NATIONAL RADIO NEWS

BEST WISHES FOR A MERRY CHRISTMAS .... AND A HAPPY NEW YEAR

IN THIS ISSUE

Voltmeters and How to Use Them

Circuit-Disturbance Testing

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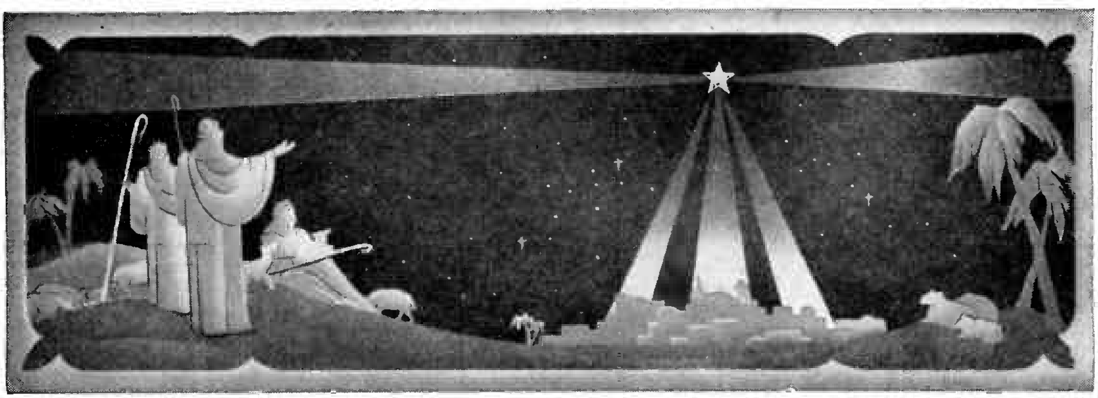
Christmas Greetings

The spirit of Christmas again calls us to a deeper appreciation of old associates and the value of new friendships.

May you have a very Merry Christmas. And may we hope that during the New Year those of our families who are serving us so gallantly in our Armed Forces will be able to return to our homes to carry on their peaceful pursuits in our accustomed happy manner of living.

J. E. Smith, *President*
E. R. Haas, *Vice-President.*



VOLTMETERS AND HOW TO USE THEM

By RAYMOND SCHAAF
W9KVG/3
N. R. I. Consultant

BY definition, a voltmeter is an instrument for the measurement of electrical pressure. Usually it consists of a low range d.c. milliammeter and a series resistor to limit the meter current to the full scale value when measuring a predetermined voltage value.

As an example, a 1-milliampere meter may have a resistance of 200 ohms. The voltage required for full-scale deflection is $E = I \times R$, or $.001 \times 200 = .2$ volt. Hence, we can use this meter as a 0—.2 voltmeter. This range is too low for ordinary servicing purposes but we can increase it by increasing the meter resistance.

Increasing the resistance of the meter movement itself, however, is not practical so resistance is added in *series* with the movement. This makes it necessary to apply a higher voltage to drive full-scale current through the meter. Thus, if 800 ohms resistance were added to the 1-ma. meter in the example above, 1 volt would be needed to give a full-scale reading.

By adding sufficient resistance, any desired voltage range can be obtained.

As with current meters, a single meter having several ranges is desirable so a low basic range is usually chosen and then additional resistors are connected in series to extend the range further. A typical switching arrangement is shown in Fig. 1.

Resistor R_1, together with the meter resistance, determines the basic voltage range. Then other resistors are added by the selector switch to obtain the desired extensions.

Many commercial test instruments (particularly the "pocket" type) combine the functions of voltage, current and resistance measurements and use a single meter. Figure 2 illustrates a typical "multimeter." The same precautions must be observed in using the voltmeter portion of such an instrument as would be observed were the instrument a simple voltmeter only.

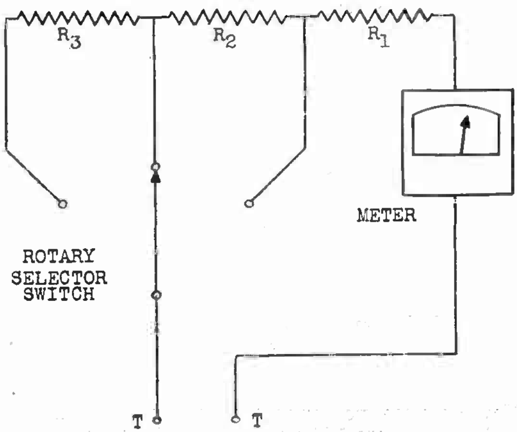


Fig. 1. Schematic of multirange voltmeter using rotary range selector switch.

Current flow through the meter of Fig. 1 can be interpreted in volts because the resistance of the meter is a constant and known factor. The current to operate the meter must come from the source being measured. Thus, the source must furnish not only the normal current taken by the load but the amount of current required to operate the meter. This is true because the voltmeter is connected *across* the terminals where the electrical pressure (voltage) is being measured.

When the source has a low internal resistance (as is the case with a good battery) and the source is not supplying appreciable current to a load, the current taken by the voltmeter scarcely matters. However, *if there is appreciable resistance in the source, or between the point of voltmeter connection and the source, the readings will vary with the sensitivity of the voltmeter.*

Sensitivity

As a practical example of a typical radio circuit, consider Fig. 3. Suppose that resistor R_1 has a value of 50,000 ohms and the tube plate-to-cathode resistance is 25,000 ohms. The total resistance is then 75,000 ohms so 4 ma. flows from the 300-volt source ($300 \div 75{,}000 = .004$ ampere).

Fig. 2. Typical pocket type commercial multimeter.

Now suppose we connect a voltmeter as shown. Will it indicate 100 volts? This depends on the current taken by the meter which must flow through resistor R1 in addition to the plate current. In other words, the meter is in parallel with the tube resistance so our circuit is really that shown in Fig. 4. A few practical cases will help you see what happens.

Case 1. If the voltmeter in Fig. 3 has a 100-volt range which requires 10 milliamperes for full-scale deflection, its resistance $R_M = E \div I$, or 10,000 ohms. This resistance is in parallel with the tube resistance R_P of 25,000 ohms, as shown in Fig. 4, so the resulting parallel combination of meter and tube is

$$R = \frac{R_P \times R_M}{R_P + R_M} = \frac{25{,}000 \times 10{,}000}{25{,}000 + 10{,}000} = 7100 \text{ ohms}$$

approximately. This value is in series with the 50,000-ohm resistor R_1 so the total circuit resistance has changed from 75,000 ohms to about 57,100 ohms.

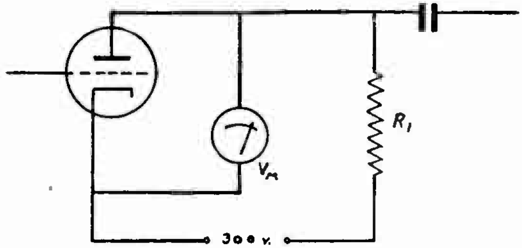


Fig. 3. A practical voltage-measuring problem. The meter reading depends on the ohms-per-volt sensitivity of the meter.

The new total current from the 300-volt source is about 5.25 ma. ($300 \div 57{,}100 = .00525$ ampere). This current through R_1 gives a voltage drop of 262.5 volts, leaving only 37.5 volts for the parallel tube and meter combination. In other words, the tube plate voltage is now only about 7/57 of the total, instead of 1/3. (The ratio is 7100 to 57,100 instead of 25,000 to 75,000.) This means that the voltage measured by the meter is about 38 volts instead of 100 volts. The connection of the voltmeter has upset the voltages so that more drop exists across R_1 (now about 262 volts) and less across the tube thus giving a false indication of the condition existing without the meter.

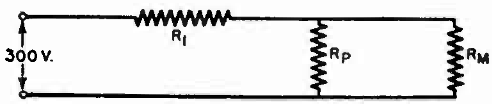


Fig. 4. The resistance of the voltmeter of Fig 3 is really in parallel with the plate-to-cathode resistance of the tube.

Case 2. Suppose we now use a voltmeter having a 100-volt range which requires only 1 milliampere for full-scale deflection. The meter resistance is now 100,000 ohms. Figuring current and voltages as we did in Case 1, we find that the plate voltage now measures 85 volts. This is closer to the original 100 volts.

Case 3. A 100-volt meter requiring only .1 milliampere has a resistance of 1,000,000 ohms. Such a meter will indicate about 98 volts if placed in the circuit of Fig. 3. The error now is only about

2%, well within the normal tolerances allowed for this kind of circuit.

Obviously, in any circuit having appreciable series resistance, the lower the current needed to give deflection, the more nearly correct the results. For this reason, voltmeters used in radio service work should require 1 milliampere *or less* for full-scale deflection.

Ohms-per-Volt

The term "ohms-per-volt" is used to express voltmeter sensitivity. The smaller the current needed for full-scale deflection, the greater the sensitivity of the meter. Also, the smaller the current for a given voltage, the greater the meter resistance must be. ($R = E \div I$). By dividing the total meter resistance by the basic full-scale voltage range, the ohms-per-volt rating will be obtained. Thus, a 2-volt meter having 2000 ohms resistance is a 1000-ohms-per-volt meter.

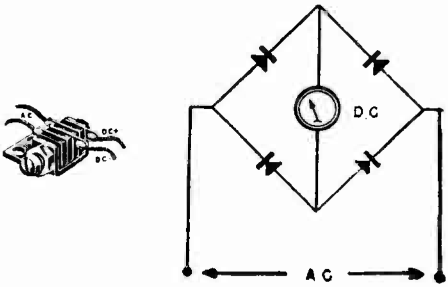


Fig. 5. Instrument type of copper-oxide rectifier and schematic of the connections by which it may be used with a d.c. meter to measure a.c. voltages.

Now here's something you should remember. Service manuals usually give you radio circuit voltages (plate-to-cathode voltages, etc.) which are taken with a 1000 ohms-per-volt voltmeter. If you are using a more sensitive meter—say 20,000 ohms-per-volt—the readings you get when you measure the circuit voltages *will be higher than the manual says for any high resistance circuit, and will be more nearly correct for the actual circuit operating conditions.*

A.C. Voltmeters

Any of the standard alternating current meters can be used as an a.c. voltmeter in exactly the manner just described. For service work, however, the standard D'Arsonval type d.c. milliammeter movement is used in combination with a copper-oxide rectifier. The object of the rectifier of course is to convert the a.c. applied to the combination to d.c. which will operate the meter satisfactorily. This type of instrument has better sensitivity characteristics than any except the vacuum tube voltmeter.

Figure 5 illustrates a typical instrument type copper-oxide rectifier. The accompanying schematic shows a d.c. meter connected to the d.c.

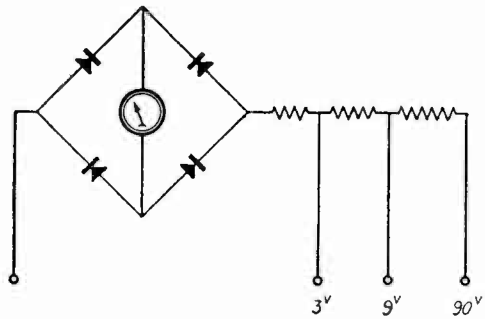


Fig. 6. A d.c. meter, properly connected to a copper-oxide rectifier and series resistors make a multi-range a.c. voltmeter.

output terminals of the rectifier unit while the a.c. actuating voltage is applied to the input terminals of the rectifier. Such a combination can form the basic unit of a multi-range a.c. voltmeter as shown in Fig. 6.

The copper-oxide rectifier type a.c. voltmeter usually has a sensitivity of 1000-ohms-per-volt; the meter movement requiring 1 milliampere for full-scale deflection. Lower sensitivities are permissible in service work for the usual a.c. meter readings are filament voltage, power line voltage, rectifier plate voltage and comparatively low frequency audio voltages at the receiver output during the process of circuit alignment. The sources for the first three measurements have low series resistance so the current drawn by the meter does not matter appreciably. For output measurements, only an indication of the maximum voltage (not the exact amount) is usually desired.

Of course, the copper-oxide unit has some faults. It is easily overloaded and has shunting capacity. When overloaded, one element of the rectifier usually burns out and readings fall to one-half the normal value. The effect of the capacity of the copper-oxide rectifier is to bypass high frequency audio and all radio frequency voltages around the meter. The instrument cannot be used with any degree of accuracy at frequencies above 5000 cycles or so. This isn't serious for most signal generators are modulated at about 400 cycles.

Now that we have learned some of the limitations of voltmeters, let us see how they can be used to isolate the defective circuit and part in a receiver.

Electrode Voltage Tests

From your knowledge of how a radio works, you know that each tube must be supplied with the proper filament, plate and grid voltages if satisfactory operation is to result. Therefore, when you have located the defective stage, you naturally want to know whether or not the filament, plate and grid voltages are normal. Before you can measure plate and grid voltages, however, you must decide on a *reference point*.

The basic reference points for any series of circuit voltage measurements are the *positive and negative* terminals of the voltage source which supplies that circuit. In a receiver these points are termed B+ and B—. In commercial practice, B— is the most commonly used reference point.

In a.c. operated receivers which have power transformers, the center tap of the high-voltage secondary is B—. As a matter of convenience it is often connected to the set chassis thus permitting the use of the chassis as a "common" return. This makes the chassis a part of the d.c. supply circuit and it can be used as a plate voltage measuring reference point.

