in the field of Radio education and I shall always be a booster for you and N. R. I."

CAPTAIN ROY E. McCONNELL,
Evansville Police Radio, WQKB,
Evansville, Indiana.

Additions to N.R.I. Ham List

VE3BAV—R. O. Martin, Biscotasing, Ont. Can.
W1NMS—James F. McMahon, Westfield, Mass.
W5JYF—Orvis Beal, Jefferson, Texas.
W4HRM—Edward R. Mashburn, Gneiss, N. C.
W6TXM—C. C. Sabor, Tucson, Ariz.
W9SOV—Harold O. Trammel, Lane, Ill.
W9YFL—Earl Bollinger, Evansville, Ind.
W9NYP—John W. Woestman, Fort Thomas, Ky.

Christmas—in a world as it should be.

end of the antenna filter coil L-1, instead of between the antenna end and chassis as shown in the schematic. Later production sets incorporate this change. It is to be noted also on these same instruments, that secure electrical contact is required between the vibrator transformer and the chassis in order to minimize internal noise.

—n r i—

RCA VICTOR A-20 — EASY REMOVAL OF THE CHASSIS

The chassis is held to the cabinet in the usual manner by chassis bolts, which of course, have to be removed, along with other operations such as removal of knobs, pilot lights on the dial bracket, cord of the dial pointer, etc., when wishing to remove chassis. After these operations while it is possible to remove the chassis from the cabinet by lifting up on the left hand side of the chassis when facing the back, you will find it much simpler if you just loosen the mounting nut of the tone control. It is necessary to use a wrench to fit this or a long nose pair of pliers. It is not necessary to take the nut right off, but just enough so that the tone control can be pushed in far enough so that its shaft clears the hole and the side of the cabinet. This, then, gives plenty of clearance and simplifies the removal of the chassis from the cabinet.

—n r i—

RCA VICTOR, 16K, 16T3, 16T4, 17K, 18T, 19K, 110K, 111K — OSCILLATOR FAILS TO OPERATE

Low line voltage may cause the oscillator to fail to operate on pushbutton ranges. If such trouble occurs, see that the oscillator grid leak is 56,000 ohms and not 33,000 which was used in some sets.

—n r i—

RCA VICTOR TRK 9 — COMPLETE SHADING REVERSAL OF PICTURE REPRODUCTION

Resistor R57, the plate load of the 1852 video amplifier, changes from a normal value of 3300 ohms to 100 ohms. Replace with a two watt 3500 ohm metalized resistor. Do not use an inductive resistor.

—n r i—

RCA VICTOR LITTLE NIPPER — SPEAKER ADJUSTMENT

Certain cases of "off center" cones have been attributed to a binding between the speaker housing and chassis base. This should be checked wherever rattle is experienced, and washers added if required.

—n r i—

RCA VICTOR 16T3, 16T4, 16K — LOW FREQUENCY OSCILLATOR PUSH BUTTON COIL

To ensure low frequency coverage on the push button oscillator coils in these models, a high inductance coil, Stock No. 37133, is used for the 540-1030 kc push button oscillator ranges.

—n r i—

RCA VICTOR 5BT — CUTTING OFF

Some of these sets have a habit of cutting off, leaving the signal very faint and very distorted. Upon checking the 30 type tube (driver), the grid was found to have a high, positive voltage when set would "cut off". Replacing the coupling condenser had no effect. It was finally decided that this audio stage was breaking into oscillation. The condition was cured by placing a 5,000 ohm resistor in series with the "B+" side of the primary of the input audio transformer.

—n r i—

RCA VICTOR BT-42 — DISTORTS

If this set distorts badly at maximum volume, with volume control scratchy and erratic, try a new 1H5G tube even though the original may test good.

—n r i—

RCA VICTOR RAE-59 — FOR INTERMITTENT RECEPTION

Try a new 0.01 mfd. 600 volt condenser in the a-v-c tube control grid return circuit. The original condenser which is usually in a leaky condition is in the condenser block located in the power amplifier and is identified by its blue and black leads. When replacing, remove only the blue lead as the black is common to several other condensers.

