NATIONAL RADIO NEWS

IN THIS ISSUE

They Are More Than Radio Parts

Circuit Analysis of a Modern Auto Receiver

Alumni Association News

APR.-MAY
1942

VOL. 10
No. 2

The War is Creating New and Greater Opportunities for Radio Men

The war is making it necessary for all of us to adjust ourselves to new conditions. For the most part these are simple sacrifices every citizen is more than willing to make because they all have their part in WINNING THE WAR.

These changing conditions also are presenting splendid opportunities for service and reward. For example, in our own field of Radio, men with training and experience are doing a fine job in the Military Service, in Defense Industries and as Radio Servicemen to their communities.

N.R.I. is proud of the many students and graduates who have, by reason of their Radio training and experience, been able to step into important assignments in the Military Service. Every day we receive letters telling us of promotions earned because of recognition of outstanding ability. The Radio-trained Soldier or Sailor is a vitally important man in the Military Service.

In Defense Industries, too, Radio-trained men are playing a prominent role. Above average in ability, with specialized training, these men are required to do work of a highly technical nature in the Government's program of *quickly* producing TWO BILLION dollars worth of military Radio equipment. Many N.R.I. men have been able to step into these essential jobs.

Within a very short time Radio set manufacturing plants will be converted to Defense production. Soon it will be impossible to buy a new Radio. This means a greater demand for services of Radio Technicians, to keep the fifty-seven million Radios now in use by the American public, in serviceable condition. It means a golden era for Radio Servicemen, because makers of replacement parts and tubes will continue producing equipment needed for Radio service and repair.

Whether in the Army, Navy, Defense Industries or servicing in his home community, the Radio man has a big job to do.

The Radio Technician is the man of the hour! By doing his duty—he will *also* cash in on this epochal situation. But halfway methods won't do. So, good friend, study—STUDY—get ready—NOW. Make every day, yes, every hour count. I cannot emphasize this too strongly.

E. R. HAAS, *Executive Vice President*

They Are More Than Radio Parts

BY JOSEPH KAUFMAN,

N. R. I. Director of Education

DO you visualize a resistor, a coil or a condenser as a part in radio equipment, something that you recognize by its construction and appearance, something that may become defective and require replacement? I am sure you do.

Do you know what these radio parts do in the circuit? In most cases you do if you have studied sufficient radio, for you probably identify parts as the cathode resistor, plate supply resistor, screen grid by pass condenser, power pack filter choke, tuning coil, etc. I would like to feel that when you call a part by its full name, which includes its purpose, that you visualize the circuit action and know how the part in question does its job. It helps considerably in service and maintenance work.

Let's imagine a few basic circuits and see how resistors, coils and condensors are put to use—see how they are more than radio parts.

Properly Feeding the Load. You may not think of a tube filament as a resistor—as a radio part, but you have every right to consider it as a resistance. Tube filaments require a definite voltage in order to develop the correct amount of heat. Some require 1.5 volts others 2, 2.5, 6, 12, etc. When the source supplies the voltage the filament needs, you can make a direct connection. For example, as shown in Fig. 1, the filament of, let us say, a type 1C5GT tube requires 1.5 volts for proper operation. A single dry cell provides 1.5 volts, so we connect them together, as shown.

We have other examples. A 110-volt a.c.-operated receiver may be connected directly to a 110-volt a.c. outlet. A 6-volt pilot lamp is being installed in a radio device; there is a secondary winding in the device that furnishes 6 volts, so you connect the lamp to this secondary winding. You can do this as long as you are sure that the source can supply the power.

But we may have several tubes which require the same filament voltage. Connect each filament to the source, if it furnishes the correct voltage, as shown in Fig. 2A. You would probably find the connections shown as in Fig. 2B. From this, one gets the idea that loads can be connected

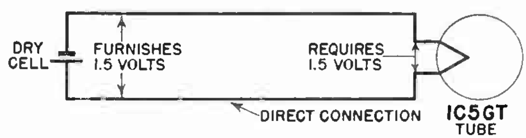


Fig. 1. A direct connection.

in parallel, but not all loads—only loads that require the same voltage. If you think of tube filaments as resistors, and reason that resistors of any value can be connected in parallel to a source, you fall into the "trap" of connecting any two devices in parallel to a source. Remember to ask yourself: Is it safe, is it proper to connect a part to the source you have?

Now suppose you have a load, part or device that you wish furnished with power, and this load requires a voltage which is lower than the source voltage. For example, you have a type 30 triode tube which requires 2 volts at its filament. One dry cell furnishes 1.5 volts, and two in series will supply 3 volts; the latter is 1 volt too much. We can use the 3 volt source if we can get rid of (or drop) 1 volt before it gets to the tube. You probably know the answer; put a resistor in series between the source and the tube filament so this resistor will drop one volt, as shown in Fig. 3.

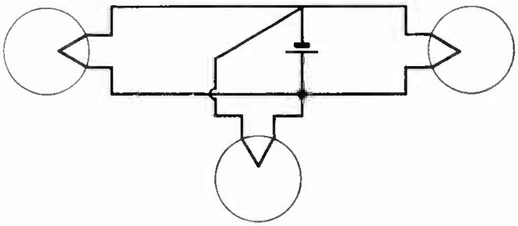


Fig. 2A. All filaments require 1.5 volts which the cell can supply.

What value should you choose for *R* in Fig. 3? We must turn to Ohm's law. Tube tables tell us that when a type 30 tube is supplied with 2 volts, it will pass 60 milliamperes, or .06 ampere. This current must also flow through resistor R, as we have a series circuit. To give a one-volt drop in *R*, its ohmic value must be 1 divided by .06, which equals 16.7 ohms.

Instead of looking at *R* in Fig. 3 as a voltage-dropping resistor, you may prefer to look at it as a current-limiting resistor. You would then say that the resistance of the tube and the resistor together must be of such a value that the circuit current will be .06 amperes. Ohm's law tells us what this circuit resistance should be: 3 divided by .06, which equals 50 ohms. When hot, the filament has a resistance of 2 divided by .06, which equals 33.3 ohms. Therefore, to make the circuit resistance 50 ohms, *R* must have the difference or 16.7 ohms.

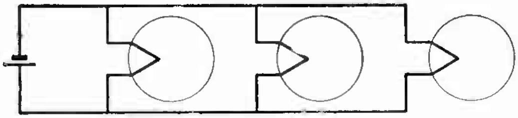


Fig. 2B. Three filaments requiring the same voltage are here connected in parallel to a source which supplies the required voltage.

There are other practical examples of a voltage-dropping resistor. In some places, the power supplied in homes is 220 volts; if you want to use a 110-volt receiver, you must drop 110 volts from the supply. You could use a voltage-dropping resistor, but if you were dealing with a.c., you probably would use a step-down transformer since it wastes less power.

A universal receiver offers another good example. All filaments require the same current but different voltages, as shown in Fig. 4A. All together, the filaments require 86 volts, but the line furnishes 115 volts. If you connected these filaments to this source, they would burn out. So we insert voltage-dropping resistor *R*, which must get rid of 29 volts. This resistor can be in a ballast tube or in the line cord.

The plate circuit of a vacuum tube is another example (See Fig. 4B). The plate-cathode voltage should be 180 volts, but the source supplies 250 volts, hence *R* must drop 70 volts.

In a series circuit where a resistor is inserted in the circuit to prevent the load from getting too much voltage, we may want to alter the load. In Fig. 3, the filament is the load; in Fig. 4A, the four series-connected filaments are the load; in Fig. 4B, the plate cathode path is the load.

Suppose we change the load—how can it still receive the proper voltage? Here is the answer.

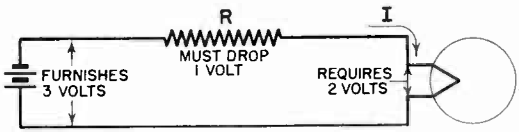


Fig. 3. Dropping the voltage not needed.

Suppose that in the circuit of Fig. 3, another 2-volt filament is connected to the existing filament terminals. We may reason: here are 2 volts; the extra tube needs 2 volts; therefore, we should be able to make a shunt connection. We connect the filament as an additional shunt load, and check the voltage—the load is now getting less than 2 volts. Our reasoning must be in error; the truth is, we limited our analysis to only a part of the circuit, when the whole circuit should be considered.

Let us see where we made our mistake. When the second tube filament shunts the original, we have decreased the resistance of the load. As a result, the circuit resistance is lowered and more current will flow through the series resistor *R*. If the source voltage and resistance of *R* remain unchanged, more than 1 volt will now be dropped in *R*, leaving less than 2 volts for the filaments.

We can either increase the voltage of the source or reduce the resistance of the series-dropping resistor. Since the source can only be changed in definite amounts, let us change *R* so under the new conditions it will still drop 1 volt. This is easily done; if we cut the resistance value of *R* in half, the voltage drop will remain the same even though the current through *R* is doubled. When this is done, the addition of the extra load will not alter the filament voltage.

When we talk about changing the load, we mean changing the power required. Power in watts is volts times amperes. If the voltage remains unchanged, then the current must change; increased load means more current, and decreased load means less load current. If the load voltage is to remain unchanged decreasing the load resistance means more load, and increasing the load resistance means less load.

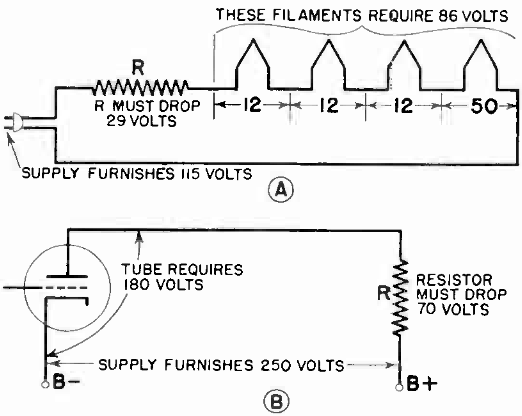


Fig. 4. Examples of load voltage reduction.

Remember, then, when the load is altered in a circuit using a series current-limiting or voltage dropping resistor, it is necessary to change the source voltage or, when this is not possible, to change the series resistor value.

Bleeding the Source for Better Regulation. Under normal conditions it is not important that the load receive exactly the rated voltage; some variation can be tolerated. For example, a 1.5-volt filament may operate satisfactorily from 1.2 to 1.6 volts; the plate voltage of a vacuum tube may operate successfully from 160 to 200 volts. However, once the voltage has been applied to the load, it is often important to see that it remains as near constant as possible from instant to instant. For example, in an audio amplifier of good fidelity, the output stage is constantly feeding the loudspeaker (its load) varying amounts of power. This power must come from the power pack. If the power pack voltage varies, so will the amplification ability of the power tube and other tubes connected to this common supply. A solution to this problem is to load the power pack, so that any change produced by the tubes will have negligible effect on the supply voltage. Let us see what the general procedure is in such a case.

Figure 5 shows a circuit in which a source E of constant voltage supplies current through a series resistor R_S to the *load*. The load, however, is shunted by a bleeder resistance R_B. For the moment, let us assume that R_B is out of the circuit. In this case, the source current I_S and the load current will be identical and controlled by R_S and R_L. When the load resistance varies, the circuit current will vary; as a result, the drop in R_S will vary too. Consequently the load voltage V_L will change, a condition we want to minimize.

Now let us introduce the bleeder resistor R_B, its resistance being several times lower than R_L. Realizing that the voltage V_L, which must be kept nearly constant, is also applied to R_B, and the latter has a lower resistance, current I_B must be much larger than I_L. The line current I_S will now be greater than when R_B was omitted, so we should reduce R_S to feed the load with the proper voltage. However, the supply voltage E is sufficiently high so that a reasonable drop exists in R_S.

The proper way of analyzing this circuit is to imagine R_B and R_L as parallel resistances, the bleeder resistance being low with respect to the load. In this case, the shunt resistance is more of a factor in the total resistance than the load resistance. Changes in R_L have negligible effect on the net resistance, hence have little effect on the source current and the drop in the series resistor.

Study the circuit shown in Fig. 5. You would say that R_S is the great offender. Get rid of it and you don't need the bleeder resistance. Unfortunately this is not always practical. All sources of supply have internal resistance that cannot be eliminated: You may have the condition where the source voltage is too high for the load, and a series voltage dropping resistor must be used. You must use the bleeder resistance if you want to minimize the voltage changes at the load.

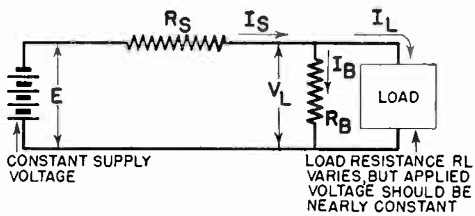


Fig. 5. Using a bleeder resistance to help maintain constant load voltage.

Although we have presented the circuit in Fig. 5 as one best suited for constant load voltage, this circuit is also used to produce a desired load voltage, especially when the ohmic resistance of the series resistor is too high for practical purposes. Practical radio men feel that resistors with high ohmic value, running above 1 megohm should not be used in power circuits when reasonably accurate output voltages are desired. Such resistors are not reliable under constant loading. The use of a shunting resistance (bleeder resistance) introduces a lower resistance in the supply circuit.

An example of the bleeder circuit, which we may call the shunt method, is shown in Fig. 6. For the moment, imagine R_2 and R_3 out of the circuit. The plate is supplied with voltage through resistor R_L. The screen grid is supplied with voltage through R_1. In both cases, the series resistors act as series voltage-dropping elements, so the electrode voltages will be less than the supply voltage.