Many transformerless a.c. operated sets, and universal a.c./d.c. sets, however, have no direct connection between B— and the chassis. If B— is connected to the chassis at all it will be through a high resistance and as a consequence there may be quite a high voltage between B— and chassis. Here it is necessary to find the true B— (usually one of the "a.c. line" terminals) and use it as the reference point.

When you have determined which point in the set is the *most negative* and therefore suitable as a reference point, you are ready to measure electrode voltages. Let us consider first, typical electrode voltage measurements in a transformer type a.c. operated set, then in turn, similar measurements in an a.c. receiver without transformer and in a universal a.c./d.c. type set.

A.C. Receiver With Power Transformer

The circuit diagram in Fig. 7 shows the first a.f. amplifier stage and the power pack of a typical a.c. receiver employing a power transformer. The other stages in this receiver have been omitted from the diagram for the essential facts regarding the isolation of the defective part can be more easily realized if we do not complicate our circuit.

The first voltage test is ordinarily from the plate terminal of the tube to chassis. If the reading is substantially that shown in the service manual, the plate supply circuit can be considered normal. If there is zero voltage at the plate, you will immediately examine the diagram or consider the circuit, and find that this could be caused by a short in C_{27}, a short in C_{41}, an open in R_{22} or in R_{23}. To pin this trouble down among these four parts, you can use the standard localization procedure of moving the test probe along the circuit. Finding voltage at point 3, for instance, narrows the search to a short in C_{27} or an open in R_{22}. The voltage test for the final

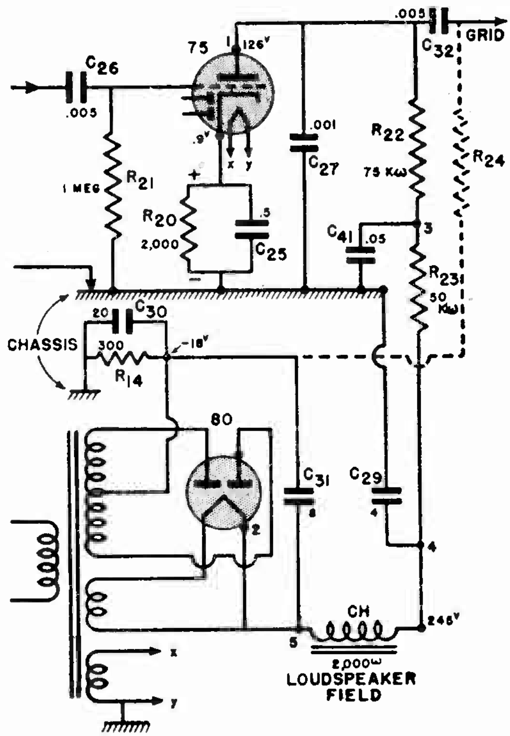


Fig. 7. The power supply and first a.f. amplifier used in the Westinghouse WR-28 receiver. Voltage values marked on the diagram are measured between the points indicated and the chassis.

isolation would then be across R_{22}. If this reads the same as from point 3 to chassis, then C_{27} is the bad part. The short has put R_{22} directly in shunt with point 3 and chassis. If the reading across R_{22} is lower than this, and operation of the receiver is restored, then R_{22} is open.

If there is no voltage at point 3, then C_{41} and R_{23} are the two suspected parts. The same technique can be used here; measure the voltage across R_{23}, and if it is the same as from point 4 to chassis, we have a shorted C_{41}. If it is lower and the receiver shows signs of life, there is an open in R_{23}.

A voltmeter with higher than 5000 ohms-per-volt sensitivity will show leakage in the bypass condensers. To check for leakage, remove the 75 tube from the socket, with the power on, and measure the drop across R_{22} and R_{23}. Naturally, unless the condensers are leaky, there is no path for current to be drawn through the resistors, and there should be no voltage drop across them, with the tube out of the socket. A drop through both resistors points to leakage in C_{27} or C_{32}, while a voltage drop across R_{23} alone points to C_{41}.

A d.c. vacuum tube voltmeter can be used for this test very effectively by making the measurements to chassis. With the tube out and no leakage, points 1, 3, and 4 should all have the same potential to chassis. If it drops at 3 but no further drop at 1, then C_{41} is leaky; if it drops from 4 to 3 to 1, then leakage in C_{27} or C_{32} is indicated. Only the vacuum tube voltmeter can be used to read the voltages to chassis on this test, since any other meter draws current through the resistors so that drops will occur anyway, making it hard to tell if leakage exists.

The second important electrode voltage in this stage, the grid bias voltage, can be tested with a voltmeter if the resistance of the meter is carefully accounted for. The bias voltage is developed between cathode and ground by the passage of plate current through resistor R_{20}. If you put a 1000 ohm-per-volt meter, using the 3-volt range; across cathode and ground, you are actually connecting 3000 ohms in shunt with R_{20}. This reduces the bias resistance to 1200 ohms, and the voltage will go down accordingly. Plate current will increase, but not enough to bring the bias up to normal. If you remember that the voltage you get in making this measurement is lower than the voltage when the meter is removed, the measurement is a valuable indication that some bias voltage exists. A high-sensitivity meter or a vacuum tube voltmeter will of course read close to the actual bias voltage.

The bias voltage should naturally exist between grid and cathode, but direct measurement across these elements with a low-resistance meter is even more misleading than across the bias resistor. The meter would join with R_{21} as a voltage divider across R_{20}, and almost the entire drop would be across R_{21}, which is several hundred times the value of the meter resistance. This measurement can be made only with a very high-resistance meter.

If you have found approximately normal bias voltage across R_{20}, you can make sure that it reaches the grid by removing the tube (to prevent false readings through it) and measuring the voltage from *plate to grid*. If you get a reading here, it proves that the grid circuit has continuity to chassis as the voltmeter is actually measuring the plate-chassis voltage through the grid resistance. Should the circuit be open, there would be no complete path for the meter current so it would not read. The value of the voltage on this reading is unimportant and highly variable with meter sensitivity and the plate and grid resistors. The test is for the existence of any voltage at all, to prove that grid and chassis are connected.

A last important voltage measurement in the stage of Fig. 7 would be across resistor R_{21}. Normally, there is no d.c. voltage drop across this resistor because in a receiver voltage amplifier, under normal conditions, there is no d.c. current flow through a grid resistor. A voltage drop across this resistor, indicating current flow, means that C_{26} is leaky or the tube is gassy. To eliminate the tube from the test, remove the top cap from the grid. If this stops the current flow, the tube is guilty, but if not, it is C_{26}.

The foregoing examples show clearly that it is a combination of logical reasoning with simple measurements that forms the real backbone of professional servicing. If you study your theory to get the real "feel" of circuit action and learn the simple, straightforward testing procedures described here, these two will work together for you and you will "go places" in radio.

A.C. Receiver Without Power Transformer

Another of the major types of receiver you will encounter as a serviceman uses the voltage-doubler circuit of Fig. 8, which includes one i.f. stage with the power pack. The electrode voltage tests that serve to run down a defective part in this stage will now be described.

Electrode voltage measurements on this receiver are made in the same way as on an a.c. receiver with power transformer. The only difference is that the measurements are not made from positive points to chassis, because the chassis in this set is not in the d.c. supply circuit. Therefore, the measurements must be made between positive points and the cathode of the i.f. tube, or to point 2 in the power pack.

WARNING. If the voltage-doubler circuit is like Fig. 9, instead of Fig. 8, then the switch will not connect to B— nor can the negative lead of filter condenser C_1 be used as a reference point. You will have to make use of the cathode of the tube in the defective stage or find the negative side of filter condensers C_2 or C_3.

Universal A.C.-D.C. Receiver

Just as in the receiver of Fig. 8, it is necessary before making voltage tests to determine whether or not the chassis is in the d.c. supply circuit. In Fig. 10, the chassis is connected to B— only through the high resistance R_{11}, so the chassis cannot be used as a reference point for voltage measurements. R_{11} is provided to discharge C_{26} when the set is turned off, to reduce the danger of shock.

The 30 volts shown on the diagram as the plate voltage of the triode in Fig. 10 is based on measurement with a 1000 ohms-per-volt meter. It is good to remember that the actual operating voltage is higher and in this case, the difference between measured and actual voltages will be considerable because of the very high resistance of R_7. If you use a 1000 ohms-per-volt meter, you should of course get a reading not far from 30 volts, but a high ohms-per-volt meter in this plate circuit will give a higher reading.

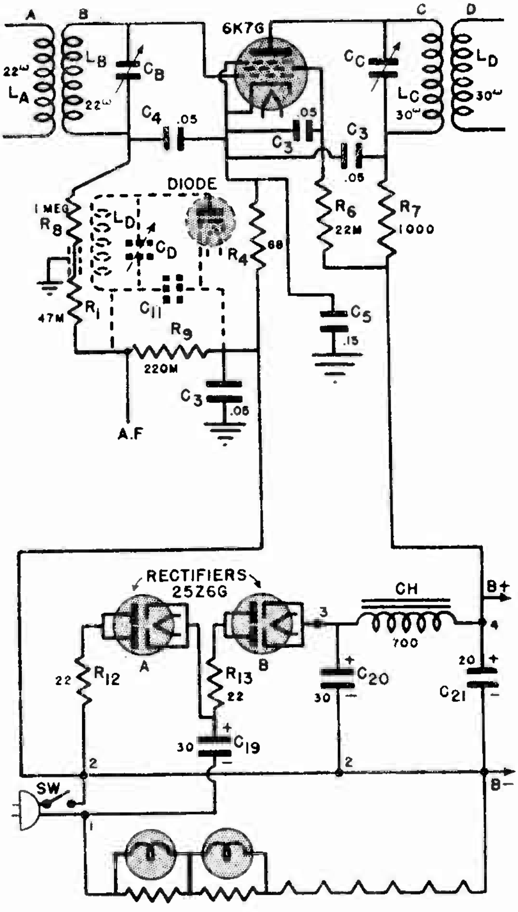


Fig. 8. Power supply and i.f. stage used in the Zenith model 5719. The diode detector circuit has been drawn in dotted lines to show its relationship to the grid return circuit of this i.f. stage. Note that the manufacturer has identified parts having the same electrical value with the same code number. This is the reason for the three .05-mfd. condensers being identified as C_3.

Grid convection current flowing through grid resistor R_6 of the triode section will produce a self-bias voltage of about 1 volt for the grid. If you measure the voltage between grid and cathode with a 1000 ohms-per-volt voltmeter during electrode voltage tests, however, the reading will be practically zero, since the meter shunts resistor R_6 down to a low value and thus makes the voltage drop across it very small. A vacuum tube voltmeter would measure this voltage across R_6, or the continuity of the circuit can be checked with a high-range ohmmeter.

If R_6 opens, you would probably expect a dead receiver on the theory that the grid would then acquire a high enough negative charge to block plate current in the triode section of the tube. Actually, however, it is likely that there would be enough leakage between the grid and cathode terminals of the tube socket (due to dust and moisture) to provide almost normal grid bias.

Hence, instead of a dead set, a more likely possibility is that with high leakage resistance here, the stage might block at regular intervals with accompanying distortion and hum. An ohmmeter test of R_6 would be the proper procedure here if an ohmmeter with a 15-megohm range is at hand; otherwise, try shunting R_6 with a good resistor having a value around 15 megohms.

When testing the grid circuit for possible defects, condenser C_{16} should concern us. If C_{16} becomes leaky, a portion of the d.c. voltage developed across R_5 would be applied across R_6, producing distortion which becomes more noticeable as volume is increased. As resistor R_6 has a high ohmic value, even a small amount of leakage in C_{16} will develop an appreciable voltage across R_6. To check for leakage in C_{16}, you can unsolder one of its leads and measure its resistance with a high-range ohmmeter, or try another condenser.

Here is a case where a voltage measurement across R_6 would indicate the leakage through C_{16}. Disconnect the lead to the grid of the tube to eliminate the self-bias normally developed in this resistor. Tune in a station and set volume control at maximum so the maximum a.v.c voltage across R_5 is applied to C_{16}, then check for a

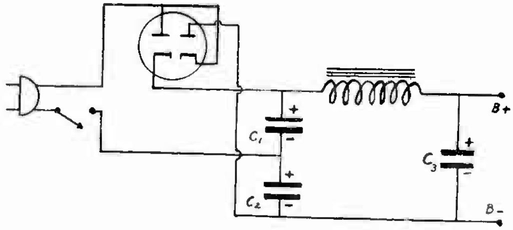


Fig. 9. This full-wave voltage doubler does not have the same reference points as the half-wave type shown in Fig. 8.

voltage across R_6. A high-sensitivity d.c. meter must be used to check this voltage across R_6.

This is a case where a leaky coupling condenser produces a negative voltage (with respect to B—) across the grid resistor, due to the polarity of the a.v.c. voltage which is acting as the d.c. source. In cases where the coupling condenser connects from the preceding tube plate, the grid end of the following resistor will be made *positive*.