—n r i—

RCA VICTOR 46 XI — NOISY

This is a 1941 model in a plastic cabinet, the tubes used are one 12SA7, one 35Z5, one 12SK7, one 50L6 and one ballast tube MS6892-9. When this set is very noisy, there will likely be found an intermittent open condenser in the loop aerial circuit. This is an 0.01 mfd. condenser found on the back rear panel. It is located close to the 50L6GT and the heat from this tube is the cause of the trouble. When replacing the condenser move it over to a cooler location. This corrects the trouble.

—n r i—

RCA VICTOR R-32 — REPLACEMENT

Duplicate replacements of the original volume controls in these sets often become noisy. An effective method of eliminating this trouble may be employed by using one 100,000 ohm volume control with a few circuit changes as follows: 1. Tie together two black wires on back of original volume control. Cut off yellow wire. 2. Cut off both yellow wires on front of control (next to end of shaft). 3. Disconnect two white wires from phono switch. 4. Disconnect white wire from first audio transformer and connect to grid of first audio 26 tube. Connect other end of same wire to center tap of 100,000 ohm volume control. 5. Ground right hand side of control, looking from front of control. 6. Cut off other white wire which was disconnected from phono switch.

N.R.I. ALUMNI NEWS

Dr. Geo. B. Thompson .... President
Edward Sorg, F. E. Oliver .... Vice-Pres.
Alfred E. Stock, Peter J. Dunn .... Vice-Pres.
Earl Merryman .... Secretary
Louis L. Menne .... Executive-Secretary

NOMINEES FOR OFFICE DURING 1942

THE primary election is over. Our candidates have been nominated. Now for the election to choose our officers for 1942.

For President of the N. R. I. Alumni Association we have two fine candidates from which to choose. The nominees for president are Edward B. Sorg of Chicago and F. Earl Oliver of Detroit. Sorg is a Past Chairman of Chicago Chapter and Oliver is a Past Chairman of Detroit Chapter. Both are very active in the affairs of their local chapters and both are at present serving as Vice-Presidents of our National Organization. Vote for one or the other for President of the N. R. I. Alumni Association for the year 1942.

In the field for Vice-Presidents we have eight candidates, four to be elected. Pete Dunn and Al Stock were renominated. They are two of the strongest boosters for our Alumni Association. Lou Kunert, Secretary of New York Chapter is a nominee for Vice-President of our National Organization. Kunert is one of those dependable fellows who take pride in giving their very best to any job entrusted to them. He is a mighty good man.

Charles J. Fehn, a hard worker in Philadelphia, is another man who gives a business-like administration to any office he holds. Fehn is at present Treasurer of Philadelphia-Camden Chapter. He also served several terms as Chairman of his Chapter.

John Stanish, Chairman of Detroit Chapter and a former Vice-President, is also placed in nomination. Stanish was a candidate for President last year. Gifted with an abundance of energy, Stanish knows how to get results. He is a real go-getter.

R. H. Rood of Los Angeles is again nominated for Vice-President. Mr. Rood served several terms as Vice-President. He has a strong following on the west coast.

E. W. Gosnell of Baltimore, who has been doing such a good job as Chairman of that Chapter, is also a candidate for the office of Vice-President. Gosnell has been coming along fast and you will hear a lot about him in future years.

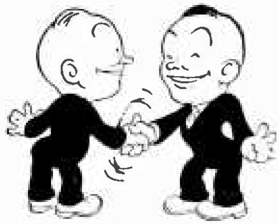
Harold Bailey of Peoria, Illinois completes the ticket for Vice-Presidents. It is particularly gratifying to announce the nomination of Mr. Bailey. He is a man who has no connection with a local chapter and, for that reason, has had no publicity of any kind. However, Mr. Bailey evidently has a lot of friends in the middle west. He is strictly the candidate of the great majority of our members who are not connected with local chapters.

For Secretary, Earl Merryman is renominated. He will be opposed by D. L. Hash of Washington, D. C. L. L. Menne is renominated for Executive Secretary and he will be opposed by John Grasser, now serving as Secretary of Baltimore Chapter.

It is urgently requested that every member of the N. R. I. Alumni Association cast a ballot this year. Turn to page 30 and mark your ballot now. Then cut or tear it along the dotted line and mail it to headquarters.

All elected officers will serve for a term of one year. The polls close December 30, 1941.

The results of this election will be announced in the next issue of the NEWS. Mr. C. Alexander, Bookkeeper at N. R. I. has been appointed teller to count the votes. Mail your ballot to him. See the election ballot on page 30 for simple instructions.