In most circuits the screen grid voltage must remain constant, otherwise distortion will take place. As the grid-cathode is excited, the plate-cathode voltage will rise and fall, the screen grid voltage will be affected in a like manner, and as a result the screen grid current will vary. Consequently, the screen grid electrode voltage and the drop in R_1 will vary. This alters the operating characteristics of the stage. By shunting the cathode-screen grid with shunt resistor R_2 (resistance of R_C is negligible with respect to effective resistance of the cathode-screen grid), this electrode voltage becomes essentially independent of variations in screen grid current. Another way of visualizing the circuit is to consider the screen grid-cathode as a resistor; if resistor R_2 is low with respect to it, any normal variation within the tube becomes negligible in altering the drop in the series supply resistor R_1.

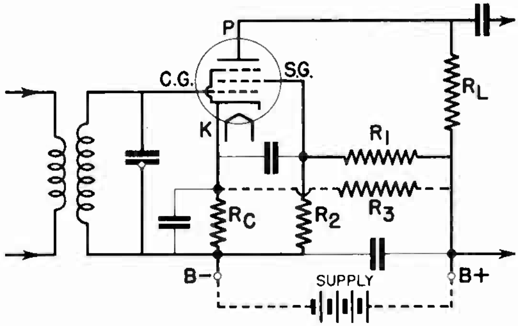


Fig. 6. A vacuum tube circuit having two bleeder systems.

Figure 6 shows another bleeding circuit which is occasionally used in radio circuits. In a detector circuit the space current in the tube is quite low with no grid excitation. To obtain sufficient self bias for the grid, R_C must be of high ohmic value. With excitation, the space current will vary and so will the grid bias. Introducing resistor R_3 makes the supply send current through R_C independently of the tube circuit. If sufficient current is bled through R_C, the ohmic value of R_C may be reduced so that any variation in current due to tube action becomes negligible.

Variable Control of Output Load. No matter what the nature of a device may be, if it receives the rated voltage it will pass the rated current. Similarly, if a load passes its rated current, its terminal voltage will be correct. Both current and voltage may be measured with meters, as is often done in practical work. Circuit adjustments can be made, by varying the supply circuit so the device receives the rated current or voltage.

In the circuits shown in Figs. 2B and 3, we can use a variable resistor for R and connect a voltmeter to the load, then adjust R so the correct load voltage is obtained. In this way variations due to differences in supply voltage or load characteristics are simultaneously included. This procedure is widely used by practical radio men. A test rheostat may be used for R; after the correct position is obtained, its resistance may be measured with an ohmmeter and a fixed resistor used in the circuit. Quite often a variable resistor is used in the circuit so an adjustment may be made at any time.

In the circuit shown in Fig. 5, either R_S or R_B may be varied, but in a practical circuit both are varied at the same time by a device we call a potentiometer. This circuit is shown in Fig. 7. For the moment, imagine P at point 1. In this setting, both the load and the potentiometer get the full supply voltage E, independently of each other. Now, as P is moved away from point 1 towards point 2, we have the circuit shown in Fig. 5, in which R_S acts as the series voltage-limiting element and R_B as the bleeder.

Without R_B in the circuit, only the load will determine the drop in R_S. Resistor R_B acts to increase the supply current and hence increases the drop in R_S. Both R_S and R_B permit wider control of V_L, in fact, is possible to make voltage V_L approach zero with reasonable potentiometer resistance values.

For a definite supply voltage E, voltage V_L depends on R_S, R_B and the load resistance. If R_B or the load is removed for a setting of P, the voltage across the load will be higher. In radio, we meet a situation where the voltage V_L is essentially independent of the load. This will be true when the load resistor is many times higher in ohmic value than either R_B, R_S or both. Thus, for any position of P, the shunt effect of the load on R_B is negligible. Voltage V_L is then determined by the ratio of R_B to the total potentiometer resistance. Here is a case where the potentiometer is the only factor controlling the load voltage, and we have a straightforward voltage-controlling device or potentiometer.

Examples of this last case are found in volume controls where the potentiometer is used as a diode load or as the grid return resistor in the grid-cathode circuit of a vacuum tube circuit. In these circuits the grid-cathode resistance of the tube runs into many megohms. This is many times greater than the ohmic resistance of the entire potentiometer, which rarely exceeds one megohm.

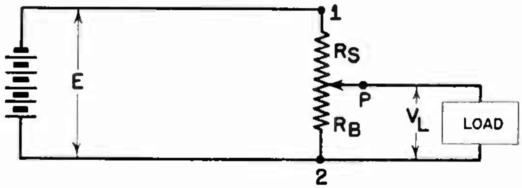


Fig. 7. Potentiometer used to control the voltage applied to the load.

Coils and Condensers as Control Elements in A.C. circuits only. In the circuits considered so far we have limited ourselves to resistors as load controls. Although we have limited our discussion to d..c. circuits, as long as we confine ourselves to resistors, the same analysis will apply to a.c. circuits.

When dealing with A.C. circuits (that is, the source produces an a.c. voltage, the load is to be supplied with an a.c. voltage and the current is a.c. too), we may use coils or condensers, or both, to limit the voltage at the load. This is not unreasonable, as we know that both have reactance. For the present, let us consider the case where the generator (or source) supplies a single-frequency voltage, too high for the load. In this case, we will consider the load as a resistor, R_L.

We could limit the load voltage V_L by inserting a coil in series as shown in Fig. 8A or we can reduce the voltage to the load by inserting a condenser as shown in Fig. 8B. The calculations of the correct reactances to use in each case are a little complicated because of the phase difference between the voltage of the reactance and the load voltage. The important fact we should realize is that a reactance may be used in series equally as effectively as a resistor.

You can help the series reactance (or a series resistance) along by using a reactance as a bleeder. For example, you can use a condenser as a bleeder as shown in Fig. 8C, or you may use a coil as a bleeder as shown in Fig. 8D. The only requirement is that the load-shunting reactance draw sufficient current through the series reactance (or resistance) to increase the voltage drop in the supply line.

We must be careful when using a condenser and a coil to avoid resonance, for should this situation arise the load voltage may rise to a value above normal.

How to Consider a Complex Voltage Source. In considering the use of coils and condensers in controlling the load voltage, we limited ourselves to a single-frequency source. Actually, in practical radio circuits the source voltage is more likely to be of a complex nature. You may wish to allow the original characteristic to go through unchanged, or you may wish to "tone" the output, and even eliminate some characteristic of the original.

For example, the output of the detector in a receiver may have a d.c., an a.f., and an r.f. component. Only the a.f. is desired so all others should be rejected. The output of the frequency converter stage may contain the desired i.f. signal, the oscillator signal, the r.f. carrier and many harmonics. The audio signal in the a.f. may have pronounced high-frequency level, and we may want to reduce the high a.f. components. Before we go on to see how these things can be done, let us consider the proper procedure for visualizing a complex signal. You will see that a complex source voltage can be considered as being made up of voltage components which we can consider independently in the circuit.

Suppose we have a simple circuit as shown in Fig. 9A, in which a low frequency source furnishing a voltage e_1 produces a current through R. If e_1 has the wave form shown to the right, the circuit current i_1 will have the same shape. The supply voltage and the circuit current are both sinusoidal.

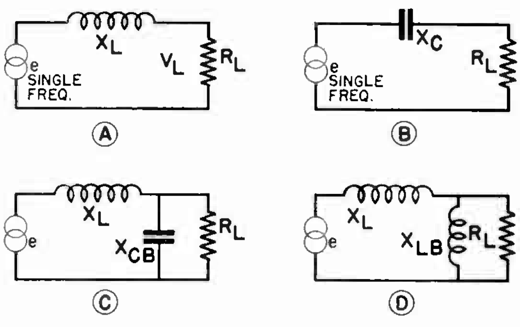


Fig. 8. Using coils and condensers as an output voltage control for a.c. circuits only.

The same load resistor R is now considered connected to a d.c. generator, as shown in Fig. 9B. If the generated voltage e_2 is as shown to the right, the current i_2 will have the same form. It is at a definite level, and has one direction of flow.

Now load resistor R is connected to a third generator, furnishing a high-frequency voltage as shown in Fig. 9C. The supply voltage e_3 and the circuit current i_3 will have the form shown at the right.

We have considered three different voltage sources connected in turn to a definite load. Suppose all three sources of voltage were connected in series and then connected to this load. We will have the circuit shown in Fig. 9D. The voltage acting at terminals *1* and *2* will be the sum of all the voltage supplies: $e_1+e_2+e_3$. To visualize the final wave form of all three voltages, we add them instant after instant, by combining the three wave forms already shown, and get the final shape shown at the right of Fig. 9D. When

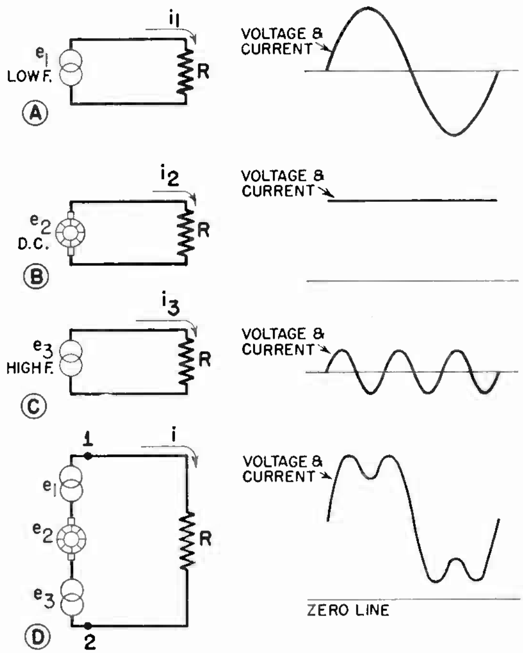


Fig. 9. Combining component voltages to produce a complex voltage, showing that a complex voltage may be considered to be made up of component voltages.

this complex voltage is applied to a resistor, the current flowing will at every instant depend on the voltage at that instant, hence the current i will have the same wave shape.

From this simple build-up, we see that a complex voltage is made up of individual voltages, and a complex current consists of simple currents. Both sinusoidal and steady d.c. voltages and currents are in their simplest form, for they cannot be broken down any further. When dealing with a source having a complex voltage, we have every right to consider its components individually in the circuit, or their effects through any part of the circuit, if such a break down will lead us to the desired information. All through practical radio circuit analysis, a complex voltage or current may be considered to consist of a d.c. component, a fundamental a.c. component and harmonic components—each component considered individually. This basic principle of electrical circuits often is called the principle of superposition.

Complex Voltage Source: Effect of a Series Coil. Now let us consider a complex voltage supply, a resistance load R_L and a series coil L, as in Fig. 10. To continue our analysis, let us consider the source to be the same as in Fig. 9D, so we can visualize the individual voltage components as shown in Figs. 9A, 9B and 9C.

Coil L in the circuit of Fig. 10 will have no opposition for any d.c. component; some reactance to the low-frequency component and considerable reactance for the high-frequency component. As a result, the d.c. component will go through coil L as if the coil did not exist, and only the resistor will effect the current flow. For the high-frequency component, both R_L and X_L offer effective opposition, but X_L has such a high reactance that it gets all of the voltage of the high frequencies. We may say that because of the high reactance of X_L to the high-frequency component, little current at this frequency flows in the circuit.

The low-frequency voltage of the source finds both X_L and R_L as reactive elements in the circuit, and both influence the flow of low-frequency current in the circuit. The low-frequency current will be less than if R_L alone were in the circuit.

Summing up, the d.c. voltage will act solely on R_L. The high-frequency voltage will be choked out of R_L and entirely dropped in X_L. The low-frequency voltage will be only partially affected by the presence of X_L. The current flowing in the circuit will have the form shown at the right of Fig. 10, and consequently the voltage across R_L will have the same wave form.

Complex Voltage Source: Effect of a Series Condenser. Now let us see what happens when a condenser is inserted in the circuit between the complex voltage source and the resistive load, as shown in Fig. 11. The source supplies the same complex voltage as is shown in Fig. 9D. Let's consider the three components separately, as permitted by the superposition principle.

First consider the d.c. component of the voltage supply. The total d.c. voltage will charge condenser C and block the flow of direct current.

For a.c. the condenser will have a reactance, with this reactance decreasing with frequency. For the low-frequency component, the reactance X_C will be high, and most of the a.c. voltage will drop in this element of the circuit; little or none will be effective across R_L. For low frequencies the circuit impedance will be high and negligible low-frequency current will flow through the circuit.

Since at high frequencies the reactance of X_C, is negligibly small, its reactance can be ignored for this source component. All the high-frequency voltage will be applied to R_L; in fact, the high-frequency current will be the predominating current component in the circuit. The current in the circuit will have the wave form shown to the right of Fig. 11, while the voltage supply will have the form shown at right of Fig. 9D.

Combination of Coil and Condenser for Current Suppression. We have assumed, in our discussion of the circuits shown in Figs. 10 and 11, that the frequencies are sufficiently different so that the reactance effects are either effective or negligible, as the case may be.

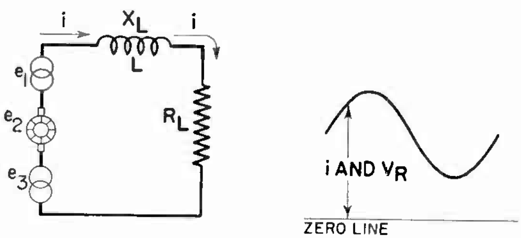


Fig. 10. A series coil will "choke out" high frequency current flow through the load resistor.

As the different frequencies approach similar values, the effectiveness of the series reactor can be increased by shunting the load with another reactance. Consider, for example, the circuit shown in Fig. 12. We insert a coil in the source supply line to suppress high-frequency current. We can shunt the load with a condenser so the high-frequency current will take the condenser path rather than through the resistive load, since the condenser offers less reactance for the passage of high frequencies than the resistor.