Filament Voltage Measurements

All the tests mentioned thus far involve the use of d.c. voltmeters. To measure filament voltage in the average home receiver, an a.c. voltmeter is needed for the filament supply is obtained directly from the a.c. power line or a low voltage winding on a power transformer. Of course, battery operated receivers, auto radio sets, and those operating from a d.c. power line make it possible to use a d.c. voltmeter for filament voltage measurements. The type of receiver will, therefore, govern the type of meter used for filament voltage measurements.

In contrast to plate and grid voltage measurements, which are made with respect to the chassis or B—, filament voltage is measured between the two filament terminals right at the tube socket. If the filament supply is a.c., the polarity with which the a.c. voltmeter is connected does not matter. Should the filament supply be d.c., proper polarity will have to be observed in connecting the voltmeter.

Filament voltage measurements are seldom necessary except in cases where a tube fails to light up and the tube itself tests good. In most instances the temperature at which the filaments of modern tubes are operated is sufficient to cause a noticeable glow when normal voltage is present. If the glow is absent, check the tube—then the filament voltage.

The above statement must be modified for battery type tubes whose filaments do not glow brightly even when operating normally and for a.c./d.c. receivers which have their filaments connected in series. In the latter case it is obvious that a break anywhere in the filament circuit will cause *all* tubes to appear dead. In a case of this sort, tests of each individual tube and circuit continuity tests with an ohmmeter are of assistance in locating the trouble.

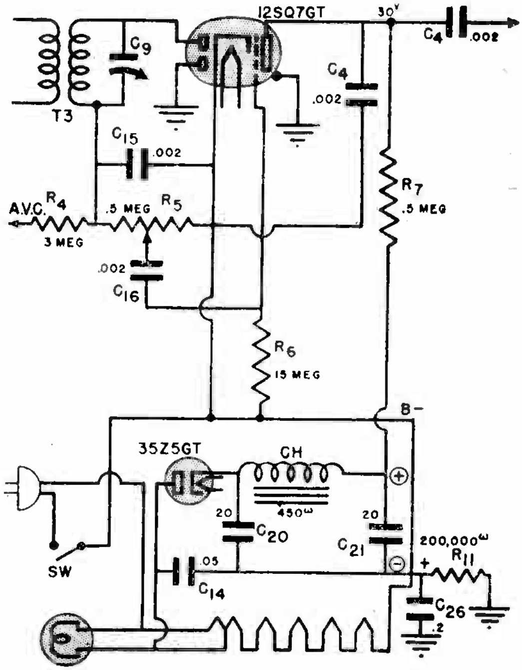
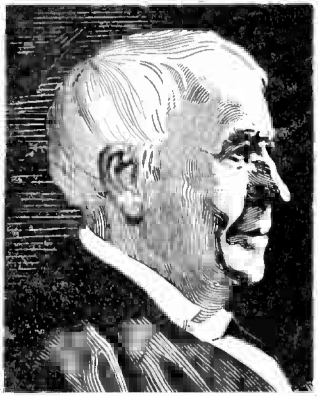


Fig. 10. Power supply and detector-first a.f. stages of the Emerson FC-400 universal a.c.-d.c. receiver.

This article must close without any mention of voltage tests for battery operated receivers or auto radio sets other than to point out that the primary difference between these types and those discussed is in the method of obtaining the necessary filament and plate voltages. If the various power supply systems are taken into consideration, it should be possible to successfully make plate and grid voltage measurements along the lines already mentioned for the conventional home type sets and apply effect-to-cause reasoning which will locate the trouble. Get the habit of analyzing the circuit *before* you connect your voltmeter. This will not only help you avoid damage to your meter but will give you an idea of what to expect and how to interpret your results. Learn to think first—then act.

Men of Science



Thomas Alva Edison is a legendary figure, one of the great Americans. He typified the spirit of freedom, the privilege of the individual to exercise his own ingenuity and to explore the unknown. His schooling was somewhat irregular but his mother, a former school teacher, gave him the benefit of her learning.

He was an industrious boy and throughout his full life remained a "hard worker." Some referred to him as the Wizard of Menlo Park, his laboratories having been located in Menlo Park, New Jersey, where a modern research laboratory stands today in memory of him.

As a "butcher boy" selling candy in a railroad train, Edison had managed to install in the baggage car a chemical laboratory. Some of these chemicals upset and started a fire as the train rounded a sharp curve. The angry conductor boxed the youthful Edison's ears so vigorously that thereafter he became partially deaf. But, he never allowed this to interfere with his work and over a period of 50 years took out 1033 patents. In fact, unquestionably he was the most prolific inventor of modern if not all times.

The electric light, the phonograph, stock ticker are only a few of the well-known devices he originated. In 1883, he patented what became known in scientific circles as the "Edison effect," which consists of the passage of electrons from the heated filament of a lamp to an internal metal plate. This lamp was the forerunner of the radio tube.

At the age of 15, Edison became a telegraph operator and later met and married a girl who was also a telegraph operator.

Born at Milan, Ohio, February 11, 1847, of Scotch-Dutch parents, Thomas Alva Edison died in 1931 at the age of 84.

Time

Twenty-four hours of time each day,
And yours the power to direct it.
If you use each minute as best you can,
Habit will grow to reflect it.

The hours of the present are yours to spend;
The future you cannot borrow.
Till the dawn of another day are kept
The priceless hours of tomorrow.

You have as much time an anyone:
A king can be given no more.
No one can steal an hour from you.
And no one a minute restore.

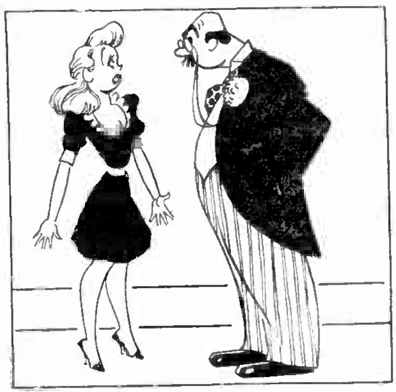
You need not explain how your time is spent,
For your time is your own, you see:
But the use that you make of the fleeting hours
Determines the man you will be.

—*Rega Kramer McCarty.*

Job Opportunity

Pacific Electronics, formerly known as Spokane Radio Company, has jobs open from time to time for Radio men in connection with their war contracts.

If interested write Pacific Electronics, Sprague and Jefferson, Spokane 5, Washington, giving complete information regarding yourself.



"Miss Jones, during the Christmas rush we are going to put you on the main floor in men's underwear."

Sample Questions and Answers for Radio Operator License Examinations

By WM. FRANKLIN COOK

N. R. I. Technical Consultant

This is another installment of the questions taken from the "Study Guide and Reference Material for Commercial Radio Operator Examinations," together with typical answers. The questions give a general idea of the scope of the commercial radio operator examinations.

The basic theory for these questions has been covered in your Course, but is being repeated here as answers to these questions. Remember, the following answers are far more detailed than would be required for an operator's license examination. The questions are theoretical, so the answers go more thoroughly into the basic theory, in order to permit similar questions to be answered.

Some of the material is advanced technical data, of course, which can be properly understood only by the advanced student or graduate. However, you will find this information valuable, whether or not you intend to take the operator's license examination.

ELEMENT II

Basic Theory and Practice

(2-215) What is meant by "counter e.m.f." in a d.c. motor?

Ans. As a motor armature rotates, a voltage is induced in it. This voltage is opposite in polarity to the applied voltage, so is called a "counter e.m.f." The difference between the applied and counter voltages is the voltage causing armature current flow, so the counter e.m.f. controls the armature current. This counter voltage is also known as "back e.m.f."

(2-216) What determines the speed of a synchronous motor?

Ans. A synchronous motor, as its name implies, is a motor which synchronizes with the frequency of the input voltage. The speed therefore is determined by the frequency for which the machine was designed.

(2-217) Describe the action and list the main characteristics of a shunt-wound d.c. motor?

Ans. A shunt-wound d.c. motor has both field and armature connected across the power line, so the field is in shunt or parallel with the armature. The motor's most desirable characteristic is its constant speed under varying load conditions. As a load is applied to it, the armature tends to reduce speed, thus decreasing the counter e.m.f. which in turn enables an increase in armature current which brings the machine back to normal speed. This action takes place practically instantaneously, thereby giving us constant speed. In addition to constant speed, the motor has good regulation, a poor starting torque (it will not start with a heavy load applied) and medium efficiency.

(2-218) Describe the action and list the main characteristics of a series d.c. motor?

Ans. A series d.c. motor has the field and armature in series. This motor is used mostly where the motor must be started under heavy load, as it has a high starting torque. The armature current is maximum when starting, which means the series field current is also maximum so the motor will start even with a heavy load connected. This motor has poor speed control, as the motor runs faster for smaller loads. Any variation in the amount of load thus changes speed—in fact, the motor will "run away" if the load is removed. The general characteristics of a series motor are a high starting torque, very poor regulation, poor speed control and a medium efficiency.

(2-219) Describe the action and list the main characteristics of a series d.c. generator.

Ans. As in the series-wound d.c. motor a series d.c. generator has a field in series with the armature. Therefore the field must carry the full load current delivered by the machine. The field consists of a comparatively few turns of a very heavy wire. A series generator can only build up an e.m.f. when connected to an external load and can only develop e.m.f. when it is loaded. Its characteristics are an output voltage variable over wide limits, rising as the load current increases.

(2-220) To obtain an output frequency of 60 cycles per second, a 6-pole alternator must be driven at what number of r.p.m.?

Ans. The formula for determining the answer to this problem is $f = P \times S$ where $f =$ frequency, $P =$ *pairs* of poles (poles $\div$ 2), $S =$ speed in revolutions *per second*. The solution to the problem then is $S = \frac{f}{P} = \frac{60}{3} =$ 20 r.p.s., which must be multiplied by 60 to get revolutions per minute. This gives 1200 r.p.m.

(2-221) Describe the action and list the main characteristics of a self-excited, shunt-wound d.c. generator.

Ans. The action taking place in a shunt-wound, self-excited d.c. generator is as follows: The field is in shunt, or across the armature. When the armature starts turning, the residual magnetism in the poles induces an e.m.f. in the armature winding. This e.m.f. causes a field current which increases the magnetic flux of the field, causing more induced e.m.f. in the armature. This process repeats itself until the poles reach saturation or until the amount of e.m.f. generated is regulated by some external means, which is generally a field rheostat.

(2-222) Describe the action and list the main characteristics of a flat-compounded d.c. motor.

Ans. A compounded motor combines the features of the shunt and series motors. It has two fields, a series field and a shunt field, so arranged that the two fields oppose each other, in the type known as the differentially compounded type. This type motor has the high starting torque of the series motor and the constant speed of the shunt motor. These two desirable characteristics are brought about by the action of the series field. As the load on the motor increases, the motor tends to slow down and this causes a higher current to be drawn from the line. When this happens, a higher current flows through the series field winding. Since the two fields are wound in opposition to each other, the total field strength is weakened, which reduces the counter or back e.m.f. allowing the armature to draw more current and speed up. In this manner the natural tendency of the motor to slow down under load is overcome and a fairly constant speed is maintained.

(2-223) What is the output frequency of the generator having ten poles and revolving at 1200 r.p.m.?

Ans. This problem is similar to question 2-220, and is solved through the use of the formula: $f = P \times S$ where $f =$ frequency, $P =$ pairs of poles, and $S =$ revolutions per second. Hence, dividing the number of poles by 2 gives pole pairs, and dividing r.p.m. by 60 gives r.p.s. then, frequency $= 5 \times 20$, or 100 cycles per second.

(2-225) Why are series motors not used for motor-generator sets?

Ans. Since a series motor has very poor speed regulation a generator directly coupled to such a motor would have a poor voltage regulation because, as the load changed, the motor speed would change. This causes the generator output to vary with the motor speed. This condition would make it very unsuitable for use in radio circuits where a wide variation in loads is present.

(2-226) Why is carbon commonly used as a brush material?

Ans. Carbon has several desirable characteristics, so it is quite commonly used as a brush material. It is economical, it will carry currents up to 35 amperes, it is soft enough for the base of the brush to shape itself to the shape of the commutator, it has good wearing properties and it does not mar the surface of the commutator. Because it shapes itself to the commutator it makes good electrical contact which reduces the sparking at the brushes. Also, it has sufficient resistance to prevent a direct short-circuit between adjacent segments when touching two or more. Carbon is also a mildly abrasive material and thereby tends to keep the surface of the commutator clean.

(2-227) If a self-excited d.c. generator failed to build up to normal output voltage when running at normal speed, what might be the cause and how could it be remedied?

Ans. The failure of a self-excited d.c. generator to build up normal output voltage could be caused by the loss of residual magnetism in the field. The only remedy for this condition is to apply an external e.m.f. to the field winding while the armature is turning. This will provide a field and start the building up process, which restores the residual magnetism for future operations. Other causes could be the improper contact at the brushes, an open field circuit faulty connections any place in the generator or a defective armature winding.

(2-228) A transformer having a center-tapped secondary is used with a full-wave rectifier with the transformer center tap for the common negative return; if the same transformer was connected for full-wave bridge rectification, what would be the effect upon the output voltage?

Ans. As the bridge circuit connects across the transformer ends, the output voltage would be twice its original value.

(2-229) If a high voltage rectifier system was changed from full-wave, center-tapped transformer connection to a bridge connected, full-wave rectifier system using the same high voltage transformer, what changes in the filter components would be necessary?

