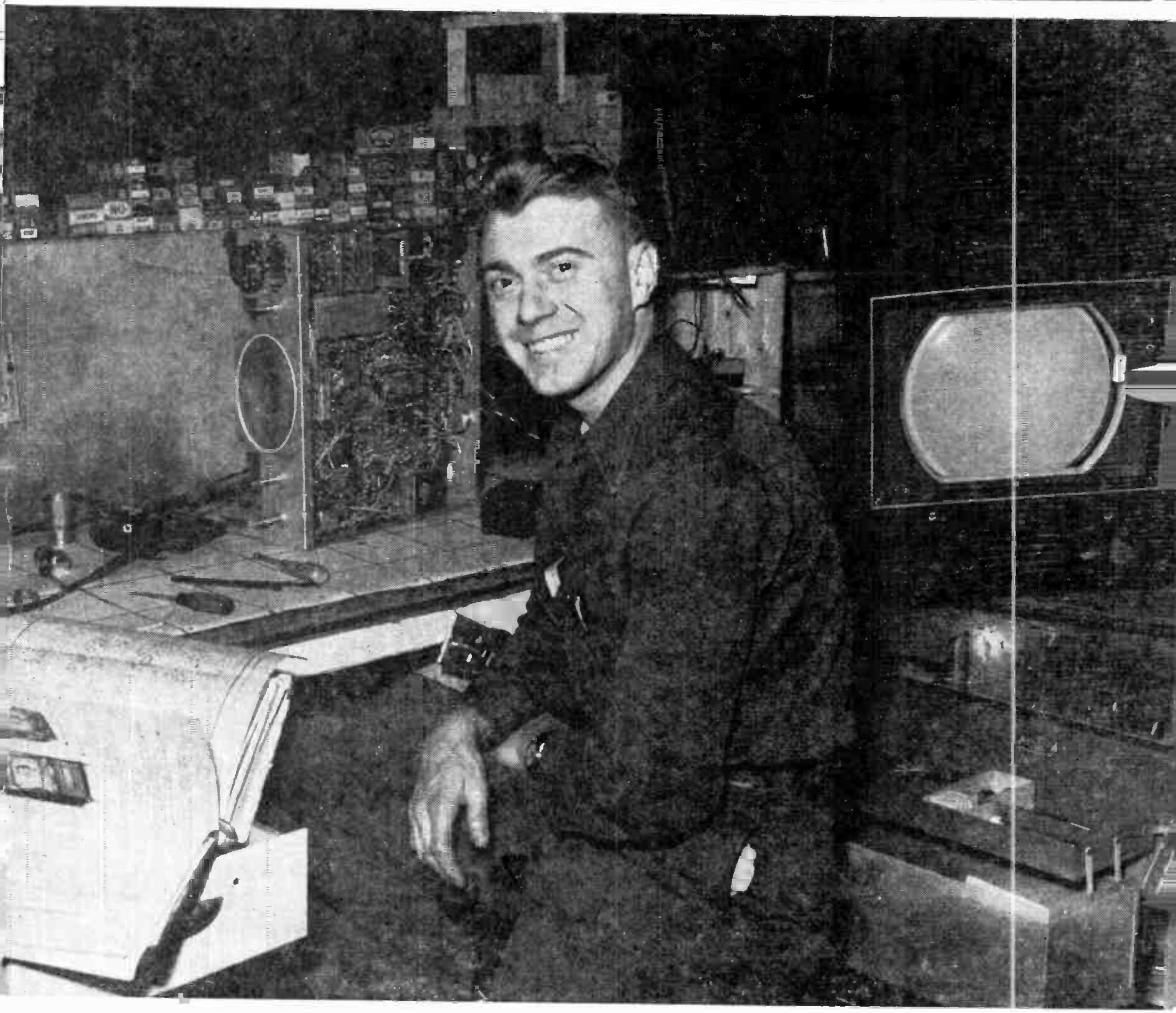
National RADIO-TV NEWS



IN THIS ISSUE

Television Circuits for UHF

Servicing with NRI Electronic Multitester

Alumni Association News

Oct.-Nov. 1952

VOL. 15 No. 5

Will Power and Won't Power

PEOPLE point out a successful man and say he has a lot of will power. It's true that will power is a necessary requisite to success. But seldom mentioned and just as important is "won't power"—the power to say "No" at the proper time.

"Won't power" alone does not guarantee success in any venture but when used at the right time is as important as will power.

Apply this simple combination in the use of your spare time. Use will power when it comes to utilizing your spare time. Use won't power when it comes to wasting it. Put a *cash* value on your spare time and spend it grudgingly.

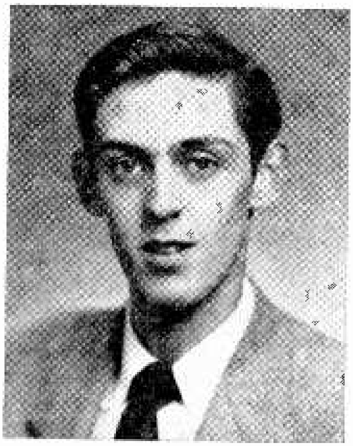
I am old enough to have seen hundreds of boys grow to manhood. When I compare their stations in life today, I see some "on top," others "at the bottom," and some "in between." When I talk to them, I find those "on top" spent part of their spare time preparing for self-improvement; that the less fortunate did not.

I want to see you "on top" in Radio and Television some day. So won't you take the advice of someone who's lived long enough to see the many benefits of regular, spare time study.

When you are tempted to neglect your studies, use "*won't*" power. If you have not already done so, lay out a schedule for regular study every week and use *will power* to stick to it.

That combination of "I will" and 'I won't" can lift you to heights even beyond your fondest dreams today.

J. E. Smith, *President.*



B. van Sutphin

Television Circuits For UHF

By

B. VAN SUTPHIN

NRI Consultant

UHF Television is now on its way to becoming a reality in many communities; and with the advent of TV on these higher frequencies, the service technician will be called upon to repair many circuits that are strange when compared with the equipment used for VHF.

As the frequency of operation is raised, circuits begin to look different. Inductors become pieces of wire, and stray capacity is often used to provide coupling between circuits.

As the frequency approaches the UHF range, other differences appear. Circuit noise becomes the limiting factor of performance, and the input stages of a receiver must be designed for minimum noise rather than maximum gain; in many instances, a crystal diode is used as a detector, because, under proper conditions, the diode generates less noise.

In those cities that already have VHF stations in operation, set owners will not need to buy new receivers in order to receive the UHF channels. Manufacturers have designed units that will, by superheterodyne action, convert the ultra-high frequencies to lower ones. The output of the converter is then fed to a VHF receiver tuned to one of the "low channels."

For example, suppose the VHF receiver is tuned to 82 mc (channel 6), and reception is desired on channel 14 (470 mc). A local oscillator signal of 388 mc will beat with the desired signal to produce 82 mc, and the circuits of the VHF receiver will then convert the 82 mc signal to another lower frequency for further amplification, etc. (Notice that this system gives double conversion.)

Even though high-gain antennas will be used for UHF television reception, the signal applied to the input of a UHF TV receiver will still be considerably less than that applied to the input of a VHF television receiver. Therefore, the signal-to-noise ratio of the receiver is kept high to provide maximum gain with minimum noise. For satisfactory reception with any type of receiver, the signal applied to the input stage must be considerably greater than the noise generated in that stage. Therefore, decreasing the noise generated in the first amplifying stage of a TV receiver has the same effect on the signal-to-noise ratio as increasing the input signal.

The picture portion of a television signal is amplitude modulated, and is therefore affected by even small amounts of noise. Because the eye is extremely sensitive to noise in the picture, every effort is made to obtain the highest possible signal-to-noise ratio. The ultimate limit of this ratio is the noise level in the input stage of the receiver. Consequently, special circuits are used in the input stages of UHF sets, as you will see later in this article.

Special tubes have been designed for use in UHF circuits. At the present time, the 6F4 triode acorn tube and the 6AF4 triode miniature tube are the most common ones for use in UHF converters, but the new 6AJ4 and 6AN4—miniature UHF triodes specially designed for low noise—will probably replace them.

Since the UHF converter must handle frequencies between 470 megacycles and 890 megacycles, the design and layout of the circuits used are far more critical than for the VHF channels. Because the shielding and the positioning of parts are so critical, UHF converters often are sold as sealed units that are to be serviced only by the manufacturer. However, as UHF Television becomes more wide-spread, the factories will turn the work over to practicing servicemen.

Noise Sources

Before proceeding, let us see what the sources of noise are in a circuit.

Heat always causes an agitation of the electrons in a conductor, and even at room temperatures, there is sufficient agitation to produce a random electron motion. When signals or dc currents flow through these parts, they are modulated by the irregular electron motion, and as a result, a noise component is added to the original signal. The amount of this noise depends on the band width of the stage, and on the resistance of the parts so affected. In this connection, servicemen must remember that carbon resistors should not be used as replacements in UHF circuits—instead, metallized resistors are recommended.

In high-frequency circuits, this noise is kept down by limiting the resistances (or impedances) in the input circuits. Relatively low values of impedance—300 to 10,000 ohms—are required in these circuits in any case to provide proper impedance matching. The band-width of stages cannot be narrowed, as that would limit the picture quality.

It is quite important to have low noise in the first amplifying stage, because in this stage the signal is the weakest. When the signal has been amplified by this stage, the noise added by succeeding stages does not have too much effect upon the signal-to-noise ratio.

Tubes also contribute to the noise generated in a circuit. One cause of tube noise is the random fluctuation in the number of electrons leaving the cathode. Instead of traveling in an unvarying stream, the electrons travel in bunches, and the average of all these bunches is the plate current. The fluctuations above the average are noise; when amplified, this noise has a sound like that of a shower of shot falling upon a metal surface. This noise is therefore called "shot effect."

Also, the noise generated in a tube depends upon the number of elements in that tube; the fewer the elements, the less the noise. In fact, the average pentode is approximately four times as noisy as a triode of equal amplification. This fact limits the usefulness of multi-grid tubes in UHF circuits.

In a mixer stage, the oscillator signal varies the current in the detector circuit so that it is near zero part of the time, and at such times the noise component is the greater portion of the total signal. Therefore, it is extremely important for the mixer used in UHF circuits to have low noise. For this reason, a crystal diode is often used as the mixer.

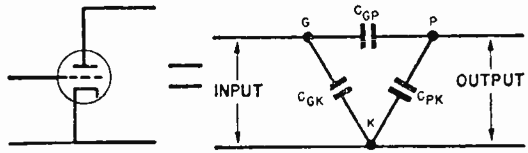


Fig. 1. The inter-electrode capacities of a triode.

UHF Tubes

There are various limiting factors set up by the individual elements in the tube. The capacity between elements places a certain capacitance across the input and the output circuit.

Fig. 1 shows the inter-electrode capacities existing in a triode amplifier circuit. You will notice that the input is shunted by the grid-cathode capacity, and the combination of the grid-plate capacity and the grid-cathode capacity.

At ultra-high frequencies, these capacities are quite important because they are connected across the tuning elements, and consequently will affect the amount of inductance required for resonance.

Tubes for UHF are especially designed to have low input and output capacity; tube elements are physically smaller, the leads from the tube base to the elements are shorter, and glass bases are used.

Even so, it is customary to use the internal tube capacity as the tuning capacity, dispensing entirely with a tuning condenser. In such cases, variable inductances are used to get final alignment to the desired frequency. This is the only way that a desirable L-C ratio can be maintained.

Actually, the input capacity of a triode is far larger than the internal tube capacity, because of the interaction between the input and output circuits through the grid-plate capacity. The signal voltage developed across the load is fed back by the grid-plate capacity to the input with the result that the grid-plate capacity acts as though it were increased by as much as the amplification factor of the tube. If the gain of the stage is high, the input capacity is, in effect, greatly increased. Therefore, it is important that the grid-plate capacity be as low as possible.

Another problem in tubes to be used in the UHF band is "transit time." The fact that it takes a certain definite time for the electrons to travel from the cathode to the plate of a tube becomes important.

If the frequency is low enough so that the electrons can flow from the cathode to the plate before the grid voltage can change appreciably the plate current is not affected by the transit time. However, at ultra-high frequencies, the grid voltage changes so rapidly that an electron may be acted upon by a considerable part of the grid voltage cycle before escaping the influence of the grid. That is, an electron being accelerated by a positive grid may not get so far away that the following negative grid swing will not slow it. As a result, electrons tend to travel in "clouds" rather than in a fairly steady stream. As the cloud of electrons approaches the grid, the negative charge causes electrons to be forced out of the grid, and as the cloud moves away, electrons flow back to the grid. This produces a current flow in the grid circuit that is the equivalent of having a low resistance connected between the grid and the cathode.

The end effect is the same as though a low resistance were connected in parallel with the input circuit, and this causes a decrease in the Q of the input circuit with consequent loading of the source.

If the spacing between the cathode and the plate is reduced, it will take an electron traveling at a fixed rate a shorter length of time to travel the distance. Making tubes with smaller cathode-plate spacing is therefore one way to reduce transit time, but there is a limit to the reduction in spacing because of the increased difficulty in manufacturing tubes with smaller spacing.

Another important point in tube design is the inductance of the cathode lead. The lead between the base of the tube and the cathode of the tube has a certain amount of inductance, and the plate current flowing through this inductance will cause a voltage drop across it. This voltage will reduce the input voltage just as if the grid were drawing current, and effectively decreases the input grid resistance, thus causing extra loading.