By making the reactance of X_L as large and the reactance of X_C as small as possible from a practical standpoint, we permit only a small amount of any a.c. current to flow in the load. When we do this, we have what is commonly called a "brute force" filter which passes only d.c. current.

This same circuit can be used to pass low frequencies but block high frequencies. Here we must choose L and C so that they have negligible effect at or below the frequencies we want to pass. L and C constitute a resonant circuit, and we are told that if we make them resonant at one-half the frequency of the lowest signal to be passed, we can accomplish this job.

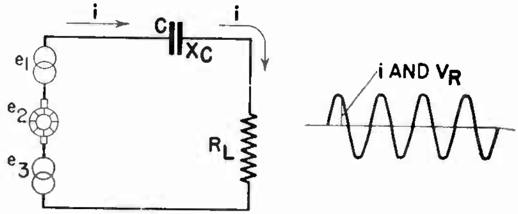


Fig. 11. A series condenser will "pass" the high-frequency current but will block direct current and reduce low-frequency currents.

Whether we want to cut off all a.c. signal or merely suppress certain high frequencies, we can do the job better by using a chain of filters as shown in Fig. 13. Radio men call this a cascade of filters.

In discussing the circuit shown in Fig. 11, we saw that a series condenser will block the flow of direct current and low-frequency currents. We may improve this action by shunting the load with a coil, as shown in Fig. 14. At low frequencies, the shunt coil will have a low reactance, much lower than the resistance of R_L. In fact, for low frequencies most of the drop will be forced to take place across the series condenser, thus keeping its flow out of the shunt path made up of X_L and R_L.

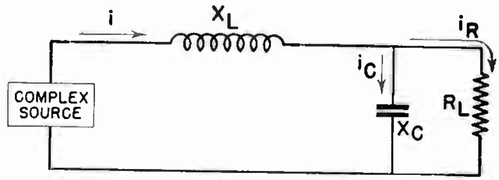


Fig. 12. Use of Xc as a bleeder in an L filter for suppressing high frequencies.

By proper choice of C and L, we can suppress low-frequency currents and pass high-frequency currents. This involves choosing L and C so they resonate at twice the frequency at which we wish pass action to start.

Resonant Circuits as Circuit Controls. At resonance a parallel resonant circuit acts as a high resistance; at resonance a series resonant circuit tends to act as a short circuit. With these facts in mind, we may employ resonant circuits to control the flow of currents in circuits. Let us not forget that a coil and condenser are normally resonant at one frequency or over a narrow band of frequencies near the resonant value.

Should we wish to exclude signals of a definite frequency, we can insert a parallel resonant circuit in the line, as shown in Fig. 15A. By making

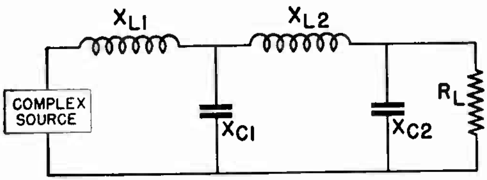


Fig. 13. Cascade L filters for more effective suppression of high-frequencies.

L and *C* resonant at the signal frequency to be rejected, this circuit will act as a high resistance, forcing most of the voltage at that frequency to be dropped in this L-C combination. For all other frequencies, either L or C will be a low-reactance path, inserting a negligibly small circuit reactance.

When a signal frequency is to be passed and all other signal frequencies reduced to negligible values, a series resonant circuit should be used, as shown in Fig. *15B*. At resonance, L and C act as a short or a nearly zero-resistance unit, and the entire source voltage at that frequency is available for R_L. At all other frequencies, either L or C acts as a high reactance, impeding the flow of current. For d.c., the condenser is a blocking element.

We need not use resonant circuits in the supply line, for resonant circuits in shunt with the load are also effective in passing or suppressing narrow frequency bands from the load.

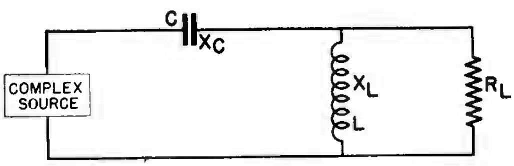


Fig. 14. A high-pass filter.

Assume that resistor R_S in Fig. 15C is shorted. In this case, even though L-C will have high resistance at resonance and low reactance at all frequencies, this shunt will in no way effect the voltage applied to R_L, as the latter is directly connected to the source. By inserting R_S, the resonant circuit shunting R_L becomes a bleeder. At resonance, L and C act as a high resistance and reduce the drop in R_S. Off the resonant frequency, either L or C will bleed current through R_S and thus drop the voltage there rather than at the load. In this way the resonant frequency finds less opposition in R_S, and is forwarded to R_L.

To exclude a definite frequency, the load is shunted with a series resonant circuit, as shown in Fig. 15D. Again the line resistor must be used, otherwise the load will get the supply voltage independently of the resonant circuit. With R_S in the circuit, *L* and *C* act as a bleeder at resonance. Analyzed more carefully, at resonance *L* and *C* act as a short path causing most of the supply voltage to be dropped in R_S. As we con-

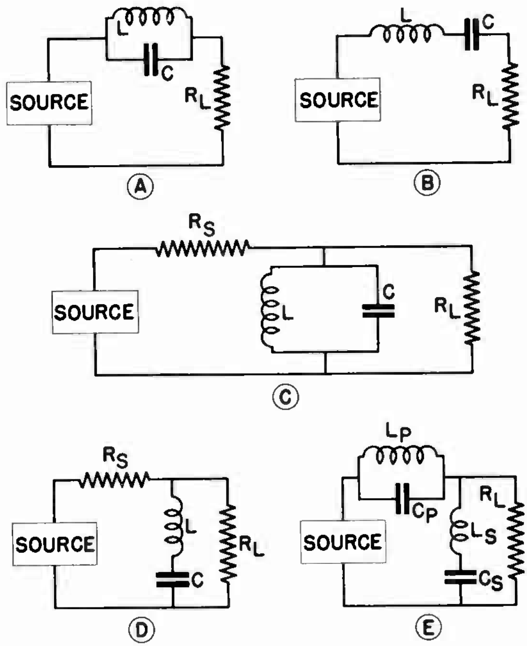


Fig. 15. Using resonant circuits for the suppression or passage of definite narrow ranges of frequencies.

sider frequencies farther away from resonance, the reactance of either L or C predominates and increases in value. This reduces the drop in R_S, so more of the supply voltage at off-resonant frequencies can be applied to the load.

We need not employ resistor R_S in the source supply line; we may employ instead a resonant circuit, as shown in Fig. 15E. When both L_P-C_P and L_S-C_S are resonant at the frequency to be suppressed, at resonance L_P-C_P will act as a high resistance, and L_S-C_S will act as a low-resistance bleeder. Most of the supply voltage at the resonant frequency is then dropped in the parallel resonant circuit. Both resonant currents do a better job of preventing the undesired frequency from reaching the load.

We may use any combination or arrangement of resonant circuits to exclude or pass desired frequencies. These may be created at the will of the designer. We may employ any combination of low and high-pass filters, or filters and resonant circuits, to accomplish any desired circuit control. But you can generally predict the results if you bear in mind the basic facts already presented.

n r i

Radio Servicemen NOW TAKE OVER

No new radio receivers for civilian use will be manufactured after April 22, by order of the War Production Board. Receivers started before the deadline can be completed, after which the 55 firms affected by this order will change over to the manufacture of military equipment. Already war orders for more than a billion dollars worth of military radio equipment have been placed with the radio industry, and many more orders are now being placed.

How does all this affect the Radio Serviceman? He will have to keep all the existing radio receivers in working condition, in order that radio broadcasting can achieve the following goals set for it by Price Administrator Leon Henderson: *"Radio constitutes an important factor in defense. Besides serving as a source of news and of entertainment vital to morale, it furnishes the principal channel through which civilian defense authorities are enabled to disseminate directions and intelligence necessary to public safety."*

What about repair parts? Recognizing the importance of keeping existing receivers in operating condition, the War Production Board has authorized continued production of replacement parts.

About 57,000,000 sets are now in use, and the final figure will be close to 60,000,000 when all sets in factories and stores have been sold.

After April 22, then, the Radio serviceman takes over. His job will be to keep these 60 million home radio receivers in operation, for Victory. His services will be in greater demand than ever before. His big opportunity is at hand.

N. R. I. EMPLOYEES BUY A SHARE IN AMERICA

N.R.I. is not only busily engaged in doing an important defense job by providing the country with thousands of radio technicians and operators, but the individual employees, numbering 148, are fully doing their bit for Uncle Sam.

The above photograph shows some of the employees gathered together at the annual meeting of the National Radio Institute Employees Federal Credit Union, a cooperative organization of N.R.I. employees. At this meeting our Credit Union qualified as an issuing agent for the sale of Defense Bonds and Stamps. N.R.I. staff employees may now buy their bonds and stamps right in the organization. In the picture Mr. E. R. Haas, our Executive Vice President and Director, is buying the first bond from Mr. Charles Alexander, Credit Union Treasurer.

Puzzling Radio Questions From Students

Modulation Hum

QUESTION: *I have a receiver to service which appears to have a hum when a signal is tuned in. I have noticed, however, that the hum ceases when I tune between stations. What causes this?*

ANSWER: It sounds as if you have a condition known as modulation hum. This is a hum produced somewhere in the radio frequency portion of the set. Due to the use of radio frequency parts between the audio amplifier and the place where the hum originates, it will not be passed on through the set when no signal is tuned in.

However, when a signal comes in, this hum will modulate the incoming signal and will travel with it through the radio frequency amplifier to the detector and audio system. Thus, it is called a modulation hum because of the manner in which it travels through the set.

The frequency of the hum will help to determine where it comes from. Hum due to misplaced filament circuit wiring or cathode-to-heater leakage in a tube will generally be 60-cycle hum. If it comes from an improperly filtered plate or screen grid supply source, it will usually be 120 cycles, as the normal full-wave rectifier used will produce this frequency.

Such a modulation hum can also arise due to a poor ground. This usually can be determined, because removing the ground or trying another ground will generally clear it up.

Of course, when you hear a hum only on one station, there is some possibility that something might be wrong at the transmitter. This is particularly true if the hum disappears after a day or so.

A frequently overlooked source of hum is the oscillator in a superheterodyne type receiver. The oscillator frequently has its own separate power supply leads. If the filter condenser used on this lead should become defective, it is possible for hum modulation to exist on the oscillator r.f. output, which, of course, will modulate the i.f. signal when the oscillator and incoming signals are **mixed.**

Output Meter Connections

QUESTION: *What is the best method of connecting an output meter for alignment purposes?*

ANSWER: The most common output meter connection is from the plate of the output tube to the set chassis. If a push-pull output connection is used, connect between either plate and chassis.

An a.c. voltmeter, usually of the copper-oxide rectifier type, is used for this purpose. A blocking condenser is used in series with the meter to keep d.c. current out of it. The range of this meter is usually about 50 or 75 volts. When this meter and condenser combination is connected between the output tube plate and set chassis, it will measure the signal voltage existing at this point. Of course, we are not interested at all in how much voltage we have; we just want an indication of when we have the maximum.

A low-range (3 to 10 volts) a.c. voltmeter can be used across the voice coil of the loudspeaker. A blocking condenser is not needed here, as there is no d.c. current in the voice coil.

If a d.c. meter with a high ohms-per-volt rating is available, it may be used to measure the voltage produced by the automatic volume control circuit. In other words, the automatic volume control circuit produces a d.c. voltage for bias purposes which is proportional to the strength of the incoming signal. You can use this as a measure of the alignment adjustments.

The voltage produced in this case usually is between 5 and 25 volts d.c. However, as mentioned first, you must use a meter of high sensitivity. Any low-sensitivity meter will have such low internal resistance that it will shunt the automatic volume control circuit and reduce the measurable voltage to an extremely low value.

It is also possible to obtain an output indication if the receiver uses a tuning eye, tuning meter or other similar indicator. Just align the set for maximum closure of the eye or maximum tuning indicator swing.

Of course, special instruments such as vacuum tube voltmeters, or a cathode ray oscilloscope can also be used. An a.c. type vacuum tube voltmeter would be used just like an a.c. meter, while a d.c. type can be used for automatic volume control measurements. The cathode ray oscilloscope can be used as an a.c. voltmeter at the output.

From the foregoing, information has been given primarily on ordinary alignment of radio receivers. There are, of course, special alignment procedures, such as in receivers with automatic frequency control and in frequency modulation receivers where special equipment may be necessary. In such cases, the instructions of the set manufacturer should be followed if available.

Are Answered By N. R. I. Experts

Measuring Current

QUESTION: *How can I determine the current flow in the circuit if I do not have a milliammeter available?*

ANSWER: If no milliammeter is available for measuring current, Ohm's Law can be used.

At some point in the circuit, the voltage can be measured across a resistor (or part having resistance). Then the resistance can be measured with an ohmmeter, if its value is not known. Dividing the voltage by the resistance will give the current flow. Remember that the current will be in amperes, so you will have to multiply by 1000 to convert to milliamperes.

In a circuit such as an r.f. plate circuit, where the coils used may have very low d.c. resistance, we cannot make a measurement of this type. However, it is possible to insert a small resistance such as 100 ohms or so in most of these circuits without appreciably affecting the circuit. Then by measuring the voltage across this known resistance, the current can again be calculated. If the circuit draws but a small amount of current, the resistor value may have to be larger.

Code Characters

QUESTION: *I am somewhat confused by the code characters for the period and the comma. I have seen two different sets of characters given for these. Which is correct?*

ANSWER: In the International Telecommunications Conference of 1938, it was decided by representatives of seventy-four countries to revise certain of the code characters. Representatives from the United States attended this conference but as yet there has been no official acceptance of the revision by this country.