Ans. Since changing to a bridge connected full-wave rectifier system would double the output voltage, the filter condensers would have to be replaced with parts having twice the original voltage breakdown rating. Should a greater load current flow result from the higher voltage, the filter choke ratings would have to be increased.

(2-230) List the main advantages of a full-wave rectifier as compared to a half-wave rectifier.

Ans. The ripple frequency of a full-wave rectifier is twice that of a half-wave rectifier. Therefore, the filter design need not be so elaborate. This also means that the filter will be less expensive. The full-wave rectifier is also more efficient, furnishing a higher output voltage, and is more compact per watt output than a half-wave rectifier.

(2-231) Using a plate transformer having a secondary voltage of 500 volts r.m.s. in a single phase half-wave rectifier working into a condenser input filter, what should be the minimum allowable d.c. working-voltage rating for the filter input condenser?

Ans. This problem is solved through use of the following formula: Peak voltage e = root mean square (r.m.s.) voltage x 1.414 = 707 volts.

(2-232) A single phase power transformer, with secondary center-tapped, has a total secondary voltage of 2000 volts r.m.s. When used in a full-wave rectifying circuit and condenser input filter, the filter input condenser should have what continuous d.c. working-voltage rating?

Ans. This problem is solved by use of the following formula: Peak voltage = root mean square (r.m.s.) voltage x 1.414. Since only one-half of the transformer voltage is applied across the filter circuit, multiply 1000 by 1.414 and the answer is 1414 volts. The condenser should therefore have a working voltage of 1500 volts, (this is the nearest standard working voltage) or more.

(2-233) Why may a transformer not be used with direct current?

Ans. A transformer uses the principle of induction for its operation, which requires that the magnetic field surrounding the secondary be constantly changing. Direct current cannot supply this constantly changing magnetic field. Therefore, the transformer cannot be used on direct current.

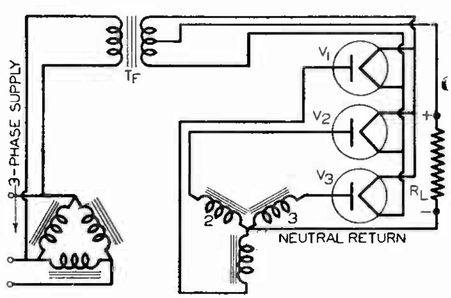


Fig. 2-234

(2-234) Draw a simple schematic diagram of a half-wave, 3-phase rectifier system.

Ans. Figure *2-234* shows a 3-phase half-wave rectifier circuit. Each phase of the Y-connected secondary is seen to be equivalent to a single-phase half-wave rectifier circuit, and the three circuits have a common load and a common neutral return wire. The tube filaments are heated by a separate transformer connected across one phase of the 3-phase supply.

(2-235) What are the primary advantages of a high-vacuum rectifier as compared to the hot-cathode mercury vapor rectifier?

Ans. Outside temperature variations do not greatly affect high vacuum types and they are free from the "hash" or r.f. interference which accompanies the operation of a mercury vapor tube.

(2-236) What are the primary characteristics of a gas-filled rectifier tube?

Ans. In a two element vacuum tube great numbers of electrons gather in the space between the cathode and the plate. These electrons form what is known as a space charge or electron cloud. It is this space charge which prevents the positively charged anode from attracting all of the electrons emitted by the cathode of a 2-electrode tube. Thus it can be seen that the space charge acts as a resistor to the electron flow in a tube and where we have resistance we must have a voltage drop. This is important in rectifier circuits because, we usually want all the voltage we can get. If we add gas to the tube we will eliminate the effect of the space charge to quite an extent. Almost any gas can be used but best results are obtained with a heavy gas such as murcury vapor. A gas-filled rectifier will have a low internal voltage drop and it is capable of supplying high output currents. Due to the generation of gas ions, the internal drop is practically constant, regardless of local current. This gives good regulation, as the drop does not increase with load current increases.

(2-237) What are the primary advantages of a mercury vapor rectifier as compared to the thermionic high vacuum rectifier?

Ans. The regulation is excellent when mercury vapor tubes are used, as the internal drop is constant at about 15 volts, regardless of the load current variations. This low drop also means somewhat higher output voltage.

(2-238) Why is it desirable to have low resistance filter chokes?

Ans. Voltage regulation is improved and a higher output is obtained when low resistance chokes are used. The lower the resistance, the smaller the d.c. drop. Also, there is less change in the output during load current variations, so the regulation is improved.

(2-239) Why is it necessary to use choke input filter systems in connection with mercury vapor rectifier tubes?

Ans. A mercury vapor rectifier tube has a very low internal resistance. Due to this low resistance a heavy current surge takes place the instant voltage is applied. When we use choke input to the filter, the surge is held to a minimum value, which prevents damage to the tube. The input choke should preferably be of the "swinging" variety.

(2-240) What are the primary characteristics of a choke input filter?

Ans. A choke input filter has better regulation than a condenser input filter. It limits the surge current and thus protects the rectifier tube. The d.c. output voltage is less than that from a condenser input filter, but the choke input is necessary for high-current power packs, particularly when using mercury vapor rectifier tubes.

(2-241) What are the primary characteristics of a condenser input filter?

Ans. The condenser input filter has a higher d.c. output than the choke input filter. However, the regulation is poor, as higher loads discharge the condenser more between pulses, so the output reduces. With a condenser input filter circuit, there is no inductance between the condenser and the rectifier tube to limit the surge of current which takes place when the power supply is first turned on, so the rectifier is subject to overloads. Further, the manner of operation causes the rectifier to deliver short, high current pulses, which requires the choice of a tube capable of withstanding these peaks.

(2-242) What is the primary purpose of a "swinging choke" in a filter system?

Ans. The swinging choke has a special air gap in the iron core so it is easily saturated. As the d.c. current increases, the core approaches saturation, so further increases do not produce comparable flux increases. Hence, the inductance drops as the current increases, or "swings" with current changes. When the inductance drops, the following condenser begins to act more like an input filter condenser. This raises the d.c. voltage, compensating for the drops which occur with increased current flow.

(2-243) Why does the output of a d.c. generator generally require less filtering than the output of a rectifier system?

Ans. It is impossible to wind a generator armature in such a manner that direct current can be obtained from the terminals of the armature coil. It is necessary to employ a commutator (mechanical rectifier) to keep the direction of current flow in the external circuit in one direction, even though the current reverses in the armature coil. The use of a commutator gives rise to a ripple frequency which is determined by the number of commutator segments, the number of pole pieces and the speed of rotation. Since the ripple frequency is usually quite high, in comparison to the ripple frequency of a rectifier system, less filtering is required to obtain an equivalent d.c. output.

(2-244) When filter condensers are connected in series, resistors of high ohmic value are often connected across the terminals of the individual condensers. What is the purpose of this arrangement?

Ans. Condensers of equal rating are connected in series when the working voltage is higher than the individual condensers can withstand. Resistors are connected across the individual condensers which are connected in series to equalize the voltage drops across each condenser. These voltage drops would be in proportion to the leakage resistance otherwise, in which case the better condenser would have the greater voltage across it—perhaps enough to ruin the condenser. By using resistors of equal value and a size below the leakage resistance of the condensers, the voltage drops will be equal and within the safe limits of the condensers. These resistors can then also act as bleeders and discharge the condensers after the apparatus is turned off.

(2-245) Draw a diagram of a bridge type, single phase, rectifier employing mercury vapor tubes and connected to a choke input, two section filter system, including a bleeder resistance.

Ans. Fig. 2-245 shows the diagram. In this diagram it should be noted that each choke and its associated output condenser form one section of a two-section filter.

(2-246) Draw a diagram of a full wave, single phase rectifier employing thermionic vacuum tubes, connected to a condenser input, two section filter system and including a bleeder resistance.

Ans. See Fig. 2-246.

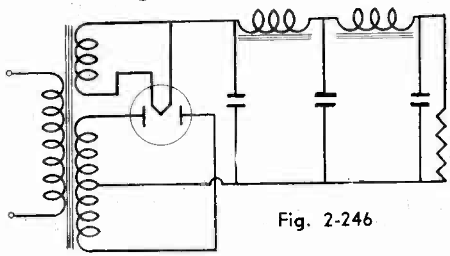


Fig. 2-246

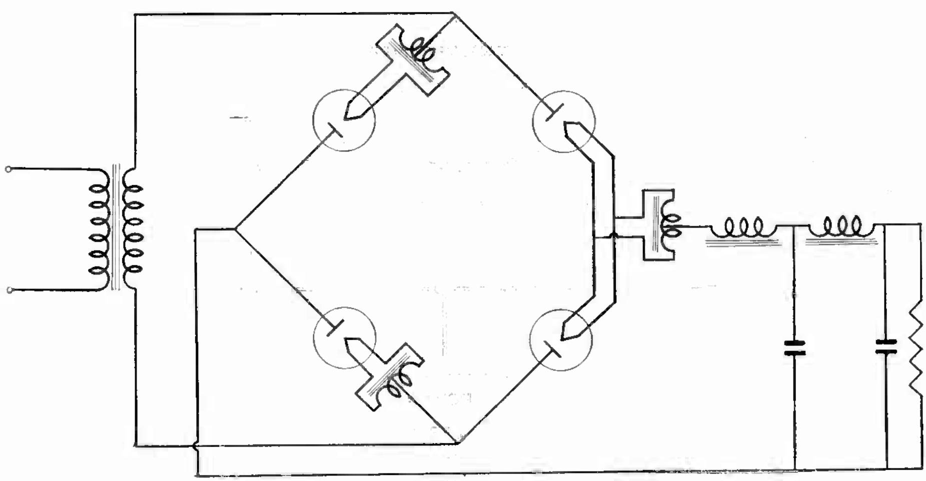


Fig. 2-245

CIRCUIT-DISTURBANCE TESTING

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THE circuit-disturbance test is a useful means of rapidly isolating the defective stage in a radio receiver. The non-technical man who observes a radio serviceman checking a receiver by making the circuit-disturbance test and then rapidly finding the fault is amazed by the ability of the technical expert. Of course, there is really nothing "magical" in the ability of the service expert to locate the trouble in this way, for a circuit-disturbance technique is based on the sound application of fundamental radio principles.

The test cannot be used by an untrained person since that individual would have no means of interpreting the results accurately. A prerequisite is that the user of the circuit-disturbance test have a thorough knowledge of fundamental radio theory. Then he can intelligently apply and use this trouble-shooting technique efficiently.

Let's consider carefully some of the essential principles involved.

The Passage of Signals Through a Typical T.R.F. and Typical Superheterodyne Receiver. The t.r.f. and superheterodyne are the two fundamental types of radio receivers. In each case, the signal enters the antenna circuit and from the final stage enters the loudspeaker, which converts the electrical impulses into sound impulses that can be heard by the human ear.

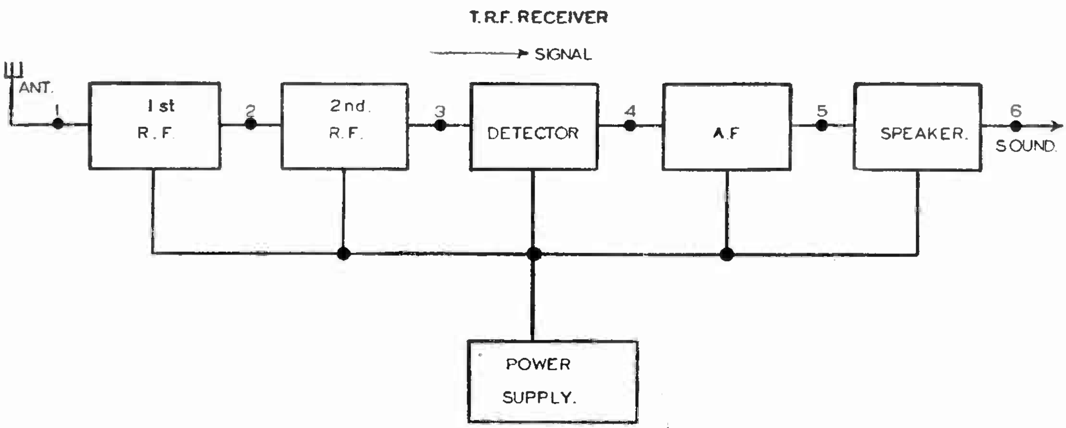


Fig. 1

The electrical signal goes through the various circuits and stages of the radio in order (in sequence). That is, we have a definite electrical path. You start at the input and go through the set to the output. Each stage receives the signal from the one preceding it and the signal is built up progressively.

We think of the set as the equivalent of an electrical chain and we remember that the weakest link in any chain represents the strength of the entire chain. Thus, a break in our electrical system, a defect in a certain stage, will mean that the signal will not go through from input to output in the normal way, but will be stopped or interrupted at the defective stage.

Although, under normal conditions, the signal enters the antenna circuit, it can for the purposes of testing be injected at any point in the chain of signal-handling stages. Referring to Fig. *1*. which is the block diagram of a t.r.f. receiver, (Fig. 2 is the block diagram of a superheterodyne), if it is found that connecting a signal generator to point *2* results in a signal being heard in the loudspeaker but that on connecting the generator to point *1*, no signal is heard, it is clear that a defect exists in the system between points *1* and *2*. This is the broken link of the chain, for the radio frequency stage will not pass a signal.