To reduce this effect, most of the tubes used for UHF have two cathode connections. That is, the cathode of the tube is connected to two of the pins on the base. Although each of the cathode leads has a certain amount of inductance, the ac plate current flows to the cathode through one lead, and the grid circuit is connected to the cathode by the other lead, so that the voltage drop caused by the plate current does not affect the grid circuit.

UHF Circuits

Now that we have covered the problems of the circuit elements, let us consider the problems that occur when the individual circuit elements are connected together in a stage.

Because of the high frequencies involved in UHF Television, "lumped" circuit constants

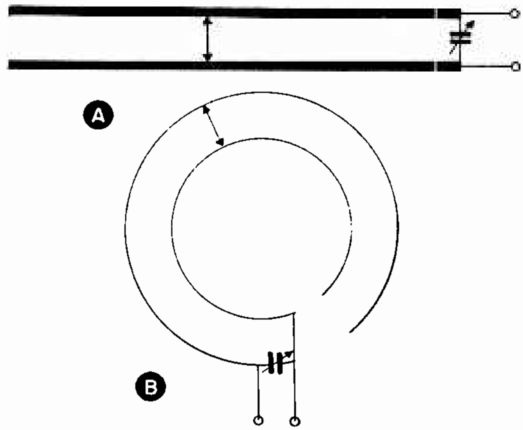


Fig. 2. (A) A quarter-wave shorted line of the type used to tune some UHF converters. (B) A line of the same type curved to form an arc.

(coils and condensers) will not be used. Tuned circuits will take on somewhat peculiar shapes to give usable efficiency.

There are a number of different types of resonant circuits that could be used in the UHF band, but for the time being, the most common type will be a quarter-wave shorted section of parallel line. Resonance at the desired frequency is obtained by moving a shorting bar along the line, and a mechanical arrangement is usually provided so that simultaneous movement of the shorting bars on two or three tuned lines can be made.

Fig. 2A shows a tuned line of the type that is used by General Electric in their UHF Converter. Fig. 2B shows how the tuned line is curved into an arc as in the Mallory "Inductuner" and others. The second system conserves space, and provides greater ease in mechanically ganging the various tuned circuits.

There are other types of circuits that could be used, and further research in the field will probably produce tuners having little resemblance to those mentioned in this article.

Most manufacturers do not use tubes in the preselector stage, since it is extremely difficult to design a low-noise amplifier circuit that will tune the required range. Insead, they find it better to have no amplification in the preselector stage, and no amplification in the mixer stage, and then use a special low-noise i-f amplifier to provide gain.

Even though the preselector section of a UHF converter contributes no gain, it is still quite important for a preselector to be used. The two major reasons are to provide discrimination

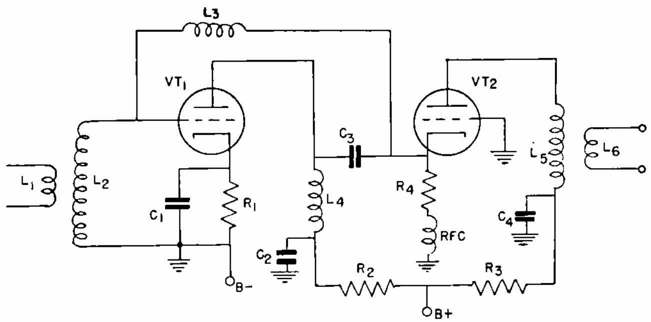


Fig. 3. The basic cascode amplifier.

against unwanted frequencies, and to prevent excessive radiation of the local oscillator signal.

When germanium or selenium diodes are used in properly designed UHF mixer circuits, their noise characteristics are considerably better than those of any of the common tubes; this illustrates that low noise may be more important than high gain.

A special low-noise i-f amplifier known as the "cascode" circuit is used following the diode mixer to provide the necessary gain. The design work for that stage is considerably simplified because it operates at a fixed frequency.

Actually, the cascode amplifier is a combination of two circuits: one, a grounded-cathode triode stage, and two, a grounded-grid triode stage. The input stage has a neutralizing choke connected so that the circuit noise is degenerated. Oscillation is no problem as the stage gain is less than unity.

Fig. 3 shows the basic diagram of a cascode amplifier. The operation of the circuit is as follows: The input signal is applied across coil L_1, which is inductively coupled to coil L_2. The reactance of condenser C_1 is low at the input frequency, and consequently the input signal is effectively connected between the cathode and the grid of VT_1. (Resistor R_1 furnishes the necessary bias for VT_1, but as far as signals are concerned the cathode may be considered to be grounded.) As the signal voltage across coil L_2 varies, the voltage on the grid of the tube varies to produce changes in the current flowing through the tube.

The ac signal in the plate circuit of VT_1 appears across coil L_4. The action of condensers C_2 and C_3 effectively connects the series circuit consisting of R_4 and RFC in parallel with L_4. Therefore, the signal voltage across L_4 appears across the cathode circuit of VT_2. The purpose of RFC is to increase the ac impedance of the load for VT_1.

From the cathode of VT_2 a portion of the signal is taken off and fed back to the grid circuit of VT_1 by coil L_3. The signal fed back by coil L_3 is such that it decreases the noise factor of VT_1. Therefore, coil L_3 provides noise neutralization for the input stage. VT_2 then amplifies the signal and applies it across coil L_5. The signal across coil L_5 is then inductively coupled to coil L_6, the output circuit of the stage.

Condenser C_2 and resistor R_2, like condenser C_4 and resistor R_3 provide "decoupling" so that the signal voltage will not be fed back to the power supply; therefore they keep "power-supply coupling" between these two stages at a minimum.

This is the basic circuit of all Cascode amplifiers —a grounded-cathode stage followed by a grounded-grid stage. There may be slight differences in the circuits used by various manufacturers—different neutralization systems, dc coupling between the two circuits, etc.—but the basic idea is the same.

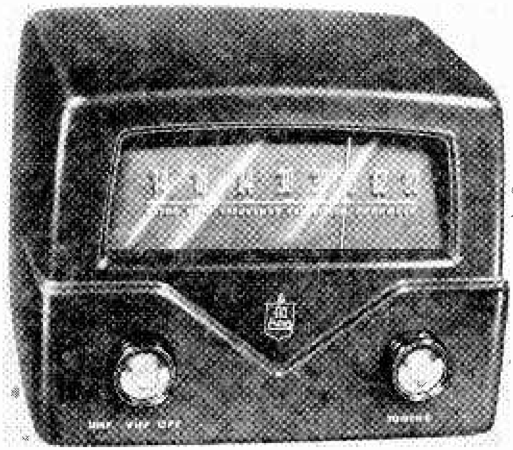
The cascode amplifier was designed in 1944 by a group of engineers who were working with radar circuits. They were testing various low-noise amplifiers suitable for radar use when they discovered the cascode. Thorough testing proved that the cascode was the best circuit for use because it provided the gain of a pentode with the noise factor of a triode.

The necessity of using two triodes was originally a disadvantage, but is less so now that miniature twin-triodes have become common. (It is rumored in the industry that some manufacturers are planning special twin-triodes designed for use in this circuit.)

Fig. 4 shows the Mallory TV-101 converter, which is typical of the UHF converters now in production. This converter uses a three-section Inductuner. The converter, shown schematically in Fig. 6, consists of a preselector, a crystal diode mixer, an oscillator, and a cascode i-f amplifier. It uses three quarter-wave shorted sections of parallel lines of the type shown in Fig. 2B and Fig. 5. The preselector uses two tuning sections to provide double-tuned selectivity and proper impedance matching between the antenna and the mixer. The third tuning section is used as the oscillator tuning element. Shaping the individual tuning elements gives proper tracking.

As mentioned previously, the preselector circuit is of necessity a compromise between minimum loss, proper-matching, minimum oscillator radiation, and low-noise operation.

The output of the preselector is coupled into the diode mixer stage, which is designed for minimum



Courtesy P. R. Mallory and Co., Inc.

Fig. 4. A typical UHF converter—the Mallory TV-101.

loss and minimum noise. The output of the local oscillator is also coupled into the crystal mixer. The rectified oscillator signal provides the correct current flow through the diode mixer for best noise factor. Notice that the mixer is coupled to the cathode of the 6AF4 oscillator tube through the heater-cathode capacity of the tube. This is to prevent interaction between the tuning of the two circuits, and to give relatively uniform oscillator injection across the band.

The oscillator tuning section covers a range from 378 to 828 megacycles. This range is required for a converter designed to operate with an intermediate frequency of 82 megacycles. Such a converter may be used with channel 5 or 6 of a conventional VHF receiver.

The output of the mixer is then coupled to an amplifier of the type described previously. (Notice that there is one slight difference in the cathode circuit of the second tube. The circuit is completed through the secondary of the input transformer, the neutralizing choke, and the 56 ohm resistor with a 1000 mmfd. condenser in parallel.)

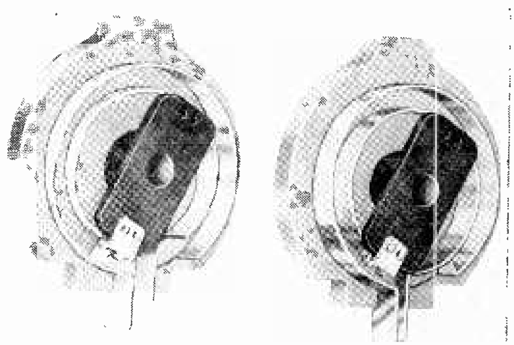
There are three positions of the control switch on the converter: 1, OFF; 2, VHF; 3, UHF. If the VHF receiver is plugged into the ac outlet provided on the UHF unit, the switch on the converter will control the entire system. When the converter is turned off, the VHF receiver will also go off and when the converter is set to "VHF" or "UHF" the correct antenna will be connected automatically.

Alignment

Initially, alignment of UHF converters will present few problems as the units will be pre-aligned at the factory. Because tuned circuits of excellent stability are used, realignment in the field will seldom be required. However, the problems are relatively simple even when complete realignment is necessary.

For proper alignment of any equipment, a signal source and an indicating meter are required; UHF converters are no exception. Initially only few stations will be on the air in a given area, and the station signals can be used as the signal sources for realignment purposes. Because of the relatively wide band width of UHF circuits, a simple peaking of the resonant circuit will be sufficient.

Also, the harmonic output of present signal generators (sweep and/or marker) can be used; generators having a high fundamental range usually have usable output on their UHF harmonics. As UHF television becomes more widespread, the test equipment manufacturers will market UHF sweep signal generators with marker features.



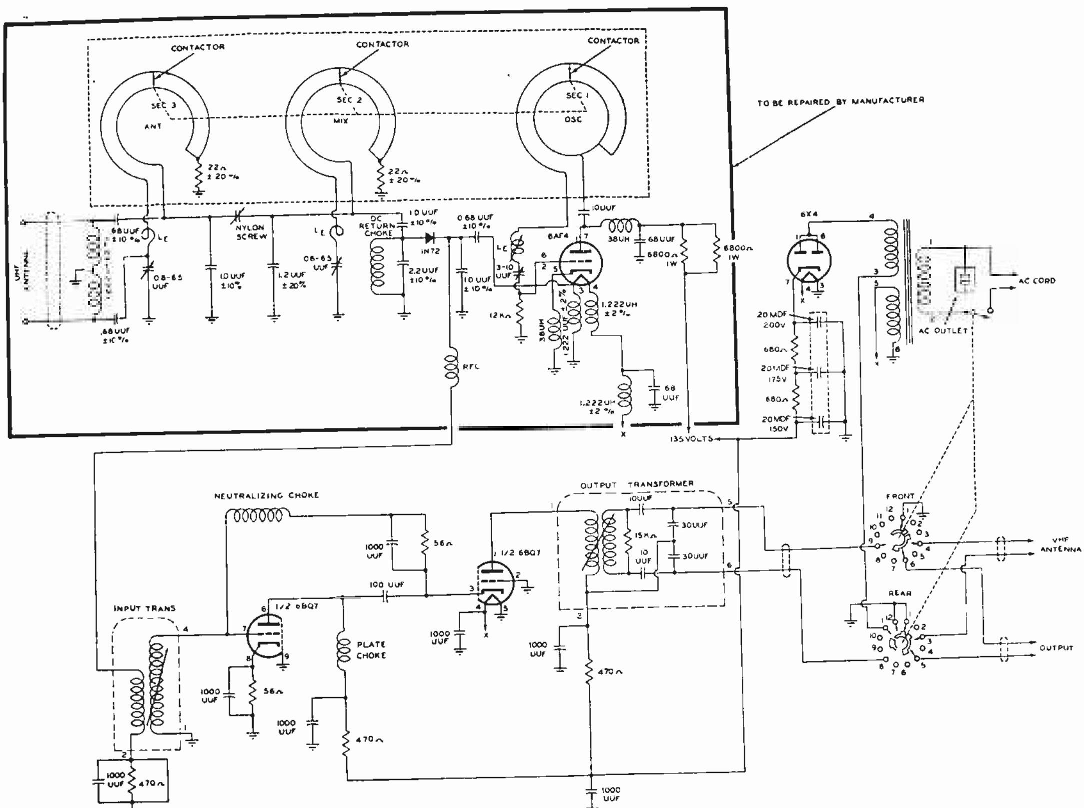
Courtesy P. R. Mallory and Co., Inc.

Fig. 5. The individual tuning elements for the UHF "INDUCTUNER." The unit on the right tunes the oscillator.