Here and There Among Alumni Members

Graduate Wallace G. Baptist has a mighty fine Radio Servicing business in Jacksonville, Ill. His radio lab is a beaut. All his employees are either N. R. I. graduates or are enrolled for the course. That's real N. R. I. spirit.

———n r i———

Chas. W. Garrin of Roswell, N. Mexico, was eighteen when he graduated in April, 1941. Then he had to take a rest while he was recovering from an operation. He writes that he is now a Radio operator, American Airlines, Municipal Airport, Cleveland, Ohio. A young man we are very proud of.

———n r i———

Fred Tudor secured a position as operator at CJIC, Toronto, was promoted to Chief Engineer and more recently has stepped up again, this time with the Canadian Broadcasting Corporation as broadcast operator covering Master Control operations. Quite an advancement both in position and salary. Since starting in Radio his earnings have increased four times.

———n r i———

Mr. and Mrs. A. Albert Herr of Harrisburg, Pa. visited N. R. I. recently. Mr. Herr is transmitter operator at station WKBD, a member of the Mason and Dixon network and an affiliate of both NBC and Mutual.

———n r i———

Our fellow member Clive D. Cook, of New Zealand, after volunteering and being rejected no less than six times, because of some physical condition, finally was accepted for service in the Air Force of Great Britain. He is now receiving training after which he will proceed to England.

———n r i———

David L. Scott of Covington, Va. lost all of his possessions in a fire which destroyed his home. But he bounced right back and is starting anew.

———n r i———

Mr. R. O. Martin of Biscotasing, Ont. has volunteered for service in the Canadian Army as a Radio Technician. He also has an amateur license with call letters VE3BAU.

———n r i———

We are very sorry to learn that Mr. and Mrs. Lewis Bishop of Columbus, Ind., lost their baby a few weeks ago. Our sympathies to you folks.

———n r i———

M. C. Ashbaugh is on duty with the Naval Reserves, stationed at the Air Station, Corpus Christi, Texas.

———n r i———

D. G. Behm is employed as Deputy Sheriff of Lake County, Ohio. They have a two-way radio system. Behm now has his operator's license and is reaping the rewards of a trained Radio man.

E. L. Menees of Anderson, S. Carolina, has a splendid radio servicing business with more than 150 radio accounts. His radio servicing alone nets him an average of $40.00 a week; $75.00 to $100.00 weeks are not unusual. He has a nice delivery truck, and a good supply of radios and parts. He owns his home and business is on the up-grade.

———n r i———

Chas. G. Reynolds is doing final inspection work and test on 16 millimeter sound projectors at RCA, Indianapolis, Ind. He earned $15.00 a week when he enrolled. He now averages $45.00 a week.

———n r i———

Marcel Belanger is working in the transmitter room for Station CKNB, Campbellton, N. B., Canada. They will soon increase their power to 1,000 watts with directional antenna.

———n r i———

Alvin E. Brough, who started Radio servicing on a spare time basis, then was made Service Manager for a concern four months after graduating, informs us that he is now earning $50.00 a week. He is located in Leicester, N. Y.

———n r i———

Harold A. Jenkins passed the exam for a Radio Telephone License, First Class. He expects to go to work for the Orlando, Fla. Police Dept.

———n r i———

Some ten years ago Claude L. Allday of Texas graduated. He advanced to Chief Radio Technician in the U. S. Air Corps. He secured one promotion after another—Civil Service rating, Assistant Radio Inspector, Radio Inspector—$2600 a year to $3600 in one jump. Then Chief Radio Instructor, National Defense, Whitehaven, Tenn., at $325.00 a month. At the height of his success Mr. Allday took sick; then followed an operation from which he failed to recover. Mrs. Allday sends the sad news that her husband passed away. What a pity that this brilliant Radio mind could not have been spared to carry on the great job he was doing in connection with National Defense. The Alumni Association has lost a great friend—America one of her most loyal sons.

———n r i———

Our C. E. Davidson, Jr., Radio Engineer of WNOE, New Orleans, La. covered the army maneuvers between the Second and Third Armies, in Louisiana.

———n r i———

A. Mello who operates Mello Radio, Elizabeth, N. J. is knocking out big dough right now. His gross volume of business is steadily increasing from month to month.