Note, too, that all of the stages are connected to the power supply and that any defect in this common power supply will affect simultaneously all stages in the receiver. Complete failure of a set is frequently due to some defect in the power supply system, such as a shorted or leaky filter condenser, an open choke coil or possibly a burned-out transformer winding.

Should we find that pulling out the output tube in a radio receiver produces a click but pulling out a tube preceding the output tube does not produce a click, we look for trouble between the two stages. As an example, an open coupling condenser could cause the failure of the system. Some defect in the stage from which we derive the signal could also be responsible for the condition. This fact, or facts, gives us a simple means of isolating the defective stage.

However, instead of removing a tube or in some other way producing a circuit-disturbance you could use a signal generator which would provide an audio, an r.f. or i.f. signal for signal injection purposes. An important rule to remember is that the signal supplied to the input of the stage must be of a type which the stage normally can handle.

This means that the signal must not be too large in amplitude or intensity and it must have the correct frequency.

Students sometimes fail to realize that an r.f. signal must be used to test an r.f. stage, an a.f. signal to test an audio stage and and i.f. signal to test an i.f. stage. You would not, for example, use an audio signal input to the grid of a mixer tube or an i.f. tube if you wanted to test the ability of the following circuits to deliver a signal to the loudspeaker. Instead you would set your signal generator to produce the frequency to which the mixer was tuned or the frequency of the i.f. amplifier. But suppose you could point your finger at the input of a stage and have the right signal immediately developed in the signal input circuit of that stage —you'd certainly use the finger-pointing method.

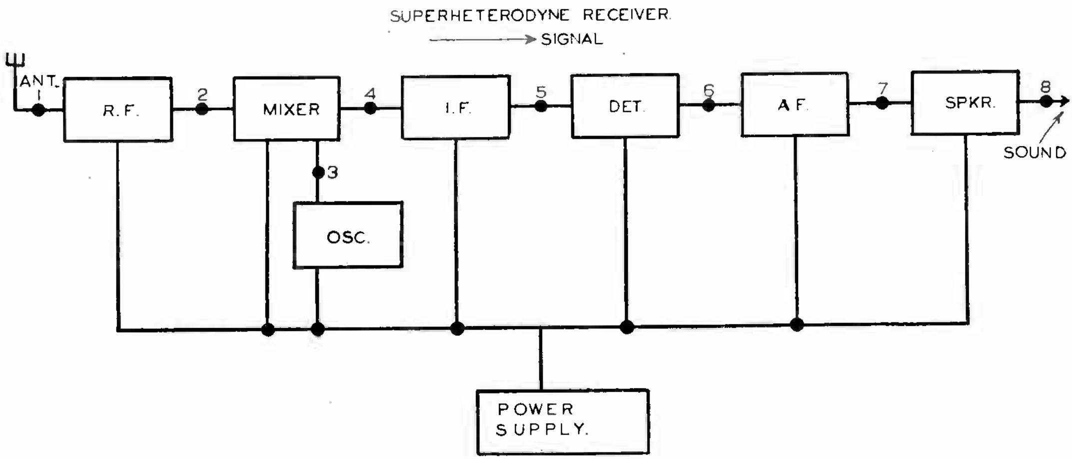


Fig. 2

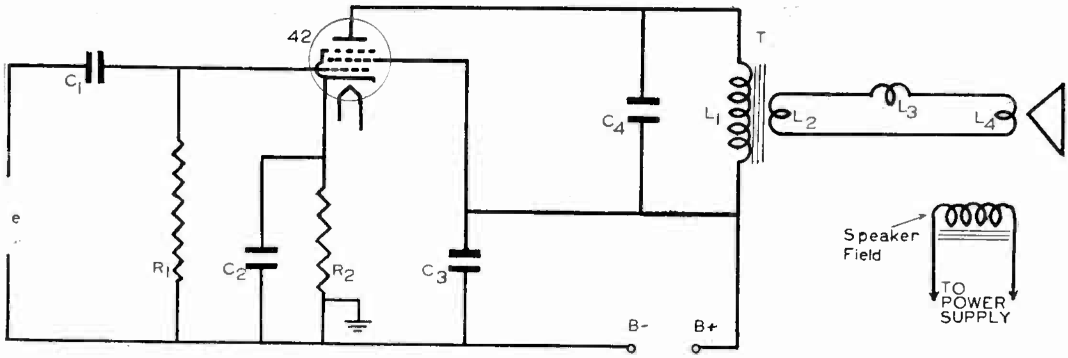


Fig. 3

The circuit-disturbance test is not quite as magical as that—you have actually to touch the control grid with your finger or in some other way disturb the circuit. Let's see what we mean by disturbing the circuit—how to set up a signal and just how to do it.

Circuit-Disturbance Methods. A signal applied to the input of a stage results in a variation in the plate current, so any disturbance we make must, to duplicate the action of a signal, also result in a change in plate current. There are five distinct means of causing a circuit disturbance given in the following list. Let's see what they consist of—later we will see when each may be used.

(1) Removing a tube from or installing a tube in a socket.

(2) Intermittently opening a grid circuit by removing and replacing the tube top cap.

(3) Touching the grid with your finger or with a test lead.

(4) Short-circuiting the bias resistor or in some way causing a change in the net grid-cathode potential of the tube and, hence, a change in plate current.

(5) Using the voltmeter for producing a current change. Let us consider, in the order named, the various methods of producing the circuit-disturbance tests and what some of the considerations involved are.

No. 1: Removing a Tube from Its Socket and Putting the Tube Back in Its Socket. In the case of a voltage amplifier tube used in an r.f., i.f., or audio circuit, the removal of the tube will produce a current change which in turn allows the development of a pulse signal. The load on the power supply does not greatly change when the tube is removed or installed. Hence, we stand little chance of causing damage to the parts in the radio that are in good condition by making such a test.

Where the tube is a power output tube and draws appreciable current, however, we may under cer-

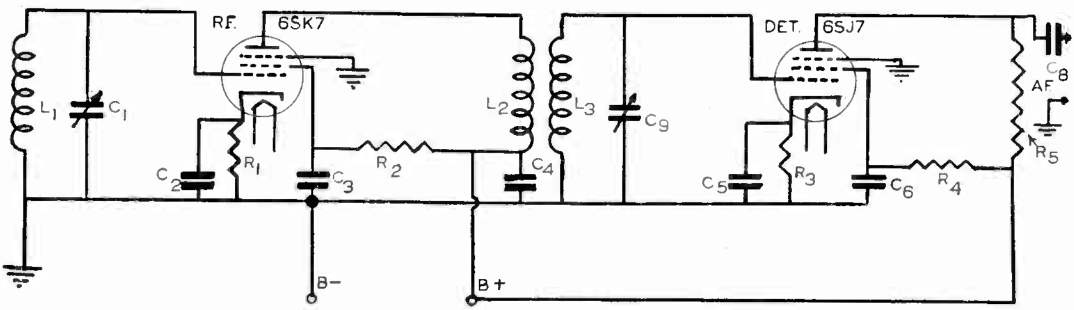


Fig. 4

tain conditions produce certain effects which are not desirable. As an example, suppose that we had a type 6L6 tube in a power output circuit and that we removed the tube for the purpose of making a circuit-disturbance test.

The effect would be that the load on the power supply would suddenly be decreased and there would be a tendency for the power supply temporarily to develop a higher-than-normal voltage.

In other words, when the current goes down, the voltage goes up, due to the regulation of the power supply.

This may result in puncturing the dielectric of a filter condenser or in causing other circuit damage by the sudden increase in the power supply voltage. Removal of a high power output tube is not good servicing practice.

In this case it would be wisest to disturb the tube plate current by some other means which would not cause such a strain on the power supply.

No. 2: Opening a Grid Circuit. This is a convenient method of making the circuit-disturbance test. In the case of certain tubes having a top cap, it is a very convenient method. The lead to the top cap is simply removed and an intermittent connection of the grid lead to the cap is made. This results in the production of clicks. The relative intensity of the clicks in the loudspeaker indicates the relative gain in the circuits following the stage in which the circuit disturbance is produced.

In a stage in a receiver which has a tube that has a grid connection going to the tube base, it is inconvenient to open the grid circuit. The only way you would have of doing this would be actually to unsolder the wire to the grid contact on the socket.

Rather than do this, we can use some other method, such as connecting the voltmeter to the circuit, which will be described shortly. In certain cases, too, we can depend upon the high gain of the succeeding circuits for the effects we want. As an example, in the case of the 6SQ7 we need merely touch a finger to the grid of this tube while the volume control is set at maximum, and if the circuits are in normal condition a loud hum or noise in the output will be heard.

Upon opening the grid circuit, a change occurs in the electronic stream between the cathode and the plate of the tube. This current change is responsible for the production of the noise signal pulse. With the grid of the tube open, the plate current is reduced to a low value. When the grid is connected, the plate current rises sharply.

Using this technique, we have in effect supplied an input signal to the tube.

No. 3: Touching the Grid with Your Finger or with a Test Lead. This point has been mentioned in the preceding discussion. However, rather than merely touching the grid with a finger you could just as well connect the lead of a voltmeter to the grid. This would result in a circuit disturbance. The lead would pick up stray fields which would induce a voltage in the conductor that could be used for the circuit-disturbance test.

This test is particularly useful when checking audio amplifier systems employing high-gain tubes such as the 6F5-6F6 combination, 6SQ7-25L6 or something similar. It is not always successful for checking r.f. or i.f. circuits or a.f. circuits having low input resistance.

To make the test, connect a lead or touch your finger to the grid circuit as indicated. The volume control of the radio should be set at maximum so that proper results will be obtained. In this way the gain of the circuit will be maximum.

If the gain of the stage is lower than normal a loud hum or disturbance will not be heard, or it may only be heard weakly.

Such a test is not useful when the audio gain is low, as it is in some older receivers. Many of these sets employ a 27 amplifier or power detector and work directly from this tube into a pair of *45* grids through a transformer. The low gain of such a circuit would not permit the above method to be used successfully.

No. 4: Short-Circuiting the Bias Resistor or in Some Way Causing a Change in the Net Grid-Cathode Potential of the Tube and a Change in Plate Current. The shorting of the bias resistor is a simple but somewhat inconvenient way of causing a variation in plate current. Referring to Fig. *3*, shorting R_2 would remove the bias and produce a rise in plate current—a signal pulse that would be heard as a click in the loudspeaker under normal conditions. Shorting the grid to the cathode would also produce a click but simply shorting R_1 would not. The reason is that under normal conditions no current flows in R_1 and no change in grid voltage, therefore no plate current change would take place if R_1 is shorted.

A commonly encountered type of circuit is shown in Fig. *4*. Shorting R_1 or R_3 will produce clicks. Those produced by intermittently shorting R_1 will be louder than those produced by shorting R_3 since the *6SJ7* gain will be added. Occasionally you may encounter an older receiver having the typical circuit shown in Fig. *5*.

The grid return connects to a source of bias.

This bias may be derived from the power supply system. If the bias supply is short-circuited, a change in the plate current occurs. A change in the current produces a change in the flux about L_1 and this flux cutting L_2 induces a voltage. The pulse voltage induced in L_2 causes a current to flow in L_3. This transformer action is familiar to you, of course.

Shorting the grid to ground in this type of circuit would change the grid voltage and the plate current, producing a click. Shorting C_2 would also be a means of producing the circuit disturbance.

Conclusion: The shorting of the grid to ground is useful only when such a short circuit produces a change in the plate current of the tube.

No. 5: Using the Voltmeter for Producing a Current Change. The voltmeter is a handy instrument to use for making the circuit-disturbance test. By moving the positive lead of a voltmeter which connects to the plate of a tube up and down or making and breaking the circuit and

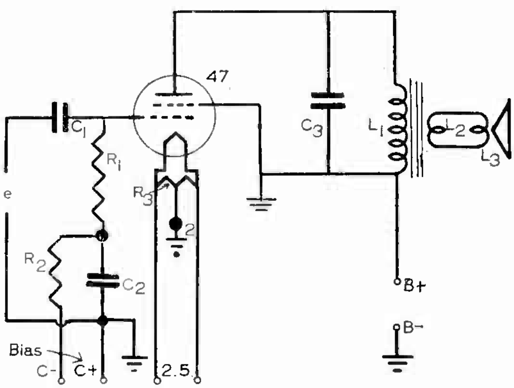


Fig. 5

leaving the negative lead on the cathode connection of the tube, we can produce a series of pulses or clicks. Still another way of producing the disturbance is to connect the meter between the plate and grid of a tube which will cause current to flow from the plate circuit through the meter and grid circuit resistance, making the grid positive and thus causing a plate current change.

If the meter has low resistance the grid voltage change and resulting current increase will be great. If it has high resistance the increase will be relatively small, since the change in grid voltage will be small.

For this reason, a vacuum tube voltmeter connected between the plate and cathode of a tube would have practically no disturbing effect. A 1000-ohms-per-volt type meter, however, would cause a higher intensity click to be reproduced and heard through the loudspeaker. A 5000-ohms-per-volt or 20,000-ohms-per-volt type of meter would produce a less intense click.