There are two types of output meters that can be used for alignment purposes. Technicians who possess a vacuum tube voltmeter with an rf probe can connect the probe to the output terminals of the UHF converter, and align for maximum rf voltage. The second method is to use a DC voltmeter across the video detector load resistor in the VHF receiver, used with the converter; again the resonant circuits will be peaked for maximum voltage.

Warning: Always try to obtain the manufacturer's alignment information before attempting complete realignment of a UHF converter. If service information for a particular unit is not available locally, write directly to the manufacturer to obtain the necessary data.

CIRCUIT DIAGRAM OF UHF CONVERTER



Courtesy P. R. Mallory and Co., Inc.

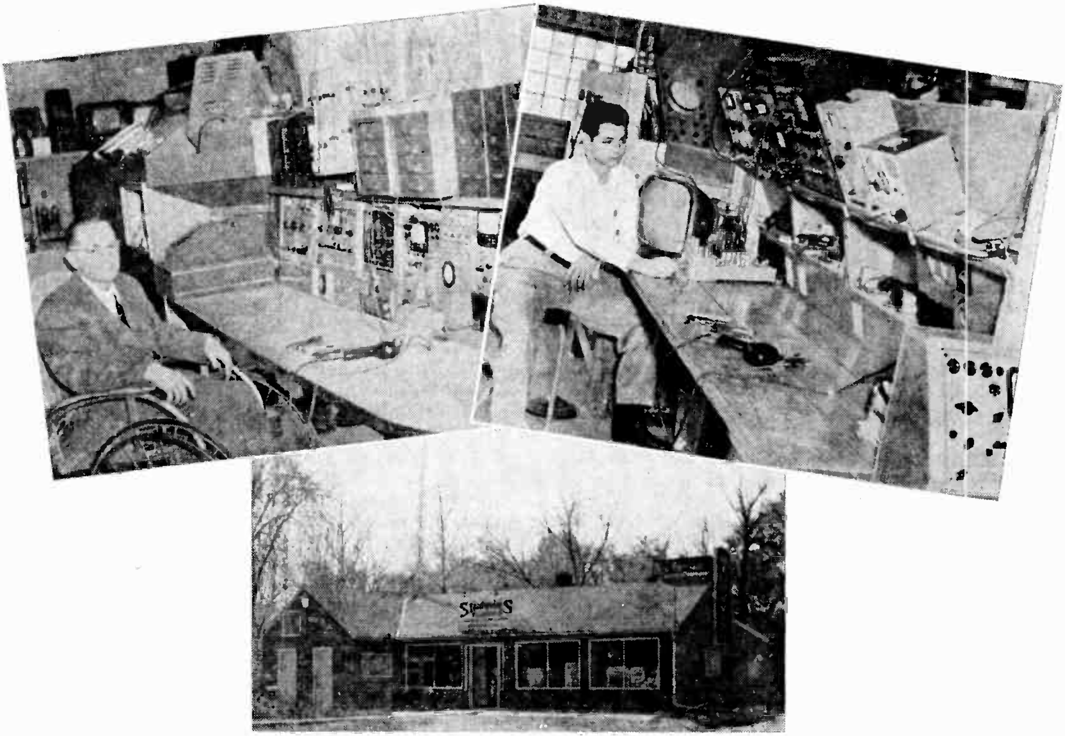
Fig. 6. The schematic of the UHF converter shown in Fig. 5, and described in this article.

In closing this article it would be well to point out that in the next four or five years UHF television stations will be installed in most large cities. Therefore, there will be many opportunities for the serviceman who has the knowledge necessary to service UHF receivers and converters. Installing UHF antennas, converters, and receivers will be "big business."

In the past, the radio service industry has been called upon to understand and service many new circuits—AVC, bass compensation, FM, TV, etc.—and the NRI trained men has always been able to take them in his stride. The same thing applies today—UHF is not new to the NRI man, it is just a continuation of the old.

Remember that all new developments are based on the fundamental radio principles given in the NRI lessons; learn the fundamentals and you will find it easy to understand the latest circuits.

A great new field for the service technician is opening—the man who has the basic knowledge necessary to understand the advanced material and the man who is familiar with UHF problems will have an advantage over other servicemen. YOU, as an NRI student or graduate have that advantage.



Hard Work, a Determination to Succeed and a Square Deal for Every Customer Built This Booming Radio and Television Business

"I registered with NRI in February, 1935. I knew absolutely nothing about Radio then. My health was poor. Hard work and determination to overcome difficulties has crowned our efforts with success. Today I have one of the largest Radio and Television businesses in the southeast part of Missouri.

We are now selling quite a few Television sets as well as some appliances. Our service work is doing very well. We have had to turn down work because we had much more than we could do. We have done a wonderful business here this last year.

Our work bench is about twenty feet long, and a double affair with a full set of test equipment on each side. The young fellow at the bench is my son. That is his side of the bench. You probably never saw instruments set in as these are but if you ever worked at such a bench you would be highly in favor of it. It gives a lot of working space, not too wide a bench, puts the instruments out of the way and yet they are easily read.

Our business increases quite a large margin each year. We have a motto in our shop which says 'A Square Deal to Every Customer.'

To the man who has ambition enough to stay with the job I suggest Radio and Television for I know money can be made at it."

Arley Studyvin
Studyvin's Sales and Service
DeSoto, Missouri

Building a High-Voltage Probe For the NRI Electronic Multitester

By JOHN G. DODGSON

NRI Consultant

THE NRI Electronic Multitester was primarily designed for the experimental work in the NRI Course. However, because most students engage in spare-time service work before they graduate and because commercial test instruments are expensive, the NRI Electronic Multitester is often used in servicing.

The Multitester has a basic vacuum-tube voltmeter design, therefore it is entirely adequate for most service work.

The Multitester is capable of measuring up to 600 volts dc in four ranges: 3 volts, 15 volts, 150 volts, and 600 volts. It can measure dc resistance up to 125 megohms in four ranges: R × 10, R × 10K, R × 100K, and R × 250K. It will measure dc current up to 150 ma in two ranges: 15 ma and 150 ma. When used with its associated AC-RF Head, it will measure ac and rf voltages up to 600 volts at frequencies from 50 cycles to 100 megacycles in the same ranges that it will measure dc voltage.

Voltages above 600 volts are seldom encountered in radio servicing; however, considerably higher voltages are encountered in TV servicing. The voltage applied to the second anode of the picture tube in a TV receiver may be as high as 20,000 volts dc. In a projection-type TV receiver, voltages on the cathode ray tube may sometimes be as high as 40,000 volts.

Naturally, the tester, like most commercial instruments, will not measure these high voltages without a special probe. High-voltage probes are readily available for most commercial instruments, and one can be easily and inexpensively assembled for the NRI Electronic Multitester.

A high-voltage probe consists of a high resistance contained in a suitable insulating case. This high resistance reduces the high voltage that is to be measured to a lower voltage that can be fed to the test instrument. This reduced voltage is read on the meter and then multiplied by a certain multiplying factor, which depends upon the amount of voltage reduction by the high-voltage probe.

For example, if the high-voltage probe reduced the high voltage that is applied to the probe to 1/50 of its original value, then the multiplying factor would be 50. With a probe having a multiplying factor of 50, a voltage of 10,000 volts would be reduced to 1/50 of this value, or 200 volts. This 200 volts would be read on the meter and then multiplied by 50. The result would then be 10,000 volts.

There are two methods of reducing the high voltage to a suitable low voltage that can be applied to the test instrument. The usual method used for commercial probes is the insertion of a high resistance in series with the input of the test instrument. We can also connect a string of high-value resistors together and then measure the voltage drop across the last resistor.

Let us consider the advantages and disadvantages of the two methods. We will choose a multiplying factor of 50 for the probe. This multiplying factor is convenient because it is relatively easy to multiply by; and in addition to this, it enables us to measure voltages up to 30,000 volts. You will seldom need to measure voltages above this, because projection receivers are practically obsolete.

To compute the resistance necessary to give a multiplying factor of 50 for a probe used directly in series with the meter, this formula is used:

$$\frac{R + Z}{Z} = MF$$

where: R = total resistance of probe, and
Z = impedance of test instrument.

Solving for R when Z = 5 meg:

$$\frac{R + 5}{5} = 50$$

$$5 \times \frac{R + 5}{5} = 50 \times 5$$

$$R + 5 = 250$$

$$R = 250 - 5$$

$$R = 245 \text{ megohms}$$

FORMULA I

A single resistor of 245 megohms would have to be a "special" since standard commercial resistors are seldom made higher than 22 megohms.

Futhermore, the resistor would need a high wattage rating. Remember that when measuring 10,000 volts, the probe must "drop" 9800 volts in order to feed 200 volts to the tester. The difficulty in obtaining this high-resistance, high-wattage resistor renders the idea impractical for construction purposes.

Naturally, several resistors could be connected in series to give a total value of 245 megohms. Eleven 22-megohm resistors—the highest value commercially available—could be connected in series, giving a total of 242 megohms. The additional 3 megohms could be supplied by smaller resistors.

This would give us a "stick" of at least twelve resistors and possibly as many as 15.

Since the voltage at the "hot" end of the probe is quite high, it is important to use large resistors so as to prevent corona discharge. Corona trouble can be eliminated by using resistors rated at 1 watt (since they are physically larger than ½ watt resistors) for the first 3 or 4 in the "head" end of the probe. A rating of one-half watt could safely be used for the remaining resistors. Because of the large, higher-wattage resistors in the front end of the probe and the large total number, the probe would be inconveniently long.

Aside from the inconvenience of the probe, let us consider its accuracy. From the formula, we can see that the accuracy depends on the tolerance of the resistors. The tolerance of the standard 22-megohm resistor is 10%. If we use fifteen 10% resistors, the tolerances could balance out so that we would get the total resistance we want. However, in practice, this may not actually be true. Suppose each resistor were 5% below its rated value. If we used eleven 22-megohm resistors and three 1-megohm resistors, our total value would actually be 232.75 megohms. Therefore, according to the multiplying factor formula, our multiplying factor would actually be 45.55. Consider this inaccuracy if we measure 10,000 volts. The probe would drop 9789 volts, giving us a result of 10,545!

Because of the inconvenience and inaccuracy of this type of probe, let us now consider the other method of constructing a probe—connecting a string of resistors together and measuring the voltage drop across the last resistor.

The formula used to compute the resistance needed for this type of probe is as follows:

$$\frac{R(N-1)}{Z} + N = MF$$

where: R = value of individual resistor
N = number of resistors
Z = impedance of multitester

FORMULA II

If we use ten 22-megohm resistors, we will have a multiplying factor of 49.6.

$$\frac{R(N-1)}{Z} + N = MF$$

$$\frac{22(10-1)}{5} + 10 = MF$$

$$\frac{198}{5} + 10 = MF$$

$$39.6 + 10 = 49.6$$

This result is close enough to 50 to be acceptable.

Since we can easily obtain 22-megohm resistors, and since we want to limit the number of resistors, this method seems more feasible than the former method. Of course, we still have a tolerance problem, but we have improved the accuracy by decreasing the number of resistors. The arcing problem can be eliminated by using longer (one-watt) resistors in the front end of the probe.

Now that we have decided upon the internal structure of the probe, we must construct an insulating case. The case must be made of a good insulating material that is inexpensive and easy to obtain. Polystyrene seems to fit the bill. It is an excellent insulator, readily available, and yet relatively inexpensive.

Of course, the first step in building the probe is to purchase the material. You can get the resistors from any radio wholesaler. It is advisable to buy three 1-watt resistors and seven ½-watt resistors. You may also be able to get the polystyrene from the radio wholesaler. If not, you can get it from some mail-order house. Consult advertisements in magazines such as *Radio and Television News, Popular Science, Popular Mechanics, Science and Mechanics*, etc. (One such advertiser is Leeds Radio Co., 75 Vesey St., New York, N. Y.)

A 12-inch hollow tube of polystyrene having an inside diameter of between ½ and ¾ inch can be used for the body of the probe. The wall of this tube should be about 1/8 to 3/16 of an inch thick.

The front end of the probe can be constructed from a solid polystyrene rod about 2 inches long with a diameter equal to the *out-side* diameter of the body of the probe.

Besides the resistors and the polystyrene, you will need a few sheets of both coarse and fine sandpaper and a large steel darning needle at least 3 inches long with a diameter not over 3/16 of an inch. The needle should be cadmium or nickel plated so that solder will stick to its surface.

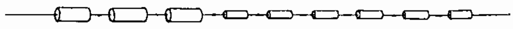


Fig. 1. Connect the first nine resistors, leaving 1/2 inch of space between. Be sure to make smooth joints.

You will need three test leads. Two of these must have male plugs at one end, the other can have either an alligator or a crocodile clip on one end. The "open" ends are connected to the probe. These test leads can be purchased from any radio wholesaler.

Besides the usual radio tools, you will need a drill—either a hand or power type. Of course, the power drill is much easier to work with.

The drill size depends upon the diameter of the needle. The diameter of the drill should be nearly equal to the diameter of the needle.

Now that you have gathered the material and the tools, the next step is assembly. Connect nine of the resistors together as shown in Fig. 1.