———n r i———

J. Ls Huard of Drummondville, Que., has taken a position with the Canadian Broadcasting Corp. He was good enough to tip us off that the job he was leaving was open and we immediately got busy to line up an N. R. I. man for it.

Baltimore Chapter

The Baltimore Chapter is in there pitching and getting results. Continued use of the experimental-lecture set-up has formed an interesting base for our meetings. The lecture program is very flexible so that it may be used to the best advantage from the member's viewpoint. The theoretical groundwork is laid by a short description of the material to be covered during the evening's experiments, the experiments performed, results tabulated, followed by an analysis of the basic laws covered. Then the assembly is thrown open for questions and if any of the questions require additional proofs further experiments are conducted along the same general lines until sufficient data is on hand to completely satisfy the requirements of the question. Conclusions are then drawn and compared with the theory involved.

In this way many points are covered that would otherwise be impossible to make in the time available. Mr. Harold Z. Snyder and Mr. H. J. Rathbun are the boys who deserve a lot of credit for these interesting meetings. They do the work. Snyder dashes all over the black board to clarify all theoretical points and Rathbun, soldering iron close at hand, carries out the experiment in a practical way. They are a real team which has greatly stimulated interest in our meetings.

Mr. J. B. Straughn, N. R. I. Service Consultant, conducted our lecture period at our last meeting, covering many interesting points and new wrinkles in rapid analysis and repair of defective receivers. He also covered FM-AM receiver construction and pointed out various pitfalls that may be avoided when trouble shooting sets of this type.

Mr. L. J. Arthur, our Publicity Editor, deserves an orchid for the splendid handling of our meeting notices. Mr. E. W. Gosnell, our Chairman, certainly picked the right man for the job when he appointed Mr. Arthur. Incidentally, Mr. Gosnell is doing a mighty fine job of his own in the type of programs he is giving us, the dispatch with which he handles details and the business-like manner in which he directs the activities of our chapter.

There's a big affair of some sort or another cooking. It may be a dance, may be a raffle, may be a bingo, may be . . . Well, suppose all you fellows who haven't been hitting the deck come around and help us decide. The same meeting place—the same time, Redmen's Hall, 745 W. Baltimore St., every second and fourth Tuesday. These meetings aren't for graduates only. All you students are cordially invited to sample our meetings—you'll certainly come back for more.

JOHN W. GRASSER, Secretary.

New York Chapter

Our attendance has been averaging about 40 but we are doing much better now. Last meeting we had a number of visitors. Three of these joined the chapter.

Chairman Gordy conducted a short service forum which is always very interesting. After a short intermission Gordy gave us a talk on "Phase inverters," which was very instructive. We are well on our way toward a highly successful winter season.

On December 4th we are to have Mr. J. E. Smith, President of N. R. I. as our honor guest and speaker. Mr. J. B. Straughn, N. R. I. Service Consultant, is to give us a technical talk and Mr. L. L. Menne, Executive Secretary, will complete the delegation from Washington, for that particular meeting. This issue of the NEWS will go to press before we will be able to report on that meeting but a report will be made in the following issue.

Last spring Ralph Baer joined our chapter. He has been attending meetings regularly. It is a pleasure to announce that he was recently made manager of the Parkway Radio Shop of New York City. This young fellow is going places in the radio world. He sure knows Radio and is a great help to Chairman Gordy.

Again we extend an invitation to all students and graduates in the New York area to meet with us on the first and third Thursday of the month at Damanzeks Manor, 12 St. Marks Place, New York City.

LOUIS J. KUNERT, Secretary.

Detroit Chapter

Meeting regularly on the second and fourth Friday of each month at John Stanish's place of business, 2500 Jos. Campau.

Chairman Stanish has been putting forth a great deal of energy to give us good programs. We are glad to report that the boom in Radio servicing has brought some of our old-time members back with us. It would be great to have all of our members, new and old, turn out for one of our meetings.

A special meeting is being arranged to accommodate L. L. Menne, who will visit us soon. Chairman Stanish is arranging the program. It will be a dandy. In fact, if you live in this area you should attend all of our meetings. You are missing a great deal if you fail to do so. You will meet a swell bunch of fellows. Drop in on us.