The most important revisions from this conference involved the characters for the period and comma and the elimination of the exclamation mark. According to the revision made by the conference, the period is now sent as a series of three A's (.—.—.—). The comma is now sent, according to the revision, as two dashes, two dots, two dashes (——..——).

Until officially recognized by the authorities in the United States, the old code characters will be considered authentic. However, I suggest that you learn the new characters so you will not become confused if you hear them on the air. I have noticed a number of operators have gone ahead and started using the revised signals for the period and comma. In contrast, some of the commercial stations still use the old characters. In other words, you will hear both characters in general use, while only the old characters are official in the United States at present.

Of course, this has resulted in some confusion and eventually there will undoubtedly be an official ruling made. In all probability, the new characters will be accepted.

Band Spread

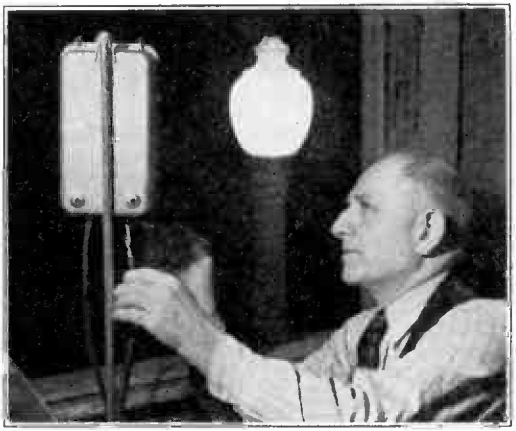
QUESTION: *I do not understand just what is meant by band spread. Does this have anything to do with the selectivity of the receiver?*

ANSWER: Band spread refers to a means of spreading out a band of frequencies to make it easier to tune in stations located close together in the short-wave band. This does not affect the selectivity of the receiver at all. The selectivity, which is the ability to discriminate between stations on adjacent channels, remains the same as before.

There are several means of obtaining this band spread. One of the first means used was to employ a high ratio between the tuning knob and the condenser gang. In other words, by requiring a number of revolutions of the tuning knob for one revolution of the tuning condenser gang, the tuning condenser is made to move slower. Ratios as high as 20 to 1 have been employed, where 20 rotations of the tuning knob are necessary to make one sweep across the dial.

This is a mechanical system of band spreading. There is an electrical system, however, which makes use of very small tuning condensers. These can be connected in parallel with the main tuning condensers, or they may be used as the main tuning condensers. The idea of using small tuning condensers comes from the fact that if the amount of capacity is small, then the change in capacity will likewise be small. As the frequency range covered depends on the change in capacity, this means that one rotation of such a tuning condenser will cover but a small section of the short-wave spectrum and as a result, the various frequencies will apparently be separated better.

Of course, different coils are necessary if the small variable condensers become the main tuning condensers.



ELECTRIC EYE AIDS CIVILIAN DEFENSE

The "electric eye," used for years to count traffic, open doors for busy waitresses, sort coffee beans according to color and do a dozen or more other jobs which previously had to be done by hand, has just come into a real wartime occupation, that of standing by as all-night guard for alert warnings of possible air raids. Focused on the street lights, which will be turned off the instant a warning is received in any city, the "electric eye" sounds an immediate warning and likewise turns off the lights in the home, store, display signs or wherever lights are to be extinguished to perfect a city blackout.

The idea originated with Andrew Tessier, who with his brother conducts a small machine shop in Schenectady, N. Y. and is engaged in wartime defense orders. When war was declared, orders were issued to all people, including business houses, that lights must be extinguished within five minutes after an air raid warning. Tessier's shop is too small to afford an all-night watchman, yet he felt that it would be dangerous to put out his night lights. However, he tried it and the first night his lights were all out, his place was broken into.

It was then he hit on the idea of using a photo tube, or "electric eye" as it is more popularly known. He installed this at the window on the second floor of his shop, with the eye pointed toward the street light on the corner, and adjusted it so that whenever the street light went out, all lights in his place would go out. When the street lights came back on again, on would go his all-night lights.

The electric eye equipment, secured from General Electric, cost about $30. It cost him $10 more to install it, so for an expense of less than $50, Mr. Tessier has an all-night guard on the lighting of his plant for the duration of the war, as against $20 or $25 per week he would have to pay a watchman to perform the same duty.

The set up which Mr. Tessier has installed could be used by merchants who cannot afford an all-night watchman. Since the war these merchants have been turning out their lights when they close their places of business at 6 o'clock at night, and thus have sacrificed whatever advertising might come from window shoppers during the evenings.

Student P. A. Browne, Chief Instructor J. A. Dowie and Graduate Wm. Justus. Browne and Justus dropped in on us at N.R.I. on their return trip from Philadelphia where they attended the Elks National Convention. Both are members of the Elks Band of Columbus, Ohio, Elks National Champions for five consecutive years. They are good radio men, too. Browne and Justus sent this picture to us with the comment, "A Champion between two champions."

Novel Radio Items

—BY L. J. MARKUS—

Plaster-of-paris blocks with embedded terminals are planted with sugar beets in Colorado. The blocks absorb moisture or release it just as the surrounding soil does. By measuring the resistance between the terminals of a block, the farmer can determine the moisture content of the soil and thus tell quickly whether irrigation is needed and how much water is needed.

—n r i—

A U. S. patent has been granted for a hair dryer having a built-in radio receiver, for use in beauty shops.

—n r i—

To help keep up the morale of the folks back home, one Norfolk, Virginia club for soldiers and sailors has installed a sound recorder which men in the services can use for cutting their own "talking letters." Facilities for mailing the recordings back home promptly are also provided.

—n r i—

How do these two answers sound to you: 1. *A radio receiver cannot have more than 110 volts because that is all the power company supplies;* 2. *A rectifier tube having two plates is called a half-wave rectifier because it rectifies half a cycle at a time.* For the benefit of beginning N.R.I. students who have not yet studied these subjects, many radio receivers have power transformers which step up the voltage to values much higher than the power line voltage. Also, a rectifier tube with two plates is a *full-wave* rectifier.

—n r i—

A new machine called the rheotron gives electrons the highest speed ever produced by man-made apparatus. The heart of the rheotron is a doughnut-shaped glass vacuum tube mounted between the poles of a large electromagnet. Electrons emitted by a hot filament are whirled around and around the inside of the glass doughnut by the action of electromagnetic forces and finally attain a speed closely approaching 186,000 miles per second, the speed of light. At this speed the electrons will go right through an inch of solid aluminum, or can produce an x-radiation stronger than a corresponding beam from all the radium in the world put together.

—n r i—

Will the 5-volt filament of a type 80 rectifier burn out if corrected directly across the 700-volt secondary winding of the power transformer in a radio receiver? No! Furthermore, the filament won't be any brighter than when connected across the 5-volt secondary winding of the same transformer! Here's the explanation, based upon Ohm's Law: The type 80 tube has a rated filament current of 2 amperes, and the d.c. resistance of the secondary winding is usually about 350 ohms. The filament resistance is only about 3 ohms, so we have in this "daring" experiment a voltage of 700 volts acting in a circuit having a total resistance of 350+3, or 353 ohms. This means that the highest current which can flow is just about 2 amperes—the rated filament current of the tube! Caution: We do *not* recommend that you try this experiment, for the tube filament is practically a short-circuit on the secondary. The transformer may fail even though the tube is unharmed.

—n r i—

The development of a light-weight non-spillable 2-volt storage battery in a transparent plastic case has made possible the new General Electric portable receiver which has no dry cells whatsoever. A vibrator similar to that employed in auto radio sets steps up the storage battery voltage to 90 volts d.c. for plate circuit requirements. The receiver will operate for 15 to 20 hours from this storage battery without requiring recharging. A compact, light-weight battery charger is built into the receiver, so the battery can be recharged simply by plugging the set into any 115-volt a.c. power outlet. An additional cable furnished with the receiver permits recharging from an automobile battery by plugging into the cigar-lighter outlet on the dashboard of the car.

—n r i—

A radio-frequency metal detector developed by Col. J. J. Moorhead of the U. S. Army was successfully used at Pearl Harbor, Hawaii on December 7, 1941 to locate embedded metal fragments in twenty victims of the bombing. In many other cases, it quickly proved the absence of shell fragments. The Moorhead Foreign-Body Finder consists of an r.f. oscillator, connected to a movable coil or capacity mounted in a waterproof housing about ½ inch in diameter and about 12 inches long. This exploring "finger" is brought toward the wound from two directions at right angles to each other. Marks are made on the flesh at the positions of maximum milliammeter deflection, and the projection of these points into the flesh locates the position of the metal fragment. The radio metal detector weighs about 10 pounds and costs about a hundred dollars, whereas x-ray outfits used for the same purpose cost thousands of dollars.

CIRCUIT ANALYSIS
OF A
MODERN AUTO RECEIVER

BY J. B. STRAUGHN
N.R.I. Service Consultant

The Truetone Model D746 is a five-tube superheterodyne receiver having a tuning range of 530 kc. to 1550 kc., operates from a 6-volt storage battery and uses the automotive type 6.3-volt tubes. The B supply is obtained from a vibrator with a tube rectifier.

Additional data in the factory manual states that the receiver is of the single-unit type, no flexible shaft being used, as the entire radio and automatic mechanical tuning mechanism is self-contained.

Five levers are provided for accurate and convenient automatic station selection, plus the conventional manual tuning control, which makes full tuning range coverage available at all times without any switching device from automatic to manual tuning.

The tube complement consists of: A type 6A8 pentagrid converter. A type 6K7 remote cut-off pentode as an i.f. amplifier. A type 6Q7 duplex diode triode used as a second detector, a.v.c. and first audio. A type 6K6 pentode output amplifier and a type 6X5 high vacuum indirectly heated cathode rectifier.

This set derives r.f. gain from its frequency converter and one stage of i.f.; obtains a.f. gain from one voltage amplifier and the output a.f. stage.

Signal Circuits

The signal picked up by the antenna causes a current to flow through condensers C_2 and C_3. Condenser C_3 is not only in the input circuit but in the first tuned circuit feeding the frequency converter tube. This is capacity coupling to the antenna in contrast to the more usual inductive coupling found in home receivers. The voltage applied to C_3 is stepped up by resonance. The resonant signal appearing across tuning condenser C is applied directly between the control grid (grid No. 4) and cathode of the 6A8 type tube.

At the same time, a local oscillator is producing a signal for frequency conversion. The oscillator electrodes in the 6A8 tubes are cathode (pin 8), control grid (pin 5) and anode (pin 6). When the oscillator is working, we have a variation in the electron stream passing through the oscillator anode to the screen and plate electrodes. When the incoming signal voltage is applied to the mixer grid (G), the electron stream is again caused to vary, this time at the signal frequency. Mixing of the two signals takes place in the tube. The oscillator frequency is always above the frequency of the incoming signal by the amount of the intermediate frequency, which in this case is 465-kc., as noted on diagram.

Because of the curvature in the Eg-Ip characteristic of the tube operating as a detector a beat frequency is produced in the plate circuit. The resulting 465-kc. beat builds up a large circulatory current and a high voltage in the primary of transformer T_3. All other frequencies, such as the sum of the oscillator and incoming signal, the oscillator signal and the incoming signal, are bypassed around the primary coil by the first i.f. trimmer condenser. All signals, including the i.f. signal, are returned to the cathode through condenser C_8.

By mutual induction, an i.f. signal voltage is induced into the secondary of transformer T_3 and the resonant i.f. signal voltage appears across the secondary coil and its trimmer condenser. This signal is applied between the control grid and cathode of the 6K7 tube, the cathode connection being through condenser C_8. Because the primary circuit of T_4 presents a large impedance in the plate circuit of the 6K7 tube, the latter produces an i.f. voltage across the primary of T_4 greatly amplified with respect to the input signal. A signal voltage is induced into the secondary of T_4 and after resonant step up is large enough for rectification.

The upper diode plate in the 6Q7 tube is used for detection and when positive, electrons flow from the cathode to this plate, through the secondary of transformer T_4, and through R_6, the volume control, to the cathode. R_6 therefore acts as the diode load resistor, and a rectified signal appears across it. This is a combination of d.c. and a.f. signal. Condenser C_9 serves to remove the i.f. from the diode output, so it does not appear across the volume control.

The audio signal is fed from the variable tap on the control through condenser C_{10} to the control grid of the 6Q7 tube. The signal is developed across resistor R_9 in this circuit, the low potential end of R_9 being connected to the tube cathode and the cathode end of the volume control through condenser C_{14}.

The resulting audio variations in the 6Q7 plate current cause a large audio signal voltage to be built up across resistor R_{12}. C_{13} serves to remove any i.f. signal which may have gotten into the plate circuit, by passing it around the plate load to the cathode. The amplified audio signal is now applied across R_{13} through condensers C_{15} at grid end and through C_{11}, R_7 and C_{16} at the other end.

The signal voltage across R_{13} is applied to the control grid-cathode of the 6K6 type tube, the cathode connection being through C_{16}.

The 6K6 tube then amplifies the signal voltage across R_{13} and we now have a very large signal current flowing through the primary of output transformer T_6. The turns ratio of the transformer matches the voice coil impedance to the tube plate impedance. The voltage induced into the secondary and the resultant current flow through the voice coil causes the voice coil and attached cone to move in and out in step with the audio signal, and in this way the cone produces sound waves.

Signal Circuit Features

We will now consider some of the signal circuit features in this set. First, from the diagram we see that the oscillator is not equipped with a low-frequency padder condenser, and we may therefore assume that the oscillator tuning condenser has specially cut plates in order to obtain tracking over the entire band. In addition, and this is peculiar only to some auto receivers, condenser C_3 serves as an r.f. padder condenser and has the duty of helping make the preselector track or follow the oscillator by the i.f. frequency.