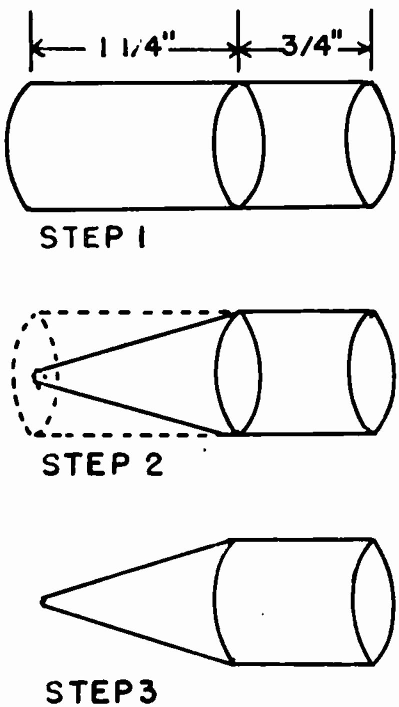


Fig. 2. Step 1—Draw a line around the probe as shown above with a sharp instrument. A pen or pencil line will rub off. Step 2—Roughly shave or cut the larger part of the rod from the mark to a point. Step 3—Smooth off the end by first sanding with coarse grain sandpaper and then with smooth grain sandpaper.

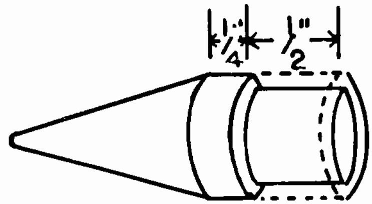


Fig. 3. Step 1—Cut one-half inch off the unshaped end of the rod and then smoothly sand it to fit into one end of the hollow tube. Care must be taken so that it is a tight fit because only pressure holds the rod in the tube. However, do not force the rod into the tube or the tube will break.

Be sure to use the three 1-watt resistors on the front of the probe. Do not connect the tenth resistor yet.

There should be a distance of ½ inch between the resistors. Take special care when soldering, so that the joints will be smooth. Any projections (solder or wire) may cause corona or arcing when high voltage is measured. After the resistors are soldered together, the joints can be smoothed off with a triangular file or emery paper.

The front end of the probe is to be shaped from the two-inch solid rod as shown in Figure 2. The other end of the rod is shaped to fit tightly into the hollow tube. Details of this operation are shown in Figure 3.

After shaping both ends of the rod, drill a hole through the center of the rod, and put the steel needle in it. See Figure 4.

Finally, thread the free end of the first 22-megohm, 1-watt resistor through the eye of the darning needle and make a closed hook-joint, then solder it. As before, be certain that the joint is smooth. This finishes the front end of the probe.

Before completing the back end of the probe, see if the male plugs and alligator (crocodile) clip will fit through the hollow tube. If they

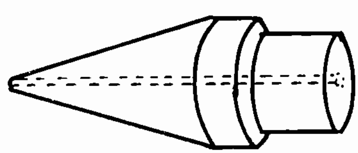


Fig. 4. Drill a hole through the center of the rod, then insert the needle. The needle must make a "snug" fit. If the drill diameter is larger than the needle diameter, then drill only part of the way; heat the needle, and force it the rest of the way.

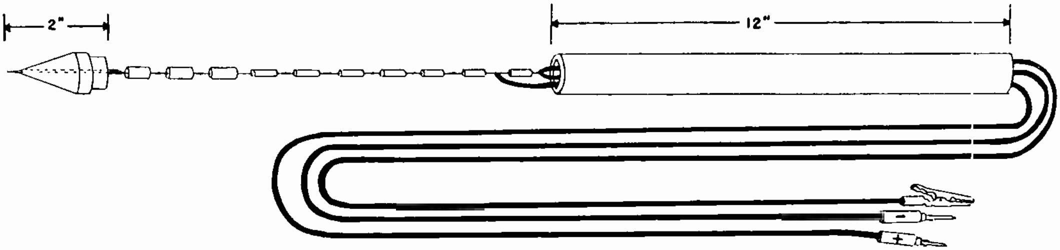


Fig. 5. This is how your finished probe will look. Slip the hollow tube down over the resistors, and fit the front end into it.

won't, you will have to thread the test leads through the tube before they can be connected to the resistor.

Connect the last 22-megohm resistor to the stick, leaving three-fourths of an inch between the ninth and tenth resistors. Connect one of the test leads having a male plug at the end between these last two resistors. Connect the other two test leads (one with a male plug and the other with a clip) to the end of the stick. Once again, smooth off the soldered joints with a file or emery paper. The probe should now look as shown in Figure 5.

Insert the front end of the probe into the hollow tube, and the probe will be completed and ready for use.

It is advisable to mark the test lead that is connected between the ninth and tenth resistors with a plus sign. You can do this with fingernail polish or paint. This male plug is to be inserted into the plus VDC jack of the multitester. The other test lead with a male plug, connected to the end of the resistor stick, is to be inserted into the minus VDC jack of the multitester. The lead with the clip at the end is to be clipped onto the chassis of the receiver under test.

You have now added four more dc voltage ranges to your NRI electronic multitester. The new ranges are merely the original dc voltage ranges multiplied by 50. These new ranges are: another 150 volt range—read on the 3-volt scale and multiplied by 50; a 750-volt range—read on the 15-volt scale and multiplied by 50; a 7500-volt range—read on the 150-volt scale and multiplied by 50; and, finally, a 30,000-volt range read on the 600-volt scale and multiplied by 50. Of course, the range selector switch is to be set to the appropriate range whenever measurements are made.

Before using the probe, first carefully calibrate the Multitester for DC measurements. Insert the plus lead from the probe (the lead connected to the junction of the ninth and tenth resistors) into the plus VDC jack (jack 24) of the Multitester and the negative lead (the one connected to the end of the resistor stick) into the —VDC jack (jack 25). The lead with the alligator clip is to be connected to the chassis of the instrument under test.

When unknown voltages are being measured, turn the range selector switch of the Multitester to the 600V range first so as to prevent possible damage to the instrument from high voltage. Then turn the range selector switch to a range where the voltage can be easily read.

It is advisable to check the probe against a known high-voltage dc source. If the probe is reading high, then a correction can be made by replacing the last one-half watt, 22-megohm resistor with a resistor having a slightly lower value than the original resistor used in the probe. If the probe is reading low, then replace the last 22-megohm resistor with one reading a little higher than the original resistor.

——— nri ———

Job Opportunity

"We are now recruiting a technician for our Electronics Shop. Starting salary is $3402 per year. May advance to $4650 per year.

"Interested applicants may write or apply directly to the Personnel Division, 609 East Third Street, Indiana University, Bloomington, Indiana.

"Thank you for any help you may be able to give us."

Mrs. Charlotte Mathis, Personnel Assistant
Indiana University,
Bloomington, Indiana.

SURVEY SHOWS PUBLIC HAS HIGH REGARD FOR TELEVISION SERVICEMEN

THE television service industry has the hearty endorsement of TV set owners in a nationwide public opinion poll conducted for RCA Victor and the RCA Service Company by Elmo Roper, one of the country's leading market research experts.

A large proportion, 86%, of all television owners who had had experience with television service indicated a high opinion of the quality of work performed by their TV service technician. The findings also indicate that the great majority of the television public consider TV servicemen to be courteous, prompt in responding to calls, and fair and reasonable in their charges.

"Recently published articles have reflected on the honesty and competence of television servicemen by charging that the TV public was being gouged," said E. C. Cahill, president of the RCA Service Company. "While we knew from experience that these reports were based on isolated instances, and did not, by any means, reflect the true character of the service industry, we were disturbed by the unfair and misleading impressions they were creating among the public. So we commissioned Mr. Roper to get the full facts from the people who were in the best position to judge—the television set owners.

"The findings have fully substantiated our confidence in the ability and integrity of television technicians," Mr. Cahill continued. "For example, when the set owners who had had service calls were asked to evaluate the work done, only 7% expressed dissatisfaction. A sizable majority, 68%, replied the work was 'really good,' while 18% described it as 'fairly good.'" (7% did not reply.)

The new Roper survey is believed to be the first scientific, impartial, nationwide sampling ever made to determine the true public attitude toward the technicians who install and maintain the nation's 17 million TV receivers. While other surveys have been conducted on this subject, they have been confined to local areas. The Roper survey polled 5,000 families, representing an accurate cross-section of adults in television areas throughout the country. The facts relative to the service industry are based on the replies received from over 90% of the television homes in the sample.

While articles have appeared purporting to "expose" television technicians for overcharging their customers, the customers themselves don't agree. Two out of three described the servicemen's charges as "entirely reasonable." Only one out of ten considered their service bills "too high."

When asked if the technician who called to service or repair a set was pleasant and courteous, only a fraction of 1% gave a negative reply.

Almost 9 out of 10 of these respondents, 88%, said he was "pleasant and courteous." Another 6% considered his manner "satisfactory." (6% did not reply.)

The public maintains a similar high opinion of the promptness of servicemen, the survey reveals. Three out of four said they thought the work had been done in a reasonable length of time. Only one out of five felt he had had to wait too long.

"Television could not be the nationwide medium it is today," Mr. Cahill said, "with millions of receivers functioning in the American homes, if it were not for the tremendous job which has been and is being performed by the service industry.

"The need for installation and servicing of these millions of television receivers, the most complex instruments ever introduced into homes, constituted an immense challenge, and the service industry has met that challenge squarely and honestly. As the survey clearly proves, television manufacturers, distributors and dealers, as well as the thousands of independent servicemen and service associations, have discharged their responsibility with remarkable success."

Mr. Cahill pointed out that probably few people realized the scope of the service industry. At a conservative estimate, he said, the elaborate testing equipment, the trucks and tolls required represent an investment of more than $200,000,000.

"The industry that performed the monumental job of installing and maintaining millions of civilian television sets has also, quietly and without fanfare, provided a steady supply of skilled technicians to the armed services to help maintain the complicated electronic instruments of defense," said Mr. Cahill.

"While we are proud of the industry's record of competence and integrity, as shown by the survey, neither we nor the service associations will be content until the small percentage of undesirable practices is completely eliminated. We are constantly working with these associations toward this objective."

NRI Proudly Announces the new Model 70 NRI Professional Tube Tester

Tests Radio and Television Tubes

Every Radio-TV serviceman needs and should have a tube tester as soon as he goes into a part-time or full-time Radio-TV service business. It is his constant companion on all his service calls enabling him to check tubes in the customer's home. Not only does a good tube tester sell tubes but it permits a better estimate of the cost of the repair job. Your tube tester will pay for itself in bringing you extra profits.

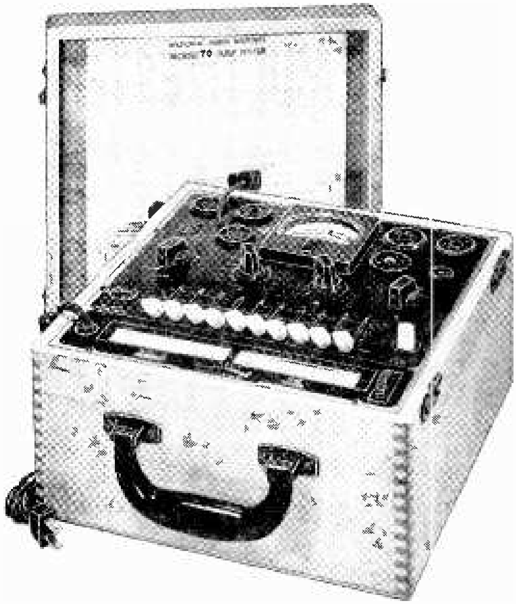
This portable tube tester was designed especially to serve NRI students and graduates. We were primarily concerned with: (1) Completeness of the Test; (2) Ease of Operation; (3) Long Life (freedom from obsolescence); (4) Appearance; and, (5) Cost.

READ THESE QUALITY SPECIFICATIONS

1. **Employs Standardized RTMA Emission Test Circuit**—Ten separate four-position tube element switches make tube prong connections flexible—take care of future electrode connections.
2. **Eight Tube Test Sockets**—Tests 4, 5, 6, 7, and 7L prong tubes; plus octal, loctal, 7-prong miniature; and 9-prong miniature tubes.
3. **Tests Electric Eyes and Gaseous Rectifiers.**
4. **Fifteen filament Voltage Taps**—0.75, 1.5, 2, 2.5, 3.3, 5, 6.3, 7.5, 12.6, 18.9, 25, 35, 50, 70, and 110 volts; filament voltages for all receiving tubes.
5. **Double Jeweled D'Arsonval Meter Movement**—Three inch; ±2% accuracy.
6. **Short and Leakage Test**—Between all elements while tube is "hot."
7. **Value Test**—Reads directly BAD, ?, or GOOD. Meter is calibrated for comparison tests. Separate "diode" scale.
8. **Manual Line Voltage Adjustment** — uses test meter as a voltmeter.
9. **Separate Tests for Multi-function Tubes**—individual tests for each diode in full-wave rectifiers. Separate check on each section of multiple tubes.
10. **Filament Continuity Test and Open Element Test.**
11. **Handsome Professional Looking Hardwood Case**—Beautiful natural grain, clear lacquer finish. Glued lock-corner construction. Size: 10¾" x 10¾" x 6¼". 14 gauge, etched aluminum panel, black enamel field.
12. **Actual Weight**—11 pounds. Shipping Weight, 13 pounds.
13. **Power Requirements**—50-60 cycle, 110-120 volts A.C. required. (Cannot be operated on D.C. or 25 cycle A.C.)
14. **High Speed, Double Window Roll Chart.**
15. **Standard 90 day RTMA Warranty**—covers entire tube tester.
16. **Detailed Instruction Manual**—included with each tube tester.