F. EARL OLIVER, Secretary.

Election Ballot

Fill in this ballot carefully, following instructions given on page 27. Mail your ballot to National Headquarters immediately.

FOR PRESIDENT (Vote for one man)

☐ Edward B. Sorg, Chicago, Ill.

☐ F. Earl Oliver, Detroit, Mich.

FOR VICE PRESIDENT
(Vote for four men)

☐ Louis J. Kunert, Middle Village, N. Y.

☐ Peter J. Dunn, Baltimore, Md.

☐ Chas. J. Fehn, Philadelphia, Pa.

☐ John Stanish, Detroit, Mich.

☐ Harold Bailey, Peoria, Ill.

☐ R. H. Rood, Los Angeles, Calif.

☐ E. W. Gosnell, Baltimore, Md.

☐ Alfred E. Stock, New York, N. Y.

FOR SECRETARY (Vote for one man)

☐ Earl Merryman, Washington, D. C.

☐ D. L. Hash, Washington, D. C.

FOR EXECUTIVE SECRETARY
(Vote for one man)

☐ L. L. Menne, Washington, D. C.

☐ John W. Grasser, Baltimore, Md.

SIGN HERE:

Your Name ....

Your Address ....

City .... State ....

Polls close December 30, 1941

Mail Your Completed Ballot to:

C. ALEXANDER, BOOKKEEPER

NATIONAL RADIO INSTITUTE
16th and U STREETS, N. W.
WASHINGTON, D. C.

Tear carefully along this line

Chicago Chapter

Our last meeting was a humdinger. It was a grand rally to get the fellows back with us for a busy winter season. About 65 attended.

Chairman Lukes outlined our objectives for the season. He pointed out the many advantages of regular attendance and gave us a pre-view of the good things on our schedule.

Following this our Chairman introduced Mr. Milt Colman of Radiolek, who gave us a short talk on priorities and their meaning to Radio servicemen.

Mr. Earl Bennett, our old stand-by then was called upon for the principal talk of the evening. He began at the power pack of a set, drawing in each part as he went along, explaining it's purpose and the effect on the set in case of a breakdown of that particular part. He proceeded as far as the input to the detector and an explanation of AVC, when it was time to adjourn for refreshments.

At our next meeting Mr. L. L. Menne, from headquarters, will visit us. There is plenty on the program for that night.

It was voted to hold our meetings on Wednesday. We are negotiating for a new meeting place and we expect to have all arrangements completed for announcement in our next report.

JAMES CADA, Secretary.

——— *n r i* ———

Phila.-Camden Chapter

Meeting regularly and doing things. Always a good program for the benefit of our members.

Our Executive Secretary L. L. Menne visited us recently. Mr. J. B. Straughn N. R. I. Service Consultant, was our speaker on that occasion. He gave us an interesting discussion of an all-wave combination F. M.-A. M. phono receiver. He analyzed the circuits and covered servicing problems. Diagrams were furnished to all present which made it easy to follow the talk. Other questions on servicing problems were asked for and Mr. Straughn clearly explained the method of approach to get the desired result.

We meet on the first and third Thursday of the month at 3622 Frankford Ave., Philadelphia. If any of you students or graduates in this area want to meet a bunch of fine fellows who come here to discuss the same problems you undoubtedly encounter from time to time, please remember, you are most welcome here. Just drop in on us any meeting night. You will want to come regularly once you start.

HAROLD STRAWN, Secretary.

THE MAILBAG

Likes Our Work

I am proud to be a member of the N. R. I. A. A. and consider it a great privilege to be able to vote in it. I have been a member for several years now, and I have seen it grow larger and better. I believe any radio man who has graduated from N. R. I. and reads all the splendid articles in the N. R. NEWS can and will be a better informed and up-to-date radio man. The articles about Servicing, Selling, Going into Business, were splendid. I thank you for all the help I have received from those articles and I await the many more benefits your splendid articles will bring in the future.

ALFRED GIRARD
Worcester, Mass.

———— n r i ————

Good All The Way

From the first to the last page of the Oct.-Nov. issue I was grossly interested. The Editorial written by Mr. E. R. Haas, was a fine start. "Circuit Analysis of a Universal Receiver," by J. B. Straughn, was good. "An Adventure with Electrons," was outstanding. It also pleased me to see the picture of Dr. George B. Thompson, our Alumni President, and his timely message was very inspiring.