Restrictions in Using Circuit-Disturbance Methods. Methods *1*, *2* and *3* of producing the pulse are the most convenient to use but at times cannot be used for certain reasons. (Method 1 is to remove or install a tube in a socket. Method 2 is to open a grid circuit by removing a tube top cap and by making an intermittent connection to produce clicks. Method No. 3 is to touch the grid with your finger or a test lead.) If the receiver has series or parallel filaments and a common series resistance is employed, pulling out one tube will affect the other stages. *One primary rule in using the circuit-disturbance test is to confine the point of injection of the disturbance to a specific or definite part of the radio.*

Removal of a tube in an a.c.-d.c. set or a battery receiver having a filament arrangement similar to Fig. *6* is not, therefore, a suitable way to carry out the circuit-disturbance test. Whenever the filaments are hooked in series, whether in an a.c.-d.c. set or in a battery receiver, removal of a tube cannot be used as a means of producing the disturbance. Similarly, tubes whose filaments are connected in parallel may not be removed for the purpose of making a circuit-disturbance test if a series-dropping resistor is used between the filaments and the supply source.

Let's observe what happens in Fig. *6* when we pull out a tube. Removing tube No. *1* would mean that less current would flow through resistor *R* which is common to all of the tubes indicated in the diagram, and accordingly an increase in voltage across the filaments of tubes No. *2* and *3* would occur. Stages containing tubes *2* and *3* would be affected as well as the stage containing tube *1*. This defeats the purpose of the test, since we do not have a means of injecting a disturbance which will be confined to stage No. *1* alone —the desired condition. Also the filament voltage increase might be sufficient to burn out filaments *2* and *3*. For this reason we must use some other method rather than tube removal in the testing of a circuit of this type.

Method No. 2: (Intermittently opening a grid circuit by removing and replacing the tube top cap.) This method cannot be used conveniently if the tube has no grid cap. Use either method *1*, *3* or *4*.

Method No. 3: (Touching the grid with your finger or a test lead.) The grid of the tube may not be reached easily or the input resistance may be too low to allow a loud disturbance to occur. The audio gain may also be quite low so that producing a disturbance by this method is not practical. This method finds greatest application in high-gain audio circuits, as previously mentioned, employing a *6F5-6F6* combination or equivalent.

Method No. 4: (Short-circuiting the bias resistor or in some way causing a change in the net grid-cathode potential of the tube and, hence, a change in the plate current.) This cannot be used if there is no cathode bias resistor.

Method No. 5: (Using the voltmeter for producing a current change.) This is not useful if the voltmeter is a vacuum tube or high-resistance type.

OTHER CIRCUIT-DISTURBANCE FACTS

The Increase in Intensity of the Clicks. Connecting a voltmeter between the plate and cathode of a tube will produce a certain intensity click. Connecting the voltmeter between the plate and the cathode of a tube in a preceding stage will also produce a click but one which will be of higher intensity.

This is an important point since it enables us to judge approximately the relative gain of the various circuits. With experience you will see just how this works out.

Should you make a circuit-disturbance test following the indicated methods on a modern radio receiver which is in working order you will find, for example, that moving the grid cap connection up and down on an i.f. tube will produce a loud intensity click but that moving the grid cap connection on the mixer tube up and down will produce a still louder click. This shows that you have gain in the mixer stage.

It may be found, in some cases, that the clicks come through from every stage but the set refuses to work. This points to oscillator failure. The oscillator can be checked simply by connecting a high-resistance voltmeter across the grid leak. The negative meter terminal is connected to the grid, the positive to the cathode. An open anode grid or oscillator plate circuit is a common cause of trouble and may be due to a break in a coil or an open in a resistor. A typical example (in the Philco 602) will be given later on in this article. An open in the oscillator grid coil, shorted oscillator tuning condenser or a short circuit between the oscillator plate and B— also can cause oscillator failure.

Applications of the Circuit-Disturbance Test in Testing the Philco 602

Method No. 1 (Removing a tube from or installing a tube in a socket) will not be used in checking the receiver, as it is unsuitable for the reason that the tube filaments of this set (Philco 602) are connected in series.

Method No. 2. (Opening a grid circuit by removing the connection to the top cap of a tube. The connection is made and broken to produce a series of clicks in the loudspeaker under normal conditions.)

Referring to Fig. 7, we can quickly check the audio system by taking the grid cap off the 75 grid and, making an intermittent connection, we will hear a loud series of clicks. However, for

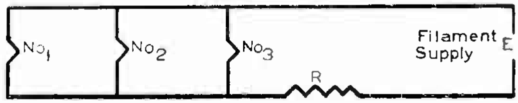


Fig. 6

this particular tube, it is a much simpler matter merely to touch the grid with the volume control advanced to maximum. Then a loud hum or buzzing noise should be heard. This indicates the audio system is working.

Failure to get this sort of response will show that there is some defect in the audio system, perhaps an open in condenser *45*.

The trouble might also be a defective 75 tube in some cases. A low-emission tube would give low gain and a loud noise would not be produced touching the 75 grid under such conditions.

Audio troubles will be dealt with later on in this article so we shall not go into the matter here. It is also a fact that it is inconvenient to use this method (No. 2—opening a grid circuit) for checking certain types of audio systems.

Assuming the audio system checks satisfactorily, we can proceed to the stage ahead of the 75. If we find that moving the grid connection of the 78 i.f. amplifier up and down produces a series of clicks we know that the signal is going through the 78 i.f. amplifier tube and the following circuits. If we fail to get a click, making and breaking the grid connection, we know that the 78 tube itself is defective or that the signal is not getting through the remaining circuits. This might be due, in many practical cases, to an open in the primary of transformer 28.

Lack of clicks could also be due to the fact that we don't get a wide plate current change in the primary of transformer 28 because of an open in cathode resistor *24* or an open in the screen circuit of the tube.

If the screen grid condenser were shorted, the gain of the tube would be lower than normal and the clicks would be weaker than normal.

Assuming that we do hear the clicks when the 78 grid is disturbed, let's proceed to the 6A7.

When the grid connection to this tube is moved up and down we should hear a series of clicks of louder intensity than those which were produced when the grid connection to the 78 was disturbed.

If we do not hear these clicks we would look for trouble in the *6A7* tube or in the link between this tube and the following one—the transformer marked *22*. An open primary on the transformer might be encountered in many cases, or an open cathode circuit in the *6A7* stage or a shorted screen grid by-pass are commonly the causes of trouble in this set.

If we heard loud clicks, making and breaking the connection to the *6A7*, but found that making and breaking the connection to the antenna produced only weak clicks, we might have an open primary on transformer *4*.

If the set seemed alive from antenna to output stage but did not pick up a signal we would look for trouble in the oscillator circuit and would check it. In many cases you find that there is a lack of continuity from the oscillator anode grid (oscillator plate) back to B+. This may be due to a break in a plate circuit resistor or coil, a condition that can be checked using an ohmmeter. In Fig. 7 the coil and resistor in the oscillator anode circuit are marked, respectively, *5* and *9*.

Method No. 3. (Touching the grid of a tube with your finger or with a test lead.)

Touching the grid of the *43* might produce a weak noise. This test would not be very suitable here.

However, by touching the grid of the *75* we should get a relatively loud response in the loudspeaker, showing that the audio system and power supply are working, under normal conditions. The volume control of the set is turned to maximum, of course.

Failure to get this response would show that there was some defect in the audio system or power supply.

Let's assume that the audio system and power supply are all right. Now, touching your finger to the grid of the 78, when the set is tuned to a station, will detune the circuit. If the set is "dead," touching the finger to the grid of the 78 will produce no worth-while indication.

The same thing would apply with reference to the *6A7*. We would use Method No. *2* (opening a grid circuit) or one of the other methods such as *5* (using the voltmeter) instead .

If the radio were out of the cabinet we could conveniently use No. *4*.

Method No. 4. (Short-circuiting the bias resistor or in some way causing a change in the net grid-cathode voltage.)

This method is useful only when the wiring of the set is exposed, as when the chassis is on the workbench and turned upside down.

Let's see how the method can be applied in the case of the power output stage. Resistor *46* is in the cathode circuit of the *43*. If we short-circuit this resistor we shall change the bias of the tube and hence produce a signal pulse due to a change in the plate current which varies according to the grid voltage.

Short-circuiting *46* should give us a loud click. Failure to get this response would indicate a weak-emission *43* tube or possibly an open in either the grid or plate circuit of this tube.

In some cases we might find that we had an open speaker field, giving a weak output. In other cases the voice coil might be open.

In any event, we could localize the trouble using this technique.

If grid condenser *45* were shorted, the bias on the tube would be much higher than normal, since the positive grid would increase the tube's current and the voltage developed across the cathode resistor would be much higher than it should be.

Shorting *46* under such conditions would produce a loud click.

We could quickly check the audio system in its entirety by short-circuiting the grid of the *75* to the cathode of the tube. This would change the net grid-cathode potential and should produce a click or hum. The *78* i.f. amplifier stage similarly could be checked by short-circuiting resistor *24*. When this is done a plate current change occurs in the primary of transformer *28* and the pulse signal goes through the circuits of the radio.

If a click were not heard we would know that we were not getting a plate current change and this might be due to a short-circuited condenser *25* or an open in the primary of transformer *28*.

The *6A7* stage could be tested in a similar way. We would short-circuit resistor *19*. If a change did not occur we would look for a short-circuited condenser *20* or an open in the plate circuit.

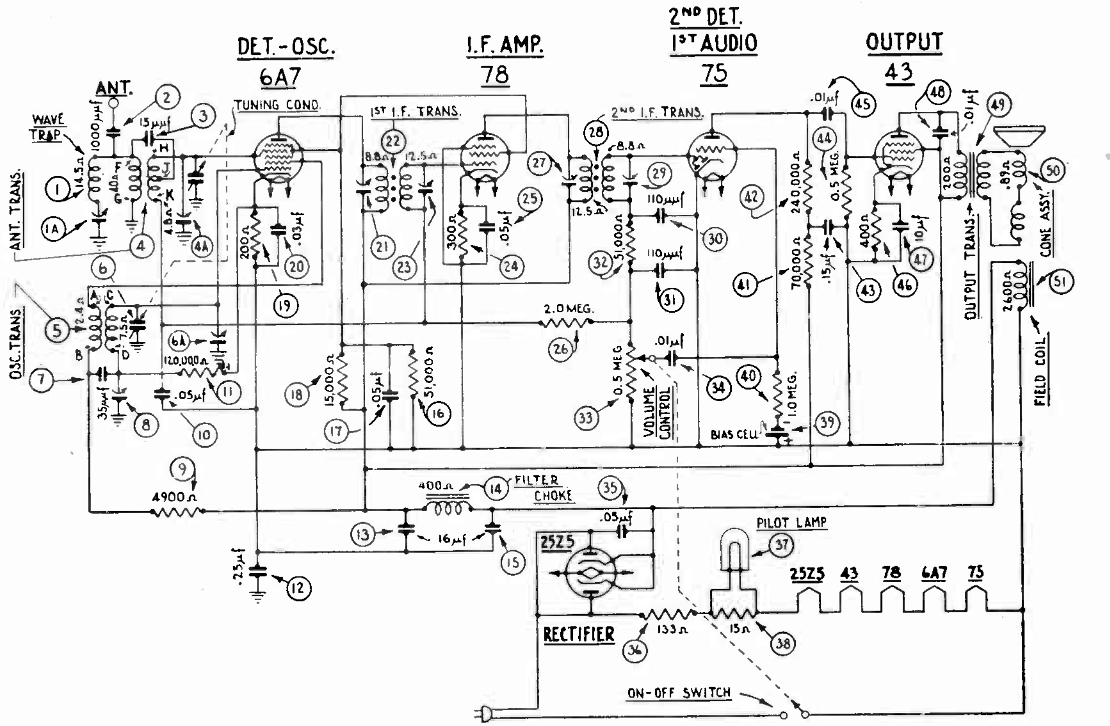


Fig. 7

In some cases we might find that the pulse signal would not swing the grid of the following tube because of an exceptionally high bias on that following tube. For example, if resistor *24* changed in value to a much higher value, we would need a comparatively strong input signal in order to produce a loud click in the speaker. Therefore, if we found that a weak click only was produced short-circuiting resistor *19* and that the 78 stage seemed to be working, we could turn the power off and check the individual resistance values in the cathode circuit and in the plate circuit.

This would enable us to check on the condition of the stages.

Method No. 5. (Using the voltmeter for producing a current change.)

This is probably the most useful of all the methods with the possible exception of Method No. *3*. (Touching the grid with your finger or a test lead.)

In using the voltmeter technique it is convenient to attach one lead to the ON-OFF switch which is the B— terminal and the other positive lead of the voltmeter to the various plate circuits of the tubes. For example, we would touch first the plate of the *43*, moving the test prod up and down on the plate of this tube, then the plate of the *75*, *78* and the *6A7*. As we do this, moving from the power output stage to the stage nearest the antenna, the clicks should increase in intensity, showing that the stages following the point of injection of the disturbance are contributing to the over-all gain of the radio.

The clicks heard when the connection is made to the plate of the *75* should be louder, for example, than the clicks heard when the meter is connected to the plate of the *43*. Again, the clicks should be louder when we connect to the plate of the *78* than they are when the meter is connected to the plate of the *75*.