Easy to Use

This is an easy-to-use, highly versatile test instrument. There are only four operations in testing a tube: (1) Line Test, in which adjustments are made to compensate for variations in line voltage; (2) Short Test, which locates leakage or shorts between tube elements; (3) Filament Continuity Test, spots open filaments immediately; and (4) Emission Test, which measures the cathode emission of the tube.



Use This Order Blank

National Radio Institute
16th & You Streets, N. W.
Washington 9, D. C.

Mod. 70

Enclosed is $49.75 (certified check, money order, or bank draft) for which send me, express charges collect, one Model 70 NRI Professional Tube Tester, instruction manual included.

Name .... Student No. ....

Address ....

City ....Zone ......State ......

EXPRESS OFFICE ....

If you live in Washington, D. C., add 2% for D. C. Sales Tax.

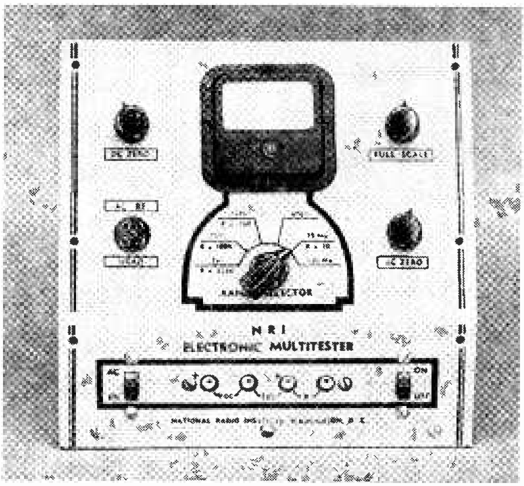
SERVICING WITH THE NRI ELECTRONIC MULTITESTER

By

RAYMOND H. SCHAAF

NRI Consultant

Raymond H. Schaaf



THE NRI Electronic Multitester is basically a vacuum-tube voltmeter capable of measuring dc voltage, dc current and resistance. To measure low-frequency ac, audio, and rf voltages, an AC Head which contains a vacuum-tube rectifier that converts these voltages to dc, is used. For the purpose of this article we have assumed that you have already built the AC Head and finished the experiments in Kit 3E and are therefore somewhat familiar with its operation.

The ranges covered by the Multitester are as follows:

DC Volts—0 to 600—in four ranges
AC Volts—0 to 600—in four ranges
DC Current—0 to 150 ma—in two ranges
Ohms—0 to 125 megohms—in four ranges

A close-up of the meter scale is shown in Fig. 1.

The instructions for calibrating the Multitester, together with an explanation of the theory underlying its operation, are given in detail in the Manuals of Instructions for Experiments 11 to 20, and 21 to 30, which you received with Kits 2 and 3. Instructions for making dc voltage, dc current, and resistance measurements are given in the Manual of Instructions for Experiments 11 to 20, and the instructions for making ac measurements with the NRI Electronic Multitester are given in the Manual of Instructions for Experiments 21 to 30. None of these instructions will be repeated here.

We will, however, emphasize the importance of accurate calibration of the instrument. Before you make any measurement of ac or dc voltage, or dc current, the meter must read zero at the left of the scale when no voltage or current is applied to the input of the Multitester or its AC Head.

In the instructions that follow, the Multitester (and the AC Head when low-frequency ac, audio, or rf voltages are to be measured) will be considered to be simply an indicating instrument having two test leads and a range-selector switch.

To illustrate the use of the NRI Multitester, let us consider typical measurements on a Westinghouse model WR-150 receiver. The circuit of this set is shown in Fig 2. Let's assume that all the tubes check OK, there are no apparent surface defects, but the set is dead.

DC Voltage Measurements

One way to find the trouble is to check each individual part until the defective one is located. This method takes too much time. A faster method is to measure the operating voltages applied to the various tubes. If they are normal, the defect must be in some signal-carrying circuit. On the other hand, abnormal voltages (either high, low, or totally lacking where a voltage should exist) provide definite clues as to what the trouble is and where to look for it.

The first step is to find a common reference point to which all operating voltages can be measured. In most instances, B— is taken as the reference, for it is commonly connected directly to the receiver chassis (for the purpose of a convenient return circuit). A glance at the diagram of the model WR-150 shows that this is true of this particular receiver. Our voltmeter connections are thus simplified, for we can connect the black test lead from the —VDC jack to the receiver chassis and leave it there, and simply move the red test probe from point to point. This also helps maintain the proper test-lead polarity, which is essential when dc voltages are being measured.

In many ac-dc receivers, however, B— is not connected to the receiver chassis, so always check the sets you work on to see which method is used.

The next step is to select the proper points to which to connect the red test probe for the various measurements we want. First, we will want to measure the output of the rectifier to see just how much voltage is being supplied to the plate and screen circuits. Next we will measure, first the plate, then the screen, voltage **at each tube socket.** Lack of voltage may be due to an open in the circuit supplying that particular tube element or to a shorted by-pass condenser. Low voltage may indicate a leaky by-pass or an open filter condenser (this last particularly if the rectifier output is low).

Before connecting the Multitester to the selected measurement points, we must decide at what position to set the range-selector switch. Since this is an ac-dc set having a half-wave rectifier, we know the maximum dc output of the rectifier can't be much more than the line voltage. It is safe, therefore, to set the range selector at 150V, which gives us a range of 0-150 volts dc.

In other sets, particularly those having power transformers, the 600V (0-600 volts) range may be required for the plate and screen voltage measurements because some tubes are operated at much higher voltages (200 to 300).

To measure the output of the rectifier in Fig. 2: turn the set ON; make sure the test leads are in the correct jacks (red in +VDC black in —VDC and connected to the set chassis); and the range selector set at 150V; then, turn ON the Multitester and hold the red test probe on

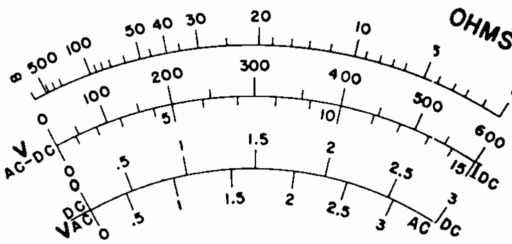


Fig. 1. These are the scales on the meter of the NRI Electronic Multitester. The top scale is the Ohms or resistance scale. It is printed red. In the center there are two scales, 0-600 and 0-15. These scales are used for both ac and dc voltage measurements for the 15 volt, 150 volt, and 600 volt ranges. The 0-15 scale is also used for dc current measurements. The red 0-3 scale along the bottom is only for ac voltage measurements within the range from 0 to 3 volts. The black 0-3 scale just above it is the corresponding scale for dc voltages from 0 to 3 volts.

either the #4 or the #8 pin (marked K1 and K2 in the diagram) of the rectifier tube socket and read the meter. Multiply the meter reading by 10 to get the actual voltage value.

The next voltage to be measured is the plate voltage of the output stage. Leaving the black test probe connected to the chassis, hold the red test probe on the #3 pin (P) of the 25L6 tube socket, and read the meter.

The screen voltage applied to the 25L6 can now be checked by holding the red test probe on the #4 pin (G2) of the output tube socket.

The plate and screen voltages of the second-detector and first-detector-oscillator stages are checked in the same manner. Plate voltage is measured by holding the red probe on the #3 pins (P) of the tube sockets; screen voltage by holding the red probe on the #4 pins (G2).

Of course, the pin you select to hold the red probe on is going to depend on the tube base layout. For instance, if 6SJ7 tubes are used, plate voltage is measured at the #8 pins and screen voltage at the #6 pins. If you aren't sure about the pin arrangement, look it up in a tube chart. This isn't necessary when the diagram shows the actual position of each element in relation to the tube socket as in Fig. 2. However, all diagrams aren't drawn in this way.

Whether or not you will have to make further voltage measurements depends on the results of these primary tests. For instance, if you obtained normal screen voltage at the 25L6 socket (about the same as that of the rectifier output), but no plate voltage, you would conclude that the primary winding of the output transformer was open. (If condenser C13 were shorted it would probably pull the screen voltage far down, too.) No further test for voltage would be needed; you'd use an ohm-meter to check the output transformer primary for continuity.

Let's suppose that the output stage is normal. Now, if you get screen voltage on the second-detector, but no plate voltage, then either R_6 or R_7 is open, or C_{10} or C_{11} is shorted. You can get a clue as to which it may be by measuring the voltage between the chassis and the junction point of R_6 and R_7. Voltage here but none at the plate indicates that R_7 is open or C_{11} is shorted. No voltage here suggests an open in R_6, or a short in C_{10}. In either case R_7, C_{11}, R_6, and C_{10} can be checked with an ohmmeter. How to do this with the ohmmeter section of the tester will be explained later.

You will note that in these measurements, the tester has been used just like any ordinary dc voltmeter. The only difference is that the resistive loading effects of the NRI Electronic Multitester are far less than those of an ordinary dc voltmeter.

As you become adept at using the Multitester, it will take you only one or two minutes to make the series of voltage tests described above, so you will not need to turn OFF the tester and then turn it ON again in between these measurements. However, if you wish to interpret the result of a measurement as soon as you have made it, and need time to do it, **turn OFF the tester until you are ready for the next measurement.**

Another voltage measurement we can make is the bias for the 25L6 tube. This measurement is made by holding the red probe on the #8 pin (K) of the 25L6 socket. (The black probe is still connected to the chassis.) The **normal** bias is measurable on the 15V range, but if R_8 is open, the voltage across it will equal the plate voltage. Hence, you should first check with the 150V range, then switch to the 15V range after you are sure the tester won't be overloaded.

As we just indicated, a bias far above normal indicates an open in R_8. This is the only bias circuit defect that would cause this receiver to be dead.

Receivers having power transformers are checked in exactly the same way. If B— is connected to the chassis, then the chassis can be used as one terminal for all dc operating voltage measurements. Again connect the black test probe to the chassis and move only the red probe from point to point. Remember that the plate and screen voltages of power transformer sets will be much higher than those in ac-dc sets, so use the 600V range unless the reading on this range indicates that it is safe to switch to a lower range.

There are occasions when you will want to measure avc voltages. Being a vacuum tube voltmeter, the NRI Electronic Multitester is admirably suited for this because it won't load the circuit and pull the voltage down as the average dc meter will. Watch polarity—the avc supply is **negative** with respect to the chassis, so interchange the test leads.

Measuring AC Voltages

It may be desirable to check the filament voltage right at the tube sockets or to check the output from the high-voltage secondary winding of a power transformer. If you are in a customer's home, you may want to check the power at the wall outlet into which the radio is normally plugged to see if there is voltage available and whether it is ac or dc.

Since the NRI Multitester is basically a dc volt-ohmmeter, the AC Head must be used. Operating instructions for the Head are contained in the Manual of Instructions for Experiments 21 to 30 and will not be repeated here.

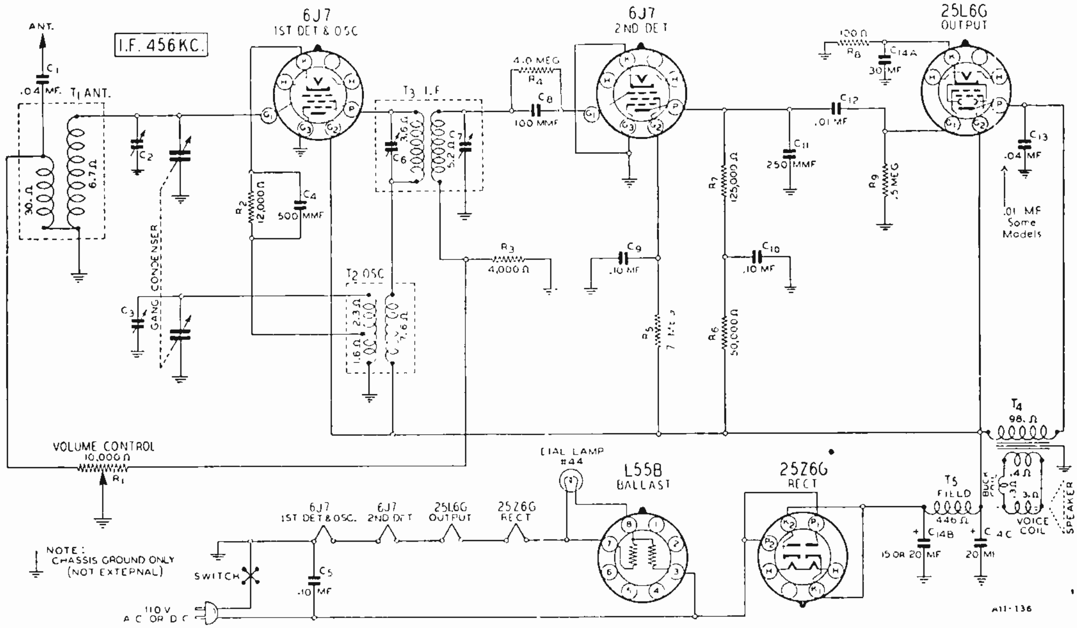
We do, however, want to emphasize the importance of adjusting the AC ZERO control to make the meter read 0 at the left end of the scale when the Head is used. Gas and contact potential effects, plus the extra load on the filament supply, may make an appreciable change in the zero adjustment normally used for dc voltage and resistance measurements. The meter must read zero before you make any measurements (ac or dc) if reasonable accuracy is to be expected.