Condenser C_1 has a capacity of only .00002 mfd. consisting only of two flat metal plates separated by mica. A condenser of this construction has a very low power factor even at high frequencies produced by the auto ignition system—in other words, it is an excellent by-pass. Condenser C_2 is of the usual wound wax paper type and its capacity effect holds only for the lower r.f. values. Because of its construction it actually becomes a coil at ultra high frequencies.

Ignition interferences are modulated on ultra high frequencies. When it enters the input circuit, C_2 acting as a coil chokes this signal forcing it to take the C_1 path to ground. Broadcast signals will be by-passed by C_1 to some extent but will mainly be capacitively coupled to the resonant circuit by condenser C_3. At broadcast frequencies C_2 and C_3 is the low reactance path.

Resistor R_2 is the oscillator grid resistor. The rectified current flowing through this resistor automatically furnishes the correct negative bias for the oscillator. Condenser C_4 serves to couple the oscillator tank circuit to the oscillator control grid and also serves (together with condenser C in the oscillator circuit) as a by-pass across resistor R_2, thus smoothing out the r.f. across this resistor.

Resistor R_3 is used to cut down on the voltage to the oscillator anode, and condenser C_5 is an r.f. by-pass condenser. Condensers C_5, C_6 and resistor R_3, also serve to keep any variations in the power supply circuit from being applied to the oscillator anode as this might result in hum modulation.

Condenser C_6, which has a capacity of .05 mfd., is also the plate supply by-pass condenser for the 6A8 and 6K7 tubes. Condenser C_7, having a capacity of .1 mfd., is the screen by-pass condenser for the first detector and i.f. tube. Resistor R_4 serves to reduce the plate supply voltage to the correct amount for the screens of these two tubes.

Condenser C_{13} besides acting as an i.f. by-pass in the plate of the 6Q7 tube, also reduces the high frequency audio response of the receiver, thus raising the bass response.

Condenser C_{18}, connected between the plate and cathode of the output tube, prevents parasitic oscillations in the output stage. The plate load, because of this condenser, is essentially capacitive at the high audio frequencies at which such oscillation would normally occur.

The A.V.C. System

There is nothing unusual about the a.v.c. circuit. The audio voltage developed across resistor R_6 is filtered by resistor R_5 and condenser C_8 for application to the control grid of the 6K7 i.f. tube. Further filtration is afforded by resistor R_1 and condenser C_3 for the control grid of the first detector tube. The minimum bias for these tubes is 2.2 volts and is obtained across resistor R_7, in the main power supply system.

When the incoming signal increases in strength the voltage applied to the cathode and diode plate 5 of the 6Q7 tube increases. Naturally this results in increased diode current and a greater voltage across R_6. This increases the negative bias of tubes 6A8 and 6K7 and reduces the receiver sensitivity.

When the strength of the incoming signal decreases the rectified voltage across R_6 decreases and since this reduces the negative bias of the 6A8 and 6K7 tubes the receiver sensitivity increases thus enabling us to have an automatic control of the volume.

No a.v.c. system is 100% efficient and a change in the incoming signal strength will result in some change in the output sound level from the loudspeaker. For slight changes in signal strength the sound level won't change perceptibly and even for large changes in signal strength the output level changes far less than if a.v.c. was not used.

You will note that diode plate 4 of the 6Q7 tube connects to the grid return of the 6K7 tube at the junction of resistor R_5 and condenser C_8. This arrangement is known as a gas gate. If the 6K7 tube happens to become gassy, electrons will flow up through resistor R_6, resistor R_5 and to the control grid of the 6K7 tube. This tends to make the grid of the tube positive by an amount equal to 4,000,000 ohms ($R_5 + R_6$) multiplied by the gas current in amperes. When this occurs, the cathode of the 6Q7 together with diode plate 4 acts as a lower resistance shunt across resistors R_5 and R_6 and prevents the voltage from building up to a high value.

When diode plate 4 becomes positive due to gas in the 6K7, current will flow from the 6Q7 cathode to this diode plate, lowering the effective resistance of R_5 and R_6 and therefore lowering the voltage drop produced across them by the gas current.

Power Supply Circuits

In this, or in any other auto receiver, we only have the six volt storage battery in the car as a source of power. We can feed the tube filaments and speaker field directly from the battery since they are designed for six volt operation, but we must also feed the tube electrodes with the correct D.C. voltage, which in some cases will be as much as 200 volts.

D.C., as you know cannot be stepped up so we use a non-synchronous vibrator to interrupt the D.C. from the battery, thus changing it for all practical purposes to A.C. This A.C. may be stepped up by a power transformer, rectified by a high vacuum rectifier tube and the pulsating D.C. from the rectifier filtered just as in an A.C. set. The rectified and filtered D.C. is then ready to be applied to the various tube electrodes.

The diagram shows that the vibrator is used solely to interrupt the D.C. flowing through the primary of the power transformer T_5, and causes the supply current to flow first through one section of the primary and then through the other, giving the same effect as an A.C. current.

The hot (ungrounded) A lead connects to the center tap on the primary of the power transformer through the switch marked S_1 and choke L_4. Normally, the vibrator armature connects to terminal 2, being held in place by spring tension. When the set is turned on, current will flow through the armature coil of the vibrator connected to terminals 2 and 4. This will pull up the armature, causing it to make contact to terminal 3, and breaking the contact of the armature coil to ground through terminal 2 and the armature. Then the current flowing to the center tap on the primary passes through the upper section of the primary to terminal 3, through the armature contact to terminal 1 which connects to the other side of the storage battery.

The breaking of the circuit through the armature coil allows the spring to return the armature to contact with terminal 2 on the vibrator. The current then flows through the lower half of the power transformer primary through the contact at 2 and to the other side of the storage battery. The armature coil is also re-energized to pull the armature over again for another round trip. This action occurs as long as the receiver is turned on, and we have current flowing first through one half of the primary and then through the other half.

As a result of feeding the primary with alternating current, a large voltage is developed across the secondary of T_5 and is applied to terminals 3 and 5 of the rectifier tube.

Since B— is the center tap on the secondary of T_5, theB supply electron path is from the center tap through bias resistors R_{11}, R_8, R_7, to the 6A8. 6K7 and 6K6 cathodes (in the case of the 6Q7 cathode, the path is through R_{11} and R_8), then through the tubes to the plates and other positive electrodes, back to the rectifier cathode and across to rectifier plate 3 or 5—whichever one is positive.

Resistor R_{15} is used to prevent excess voltage from being developed across the primary. Condenser C_{17} is a smoothing or buffer condenser and helps to remove any irregularities in the peaks of the secondary voltage. It is also important to use the right size condenser at this point so that the vibrator will work smoothly and with a minimum of sparking.

The cathode currents of all tubes flow through resistors R_7, R_8 and R_{11}, with the exception of the 6Q7, which skips R_7, and develop a voltage across these resistors. The end connected to the power transformer secondary center tap is negative, while the end connected to the chassis is positive, thus forming the bias voltages.

Filter Circuits

You will note from the diagram that the vibrator coil and the heater of the rectifier tube are fed through choke L_1. To avoid vibrator interference, the filaments of all but the rectifier tube are fed in parallel directly from the ON-OFF switch, as is the pilot lamp. The speaker field is also fed from this point, and these parts are isolated from the interference produced by the vibrator by the filter consisting of condenser C_{10} and choke L_4. Condenser C_{10} serves to prevent any low frequency interfering signal from the vibrator from feeding back through choke L_1. The two condensers marked S_P are called spark plate condensers and are essentially similar in construction to condenser C_1 in the antenna circuit. Since they do not have any inductive effects at ultra high frequencies they prevent any ignition interference produced at the car motor from entering the receiver by way of its B power supply.

By this time you have probably noticed that a filter choke is not used in the power pack system. We do have, however, two filter condensers marked C_{12} and C_{11}. These are 8-mfd. electrolytic condensers and their postive leads connect together and to the cathode of the rectifier. Between their negative leads we have resistors R_8 and R_{11}. These two resistors therefore have the additional duty of replacing the more familiar filter choke.

The condensers have a reactance of approximately 80 ohms each at the ripple frequency. The frequency of the voltage applied to the plates of the rectifier is approximately 120 cycles due to the vibrator action, and the rectified ripple frequency will be twice this or 240 cycles.

It is possible to use resistors R_8 and R_{11} as resistive filters instead of using a regular filter choke, since their combined ohmic value is quite high compared to the reactance of C_{11} and C_{12} while still being low enough to not seriously reduce the D.C. supply voltage. Furthermore, as high fidelity is not a feature of this set, the A.F. section of the receiver is so designed that low frequencies on the order of 240 cycles or less are not reproduced very well.

Bias Considerations

The grid bias for the triode section of the 6Q7 tube is obtained by means of the voltage drop across resistor R_8. The grid connection, made through resistors R_9 and R_{10} to the junction of R_8 and R_{11}, is approximately 1.4 volts negative with respect to the cathode, which connects to the junction of R_7 and R_8. There may be voltage variations across resistor R_8, and these are filtered out by means of resistor R_{10} and condenser C_{14}.

The grid bias for the 6K6 type tube is obtained by means of the voltage drop across resistors R_7, R_8 and R_{11}. This is approximately 15 volts. Resistor R_{14} and condenser C_{16} serve to prevent bias voltage variations and hum across the bias resistors from getting into the grid input circuit of the output tube.

Point-to-Point Voltage Measurements

While it is possible to check the electrode voltages at the tube socket terminals, the manufacturer has indicated in the diagram strategic points at which the main supply voltages may be checked. First you will see the notation "200V" appearing on the plate supply line for the 6A8 type tube. This means that all points connected to this line should measure 200 volts to the chassis. The plate of the 6Q7 will be considerably less than this, due to the drop in resistor R_{12}, while the voltage between the plate and chassis of the 6K6 will be approximately 15 volts less than B+ due to the drop in the primary of the output transformer. The screen to chassis voltage of the 6K6 tube will be 200 volts since the screen is fed directly from the line marked 200V.

The screen voltage for the first detector and i.f. tubes is approximately 95 volts, as marked on the diagram. The C bias voltage for the 6K6 and 6Q7 tubes is approximately 15 volts and 3.6 volts respectively, as measured between the points indicated and the chassis. The initial bias for the 6A8 and 6K7 tubes is approximately 2.2 volts and exists across resistor R_7. The actual bias on the 6Q7, as pointed out previously, is not 3.6 volts since it only consists of the voltage drop across resistor R_8 which is 1.4 volts.

Point-to-Point Continuity Tests

With the set turned off, we can check the various supply circuits for continuity with an ohmmeter.

As you already know, those points supplied with a positive potential should show continuity back to the cathode of the rectifier, the most positive D.C. point in the set. As an example, place one ohmmeter probe on the plate of the 6Q7 and the other on the cathode of the 6X5 rectifier. Continuity will be indicated through resistor R_{12} and we will read a value of approximately 250,000 ohms on the ohmmeter. A check between the shield grid (electrode 4) of the 6A8 and the rectifier cathode will give us continuity through resistor R_4, with a reading of approximately 25,000 ohms. A check between the oscillator anode (pin 6) and the rectifier cathode will give us a resistance reading of approximately 30,000 ohms. The plate winding of the oscillator coil has a resistance of only 5.5 ohms and this would be negligible with respect to the value of R_3. If you suspect a defect in this winding, it must be checked individually with a low ohmmeter range.

We can now trace the continuity between those terminals supplied with a negative potential and either plate of the rectifier, the common reference point. Put one ohmmeter test probe on the top cap of the 6A8 tube, and the other probe on one of the rectifier plates. We will then obtain a reading through T_1, R_1, R_5, R_6, R_8, R_{11}, and one-half of the power transformer secondary winding. The cathode of the 6Q7 traces back through resistors R_8 and R_{11} and one half of the power transformer secondary. The control grid of the 6K6 traces back through resistors R_{13}, R_{14} and the power transformer secondary to one 6X5 plate.

Alignment

The i.f. alignment of this receiver is quite conventional. As an output indicator, we could connect a vacuum tube voltmeter across the diode load resistor R_6 or we could connect a low-range a.c. voltmeter across the voice coil. All adjustments are to be made for maximum output. The i.f. is 465 kc. as marked on the schematic.

The output of the signal generator, tuned to 465 kc., is to be connected between the top cap of the 6A8 type tube and the chassis. A reading will then be observed on the output meter and all four of the i.f. trimmers starting with the two on the second i.f. transformer are to be adjusted for maximum output. It doesn't matter whether we adjust the primary trimmer first or whether we start with the secondary trimmer. To be on the safe side, you can go over the adjustments two or three times. When a peak is finally obtained, the i.f. amplifier is correctly adjusted and the trimmers are not touched again.

The output of the signal generator is then connected to the antenna post and the receiver chassis. For best results, a dummy antenna which takes the place of the regular aerial may be used in series with the output lead of the test oscillator. This could consist of a 175-mmfd. (.000175 mfd.) condenser, as specified in the factory manual. One lead of the condenser may be connected to the antenna terminal of the receiver and the remaining lead to the ungrounded signal generator output lead. The variable condenser of the receiver is tuned to its minimum capacity position (plates entirely out of mesh) and the signal generator is adjusted to 1550 kc. The oscillator trimmer on the variable condenser is then adjusted for maximum output. The signal generator is then shifted to 1400 kc. and the signal is tuned in by rotating the receiver tuning condenser. The antenna trimmer which is mounted on the condenser gang is then adjusted for maximum output. The antenna and oscillator trimmers mounted on the condenser gang are not shown in the diagram.

The signal generator is next set to 600 kc. and this signal is tuned in at 600 kc. on the receiver dial. The padding condenser marked C_3 in the diagram is then adjusted for maximum output.

Now go back and check again at 1400 kc. If an adjustment is made, recheck again at 600 kc.