Suppose we find that moving the meter probe up and down on the plate of the *43* does not produce a loud click in the speaker. The defect may be that we don't have plate voltage on the tube, due to an open in the output transformer primary, which is immediately indicated by the voltmeter anyhow, or that the voice coil is open in the loudspeaker circuit. In other cases we might have an open speaker field.

If we found that connecting the meter between the plate of the *75* and the ON-OFF switch did not produce a click we might look for an open in resistors *41* and *42* or an open in condenser *45*.

We would bear in mind the fundamental principle that we must have some means of coupling the plate circuit of this tube to the next grid, and condenser *45* serves that purpose.

If this condenser circuit is open, our pulse signal will not get through.

The same thing would apply to the preceding stages but we will not repeat the test procedure for those stages.

Now let's see how we can produce a circuit disturbance using the voltmeter in some way other than that previously indicated.

Suppose you connected the instrument between the plate of the *43* and the grid of the same tube. What would happen?

We would produce a current change in grid resistor *44* which results in a change in the net grid-cathode potential of the tube and consequently a click will be heard in the loudspeaker as the plate current changes.

A relatively loud click will be produced in this way.

With the chassis turned upside down it may not be convenient, in some cases to put the test prods of the voltmeter on the plate and the grid of the *6A7*, or on the plate and grid of the *78*.

But we could just as easily test these stages using the same method, if we wished to go to the bother of putting one test prod on the grid of the *6A7* and the other prod on the plate.

We have shown how the various stages of the set could be checked. Let's assume, however, that the power output stage appears to be dead and that there seems to be some defect in the power supply.

We could easily check the condition of the supply by connecting a voltmeter across each of the filter condensers. If we found that normal voltage was not obtained, about 100 volts in the average case in a set of this type, we could turn the power off and check further the various circuits using an ohmmeter.

The voltage across condenser *15* in a typical case might be about 100 volts, that across *13* slightly lower or about 90 volts.

Conclusion. It should be remembered that the circuit-disturbance test will not indicate directly the nature of the defect. Its greatest usefulness is that it allows you to localize the trouble in the set, eliminating the need for testing a great many of the radio receiver components and enabling you to concentrate upon the defective section, thus minimizing the number of measurements that need to be made.

This leads to efficiency and speed in practical trouble-shooting work.

The War Spirit in Radio Language

Graduate Joseph Miller is employed by the Crosley Corporation in Cincinnati. The following, contributed by Graduate Miller, appeared in the Crosley Victory News and is reprinted here with permission by him.

WHAT WE NEED

A *condenser* that will build up capacity to do more quality work in a shorter time.
A *resistor* that will help us fight off temptation to seek special privileges denied to others.
A *choke* that will cut off all rumors and idle gossip.
A *transformer* that will step-up our moral courage so that we can better carry out the job ahead of us.
A *volume control* that will reduce to zero the talk about our work and other information considered of military value.

THE FINEST IN THE SOUTH

Chief Engineer Julius Vessels is Doing Big Things at WDOD, Chattanooga, Tennessee

Mr. J. E. Smith, President
National Radio Institute
Washington, D. C.

Dear Mr. Smith:

Since I have not written you for some time, maybe I should go back almost two years and mention the work done. I trust it might be interesting.

During the end of 1941, the station completed and moved into our new studios which are the finest in the south. Now that sounds like a good sized statement but they really are fine and the latest in design such as CBS in New York.

I installed the new speech equipment. It is a special custom built by Western Electric. Engineers from the purchasing office of the Soviet Union in Washington inspected the lay-out and said it seemed to be the best of any they had seen in this country.

Soon after the completion of the studios, we began the installation of our new transmitter using directional antennas at a new site. This was completed in January of last year. The transmitter is a Federal 165-A 5 K.W. transmitter exactly the same as WABC is using in New York for their stand-by. The Federal Telegraph Company manufactured only two of these before the war got going and we got one of them.

I am enclosing some photos. The person at the console is not me. These are merely amateur shots and not the best we have made.

Of course, I have been doing nicely financially, earning about $4500.00 last year. There has been a considerable amount of overtime and I have been real busy.

I can never forget what you have done for me, and again I wish to take this opportunity to thank you.

Kindest personal regards. Also, give my regards to Mr. Dowie and Mr. Haas.

Sincerely yours,

JULIUS C. VESSELS, *Chief Engineer*
Radio Station WDOD
Chattanooga, Tenn.

N.R.I. ALUMNI NEWS

F. Earl Oliver .... President
Peter J. Dunn .... Vice-Pres.
Louis J. Kunert .... Vice-Pres.
Earl R. Bennett .... Vice-Pres.
Chas. J. Fehn .... Vice-Pres.
Earl Merryman .... Secretary
Louis L. Menne .... Executive-Secretary

NOMINEES FOR OFFICE DURING 1944

Charles J. Fehn of Philadelphia and Louis J. Kunert of New York are the nominees for President of the National Radio Institute Alumni Association for 1944.

Mr. Fehn has served several terms as Vice President and has held all of the principal offices in Philadelphia-Camden Chapter. For many years Charlie Fehn has been the power behind the throne in Philadelphia-Camden Chapter. He has made many personal sacrifices in his effort to be of real service to our Alumni Association. He has always taken a very active part in every movement in Philadelphia. He is the type of man who can be counted upon under all circumstances. His loyalty to our Alumni Association is deep rooted.

Likewise Louis J. Kunert has been a tremendous influence in New York Chapter. He has served as Secretary of that local for many years. He too, has served several terms as Vice President of our National Organization. His reports to headquarters have always been prepared in a businesslike manner and have been received with absolute regularity. He is a shining example of efficiency in office. He accepts responsibility with a determination to give his very best and he does just that.

In some respects it is unfortunate that Mr. Fehn and Mr. Kunert should both be nominated for President in the same year. One will be elected. The other will step out of office in our National Organization for at least a year. Since both have made excellent Vice Presidents there is every reason to believe that both would again be elected as Vice Presidents. But in order to move up to the highest office within the gift of our organization, it is necessary to take some risk. We are sure that the man who runs second in this friendly contest will accept the result in good grace realizing that although he has failed to reach the presidency this year, the respect which our members hold for him is no less diminished. Most certainly he will gain in popularity and perhaps his chance will come later.

For Vice President, eight candidates have been nominated. Four are to be elected. The successful nominees this year are as follows: Peter J. Dunn, well-known to our members as a four-time President and in recent years one of our Vice Presidents. Pete Dunn is at present on duty with the Government. Although he is a veteran of the last world war he did not hesitate to offer his services again. Pete likes to get results and loses no time in going into action.

Earl R. Bennett of Evanston, Illinois, also is a past President of our Alumni Association and is at present one of our Vice Presidents. His radio servicing business in Evanston and Wilmette, Illinois, is something to be envied. He is an expert radioman, can make a fine talk or write an article on the subject and is an all-around peach of a fellow.

Dr. George B. Thompson, another candidate for Vice President is likewise a past President of our National Organization. He has also served several terms as Vice President. He is a great advocate of the home-study method of acquiring an education having completed twenty-three home-study courses. All of these courses were taken since Dr. Thompson graduated from college where he received his degree of B.S., M.S. and M.D. In short, he is a real friend of the home-study student.

Allen McCluskey of Birmingham, Alabama, is another former Vice President who again is nominated for the office. Last year Mr. McCluskey was a candidate for President. He is a good man and will receive plenty of support.

John Stanish, also a former Vice President and candidate for President in 1941, has been nominated. He has always been one of the prime movers in our Detroit Chapter. John is a human dynamo in action.

F. Earl Oliver, our retiring President, is paid a real compliment. Our members apparently want to keep him in office, judging by the number of votes he received as a candidate for Vice President. Since it is a rule of our Alumni Association that the President cannot succeed himself but is eligible for any other office, it is evident that Mr. Oliver is going to be well supported in an effort to keep him in our National Organization.

Harry Andresen, another nominee for Vice President, is a candidate for a National office for the first time. Mr. Andresen is Chairman of Chicago Chapter. In spite of the many problems which are faced by the Chairman of a local during these difficult times. Mr. Andresen has made a splendid record in Chicago. We will hear much more of him in the future.

Elmer E. Hartzell of Allentown, Pennsylvania, is a surprise nominee. Although he has no local chapter affiliations he received sufficient support to be named one of the eight nominees for Vice President. Mr. Hartzell is a real booster for our Alumni Association and it is fitting that he should be honored by this nomination. It is anticipated that he will receive plenty of votes from his locality.

For Secretary our old stand-by Earl A. Merryman, now on overseas duty, is again nominated. His opponent is Robert E. Maney, of Washington, and a member of Baltimore Chapter.

For Executive Secretary, L. L. Menne, Washington, D. C., is renominated and is opposed by Jesse O. Starr. Mr. Menne is well-known to many of our members. Mr. Starr is a radio engineer formerly of Washington, D. C., but now located in Dobbs Ferry, New York.

Please turn to the ballot on page 28. Mail it as early as possible. The polls close December 30, 1943. All elected officers will serve for a term of one year. The results of this election will be announced in the next issue of the NEWS. Mr. C. Alexander, bookkeeper at N.R.I., has again been appointed Teller to count the votes. Please mail your ballot to Mr. C. Alexander, Bookkeeper, National Radio Institute, 16th and U Streets, N. W., Washington 9, D. C.

Baltimore Chapter

Over here in Baltimore, things run along so smoothly under the guidance of Chairman E. W. Gosnell, ably assisted by our other Officers who are always regular in their attendance, our wants and problems are few. Therefore, our reports may seem rather common-place but a visit to our Chapter on one of our meeting nights will convince any one that there is plenty of lively discussion and activity.

Vice-Chairman, H. J. Rathbun, is doing a grand job as Radio Consultant for our Chapter. He is a thoroughly experienced Radio man and is tremendously interested in his part of our program which is to conduct our Radio trouble-shooting work, a regular feature of our meetings. Mr. Rathbun takes things apart before our very eyes and explains each operation as he gets new life into a tired Radio receiver.

Mr. L. Arthur, our Publicity Agent; Mr. B. J. Ulrich, our Financial Secretary; Mr. P. E. Marsh, our Recording Secretary, all have been putting their shoulders to the wheel and as a result we have a smooth running organization.

The life of a Chapter, of course, comes from the members and we wish we had space to mention the names of all of those who meet with us regularly and do so much to make our discussions interesting.

New members are always welcome. We meet on the second and fourth Tuesday of each month at 8:00 P.M. at Redmen's Hall, 745 West Baltimore Street, in Baltimore.

P. E. MARSH, Secretary.

Chicago Chapter

For the time being, we are meeting at our new headquarters, 2759 S. Crawford Avenue in Chicago. Our members expressed entire satisfaction with this new meeting place, so we will continue to meet there until further notice.

At recent meetings we have had splendid talks by our own members on such subjects as Radio Frequency, Intermittent Reception, Condensers, and Tube Values.

Our parties having proved so successful in the past, it was voted to hold another. This is scheduled for November 27, which will be after this issue of the NEWS goes to the printer, but a complete report will be given in the next issue of the NEWS. A committee was appointed to make all arrangements for the party. Notices will be mailed to our members.

Election Ballot

Fill in this ballot carefully, and mail it to National Headquarters immediately.

FOR PRESIDENT (Vote for one man)

☐ Charles J. Fehn, Philadelphia, Pa.

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

FOR VICE PRESIDENT

(Vote for four men)

☐ Peter J. Dunn, Baltimore, Md.

☐ Earl R. Bennett, Evanston, Ill.

☐ F. Earl Oliver, Detroit, Mich.

☐ Harry Andresen, Chicago, Ill.

☐ Dr. Geo. B. Thompson, Los Angeles, Calif.

☐ Elmer E. Hartzell, Allentown, Penna.

☐ Allen McCluskey, Birmingham, Ala.

☐ John Stanish, Detroit, Mich.

FOR SECRETARY (Vote for one man)

☐ Earl A. Merryman, Washington, D. C.

☐ Robert E. Maney, Washington, D. C.

FOR EXECUTIVE SECRETARY

(Vote for one man)

☐ L. L. Menne, Washington, D. C.

☐ Jesse O. Starr, Dobbs Ferry, N. Y.

SIGN HERE:

Your Name ....

Your Address ....

City .... State ....

Polls close December 30, 1943

Mail Your Completed Ballot to:

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

Tear or cut carefully along this line

At all of our meetings we do some actual Radio servicing. This is in line with the long established policy of Chicago Chapter and is undoubtedly the most interesting part of our programs.

Our Treasurer, now working on a night shift, found it necessary to resign. Mr. Leonard Senglin has been appointed Treasurer to fill the unexpired term. Election of Officers for 1944 will be held at our December meeting.

Because some of our Officers are working in defense plants requiring shifts in hours making it impossible to attend meetings regularly, the bulk of the work of conducting our Chapter affairs has fallen upon the shoulders of Chairman Harry Andresen. Mr. Andresen has done more than his share to give our members real constructive meetings and it is hoped that a slate of officers will be elected for 1944 who can and will carry the responsibilities of their respective offices. Therefore, please be sure to attend our December meeting. The cooperation of all members of Chicago Chapter is earnestly requested.

JOSEPH PAGANO, Secretary.

Phila-Camden Chapter

Meetings are still being held at the shop of Harvey Morris, 6216 Charles Street in Philadelphia. But because of our steadily increasing attendance, we are on the lookout for larger quarters to suit our conditions.