There are three ac voltage measurements commonly required in general service work. These are:

1. A measurement of the ac power line voltage.
2. Measurement of ac filament voltages.
3. Measurement of audio voltages as the instrument is used as an "output" meter in checking the alignment of a receiver or the output of an amplifier.

To measure the ac power line voltage in the Westinghouse WR-150 receiver, fasten the clips of the AC Head to pin #3 of the ballast tube socket and the "hot" or line side of the power switch in the set, turn the range selector to 150V, make sure the shorting piece of the AC Head is plugged into holes F and G, turn ON the Multitester (AC-DC switch in the AC position), and insert the plug of the receiver power cord into a live wall outlet. A voltage indication of 100 to 120 volts is generally considered to be satisfactory.

To measure the ac filament voltage at a tube socket, it is only necessary to set the range selector switch to the position that will give a reasonable meter deflection and then to hold



Courtesy of Westinghouse

Fig. 2. Circuit diagram of the Westinghouse WR-150 receiver. This is a typical ac/dc set.

the clips of the AC Head on the correct filament terminals of the tube socket. As an example, if the filament voltage applied to a 6J7 tube is to be measured, set the range selector switch at 15V, turn on the set and the tester, then hold one alligator clip on the #2 pin of the tube socket, and the other clip on the #7 pin of the tube socket. Read the voltage on the 15V scale of the meter.

As in the case of plate, screen, cathode, and control-grid terminals, the filament terminal positions may vary according to the tube types. They are not always in the #2 and #7 positions. If you aren't sure of the arrangement, look it up in a tube chart. This is important, for you will probably have the range selector set at a comparatively low range and you should not accidentally connect the test probes to terminals carrying high voltages.

To use your NRI Multitester as an "output" meter, fasten the hot clip of the Head to the plate terminal of any tube in the audio section of the receiver,* and the flexible ground lead of the Head to the chassis, or B— in case the chassis does not serve as a common return for the circuit. In the Westinghouse Model WR-150 receiver, the hot clip of the Head would be fastened to the #3 pin of the 25L6G output tube socket, and the flexible ground lead would be fastened to the chassis.

If a high reading is obtained with the AC Head connected from plate to B— **with no signal input,** the blocking condenser in the AC Head is leaky and should be replaced.

There are, of course, other ac voltage measurements that can be made. These examples are given to illustrate the principles involved in measuring ac voltage with the NRI Multitester. Always connect the flexible ground lead of the AC Head to ground or the point in the circuit nearest ground potential.

****NOTE: If you are using the Multitester as an output indicator in aligning the set, the rf out-*** *put from the signal generator should be modulated so as to provide a steady audio signal in the output of the set at any given adjustment of the receiver. If you use the signal from a regular broadcast station as your signal source in aligning the set, the meter pointer will try to follow the constantly changing audio signal of the station program and you will be unable to adjust the set accurately for peak output. When it's necessary to use a broadcast station as a signal source, in aligning a superheterodyne receiver, use your Multitester as a dc voltmeter and connect it to measure the avc voltage. (There is no avc in the Westinghouse WR-150.)*

Measuring Direct Currents

It is seldom necessary to measure current values to find what's wrong with a receiver. Nevertheless, two current ranges are provided in the NRI Multitester. They are 0-15 and 0-150 milliamperes respectively. The current to be measured is made to pass through resistors of known value. The resistor values are such that, for direct current, the meter calibration points coincide with the dc voltage calibration points of the 15V scale. Current values, therefore, are obtained by reading this scale, taking the current value directly from the scale when using the 15-ma position. When the 150-ma position is used, multiply the meter reading on 15V by 10.

The method of connecting the tester for current measurements is exactly like that used with ordinary dc milliammeters. In other words, the circuit whose current is to be measured must be opened and the tester connected in series with it. Correct polarity for the test leads must be observed, as we have already pointed out.

You will note that the —VDC jack is also the —I jack. Therefore, put the black test lead in this jack. The red test lead is to be inserted in the +I jack. Connect the test probes in **series** with the current to be measured so that the electrons flow into the tester through the black test probe and leave the tester at the red test probe.

As an example, suppose we measure the cathode current of the 25L6 output tube of the receiver diagrammed in Fig. 2. Keeping in mind the fact that the circuit must be broken so the tester can be connected in series with it, disconnect the 100-ohm resistor R_8 from the cathode terminal of the tube socket. Now, since electron flow through this resistor is toward the cathode, connect the black test probe to the end of the resistor you just disconnected from the cathode, and connect the red test probe to the cathode terminal of the tube socket.

Before turning ON either the set or the Multitester, set the range-selector switch to the 150-ma position. This range is used because the cathode current of a 25L6 is usually more than 15 ma. Now turn ON the set and the Multitester, and read the 15V scale of the meter. Multiply the meter reading by 10 to get the actual current in milliamperes.

In measuring current values, always keep in mind the fact that the maximum current the tester can safely measure is only 150 **milliamperes.** When it is necessary to measure larger current values, use a standard milliammeter of the correct range, or connect a **low-resistance, high-wattage** resistor of known value in the circuit and measure the **voltage drop** across it. The current can then be calculated by means of Ohm's Law ($I = E/R$, voltmeter reading divided by the value of the resistor in ohms). This later method may also be used to measure ac current values. In this case a non-inductive resistor should be used.

Using the Multitester As An Ohmmeter

When measuring resistance, the tester operates as a series-type ohmmeter. A known voltage (3 volts) and a known resistance (determined by the setting of the range selector switch) are connected in series with the unknown resistance. The resulting current flow sets up a voltage drop across the known resistance that is inversely proportional to the value of the unknown resistance. It is the voltage drop across the known resistance that produces the meter reading.

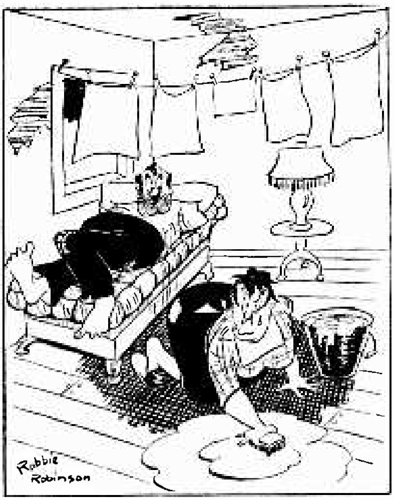
The fact that the ohmmeter circuit is a series circuit should be remembered when you are interpreting ohmmeter readings. Thus, with nothing connected to the test leads, or when the test leads are connected to a part or circuit which is "open," **the meter pointer stays at the left of the meter scale,** for no current can flow through the open circuit or part to produce the voltage necessary to give a meter reading. On the other hand, when the test leads are held together, or are connected to a complete circuit or part, current from the ohmmeter battery flows through the test circuit and sets up a voltage drop, which actuates the meter. The meter is calibrated to indicate the value of the unknown resistance.

For the greatest accuracy in your resistance measurements, adjust the DC ZERO control to position the meter pointer exactly to ∞ at the **left end** of the OHMS scale with the R jacks "open" (test leads separated) and adjust the FULL SCALE control to position the meter pointer directly over 0 at the **right end** of the OHMS scale while the R jacks are shorted. These adjustments should be made for each resistance range you wish to use, just before you take your measurement.

None of the ranges of the ohmmeter are "direct reading" in the sense that the meter reading and actual resistance coincide. In all cases a multiplying factor must be used. This is indicated by the pointer of the range-selector knob.

To simplify the factors and make them small enough for the limited space on the panel, the letter K is used to represent the value 1000. For example, the actual multiplying factor indicated by the position marked R $\times$ 10K is 10,000. When this range is used, the meter reading has to be multiplied by 10,000 to get the actual resistance value.

When the range selector is at R $\times$ 100K, the



"Maggie—your slip is showin'!"

multiplying factor is 100,000. At the R $\times$ 250K position, the meter reading must be multiplied by 250,000 to get the actual resistance value that is being measured.

We should say a word or two here about what tolerance to allow. *A reasonable variation to allow for the tester itself is ± 10%*. The variation is due to the normal commercial tolerances of the resistors in the voltage divider network on the range selector switch, variations in tubes, and battery voltages. **In addition to the 10% to be allowed for the tester, you should also allow an additional 20% to 30% for variations in the parts you check.** If this seems to be a considerable allowance, don't forget that as a serviceman you will seldom need to determine the **exact** value of a resistor. What you are primarily interested in when using an ohmmeter is establishing continuity through a circuit or part, and determining whether or not condensers are shorted or so leaky as to make a replacement advisable. **You can do this even with a 50% variation!**

Care must be exercised when checking resistors connected in a set. To avoid the effects of parallel current paths, which would give false readings, it is best to disconnect one end of the resistor from the circuit so as to isolate it. The same precaution applies to tests for continuity in circuits. Be sure there is no parallel path that the current from the ohmmeter can take and thus give a false indication of continuity.

In checking condensers, the procedure and test results depend on the kind of condenser being tested. As you know, paper and mica condensers in good condition block the flow of direct current, provided the voltage applied to them does not exceed the rated breakdown voltage. Electrolytic condensers used in filter systems, however, permit a certain amount of dc current to flow through them. Electrolytics are polarized; non-electrolytics are connected without regard to polarity.

Because paper and mica condensers block the flow of dc, you should get only a **momentary movement** of the ohmmeter pointer as the test probes are connected to one of these types of condensers. This is due to the charging of the condenser as the ohmmeter battery voltage is connected to it. After the condenser has become charged, there is no more current flow and the meter pointer will drop back to the normal open circuit position at the left of the scale, if the condenser is a good one.

The actual amount of the meter pointer movement will depend on the capacity of the condenser under test, and the setting of the range-selector switch. For a given range-selector position, the greater the capacity of the condenser, the greater the initial deflection of the meter pointer. For any given capacity, you'll get a greater deflection as you use the higher ohmmeter ranges, the R $\times$ 250K range giving the greatest deflection, and the R $\times$ 100K and R $\times$ 10K ranges giving a progressively smaller deflection.

If the condenser is open, you won't get the momentary pointer movement to the right, for an open condenser cannot charge up. If the condenser is shorted, you will get a full-scale deflection and the pointer will stay over to the right as long as you hold the test probes on the condenser leads. If the condenser is only partially broken down, or as radio men say, "leaky," you will get a partial scale deflection according to the actual dc resistance between the condenser leads.

Again, to avoid the effects of parallel current paths, disconnect one lead of the condenser from the circuit before you check it. Remember, the momentary deflection that indicates that a condenser is not "open" depends on the capacity of the condenser. Don't rely on this test for condensers whose capacity is less than .01 mfd. as small capacitances can receive only a small charge and will not give a noticeable meter deflection.

In checking electrolytics, polarity must be observed. That is, the + R jack must be connected to the + terminal of condenser being checked. The R jack at the extreme right end of the input jack strip (as you look at the front of the tester) is the + R jack. **Plug your** red test lead into this jack, and the black lead into the one next to it. Then connect the ohmmeter leads to the condenser so that the red probe is on the positive terminal of the condenser and the black probe on the negative. If the condenser is to be considered good, the reading should be 100,000 ohms or more.

Because of the large capacity of most electrolytics, they will take some time to charge up. Thus, the meter pointer will take a corresponding length of time to drop back to the left after its initial movement to the right. This action is normal. Just be sure that the pointer goes back far enough to the left to indicate a good condenser, as described above.

And in like manner, high capacity electrolytic condensers take time to completely discharge. Always short circuit such condensers *before* you test them.

In using *any* ohmmeter, and especially the NRI Electronic Multitester, you must be careful when using the highest range not to hold the metal portions of the test probes in your hands. If you do, the resistance of your body will be in parallel with the circuit or part being checked and a reading much lower than the actual circuit or part resistance will be the result. Make it a habit to hold only the insulated portions of the test probes in your hands.

Tests for circuit continuity, shorted turns, leakage between transformer windings and the transformer core, etc., are made exactly as described in your Lessons. The tester is used just like any series-type ohmmeter; a few representative tests on the Westinghouse model WR-150, which we used for voltage measurements, will serve to illustrate this fact.

It is frequently necessary to check the continuity of the filament circuit in ac-dc receivers. This is particularly necessary when all the tubes check OK but fail to light in the set. The obvious conclusion is that either the ballast tube or the line cord is open. A continuity test will show which it is. **Before using an ohmmeter, be sure to remove the plug of the power cord from the electric outlet.**

The ballast tube of the model WR-150 can be checked by connecting one ohmmeter test probe to the #3 pin of the ballast tube socket and holding the other test probe, first on the #7 pin to check the entire resistance element, then on the #8 pin to check the pilot lamp tap. (Unscrew the pilot lamp first to avoid a false reading through it.) The range-selector switch can be set at R $\times$ 10 for these measurements, for the resistance will very likely be some value between 150 and 400 ohms.

If the ballast tube is OK, the line cord is probably defective. To check this, proceed as follows:

With the line cord plug removed from the power outlet, turn ON the receiver power switch so that the line switch will establish continuity between the line cord and the tube filaments. Make sure each tube (including the ballast tube) is firmly inserted in its respective socket. Now, hold the ohmmeter test probes on the prongs of the power cord plug. If the circuit is open, no reading will be obtained. You will, however, want to make one more test to prove conclusively that it is the cord.

To do this, hold one ohmmeter lead on the receiver chassis and touch the other one to the #3 pin of the ballast tube socket. A reading for this test, coupled with an open-circuit reading for the first test, is proof that the open in the filament circuit is caused by a defective line cord or a defective ON-OFF switch.