R. A. HERDER
Irma, Alta, Canada

———— n r i ————

Pleasure And Profit

I would like to extend my appreciation for all the interest you and your staff have taken in helping me over the rough spots in my course. I've really enjoyed taking this course very much and it has been very profitable to me.

BARNEY R. LYNCH
Osceola, Indiana

———— n r i ————

A Real Booster

I never want to be without NATIONAL RADIO NEWS and you can always count me a member in good standing. I always have been and always will be a booster for our good old School and Alma Mater, and hope all other graduates feel the same as I.

FREDERICK A. LUNING
Willoughby, Ohio

Non-Partisan Views

It is no exaggeration to say that, for us, NATIONAL RADIO NEWS is one of the best Magazines of its kind on the market. Maybe you think I'm prejudiced because I'm a part of it—but I'm not. NATIONAL RADIO NEWS obviously presents non-partisan views. And I like the way the articles are written. It is clear that you are more interested in getting the sense of it across than you are in showing your book learning. The amazing thing to me is how you can put out a magazine like this for the amount of money you receive. Whatever your system is you've certainly got a good one.

ALLEN McCLUSKEY
Birmingham, Ala.

———— n r i ————

Clear And To The Point

May I say that in taking your course I certainly invested my money very wisely. I got more than my money's worth. Your lessons are clear and to the point. They do not go into a lot of useless elaboration over unimportant points but give a clear and direct insight into the subject under consideration. I wish to thank the entire staff of the National Radio Institute for the splendid training I received. I can gladly recommend your course to any one.

CLARENCE MAYO
Charlotte, No. Carolina

———— n r i ————

N. R. News Is Swell

N. R. NEWS is, to say the least, swell. As I progress with my regular lesson texts, I begin to realize how valuable and how vital these magazine articles are for the N. R. I. student. Now that I have finished my twentieth lesson, I am beginning to understand the various technical articles, and I am now reading these with very much interest and pleasure.

HAN BOEN KIAN
Batavia, Java, N. E. I.

———— n r i ————

More In This Issue

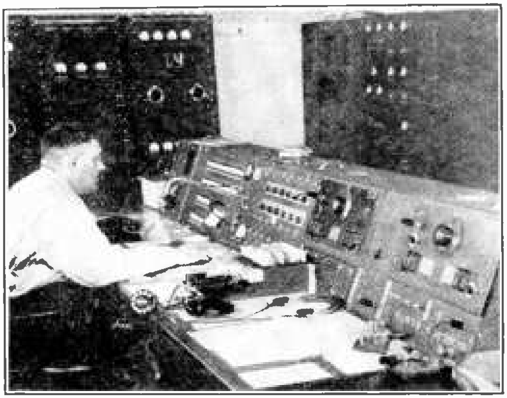
Receiver circuit analysis in N. R. NEWS, Oct.-Nov. 1941 is swell. I need some more of it.

CHAS. E. STIVERS
Houston, Texas

From An Enthusiastic Alumnus

Dear Friend Menne:

"I am forwarding to you my ballot for Nominations of Officers for the year 1942. I think the Officers should be commended for the work they have done this year for their Alumni. The NATIONAL RADIO NEWS is better than ever and the assistance given to all members of the Alumni Association should be appreciated. We have reasons for being proud of our profession and our school and the work of our Alumni should instill in the minds of the public the fact that there are skilled men in the Radio industry and Profession who will give them a square deal.



"I am forwarding a picture of myself at the Radio Console at Station WPEB, the Grand Rapids Police Radio Department, which was constructed under my direction and plans. Some one suggested more pictures for the NEWS! Perhaps you can use this one."

Fraternally Yours,
PETER VAN BENDEGOM,
809 Van Buren Ave. N. W.
Grand Rapids, Michigan.

NATIONAL RADIO NEWS

FROM N.R.I. TRAINING HEADQUARTERS

Vol. 9 No. 12

Dec., 1941-Jan., 1942

Published every other month in the interest of the students and Alumni Association of the

NATIONAL RADIO INSTITUTE
Washington, D. C.

The Official Organ of the N. R. I. Alumni Association
Editorial and Business Office, 16th & You Sts., N. W.,
Washington, D. C.

L. L. MENNE, EDITOR
L. J. MARKUS, TECHNICAL EDITOR

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