Chairman Bert Champ, having been transferred to a night shift, has been unable to attend all of our meetings. It therefore evolved upon Vice-Chairman Morris to preside over some of our meetings as well as the service end of each meeting. That quick, efficient manner of Harvey's in diagnosing sick Radios is still holding the main interest of all.

Harvey Morris is never in want of material for demonstration purposes because Librarian Syd Langendorf, back in regular attendance again, is sure to show up with three or four jobs. These added to those brought in by other members keep Harvey on the jump.

Financial Secretary, John McCaffrey is always on the job and ever ready to fit in and assist Harvey Morris when he has more than he can reasonably be expected to do in an evening. John McCaffrey, by the way, should be in line for Chairman in 1944.

Special mention should be given to Past-Chairman Norman Kraft, who still attends every meeting in spite of the thirty mile trip from his home in Perkasie.

In recent meetings we have been so busy doing actual Radio servicing, we have deviated somewhat from our regular practice. In the future, to make our meetings more diversified, it is intended to revive the practice of having members talk on a fixed Radio subject after giving the member an opportunity to prepare himself.

New members taken in recently include Frank Miller, Jr., William M. Little, John E. Bayliss, Gidean H. Bowden, all of Philadelphia, Martin F. Giedemann, formerly of New York Chapter, and now a resident of Philadelphia, and John Dragan, of Trenton, New Jersey.

Until further notice, our meetings will be held as usual on the first Thursday of each month at 6216 Charles Street, in Philadelphia. All N.R.I. members, whether students or graduates, are cordially invited to attend our meetings.

CHARLES J. FEHN,
National Vice President.

New York Chapter

At one of our early fall meetings, we presented our plan for the new season. This plan was worked out by Bert Wappler, Louis Kunert, Archie Burt and Frank Zimmer. The details of the plan were conveyed to the members by our Chairman, Bert Wappler. Here it is:

Meetings will be opened as usual at 8.30 P.M. We will then have roll call of Officers and then go over any old or new business. This will take about ten minutes. After this we will introduce our new members. Then we plan to have some member bring forward a receiver that he is having trouble with. We will try to locate the trouble for him, a diagram will be put on the blackboard and the trouble will be explained. It will be necessary for any one bringing in a receiver to also bring a circuit diagram of it.

At each of our meetings we will have one of our members give a short talk on some part of a receiver after which other members will have a short discussion with the speaker on the subject. This is an excellent idea for helping members advance in public speaking.

We also plan to have an outside speaker on certain occasions. This man will be a representative of some concern in the Radio field. In such a case we will turn the entire evening over to the speaker. This program will give us plenty of variety and will bring back to us many of our old members and a considerable number of new members.

Before the close of each meeting we will hold a short service forum which will be conducted by one of our members.

This new program is already under way. At one of our recent meetings Mr. William Henn was our first speaker. He spoke on volume control.

We want to emphasize that we have also made arrangements to give some time at each meeting to the new students—those who have not progressed very far in their courses. This feature has already brought good results.

Bert Wappler is a grand fellow and we were very fortunate in selecting him as Chairman.

He knows how to get results and he is very considerate at all times in extending cooperation to everyone.

New members are John Begley, Arthur Senf, Frank Capuano, Paul Ireland, Louis Capano and Andre LaRoche. Keep your eye on Paul Ireland. He knows Radio and can get up and talk on the subject.

Some of our members have visited the Radio shop operated by our Robert Godas. He has a nice place and is doing a splendid business.

Al Stock, our former National Vice President and Chairman, honored us with a visit. Other old members visiting us were Ernest Amman and Humbert Grossman.

Our Assistant Chairman, Archie Burt, is a mighty important figure at our meetings. He has the keys to everything—the Chairman's gavel, the books, our tools, in fact just about everything we own. But Archie is always on the job. His particular task is our service forum.

Mr. Wilson, of our Chapter, was kind enough to donate a large supply of Radio parts. The members of our Chapter are very grateful to Mr. Wilson and extend our genuine thanks for this fine fraternal spirit.

On December 2, our Chapter will be visited by Mr. J. B. Straughn, N.R.I. Consultant, and Mr. L. L. Menne, our Executive Secretary, both of whom will address us. Details of this meeting will be reported in the next issue of the NEWS.

LOUIS J. KUNERT, National Vice President.

Detroit Chapter

Two of our recent meetings were devoted to analyzing the circuit of the R.C.A. dynamic dem-

(*Page 32, please*)

Here And There Among Alumni Members

W. Arlington Baldeck is employed by Eastman Kodak Co., Rochester, N. Y., in the Electronics Division. His work consists of maintenance of Electronic equipment, some design of new equipment and interpretation of records taken by Electronics devices. Some of the devices were developed by Mr. Baldeck. Has a very fascinating position.

n r i

Joseph Miller is taking a Radio Engineering Lab. Course at the University of Cincinnati. He says a group of Electrical Inspectors were given an examination on Radio Receivers and Transmitters and Miller was one of the few who passed, thanks to his N.R.I. background.

n r i

John J. Barta is supervising the installation of Radio equipment in Naval Aircraft in Rhode Island.

n r i

Wallace G. Baptist is now Administrative Assistant to the Officer in Charge, School of Applied Electronics, at the Lexington Signal Depot, Lexington, Ky.

n r i

After six continuous years with one concern as Radio Serviceman, Theodore E. Campbell resigned to accept a position as Transmitter Engineer at WJAC, Johnstown, Pa. Is very happy in his new job.

n r i

Willard Doan is still employed as Transmitter Engineer at KGKO, Fort Worth, Texas, and, because of the shortage of Radio men, he makes $10.00 to $15.00 extra a week doing Radio Servicing in his spare time.

n r i

Dale C. Boughner is Technical Sergeant in charge of some mighty important equipment which we need not mention for military reasons. Sergeant Boughner is the highest ranking non-commissioned officer in his post, somewhere in Iceland.

n r i

Kenneth P. Conroy, who holds a third class operator's license, is Radio Communications Chief in Somerset, Mass., in connection with Civilian Defense. Mr. Conroy expects to enter the Naval Radio School before long.

n r i

On the strength of having completed the N.R.I. Course, Frank S. Wade was made a wireless mechanic in the Royal Canadian Air Force, without being required to take special training. Mr. Wade says a number of other N.R.I. Graduates are in his outfit and all are doing very well.

n r i

Byrl T. Jenkins is employed by Farnsworth Television and Radio Corporation, Marion, Indiana. He says there are seven N.R.I. graduates in his department.

n r i

Jesse O. Starr is Radio Engineer with the North American Phillips Co., Dobbs Ferry, N. Y. He says it is the job he has long dreamed about, designing and building all sorts of Radio apparatus, in a lovely little town on the bank of the Hudson river. Mr. Starr is very contented in his new surroundings.

n r i

Jerry F. Behal is employed by Zenith Radio Corp. in Chicago.

n r i

Mr. and Mrs. W. A. Brown inform us that their son, Norfleet, passed away on Oct. 8th after an operation. Norfleet was one of those fine young fellows you just had to like. He enrolled at 17 and was only about 23 years of age when he was taken from us. Our deepest sympathies to his family.

n r i

Floyd A. Roberts is Radio Electric Mechanic with United Air Lines in Wyoming. Good job and swell chance for promotion.

n r i

Had a nice letter from Clarence Stokes, former President of our Alumni Association, who is doing a war job with the Signal Corps in Pennsylvania. Although working long hours he finds time to raise chickens and claims to have had a very successful Victory Garden. Refers to himself as a "Radio Butcher" but we know if anyone else said that, there would be trouble. Stokes is a Radio expert, no less, and gave up a fine Radio business to do his war duty. A swell fellow, whom we look forward to meeting again at one of Phila.-Camden Chapter's famous parties when the gang can all get together again.

n r i

Robert A. West is employed by the Air Corps as a Radio Electrician at one of our big Army bases. Has been admitted to several Army Radio schools, thanks to his N.R.I. background.

n r i

Christian P. Markworth took a Government sponsored course. His instructor, Chief Engineer for Radio Station WHBL, Sheboygan, Wis., liked his work, encouraged him to prepare for a license. Now Markworth has a license and is employed by station WHBL.

n r i

Alfred Olson of Port Allegheny, Pa., works in the Industrial apparatus plant on Electronic equipment for Sylvania Electric Products, Inc., Emporium, Pa.

Novel Radio Items

—BY W. R. MOODY—

When radio station WABC of the Columbia Broadcasting System erected its 50,000-watt transmitter a few years ago on a tiny island in Long Island Sound, a mile off New Rochelle, New York, a ferry service was inaugurated for engineers and other members of the staff. During certain months of the year, however, service was affected when the island and mainland became totally obscured by dense fogs of long duration. To insure safe navigation during these periods, CBS engineers devised an electronic navigator to guide the boats by following the power cables under the water, which connect from the mainland to the island station. The flux lines of the magnetic field surrounding the power cables, which lie upon the ocean bed, induce a current in a specially built coil encased in a wooden box in the bow of the boat. A portable amplifier, with a gain of 86 db., steps up the signal induced in the loop and the output is fed to a volume indicator type meter used as a course indicator. The amplifier is adjusted so that when the boat is directly over the cable a maximum deflection of the needle is shown on the meter.

n r i

The National Bureau of Standards maintains a transmitting station, WWV, at Beltsville, Maryland, near Washington, D. C., and has recently improved and extended its service. A new transmitting station has been built. The service is continuous at all times, day and night. The standard frequencies are 5 megacycles, 10 megacycles and 15 megacycles. The 15 megacycle signal is used only during daytime. Two modulation tones are carried by all signals—440 cycles per second and 4,000 cycles per second. The pulses of the signals are timed to occur at .005 second intervals. They may be used for accurate time signals and their one second spacing provides an accurate time interval suitable for scientific measurements.

n r i

Recently, the New York Police Department, for the first time, broadcast photographs of missing persons by television. It has been predicted that criminals whose faces will be as familiar as those of movie stars will be found by the same method in the future.

A 10-minute program, showing the likenesses of seven persons, was beamed over station W2XWZ and was seen by 20,000 persons in a 50-mile radius.

n r i

A new electronic device permits a blind worker to operate a sewing machine safely. An electric eye attachment stops the machine if the worker's fingers approach too close to the needle. A buzzer warns the operator when the thread runs out or breaks. The device was developed by the American Foundation for the Blind.

n r i

Signal Corps radio operators now use head sets of a modern type which do not resemble old style types but are more like hearing aids. Soft plugs fit into the ear cavities. A new pair of plug inserts is issued to each new wearer of the phones. Neophrene is used instead of rubber for the inserts. Where formerly the Signal Corps required several types of head sets to operate successfully with the various communications receivers employed, the new earphones may now be used interchangeably with all signal equipment.

n r i

To test microphones for durability a new machine picks the mike up and then drops it. This is done twenty thousand times.

n r i

Electronics now allows food dehydration using r. f. energy. For the first time, removal of 99 per cent of moisture content from a compressed vegetable block is possible.

n r i

The cathode ray oscilloscope is now used in connection with calibration of camera shutters.

n r i

The bulk of overhead wires, criss-crossing the continent, are destined to come down and to be replaced by Radio and light beams in the opinion of F. D'Humy, Western Union Vice President. Replacement of the wires will be made with Radio and electronic devices.

Detroit Chapter

(*Continued from page* 29)

onstrator, using circuit diagram supplied to us by headquarters.

Our most recent meeting was held at the home of Robert Briggs. Mr. Briggs gave a very good technical description and explanation of his communications receiver and also his amateur transmitter. These outfits, of course, are silenced for the duration but when things get back to normal and Mr. Briggs is on the air again he is to have the boys over for an actual demonstration.

Radio service work is piling up more and more all the time. Most of our members have more than they can handle.

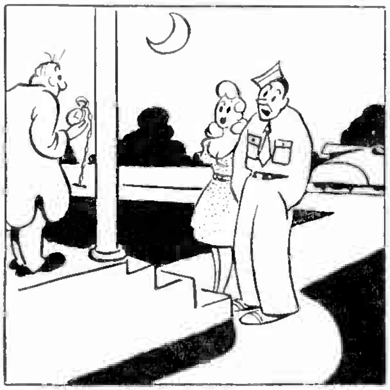
Mr. R. B. Fouke of Rockwood has opened his own shop. He is doing very nicely. With so much work ahead of him he cannot promise delivery of a job in less than a month. Mr. Fouke is a good Radio man and has the backing of all of our members who wish him every success.

Chairman John Stanish is perhaps the busiest man in Detroit. He seems to work every day of the week, including Sundays, and one wonders where he gets so much energy. In spite of being head-over-heels in work in his own business, John Stanish never neglects the meetings of our Chapter. John says it is a wise business man who knows how to work hard but who knows also that some diversion and relaxation is necessary.

So, all you busy N.R.I. men in Detroit take a tip from our Chairman. Attend our meetings. Send your name and address to Mr. F. Earl Oliver, Secretary, 3999 Bedford, Detroit, who will gladly send you notices of meetings, or, write to the undersigned at 5910 Grayton.

HARRY STEPHENS, Ass't Secretary.

n r i



"That will be all for this morning, soldier. I'll take over from here."

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J. B. STRAUGHN, TECHNICAL EDITOR

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