Now let's suppose you didn't get any plate voltage on the second-detector stage (see Fig. 2). To find the trouble with an ohmmeter, remove the receiver power cord plug from the wall outlet, and with your ohmmeter measure the resistance between the plate of the second detector and the cathode of the rectifier. You will have to use the R $\times$ 10K range for this test, for the resistance of the plate circuit is quite high. The normal value is roughly 175,000 ohms. If you get no meter pointer movement, either R_6 or R_7 is open. Leave the test probe on the rectifier cathode terminal and move the other probe to the junction point of R_6 and R_7. If you get a reading now, R_7 is open. You can confirm this by holding the test probes on the terminals of resistor R_7. No reading will be obtained.

Of course, if you do not get a reading between the rectifier cathode and the R_6-R_7 junction, then R_6 is open.

Suppose, however, you got the right result when testing from the plate of the second detector and the rectifier cathode. The conclusion is that the lack of voltage is due to a short to ground rather than to an open in the plate circuit. Either C_{10} or C_{11} may be shorted. Disconnect one lead of condenser C_{10} and check it. Then disconnect one lead of condenser C_{11} and check it. The leakage resistance in either case should be very high, above 10 or 20 megohms. A low-resistance reading indicates a leaky or shorted condenser.

The electrolytic filter condensers in this set may be checked quite easily. Just disconnect the positive leads and check between one of them at a time and the chassis. Remember to observe the proper test lead polarity and to short-circuit the condensers so as to discharge them before taking the readings. Accept the units as being really serviceable only if the readings for each section of the condenser are above 100,000 ohms.

Checking FM Detector Systems

The ratio and discriminator type of detectors commonly employed in FM sets have an S-shaped response characteristic. Because of this, voltmeters which have their zero position at the center of the scale and a meter pointer movement to the left or to the right, depending on the polarity of the applied voltage, are often used in aligning FM receivers. The NRI Electronic Multitester can be adjusted to serve as such a zero-center voltmeter. To do this, simply move the C-battery ground connection from the —3 terminal to the —1½ terminal.

When calibrating the instrument, set the meter pointer to 7.5 on the 15-volt scale by an appropriate adjustment of the DC ZERO control (with the R jacks open) and to 15 on the 15-volt scale with the R jacks shorted by means of an appropriate adjustment of the FULL SCALE control. When the R jacks are unshorted, the meter pointer should move back to the 7.5 center scale "zero" position. The above adjustments should be made with the range selector at 600 V. Check the center scale "zero" adjustment with the range selector at 3V and make any necessary readjustment with the AC ZERO control.

With your Multitester adjusted to serve as a zero-center voltmeter, the effective voltage ranges are just half of what they are normally. That is, with the range selector set to 15V, the maximum voltage you can apply without the pointer going off scale to the right or left is 7.5 volts. With the range selector at 150V, the maximum is 75 volts, and at 3V the maximum is only 1.5 volts. Be guided accordingly in selecting the range to use for the measurements you want to make.

Resistance measurements can't be made with the instrument adjusted as a zero-center voltmeter. You'll have to revert back to the normal adjustment of the instrument. Of course, if you are interested only in determining whether or not a circuit or part has continuity, without regard for the actual resistance, there's no need to change the adjustment of the instrument.

You understand, of course, that the tests we've described here are only a few of the many different tests you'll use from time to time as you service radio and TV sets. The examples given were selected because they are representative of the majority of tests you'll make in your daily work. Basic trouble shooting and parts-testing procedures are given in your regular Lessons, and in the RSM Booklets and Reference Texts you get with your Lessons. Refer to this material as often as may be necessary. Complete operating instructions for the NRI Electronic Multitester are summarized at the back of the Manual which accompanies Kit 3E. Always refer to these instructions when in doubt about a particular type of measurement, rather than run the risk of damaging your test instrument.

The frequency range covered by the NRI Multitester when used as an ac voltmeter is from 50 cycles to better than 100 megacycles. It can, therefore, be used as an audio and an rf voltmeter whenever the necessity for such measurements arises.

As you use the NRI Multitester, remember to check the calibration periodically because changes in the accuracy of the calibration (especially when the 3V range is used) will have a direct bearing upon accuracy of the measurements you make, and may give you entirely false or misleading results.

———*n r i*———

Job Opportunity

"This letter is to notify you that there are openings for television or radio technicians at **John Meck Industries, Plymouth, Indiana.**

"The present openings are in our line training program which lasts three to six months. After the training period, the technicians are eligible for more responsible positions. Starting pay is $1.75 per hour with periodic increases and opportunities for overtime; paid yearly vacation, paid holidays, and a company-paid Group Insurance plan.

"We are fortunately located in a clean, small town where housing and cost of living are not the problem they are in large industrial areas. Any technician is welcome to write or call me personally for further information and arrangements for interviews."

O. F. Vieweg, Personnel Director,
John Meck Industries,
Plymouth, Indiana.

———*n r i*———

"I am in need of a Radio and Television Technician to work in my service shop. He must have experience in television service and a good knowledge of Radio, including auto Radio service.

"We are one of the largest service and repair shops in Central Ohio and pay wages according to this locality. Good servicemen are hard to find around here. I have a graduate of your school working for me now. He is a very capable technician. It is through his recommendation that I am writing to you. The person selected must be willing to move to Ohio and settle down. We can guarantee him permanent work."

Earl B. Robinson, President,
Radio and Television, Inc.,
Newark-Granville Road, Granville, Ohio.

Steve Solo, NRI Grad., Enjoys Amateur Radio

"The NRI Radio and Television course really gave me a lift. After graduating from NRI I became a novice amateur radio operator. Then, in a few months, I passed my general class and restricted radio telephone license.

"I have a transmitter on 40, 80, and 160 meters and I'm 'on the air' most of my spare time. So far I have worked about 30 states, 'phone and C.W. About 5 states 'phone on 160 meters and the rest C.W. I'm now building a 10 meter beam. The transmitters are (command transmitters) army and I have converted them to the proper frequencies.

"I am also using the NRI transmitter that I have built from the kits received in my Radio and Television Communications Course.

"At present I'm an electrician at Ford Motor Car Co. and deal a lot with electronic equipment. I have bought all of my test equipment from servicing radios and televisions on the side.

"I know that no matter what comes up I can go out into the world and get a job. Thanks again for the knowledge and practice I've received through NRI. I would like to correspond with other NRI amateurs and students."

73's Steve Solo, W8IEC
12932 Gable
Detroit 12, Mich.

NRI Graduate Steve Solo. Below is shown a reproduction of Steve's "QSL" card.

—n r i—

Our Cover Photo

The smiling face of Harry M. Andrew on this issue's cover depicts what we believe is the look of a truly happy NRI Graduate. Mr. Andrew recently wrote to NRI as follows.

Dear Mr. Smith:

"While studying Radio and TV I got a part-time job at one of Easton's biggest appliance stores as a Radio and TV serviceman. I worked two days per week there and the rest of the time I was employed at Bethlehem Steel as a Sub. foreman.

"After three weeks of part-time work the owner, Mr. A. Haskins, offered me a full-time job. I now average between $70 and $80 per week.

"We have a crew of technicians working in our store. I do nothing but bench work. Jobs that cannot be done in the field are brought in to the shop and we go to work. Incidentally, one of the other fellows is an NRI Grad. His name is Louis Sigmund. He graduated quite some time ago.

"Well once again, thanks a million."

Harry M. Andrew,
719 Porter Street,
Easton, Penna.

—n r i—

A golfer trying to get out of a trap, said, "The traps on this course are very annoying, aren't they?"

"Yes," said the second golfer trying to putt, "would you mind closing yours?"

N.R.I. ALUMNI NEWS

Norman Kraft of Perkasie, Pa. and Claude Longstreet of Westfield, N. J. Are Candidates for President To Serve Our Alumni Association During 1953

IN a very interesting primary, which saw forty-four of our NRI Alumni members receive votes for president and one hundred seventeen receive votes for Vice President, we find some new names among the successful candidates. The polls closed August 25 and a count of the votes placed Norman Kraft of Perkasie, Penna., and Claude Longstreet of Westfield, N. J., in a contest for President. All Alumni members are requested to vote for one or the other for President to serve during 1953.

For Vice Presidents we have eight candidates, four of whom are to be elected. The candidates are Floyd Buehler of Detroit, Mich., Louis J. Kunert of Massapequa, N. Y., Harvey W. Morris of Philadelphia, Penna., Thomas Hull, Jr., of New York, N. Y., F. Earl Oliver of Detroit, Mich., Charles J. Fehn of Philadelphia, Penna., Oliver B. Hill, of Burbank, Calif., and Oscar C. Hill of Houston, Texas.

Kraft is one of the strong members in our chapter in Philadelphia. He has served Philadelphia-Camden Chapter as Chairman and he has also completed a term as one of our National Vice Presidents. Kraft seldom misses a meeting in Philadelphia although he has some seventy miles to travel to make the round-trip. In spite of this distance Kraft makes the trip regularly in good or bad weather. He does much to assist in the programs arranged for our members of Philadelphia-Camden Chapter. He has always been more than willing to help a fellow member.

Claude W. Longstreet of Westfield, N. J., has been Vice President for a number of years. He has no chapter affiliations and it is a real tribute to him to have been returned to office for several consecutive terms without having the support of members of a local chapter. Longstreet is a good Radio-TV technician and, like Kraft, is highly regarded in his community. Either man will make an excellent president.

Floyd Buehler in Detroit is the man who gives so many interesting talks to the members of our Detroit Chapter. Buehler has had wide experience in Radio and Television and is by occupation an instructor in Electronics.

Louis J. Kunert of Massapequa, N. Y., is Secretary-Treasurer of New York Chapter. He has held just about every office within the gift of our members. Along with Bert Wappler and Frank Zimmer he was recently honored by New York Chapter for having completed ten consecutive years in office in that local.

Harvey W. Morris is likewise a past President and Vice President and one of the outstanding Television Technicians in Philadelphia. He has given our chapter members much of his time in arranging good programs, specializing in Television developments.

F. Earl Oliver of Detroit is known to every member of our Alumni Association as he too is a past President. During the current year, in the capacity of Vice President, he visited other chapters in the middle west to bring to them some of the inspiration and experiences of Detroit Chapter. Sacrificing his own personal time without compensation is typical of Earl Oliver who is deeply interested in the affairs of our Alumni Association.

Oliver B. Hill of Burbank, Calif., formerly held the office of Vice President. We are pleased to again have this loyal member from the West Coast a nominee for Vice President.

Charles J. Fehn of Philadelphia is another past President who is ever loyal to our Alumni Association. He has been Treasurer of Philadelphia-Camden Chapter for many years. He is largely responsible for the smooth manner in which Philadelphia-Camden Chapter has been operating and his leadership has had much to do with the steady growth of that chapter.

Oscar C. Hill of Houston, Texas, has popped up from nowhere with good support from his locality. He has long been a member of our Alumni Association having graduated in 1938. He is another candidate without chapter affiliations who is well supported.

Thomas Hull, Jr., rounds out our ticket of eight candidates. Tommy has a lot on the ball and certainly deserves the recognition he has received. He is one of our best speakers in New York Chapter and takes part in the program at every meeting. Tommy Hull is highly regarded in the New York area and he is sure to make a strong bid for one of the offices of Vice President.

Remember you are to vote for one of the two candidates for president and four of the eight candidates for vice president. Please mark your ballot promptly and mail it as soon as possible. Only members of the NRI Alumni Association are eligible to vote. Ballot will be found on page 27. Remember the polls close at midnight on October 25, 1952. Please do not wait—vote now.

Thank you in advance for your expression of interest in the affairs of your NRI Alumni Association by exercising your privilege to cast a vote.

Just to keep Baltimore Chapter in the lime-light we show you here a picture of Chairman H. C. Voelkel leading the group in a discussion at a meeting. Chapter members enjoy these informal sessions.

Chapter Chatter

Philadelphia-Camden Chapter is proud to announce that our own Harvey Morris received the Merit Plaque given by Philco Corporation for outstanding servicing in Radio and TV. . . . Harvey is conducting a series of lectures and demonstrations for the benefit of our members, using the RCA Dynamic Board. These talks make a big hit.

New members are as follows, William E. Gothie, Jonathan O'Donnell, Harry S. Beard, John A. Pirrung and Anthony Zotto. Mr. O'Donnell lives in Hellertown, Penna., near Bethlehem, some fifty miles from Philadelphia. Distance is no barrier to our members.

We meet on the second and fourth Monday of the month, at the K. of C. Hall, Tulip and Tyson Sts. in Philadelphia.

Chicago Chapter, now rolling along in high gear, continued meetings right through the summer and is well prepared for a good fall and winter season with excellent planned programs. . . . James H. Thompson spoke on "How Circuit Diagrams are Used in Servicing." . . . Secretary, Mrs. Ilamae V. Webber spoke on "Direction Finders," with blackboard illustrations, based upon her Navy experience. . . . Mr. I. J. Prewitt spoke on "How to Find the Defective Part With an Ohmmeter." . . . Mr. L. B. Straessle had as his subject "How to Find the Defective Part with a Voltmeter" . . . and still another member, Mr. W. B. Rush, gave us a very interesting talk on his early training and experiences in Radio as far back as 1900.