Trouble-Shooting With the Diagram

Let us suppose that the receiver is distorted and that by touching the top cap (control grid) of the 6Q7 and the chassis with your hand the distortion clears up. This definitely shows that excess bias is being applied to the 6Q7 and points to leakage in C_{15} as the cause of the trouble.

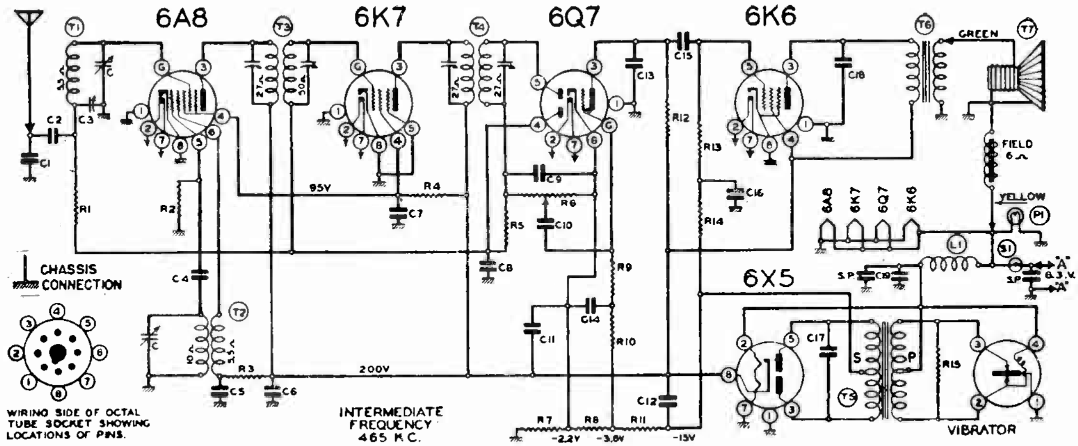
As we have already found out, the bias is due to the voltage drop across resistor R_8. A study of the diagram shows that the cathode currents of all tubes flow through this resistor.

Immediately we suspect some tube of drawing excessive plate current since the voltage drop is excessive across R_8. The 6K6 is the most likely offender, since it draws the most plate current. The diagram shows that leakage in condenser C_{15} would cause the plate current of the output tube to be excessive. We may check for this by connecting a voltmeter across resistor R_{13} with its positive probe going to the control grid of the tube. If voltage is measured, we withdraw the 6K6 type tube. If this causes the voltage to disappear, the tube is gassy. If the voltage is still present it is definite proof that C_{15} is leaky. Normally, no voltage should exist across resistor R_{13}.

You might think that a positive bias on the grid of the 6K6 would of itself cause distortion, but such is not the case, for the increase in plate current increases the voltage across resistors R_7, R_8 and R_{11} and maintains more or less normal bias for the grid of the tube. The increase in voltage across R_7, R_8 and R_{11} offsets to a certain extent the positive bias developed across R_{13} and R_{14} by leakage in C_{15}.

It is interesting to see why touching the 6Q7 top cap and chassis lets us diagnose the trouble as excess bias. Your body has resistance and between the fingers touching the top cap and chassis there is about 50,000 ohms. Connecting the top cap to the chassis through 50,000 ohms or so simply reduces the voltage between the control grid and cathode—your body in this case acting just like a resistor.

If the receiver squeals when a station is tuned in, we immediately suspect oscillation in the i.f.



TRUETONE MODEL D 746 BR.C. FACTORY NO. 577

Code No.	Part No.	Description
		RESISTORS
R1	130-186	250M ohm—1/10 w. 20%
R2	130-117	50M ohm—1/10 w. 20%
R3	130-164	30M ohm—½ w. 20%
R4	130-213	25M ohm—1 watt 10%
R5	130-126	3 megohm—1/10 w. 20%
R6	101-110	1 megohm volume control
R7	130-174	50 ohm—1/3 w. 10%
R8	130-211	30 ohm—1/3 w. 10%
R9	130-209	2 megohm—1/3 w. 20%
R10	130-210	1 megohm—1/3 w. 20%
R11	130-212	250 ohm—1 watt 10%
R12	130-186	250M ohm—1/10 w. 20%
R13	130-186	250M ohm—1/10 w. 20%
R14	130-186	250M ohm—1/10 w. 20%
R15	130-84	200 ohm—1/3 w. 20%
		CONDENSERS
C	102-69	2 gang variable condenser
C1	129-3	.00002 Mica 20%
C2	100-55	.01 x 400 v. 25%
C3	124-34	Antenna Trimmer
C4	129-12	.00025 Mica 20%
C5	100-20	.1 x 200 v. 25%
C6	100-85	.05 x 400 v. 25%
C7	100-20	.1 x 200 v. 25%
C8	100-9	.05 x 200 v. 25%
C9	129-5	.0001 Mica 20%
C10	100-78	.01 x 200 v. 25%
C11	119-50	8. mfd. lytic
C12	119-50	8. mfd. lytic
C13	129-2	.0005 Mica 20%
C14	100-78	.01 x 200 v. 25%
C15	100-55	.01 x 400 v. 25%
C16	100-19	.006 x 600 v. 25%
C17	100-34	.005 x 1200 v. 10%
C18	100-87	.01 x 600 v. 25%
C19	100-31	.5 x 120 v. 50-10%
		C11 and C12 in same unit
		PARTS
T1	111-95	Antenna coil complete
T2	110-76	Oscillator coil complete
T3	108-96D	Input I.F. 465 kc.—complete
T4	108-95C	Output I.F. 465 kc.—complete
T5	104-131	Power Transformer
T6	105-67	Output Transformer
T7	114-114	5" Dynamic Speaker
L1	105-19	"A" Filter Choke
P1	107-97	6.8 v. pilot light
S1		Off-on Switch on Volume Control
SP		Spark Plates

amplifier or the mixer. A glance at the diagram shows that this would most probably be due to an open in condenser C_7. We check for this condition by letting the set squeal and by connecting another condenser across C_7, or from pin 4 on the 6K7 tube to the chassis. If this stops the squealing, it's definite proof that C_7 is open and should be replaced. There is a possibility that an open in the plate by-pass condenser C_6 could cause the same trouble, and it is checked in the same manner as C_7.

If excessive hum is heard, we should be on the lookout for cathode-to-heater leakage in some of the tubes and for drying up of electrolytic filter condensers C_{11} and C_{12}. These two condensers should be checked by substitution being sure to observe the polarity markings of the test condensers by connecting their positive leads to the 6X5 cathode.

Motorboating or noise originating in the a.f. section of the set (check on this by removing the 6K7 type tube to see if the noise is still present) would cause us to suspect an open in condensers C_{14} and C_{16}, the a.f. decoupling capacitors. They should be checked for an open by substitution.

Distortion and audio oscillation may be due to an open in condenser C_{18}.

Excessive noise may be caused by worn vibrator contacts. In cases where it is not practical to remove the vibrator housing to see if sparking occurs at the contacts, a new vibrator should be tried, after checking condenser C_{17} by replacement and measuring the value of R_{16}. One terminal of this resistor must be disconnected when checking it with an ohmmeter so that a reading will not be obtained through the power transformer primary.

The spark plate condensers seldom if ever give trouble, although some vibrator hash may get into the receiver if C_{19} is open.

Weak signals coupled with distortion would lead you to believe that the speaker field was open. This wouldn't affect the application of correct voltages to the tube electrodes. A quick check may be made on the field by holding a screw-driver near the metal pole piece. If the field is energized there will be a pull on the screw-driver. If it is not, the field should be disconnected and checked with an ohmmeter.

If the receiver is dead and a circuit-disturbance test shows all stages to be alive, you would immediately suspect failure of the oscillator. This would most probably be due to lack of plate voltage on the oscillator anode grid, pin 6 in the diagram.

Immediately you would suspect a short or leak in condenser C_5, with perhaps opening up of resistor R_3. If these points proved to be in good condition, you would check the 5.5-ohm winding of the oscillator coil to see if it was open.

Trouble is sometimes experienced with this type oscillator if the oscillator grid resistor changes in value. A value lower than 50,000 ohms for R_2 will frequently cause the oscillator to be dead at the low-frequency end of the dial. Sometimes a value as high as 75,000 ohms may be used. If the resistor is made too high in value, the oscillator will intermittently block, particularly at the high-frequency end of the dial.

High-resistance connections in the oscillator circuit will cause the oscillator output to be poor at the low frequencies. If the oscillator stops functioning at the high frequencies, the oscillator coil probably has absorbed moisture and it would be best to install another.

Tracking failure of the oscillator and preselector, if not due to incorrect adjustment or a defect in condenser C_3, is probably due to the i.f. being aligned at the wrong frequency.

Blasting and distortion on strong local stations would indicate lack of a.v.c. voltage, and this in turn would probably be due to a short in a.v.c. filter C_8 or to a short between diode plate 4 and the cathode of the 6Q7 type tube.

RADIO OPERATORS AND TECHNICIANS ARE IN DEMAND

The Federal Radio Commission recently modified its rules so that now a man with a Radiotelephone second class license may act as an operator in a Broadcasting Station, provided the station is under the supervision of a man with a Radiotelephone, first class license. This change was put into effect to help meet the demand for operators. N.R.I. receives frequent calls from Broadcasting Stations for the names of licensed operators. Any N.R.I. men, with a radio operator's license, who may be interested in such a position are requested to place their name on file with our Graduate Service Department.

Opportunities for employment as Radio Mechanic-Technicians are offered by the Civil Service Commission to men who have had at least six months of full time paid experience in some branch of technical radio work such as radio electrician, radio engineer, radio repairman, radio operator, etc. Experience must be full time, not part time.

If you have the required experience and are interested, write to the United States Civil Service Commission, Washington, D. C. and ask for announcement No. 134, which gives full details. All inquiries should be addressed directly to the Civil Service Commission—not N.R.I. Only the Commission is in position to judge whether a man can qualify.

—n r i—

HELP AMERICA BE ON GUARD

BUY UNITED STATES DEFENSE SAVINGS BONDS

The Defense Postal Savings Plan for installment buying of United States Defense Savings Bonds offers a quick and easy way for every loyal man, woman and child in this country not only to put aside funds for future personal needs, but at the same time to give valuable help toward national defense. You will be surprised and much pleased to find how quickly you may through frequent purchases of Defense Savings Stamps accumulate funds for the regular purchase of Savings Bonds, and how many of these Bonds you may own through these convenient partial payments. Defense Postal Savings Stamps may be purchased in denominations of ten cents, twenty-five cents, fifty cents, one dollar and five dollars. See your local Postmaster. Buy a share in America.

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.*

RCA VICTOR 98T — MOTORBOATS

Dress the filter capacitor leads away from antenna coil.

—n r i—

RCA VICTOR 99-K — FADES AFTER FEW MINUTES OF OPERATION

The .01 condenser which couples the antenna coil to the control grid of the 6A8 partially opens and should be replaced with another .01 mfd. 600 volt unit.

—n r i—

RCA VICTOR QB2 — REACTIVATING RECTIFIER

The "A" supply in the CV-112 power unit (used in Model QB2) is supplied through a copper-oxide dry disc rectifier. If the radio ceases to operate or drops off in performance, it may be due to a chemical change in this rectifier, which causes the "A" voltage to drop low enough to affect the performance of the receiver. The normal "A" voltage is 1.5 volts. To reactivate the rectifier it is only necessary to short the "A" plus and "A" minus terminals of the socket by connecting them together with a piece of wire for a period of four minutes. The high temperature developed in the rectifier during this period has the tendency to restore the discs to their normal rectifying ability.

—n r i—

RCA VICTOR RP-153 RECORD CHANGER — MOTOR DATA

Should it be necessary to rebuild or service any of these motors in the field by replacing end heads or using new rotors and shafts, it must be noted that the rebuilt motors should be operated continuously for at least 48 hours before installation. The use of bronze bearings, diamond-bored for accuracy, together with the burnished steel shaft at the rotor provides a very close fit. As a result, the motor must be run in approximately 48 hours, after which the oil has had a chance to fairly cover all contact surfaces of shaft and bearings, and a very smooth operating, long life bearing results.

ZENITH 6D-525 — PILOT LIGHT BLOWS

If the pilot light blows it is due to the second filament in the 35Z5 which shunts the pilot light. Replace with a new tube. Also on Zenith push button sets—if trying to align push buttons, always use an outside aerial connected to set, as the signal pick-up with the loop is too small and push buttons will not tune to the small signal response.

C. N. STAUDTER, New York.

—n r i—

AIRLINE 1106 — WEAK ON LOW POSITION OF BASES CONTROL

Resistor connected across bass control lies too close to switch so that contact lever touches its lead when switch is in low position. Bending leads of resistor away from control will correct trouble.

NAT JONES, Idaho.

—n r i—

AIRLINE 1112A AND OTHER 1942 MODELS WITH AUTOMATIC RECORD CHANGER — WILL NOT TRIP AT END OF RECORD

Lift tone arm (pick-up) and you will find a small coil spring the tension of which may be adjusted by turning a small ratchet-like washer. This spring tends to counteract the weight of the tone arm. Decreasing its tension allows the needle to set more firmly in the record groove. The ratchet may be turned with the aid of a small screwdriver.

NAT JONES, Idaho.

—n r i—

BELMONT MODEL 550 — DEAD

If plate voltage drops to about 80 volts after chassis heats, examine the r-f input transformer. The lugs inside the can may short to the windings and feed plate voltage from the 2A7 coil to the 58 grid coil. Bend the lugs away or cut off their ends.

—n r i—

BELMONT MODEL 729A — DEAD

If a set is dead but tubes and voltages test O. K., move the brown lead from green lead on speaker terminal board to the black lead.

Page 25, please

EVEN YOUR BEST FRIEND *WILL* TELL YOU

A Fiction Story with a Moral

BY L. L. MENNE

BILL JONES was hurrying down the street. It was bowling night and he wanted to get in a few practice rolls before the matches began.