Mr. Rush is a man of considerable capability in the field of Radio and Television and we are pleased to have him as a member of our Chapter. He is both a humorous and a sincere speaker. Among other things, he said, "Boys, you are in a field of endeavor that can make you very successful. When I was a boy, Radio had yet to be really born and now Television is in its babyhood. Study and study and study—never feel that you have acquired enough knowledge and if you persist, you too will be offered a job such as I was offered today, by a Television manufacturer of national reputation. They want me to work in an advisory capacity and name my own salary."

Our enthusiastic chairman, Charles C. Mead, is doing everything possible to make our meeting place comfortable and to give us the type of program that will want us to come to every meeting, without fail. . . . Students as well as graduates are invited to meet with us on the second and fourth Wednesday of each month, thirty-third floor, Tower Space, American Furniture Mart Building, 666 Lake Shore Drive, Chicago.

New York Chapter as well as **Detroit Chapter** suspended meetings during the hot summer months but now are back in full swing with their fall and winter programs. **New York Chapter** meets on the first and third Thursday of each month at St. Marks Community Center, 12 St. Marks Place, between Second and Third Avenues in New York City. . . . **Detroit Chapter** meets on the second and fourth Friday of each month at 21 Henry Street at Woodward. This is in the Electronics Institute Building. Meetings begin at 8:15 P.M.

Baltimore Chapter seldom skips a meeting and certainly warm weather would not be sufficient excuse. They continue right through the summer for the simple reason that the fellows like to get together. There is always plenty of room at the workbench for members to diagnose troubles in Radio and Television receivers. Chairman Voelkel, Secretary Kelly and Past President Rathbun are some of the men who are always at hand to give guidance. Students and graduates of the Baltimore area are invited to attend meetings on the second and fourth Tuesday of the month in Redmen's Hall, 745 West Baltimore Street. Meetings open at 8:15 P.M.

———*n r i*———

Henry Whelan, prominent Philadelphia TV service shop operator, NRI graduate and member of Phila-Camden Chapter, lends a hand at TV trouble-shooting demonstration, at meeting.

———*n r i*———

THERE IS NO CHARM so great as the charm of a cheerful temperament. It is a great error to suppose this comes entirely by nature—it comes quite as much by culture.—*Henry Van Dyke.*

IF ALL OUR MISFORTUNES were laid in one common heap, whence every one must take an equal portion, most people would be content to take their own and depart.—*Socrates.*

Election Ballot

All NRI Alumni members are urged to fill in this ballot carefully. Mail your ballot to National Headquarters immediately.

FOR PRESIDENT (Vote for one man)

- ☐ Norman Kraft, Perkasie, Penna.
- ☐ Claude Longstreet, Westfield, N. J.

FOR VICE PRESIDENT (Vote for four men)

- ☐ F. Earl Oliver, Detroit, Mich.
- ☐ Louis J. Kunert, Massapequa, N. Y.
- ☐ Harvey J. Morris, Phila., Penna.
- ☐ Thomas Hull, Jr., New York, N. Y.
- ☐ Charles J. Fehn, Phila., Penna.
- ☐ Oscar C. Hill, Houston, Texas
- ☐ Floyd Buehler, Detroit, Mich.
- ☐ Oliver B. Hill, Burbank, Calif.

SIGN HERE:

Your Name ....

Your Address ....

City .... State ....

Polls close October 25, 1952. Mail Your Completed Ballot to:

L. L. MENNE, *Executive Secretary*
NRI ALUMNI ASSOCIATION
16th and U Streets, N.W.
WASHINGTON 9, D. C.

Ken Kacel, Secretary of Detroit Chapter, at home in this well equipped Radio-TV shop.

Ray Weidner, Librarian, Phila-Camden Chapter, takes a turn at Radio servicing for benefit of members. Third from left is Chairman Laverne Kulp.

One of our few lady members is Mrs. Ilamae Webber, efficient Secretary of Chicago Chapter. Here she is taking notes at a meeting.

Chairman Charles C. Mead, of Chicago Chapter, giving a practical demonstration of Radio servicing. Glad to get these snap-shots, even if not too clear.

Max Luedtke examines a door prize he won at a big rally meeting of Detroit Chapter. Deeply interested are Steve Novosel, Chairman Alex Nikora, Charley Mills and L. L. Menne. Earl Oliver can be seen in the background. The prize! A DeLuxe Electric Drill Kit.

New York Chapter Activities

The above pictures were taken at New York Chapter meetings. Upper left shows Lou Kunert, Frank Zimmer and Bert Wappler accepting gifts of appreciation for ten years of continuous service in office. On right is a section of the more than ninety members who were present on this occasion. Left center is J. Morrison Smith, son of J. E. Smith, speaking at the above mentioned meeting. Morrison is Secretary of NRI. Center is Alexander Remer, energetic President of NRI Alumni Association. Right center is popular lecturer, Thomas Hull, Jr. Lower left shows more of the group at the meeting. Lower right, Tommy Hull describing the Power Supply Demonstration Board he built for benefit of New York Chapter members.

SCIENCE QUESTION BOX

By Scientists of the General Electric Research Laboratory

Q: Why does heat make things expand?

A: Matter is made of molecules which are in constant motion, and the higher the temperature, the faster they move. If you have a volume of gas in a rubber balloon, the pressure of these molecules against the rubber is balanced by its pull. Warming the gas makes the molecules move faster, so they push harder against the rubber. It yields a little, and the gas expands. With cooling, their motion is slowed, they exert less pressure, and the volume of gas gets smaller. Something similar occurs in a liquid, and also in a solid, although the molecules are held more tightly together. The amount which a solid expands for the same rise in temperature is considerly less than with a gas or liquid.

Q: Does a high-speed jet plane get ahead of its own sound?

A: Yes, it may. Sound travels about 750 miles per hour, so if a plane were traveling at 1000 miles per hour it would go rapidly ahead of its own sound. If such a plane were diving toward you, it would hit you before you heard it coming. If it veered off just before it reached you, you would first hear the sound from the point of closest approach, and it would be very loud. Then you would hear the sounds from the parts of its path farther back, as well as those ahead, and they would gradually get fainter. This would be something like the sound of an explosion, sudden and loud at first, and gradually dying out. If the plane came toward you at exactly sonic speed, the sound waves emanating from all parts of the path of approach would reach you at once, in a very brief, sharp report.

Q: Is there any connection between comets and meteors?

A: Yes, there is. For instance, Tuttle's comet, which comes back about every 122 years and was last seen in 1862, moves along an elliptical orbit that is very nearly the same as the path of the Perseid shower of meteors, or "shooting stars," which seem to emanate from the constellation of Perseus. We see these every year about August 12, when the Earth crosses the orbit of the meteors. Similarly, there are other meteor showers, visible at other times of the year, which likewise move in the same orbit as certain comets. Apparently the meteors represent some of the debris from the breaking up of the comet.

Q: I understand that the nucleus of an atom consists of a number of particles called protons, all positively charged. If so, how does it hold together? Since like charges repel each other, it seems as if the protons should fly apart.

A: You have put your finger on one of the important problems of modern physics, and scientists would like to know the answer. Evidently, in addition to the electrical forces which cause the protons to repel each other, some other forces are acting. These probably operate only at extremely short range, between the protons, and the neutrons which are also present. Such forces are not noticeable in larger units of matter. The exact nature of these "binding forces" is still unknown.

Q: Is it true that a radio listener may hear a speaker before people in his audience in the studio?

A: Yes. Sound waves travel about 1100 feet per second, while radio waves travel at the speed of light, about 186,000 miles per second. In a typical case the voice of the speaker might reach the radio listener in about .005 second. During this time the actual sound waves would travel about five feet. A listener in the studio, farther away than this, would hear him after the person near the distant radio receiver.

Q: What causes the color on a shaving when a piece of steel is being machined in a lathe, and why doesn't it appear immediately when the metal is cut?

A: The color that appears on a steel shaving produced by a lathe is due to a thin film of iron oxide. Because the metal is hot, it reacts with oxygen in the air, and the film starts forming immediately when the metal is cut. It must be built up to a thickness of about a millionth of an inch before it becomes visible as brown. The color changes as it increases, blue appearing with a thickness of four millionths of an inch. This is an example of interference colors, which also appear in the thin oil films that may form on a wet street, or in a soap bubble. Light waves are reflected both from the top and bottom of the film. The two reflected beams interfere with each other in such a way as to suppress certain colors and emphasize others, depending upon the thickness.

Q: Why do earthquakes occur more often in mountainous regions than where the ground is more level?

A: All mountains, except those of volcanic origin, result from the uplift of the Earth's crust, followed by erosion which etches out these features. Where these processes are going on, great stresses are produced in the crust, and when the strains set up are relieved, great fractures called faults are produced. As huge blocks of the crust move along these faults, they set up the vibrations called earthquakes. In regions that are flatter, active mountain building processes are not going on. Such stresses are not produced, and earthquakes are less common.

Here And There Among Alumni Members

Alumnus George C. Tinker, of Ft. Mill, South Carolina, has had his own successful Radio and TV business for some time. He is now located in a new building; has two technicians working for him, and says his list of satisfied customers is growing larger each week.

n r i

Graduate Peter Kamarchik, of South Greensburg, Pennsylvania, has received his 1st class radiotelephone license. Congratulations!

n r i

Grad. Harold Kuhns, his wife and two children, of Greencastle, Penna., included a stop at NRI on their vacation agenda.

n r i

Mr. and Mrs. Robert H. Dohmen, of New Prague, Minnesota, visited NRI while on an extensive Eastern vacation tour. Graduate Dohmen has a successful Television and Appliance Sales and Service business, which grossed over $50,000 in 1951.

n r i

Robert F. Lent, of Dahlgren, Virginia, has been promoted in Civil Service status to Electronics Laboratory Mechanic. His work involves the circuitry of all types of electronic and radio equipment.

n r i

Vacation visitors at NRI were Eugene Van Hoose, of Fords, N. J.; Cleon C. Ellis, of Charleroi, Penna.; and Wilson W. Brummett, of Lafayette, Ind., all enthusiastic NRI Alumni.

n r i

Joe Laskiewicz writes that he is now co-owner of "Cardinal Electronics," located at 118 S. Broadway, South Amboy, New Jersey. Doing good sales and service business—plenty of TV.

n r i

Val Guyton, former secretary of Detroit Chapter, has been promoted again by the Wabash Railroad Company. He is now Assistant General Freight Agent in Detroit.

n r i

Alumnus James D. Johnson, of Winona, Miss., was a recent visitor at NRI. He is doing very well in his spare-time Radio business.

n r i

Graduate Julius Hillenbrand, of Ridgewood, New York, writes that he has closed his barber shop and is now in full-time Radio and TV Servicing, and doing well. Congratulations to another NRI gradaute who has become an indcpendent businessman.

n r i

Frederick B. Uzzle, a graduate of both NRI's Servicing and Communications Courses, is now Production Manager-Engineer for Station WJVB, Jacksonville Beach, Florida. Has his 1st radiotelephone and Novice Class Amateur licenses.

n r i

Jerry Tascano, member of Philadelphia-Camden Chapter of NRIAA, has become a father of a baby boy, his third.

n r i

Mr. and Mrs. Bertram D. Schafer and son, of New Kensington, Pennsylvania, were among vacation time visitors at NRI.

n r i

We are sorry to report that Bob Meili, past chairman of Philadelphia-Camden Chapter, passed away. He had been in poor health for some time. Bob took a deep interest in our Chapter activities and was instrumental in securing a new meeting place for Philadelphia-Camden Chapter when one was needed. Bob Meili will long remain in our memories as a real friend to Radio-TV men.

n r i

Graduate F. B. Roberts, of Nashville, Tennessee, is now Service Manager of the Keith-Simmons Company, of Nashville.

n r i

Graduate Jack Wagner of Lexington, North Carolina, writes that he has a good job with Western Electric testing government equipment —says that credit for this goes to NRI.

n r i

Arthur Hesterman, A/3c, is now stationed at Big Spring AFB, Big Spring, Texas. He is repairing aircraft radios. Says NRI training certainly helped him in his Air Force career.

n r i

George E. Melius, of Ghent, New York, tells us he is very busy doing full-time servicing and selling of Television and Radio. He has quite a business—says netting close to $2,000 a month.

n r i

Mr. and Mrs. David Spitzer, of Brooklyn, New York, paid a vacation visit to NRI. Mr. Spitzer is a member of the New York local NRIAA Chapter.

n r i

Graduate Irving Ellertson, of Cedar Rapids, Iowa. is now a radio technician in the engineering department of the Collins Radio Company.

n r i

Graduate James W. Schneider, of Baltimore, Maryland, is now with Bendix Radio, at Harbor Field. He is doing Radar testing. Also has a spare-time Radio and TV business.

n r i

Graduate John W. Pritting, who has been stationed in Alaska, and on Guam, with the U. S. Bureau of Standards, is now living in Arlington, Va. He is still with the Bureau, at the Radio Propagation Field Station, Ft. Belvoir, Virginia.

NATIONAL RADIO-TV NEWS
16th & U Sts., N.W. **Washington 9, D. C.**

For:

Mr. Francis H. Fingado 25236 4
611 17th St.
Denver 2, Colo.

National
RADIO-TV NEWS

Vol. 15 Oct.-Nov., 1952 No. 5

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

NATIONAL RADIO INSTITUTE
Washington 9, D. C.

The Official Organ of the N R I Alumni Association. Editorial and Business Office, 16th & You Sts., N. W., Washington 9, D. C.

L. L. MENNE, EDITOR
H. L. EMERSON, ASSOCIATE EDITOR
J. B. STRAUGHN, TECHNICAL EDITOR

Index

Printed in U.S.A.