"Hello, Bill," came a voice. Bill slowed his pace and looked into the face of his old friend Fred Brown, whom he had not seen for sometime. "Why you old son-of-a-gun," exclaimed Bill, at the same time extending his hand. "I am mighty glad to see you. What have you been doing with yourself?"

"Oh, this and that," replied Fred. "I've been knocking around picking up some odd jobs here and there but nothing permanent. Right now I am out of work. Do you know of anything I can get?"

"Offhand, I don't," said Bill. "But suppose you come over to see me at my house tomorrow night. I will be glad to talk with you. I must ask you to excuse me at the moment because I am bowling with our team in the Business Men's League tonight and I must hustle along to make the starting time. You know where I live—same place—I'll look for you at seven o'clock."

"O. K. I need some help and I'll be there," was the parting reply from Fred. With this Bill was on his way again.

Fred also was on his way but his step was much slower than Bill's. He wasn't going anywhere in particular. He wasn't in the mood to play—to relax—he was out of a job and had to conserve his cash. He had plenty on his mind without fooling around with things such as bowling matches. Yet he could not refrain from taking a backward look at Bill. He had been impressed with his neat appearance—good clothes—not flashy but giving every indication of a man who could afford something new now and then. Contented, sure of himself. Enjoying life. "What's that guy got that I haven't got? I am going to find out tomorrow night. I'll be there, you bet." Fred said to himself.

Came the next evening. All day Fred had looked forward to his meeting with Bill. But he misjudged the time required to get to Bill's place and it was almost 7:30 when he got there. "Come in," said Bill. "I've been looking for you. Meet my wife. The baby is asleep but if she wakes up we'll give you a peek at her. She's a honey. Sit down and tell me about yourself."

"Well," began Fred, "there isn't a heck of a lot to tell you. I've tried my hand at several things but I don't seem to have much luck. I was working over in Springfield until last Saturday. I quit because I didn't like the work. I felt I wasn't getting anywhere. I'd like to get in on some of this dough other fellows seem to be making. I am willing, able-bodied, there must be a place for me. I am getting a little discouraged because I don't seem to get going no matter how hard I try."

"Well, Fred," cut in Bill, "I am no expert but I have been doing pretty well and perhaps I can make some suggestions which may help you. How hard have you tried to get a good job? Just what have you done? What prospects do you have now?"

"Not much of any," replied Fred. "I guess I am a little backward. You see, Bill, I seem to lose my nerve when I go in to see a man about a job. I am afraid of being turned down again. So I tried writing a few letters of application and I hope something will come of that."

After a half hour of conversation along this line, Bill, who had been listening patiently, now took the initiative. "Pal, let me tell you what I think may help. And let me be frank because when you talk to a man about a job you are talking about the one thing upon which all of his other actions depend. Nothing is more important —so we can't beat around the bush."

"To begin with, you have never really prepared yourself for a job. Now be honest with yourself. You have nothing to offer an employer except a willingness to work hard. It takes more than that, Fred, to get out of the great crowd at the bottom of the ladder. Take my case, for example. I studied Radio in my spare time. I looked ahead. I saw I had to do something. I wanted to have some specialized training. It was up to me and I resolved to do something about it. It wasn't easy to study when other fellows were having a good time. I felt like giving up more than once. But the school gave me every encouragement. I knew I had only to do my part. I knew too, that there is no place in this world for a quitter. Soon things started to come easier. I found the course more interesting. Then I couldn't get enough of it. And today I am being paid real money not alone for what I do but for

Page 26, please

The Service Forum (Continued from page 23)

BELMONT MODEL 420 — OSCILLATION
Replace the resistor in the cathode circuit of the tube as it changes greatly in value.

n r i

AUTOMATIC MODEL P-40 — NO RECEPTION
To check the filter for shorts, remove output tube as the tube filaments complete the ohmmeter circuit to form an apparent short when testing.

n r i

RCA VICTOR MODELS 121, 122 — TWO POINT TUNING DISTORTED BETWEEN POINTS
Check i-f grid filter condenser for leakage as this will remove the AVC voltage and cause the stated effect on powerful locals.

n r i

RCA VICTOR MODEL U-40 — CUTS OFF AND ON DURING RECORD REPRODUCTION
Check the pickup shorting switch adjacent to tone arm on underside of changer to see if it has a spring out of adjustment or bent.

n r i

RCA VICTOR MODEL 811K — NOISY ON ELECTRIC TUNING
Connect a .1 mfd. 600 volt condenser from the hot side of the tuning motor to the chassis.

n r i

RCA VICTOR MODELS 101, 104 — MOTOR INTERFERENCE AFTER A FEW MONTHS OPERATION
Check the lead-in shield for a break where it connects to the set. To remedy, slide a piece of shielding over the lead and solder.

n r i

BOSCH MODEL 38 — WEAK AFTER REPAIR
Take care when replacing the chassis to keep the volume control shaft from grounding.

n r i

CROSLEY MODEL 617 — NOISY AND INTERMITTENT
Tighten the 6A8G socket clamps and realign as sensitivity and selectivity are affected by vibration of Dynatrol.

n r i

CROSLEY MODEL 648 — INTERMITTENT
Replace the 60,000 ohm resistor connected from the 6A8 oscillator grid to the chassis. A half watt or one watt resistor may be used.

n r i

CROSLEY MODEL 566 — MOTORBOATS AS VOLUME IS RAISED
Eliminate the motorboating and improve tone with 25 mfd. 25 volt electrolytic. Connect the condenser negative lead to the B minus terminal in chassis and the condenser positive lead to the on-off switch terminal which connects to resistor 26 in the diagram.

CROSLEY MODEL 6625 (SET USING 6B5 POWER TUBE) — SET LACKS VOLUME
If you find all the plate voltages low, this is usually caused by a leaky 0.05-mf. coupling condenser from the type 76 tube to the grid of the 6B5.

n r i

CROSLEY MODEL 955 — INTERMITTENT AND NOISY
Check the 1,100 ohm bias resistor connected from the cathode of the 6C5 driver tube to ground. This is a flexible resistor and marked No. 46 on the factory diagram.

n r i

CROSLEY MODEL 629 — FADES
Set fades on Radio and Phono position. This complaint may be caused by the 0.006-mfd. condenser connected from the center lug of the volume control to the 6Q7G tube socket.

n r i

CROSLEY MODEL 726 — DEAD
Set dead and no screen grid voltage on 6A8 and 6K7 I.F. tube. In this case, check the 16,500 ohm section of the candohm resistor. This resistor is marked 57-Z on the factory diagram.

n r i

CROSLEY MODEL 1117 — INTERMITTENT HUM
Install a lock washer on the top of the chassis under the 40 mfd. electrolytic condenser and solder a heavy copper braid from condenser nut to chassis.

n r i

CROSLEY MODEL 1516 — REPLACING VOLUME CONTROL
The original dual control can be replaced with a single control. Use a one meg tapped control to replace front section, leaving out resistor connected from low side of control to ground. Connect a one meg resistor in place of rear section. Also applies to other Crosley models with a similar dual control.

n r i

CROSLEY MODEL B425 — RECEPTION ONLY WHEN 22½ VOLT C BATTERY IS DISCONNECTED
Check 2,000 ohm flexible resistor on volume control for open.

n r i

FORD MODEL F-1740 — SET DEAD
3300 ohm ½ watt resistor in RF and detector plate supply is burned out. Replace with 1 watt unit. Condition is usually due to short or intermittent short in I.F. cans.

EVEN YOUR BEST FRIEND WILL TELL YOU

(Concluded from page 24)

what I know. So much for that. It is you I want to talk about."

"Here is what I advise you to do. Learn something. Man alive, with this war program going on there is an urgent need for men—but men with specialized training get the best jobs. There's the first thing you've got to do. Take a correspondence course like I did. Get a job, work in the day time—study a few hours each night. It is the perfect set-up for the man who must learn while he also must have an income. Some fellows can afford to go to college and other resident schools but most of us can't. But we can study by correspondence. Do you know that approximately 750,000 American people are studying by correspondence right now! Where do you fit in with the competition of an army of people of that size with specialized training? These people are determined to pursue organized study despite a multitude of varying adverse circumstances which make it impractical or impossible for them to attend resident classes."

"Now, to get a job while you are preparing yourself for something bigger you must also do some planning. Letters of application are all right if you will prepare them completely, neatly and mail them out at the rate of five a day. Only a few employers will answer so get out as many as you can as quickly as you can. Don't write a few letters and then sit back to await results. That's too slow and uncertain. But don't write a letter if you can possibly make a personal call. The best letter in the world still leaves much to be desired. The employment manager likes to look into the face of the applicant to size him up. No one ever got a good job without a personal interview. So get around to see these people."

"That brings up another point. Why should you be backward about asking for a job. Nothing is more honorable. Sell yourself. Act as though you have supreme confidence in yourself. Do a good selling job. Often an employer will make an opening for a man because he is impressed with the applicant and feels he is the type of man he would like in his organization. So, remember, to speak right up when you are asked a question. Act alive. Let your prospective employer feel that you will make good if given a chance."

"One thing more. Always be punctual in keeping appointments. You were going to be here at 7:00 o'clock—you didn't get here until 7:30. I noticed that. An employer would notice it too and probably would close his mind to anything you might have to say even before you got started. So, remember that, too."

"Now go to it. Get started on that course. Go home and map out a plan for the next year. Then put all of your energy into it to make it work. That's what I did and it got results. It is always a pleasure to help a man who is trying his best to help himself. You've got to have something to offer. Unless you have you must make way for the fellow who has. You know that as well as I do."

"I sure do," responded Fred. "You've got the right dope. I've known it all along but I thought I could get by some other way. I am going to take your advice. I will get lined up for that course of training right away. I'll be back to see you about that in a few days to get your slant on my plan. Tomorrow I am going to get around to see some of the people I've been writing to. I'll bet my applications have been filed. They'll probably never dig them out. Heck, what's the matter with me. If you can make good so can I. I haven't gone about it right. You have given me new confidence. Watch me make each day count from now on. And say, Bill, perhaps some day there will be a place for me on that bowling team too."

"Could be," said Bill. "Just like in business there is always room for good men but you've got to be better than average."

"I get it," exclaimed Fred as he started to depart. "You watch my smoke from now on. My mind is made up."

n r i

OUR COVER PHOTOGRAPH

Our cover photograph shows Student DeWitt Sawyer of Fitchburg, Mass., at study. This photograph appealed to us because it portrays a well organized study room, typical of a great many found in the homes of N. R. I. students. Mr. Sawyer has been a student slightly more than a year. That he has made good progress is evidenced by the exhibits in the picture.

n r i

CIVILIAN TECHNICAL CORPS

A letter to J. E. Smith, from the Civilian Technical Corps, informs us that five N. R. I. students, namely, Donald Perrin, Rex Goode, Hugh Reynolds, Delus A. Beekman, and Byron Pierce Wilcox, are now enrolled as members of the Civilian Technical Corps, and are on duty somewhere in England. The letter emphasizes that this is quite an honor because the men were required to pass a difficult technical examination which a large percentage of men applying, failed to pass. These men passed with flying colors.

N.R.I. ALUMNI NEWS

Edward Sorg .... President
John Stanish .... Vice-Pres.
Peter J. Dunn .... Vice-Pres.
Louis J. Kunert .... Vice-Pres.
Chas. J. Fehn .... Vice-Pres.
Earl Merryman .... Secretary
Louis L. Menne .... Executive-Secretary

OFFICERS OF THE N. R. I. ALUMNI ASSOCIATION

EARL A. MERRYMAN *SECRETARY*
EDWARD SORG *PRESIDENT*
LOUIS L. MENNE *EXECUTIVE SEC'Y*
JOHN STANISH *VICE PRESIDENT*
LOUIS J. KUNERT *VICE PRESIDENT*
PETER J. DUNN *VICE PRESIDENT*
CHAS. J. FEHN *VICE PRESIDENT*

Here and There Among Alumni Members

John Thomas Wright of Fayetteville, N. C., advertises his Radio Sales and Service with the slogan, "We Bring 'Em Back Alive."

——— *n r i* ———

Coleman C. Wilcox recently accepted a position with the Kansas City, Mo., Police Department as Radio Operator. Says they have a nice layout—the salary is good—and future is bright.

——— *n r i* ———

William A. Locke is Assistant Station Manager and Radio Operator for Inland Air Lines, Inc., at a station in the middle west.

——— *n r i* ———

From Johnson City, Tenn., comes a letter from W. Miles English, who has steadily been employed as a Radio Technician for ten years, informing us he is getting ready to enter government service. There is a man who will bring some valuable experience to our Uncle Sam.

——— *n r i* ———

Harold Snyder of Baltimore chapter is all puffed up because his baby daughter cut two teeth when she was only eight weeks old. It's a fact. Harold says she pounds the table for a steak.

——— *n r i* ———

Peter Maydan passed the examination for a Certificate of Proficiency in Radio, Province of Manitoba, Canada. He secured a grade of 98%. As a result he immediately stepped into a good position as Operator in Trans-Canada Air Lines.

——— *n r i* ———

John Sergent is fast gaining a reputation as one of the best Radio Servicemen in Eastern Kentucky. His place of business is at Seco, Kentucky, a small community, but plenty of business comes to Sergent from the surrounding territory.

——— *n r i* ———

N. F. Salmon is Radio Operator for the Police Department, LaGrange, Ga. This is Salmon's first job as a Radio Operator.

——— *n r i* ———

Dale Boughner is with the Signal Corps, as Operator in charge of one of Uncle Sams radio equipped reconnaissance cars. A reconnaissance patrol, of course, means getting up ahead of the main body of soldiers to make a survey — see what's out there. Boughner has had several boosts in pay and expects another soon. Radio training has certainly payed good dividends to our N. R. I. men in the Service. They are doing a great job.

——— *n r i* ———

Another N. R. I. man who deserves special mention is Robin David Robins, better known as Dave, who is Chief Radio Officer on a merchant boat and doing a splendid job of it. Dave's father, who is Secretary-Treasurer for a big bank in Canada, sent us a photograph of Dave. What a fine looking man he is in that nifty uniform!

Clarence C. Stine says 1941 was his best year to date and he has had some mighty good ones. Has a very high grade store and shop at 1039-41 West Florence Street, Los Angeles, where Mr. Stine, Mrs. Stine and son, also an N. R. I. man, are steadily at work, each with a department to handle.

——— *n r i* ———

J. Frederick Darby is Inspector of Radio for the U. S. Navy Department in one of our large cities in the middle west. Swell pay—interesting work. He likes it very much.

——— *n r i* ———

Herman J. Massaro is doing a big job in civilian defense. He is constructing trans-receivers for cities and towns in New England.

——— *n r i* ———

Murray Dickson of Paducah, Kentucky is Radio Engineer in charge of the radiophone equipment used on a fleet of boats operating on the inland waterways. This is one of the most interesting jobs in Radio.

——— *n r i* ———

Coleman Augustine, ran a spare time Radio business from his home for some months after graduating. This primed him for a full time job as head Serviceman at WLOG Service Department, the biggest shop in Logan, W. Virginia. These people are also operators of Radio Station WLOG.

——— *n r i* ———

C. S. Fletcher of Gainesville, Texas, not only is a good radio man but is also just about ready to take the Bar Examination to practice Law.

——— *n r i* ———

Wilfred Schmidt of Halethorpe, Maryland is the father of a boy—now two months old.

——— *n r i* ———

Gerald W. Peterson is Chief Engineer, in charge of all technical operations, at Station KOVO, Provo, Utah.

——— *n r i* ———

Edwin Christensen now has his own radio service shop in Haxtun, Colorado.

——— *n r i* ———

Dan Droemer is Radio Operator in the Cavalry at an Army Fort in Texas where he is Squadron Communication Sergeant.

——— *n r i* ———

Carlton Haines of Clancy, Montana has student Millard Edgmond helping him in his spare time radio business.

Chicago Chapter

Our annual election was held and the following will serve as officers for the ensuing year.

Chairman—James Cada
Vice Chairman—Stanley Lukes
Secretary—Harry Andresen
Financial Secretary—Clarence Schultz

These officers will make recommendations to the chapter for appointment of various committees, which will be announced as soon as completed.

Jimmy Cada, our new chairman, served us so efficiently as Secretary during the past year it was proper that he should be elevated to the chairmanship. He is a tireless worker and we know that he will do his job well.

Stanley Lukes, James Cada, Harry Andreson and Clarence Schultz, newly elected officers of Chicago Chapter.

We are all very proud of the fact that our own Ed Sorg was elected National President of the N. R. I. Alumni Association.

Mr. Coleman of Radolek spoke to us at one of our meetings. He gave us a splendid talk. He also invited us to hold one of our meetings at their establishment at 601 West Randolph Street in Chicago—an invitation which was enthusiastically accepted.

Stanley Lukes took over one of our meetings and talked to us on burned out tube elements, frequently going to the black board to clarify his remarks. A door prize consisting of a condenser kit was won by Theodore Cabriel.

Our next meeting, held at Radolek Company, was an especially good one. Mr. Braun, President of Radolek gave us a talk on the responsibilities of radio servicemen in these times of emergency. He made some good points in connection with cut throat competition, something which we are all trying so hard to overcome.

At this same meeting Mr. Porth of Burgess Battery Company, also gave a talk on the various types of "A" batteries and their uses. Many interesting questions were asked, all of which, were fully answered by Mr. Porth.

At another meeting our ever reliable Earl Bennett gave us a talk on radio servicing problems and their solutions. After the meeting refreshments were served.

Our average attendence is about fifty and often we go well over this number.

We have arranged to hold our April meeting at the Chicago Lighting Institute where we will have a show presented that will last at least an hour and a half. Anyone interested in information regarding these meetings is requested to get in touch with chairman, James Cada, 2511 South Highland Avenue, Berwyn, Ill.

H. ANDRESEN, *Secretary.*

n r i

New York Chapter

Chairman Gordy gave us a splendid talk on Frequency Modulation. At another meeting, one of our members Mr. Donald Hildesheim, aided by our ever present Ralph Baer, presided at our open forum. Much time was given to a discussion on the Wheatstone Bridge.

This meeting proved so interesting we called upon both of these gentlemen to preside at another meeting. They are very capable radio men who have the knack of getting their information over to the fellows.

We plan to devote some of our coming meetings to a study of Code. This is a subject of great interest right now.

Gordy has joined Uncle Sam in an important Defense job. He is leaving New York and, of course, it was necessary for him to resign the Chairmanship of the chapter. We are all sorry to see Gordy go. His resignation was accepted with genuine regret and we gave him a great big vote of thanks for his splendid services to our chapter. Men, such as Gordy, are needed by the government and we know he will do a top-notch job for Uncle Sam.

A new chairman will be elected, next meeting.

We are just about ready to begin work with the N. R. I. experimental kits. We are all looking forward to this practical work. We have many other good things in store for our members.

Meetings, as usual, on the first and third Thursday of each month, at Damanzek's Manor, 12 St. Marks Place, (between 2nd and 3rd Ave.) New York City.

L. J. KUNERT, *Secretary.*

Baltimore Chapter

A call of the roll shows that several of our regulars have enlisted. Some are in the Army and Navy, others in Defense Industries and still others in Civilian Defense. Greetings to H. J. Waters, our most recent volunteer who is now at a Navy Training Station.

Mr. John Grasser is an Air Raid Warden for his district. Mr. Pete Dunn is also an Air Raid Warden. Mr. G. C. Phillips and Mr. L. J. Arthur are Aircraft Spotters. Several others are lined up with civilian defense.

Our chapter has been continuing with our lecture experiment set-up. Mr. H. Z. Snyder and Mr. H. J. Rathbun are cooperating in giving us interesting talks, profusely illustrated, and with experimental proofs. These interesting experiments have been of great help to our members.

For the sake of variety, Mr. Snyder devoted one meeting to an oscilloscope demonstration. He showed the uses for this instrument, the various patterns which could be obtained, effects of overloading, distortion, etc.

The chapter is conducting a raffle for a Defense Bond. Mr. B. J. Ulrich is chairman of a committee which is pushing the sale of tickets—just another demonstration of our desire to do everything possible for National Defense.

Mr. J. B. Straughn and Mr. L. L. Menne, drop in on us occasionally and, of course, we always prevail upon them for some remarks. Mr. Menne inducted Mr. Dunn into his office of National Vice President with an impressive formal but simple ceremony. Congratulations Pete! All our good wishes go with you during your 1942 term as a National Officer.

Mr. Marsh brought in a receiver which was giving him a great deal of trouble. Mr. Straughn acted as trouble shooter for the benefit of all present, and soon the receiver was in working order. An open cathode circuit proved to be the defect.

Upon adjournment the boys stepped to the back of the hall for "elbow bending" exercises with the compliments of our very popular chairman, Mr. E. W. Gosnell, who provided the refreshments.

Our publicity director, Mr. L. J. Arthur, is doing splendid work. His services are very much appreciated.

If you live in the Baltimore area, you are welcome to join us any second or fourth Tuesday at Redmen's Hall, 745 W. Baltimore Street, 8 P. M.

B. G. Ulrich, Secretary.

A slip of the lip may sink a ship.

Detroit Chapter

Election of officers is announced as follows:

Chairman—John Stanish
Vice Chairman—Harold Chase
Sec'y.-Treas.—F. Earl Oliver
Ass't Sec'y—Wm. Ankeny
Librarian—Troy Hunt
Ass't Librarian—H. R. Stephens

Attendance at our meetings is steadily going up. At our last meeting we appointed a committee to contact old members to bring them back into the fold, now that so much can be gained by association with us. This same committee will also get in touch with N. R. I. men in this area, who have not yet joined us, to invite them to meet with us. This is a time when Radio men are much in demand. We can be of real help to one another.

A group of Detroit chapter members listen attentively to a talk by chairman John Stanish.

We meet regularly on the second and fourth Friday of each month at John Stanish's place of business, 2500 Jos. Campau. Stanish, who was re-elected chairman by unanimous vote, is a real live wire and every meeting is full of action.

Get on the band wagon with Detroit chapter. We are going places.

F. Earl Oliver, Secretary.

—n r i—

Philadelphia-Camden Chapter

Secretary Harold S. Strawn reports that things are moving along nicely with Phila.-Camden chapter. Meetings are held regularly, at their new location, Freas Shop, N. E. corner, Atlantic and Emerald Sts., Philadelphia.

This chapter meets on the first and third Thursday of each month.

Liked Recent Articles

I want to compliment Mr. J. E. Smith and Mr. E. R. Haas for the many inspirational introductions which are found on the inside cover of NATIONAL RADIO NEWS. Mr. Smith's, "A plan for Today," which was published in an issue of some months ago, was without a doubt, one of the finest I have ever read. I also liked the following articles, "A Yardstick for Comparing Radio Receivers," "Color Television," and "Isolating the Defective Stage," your, Service Forum and, Novel Radio Items.

JOSEPH F. STOFKA, Kingston, Penna.

n r i

A Shop Hint

A Common little copper bristle brush sold in the dime stores for cleaning suede shoes makes an excellent brush for cleaning the tip of your soldering iron—saves the wear and tear on the point.

LEO E. COLLINS, Brooklyn, N. Y.

n r i

Visitor Is Impressed

When I was in Washington I visited N. R. I. and had a nice long talk with Mr. Dowie. He was just as I expected he would be, but I was surprised at the size of "Our School." Sure is a nice place you have there.

ARNOLD R. DILLEY, Richwood, W. Va.

n r i

N. R. I. Text In High Places

You may be interested to know that I noticed the N. R. I. course neatly bound in the bookcase in the examining room of the F. C. C. at Dallas; also saw a few copies of NATIONAL RADIO NEWS.

CECIL MILLER, Sherman, Texas

From A Proud Mother

On July 1, 1940 my son enlisted in the Army Signal Corps. He is now acting Chief Radio Operator and is also a Radio Technician. Being an N. R. I. graduate has been a wonderful help to him, and has aided him to advance with special ratings. He was one of forty trained men who were picked for special work, and he, with ten others was sent to ————————.

MRS. W. A. JOHNSON, Sidney, Iowa

n r i

Vacuum Tube Voltmeter

Extend to Mr. Wm. Franklin Cook my sincere appreciation for his two articles on "The Vacuum Tube Voltmeter." I recently acquired a good vacuum tube voltmeter and bought two relatively expensive books on the subject. They failed to give me the needed insight. Then along comes good old NATIONAL RADIO NEWS with two comprehensive articles containing just exactly the information for which I had been searching.

JESSE O. STARR, Washington, D. C.

n r i

Service Forum And Puzzling Radio Questions

I just finished the NATIONAL RADIO NEWS and think it is swell. I like the Service Forum and Puzzling Radio Questions.

JOHN G. SCHROEDER, Gretna, Man., Canada

n r i

N. R. I. Training Helps This Soldier

Here at Fort Monmouth I have been side by side with graduates of many well known radio schools. Thanks to N. R. I. training I have been able to hold my own in all subjects. My grades have averaged better than 95%, which is considerably above average."

THEODORE C. YOUNGMAN, Fort Monmouth, N. J.

Secretary Merryman Is With F. C. C.

Earl A. Merryman, Secretary of the N. R. I. Alumni Association since it was organized in 1929, is on duty with the Federal Communications Commission as Monitoring Officer in Charge, in one of our large southern cities. Earl wrote Mr. Smith as follows:

"I have been so busy absorbing some new fangled ideas about this Monitoring work, I have had no opportunity to reply to your recent letter until now.

"You have always known how close to my heart has been the good old N. R. I. and if anybody thinks they can take that Secretary's job away from me, well, they have another thought coming. My home is still Washington, D. C. This work takes one here and yonder, if you know what I mean.

"J. E., you would be very pleased if I told you how many men I have met since I have been with the Commission this year and a half. I have never heard anything but praise for you and the N. R. I., and you know I still sing the praises to the high heavens at every gathering where good radio men get together.

"I would like you to say hello to all my friends who have made the N. R. I. Alumni Association such a success since we started it way back in 1929. It is now more than 12 years ago, when Fetzer, Moore, Murray and the rest of that old gang got together with the late Charles Curtis, Vice-President of the United States, at the Capitol and we inscribed our names to the grand old loving cup that adorns the hallway at 16th and U Sts., N. W.

"Greetings to you and all at old N. R. I. I hope to see you soon but at present, like a great many N. R. I. brothers, I am going 'all out' for victory, wherever I may be needed."

Sincerely yours,
EARL A. MERRYMAN
Monitoring Officer in Charge
Memphis, Tenn.

n r i

Allied's New 1942 Catalog

Allied Radio Corporation, Chicago, announces the release of a new 1942 Spring and Summer catalog, designed to supplement the 1942 Fall and Winter catalog by bringing prices up-to-date and keeping pace with the latest developments.

The new edition is a complete catalog in itself, offering "Everything in Radio and Electronics" from a single source of supply. It contains thousands of quality parts from the nation's leading manufacturers. This new 1942 Spring and Summer catalog may be had free of charge from Allied Radio Corporation, 833 West Jackson Boulevard, Chicago, Illinois.

NATIONAL RADIO NEWS

FROM N.R.I. TRAINING HEADQUARTERS

Vol. 10 No. 2

April-May, 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

Index