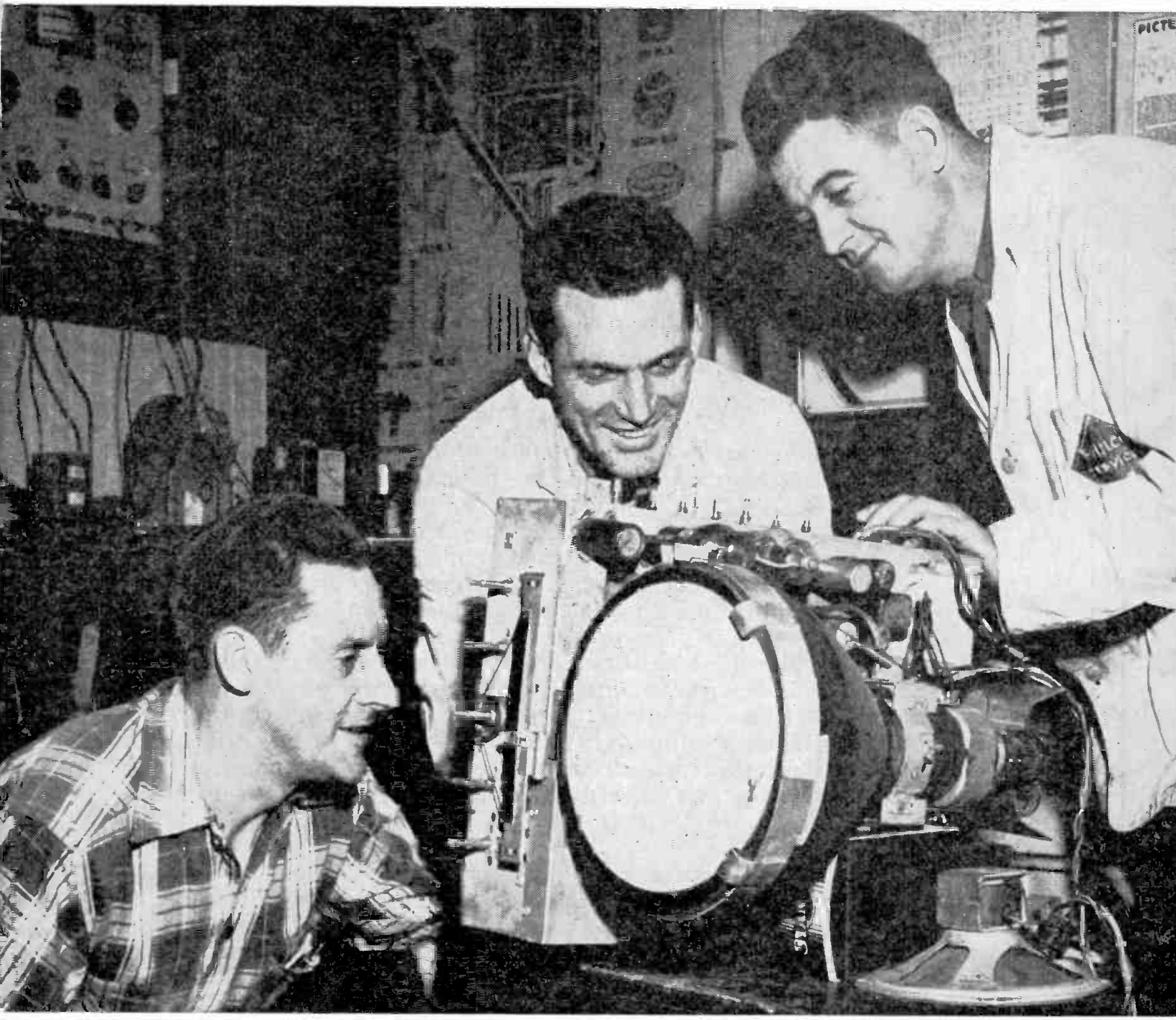
National RADIO-TV NEWS



April-May
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Honesty is The Best Policy

WE were all taught in childhood that "Honesty is the best policy." As we grew older we heard and read things which sometimes caused us to wonder whether this is strictly true or if it is just a pious statement handed down by some who assume respectability but do not always practice what they preach. But in time we learned that while an occasional man makes a little money by shady practices, the really sound successes are built upon a foundation of integrity.

Many years ago, even before the days of Radio, I attended a political rally. Men were debating the merits of their party candidates. I remember one man who talked for about fifteen minutes. His object was to convince his listeners that his candidate was inherently honest. He dwelt at great length on that one point. He made quite an impression.

Then came the time for a man on the other side of the political fence to speak. He said, "My friend has used all of his time in an effort to convince you that his candidate is honest. I feel that he has told you little of importance—not that we are unwilling to concede that his candidate is honest but because I feel you will agree with me that it is no credit to a man to say that he is honest—*he is supposed to be honest.*" With that simple truth he swept aside, in a few words, all the effect of what the other man had spent fifteen minutes to build up.

In the Radio and Television business, as in most businesses, here and there some tricky fellows will pop up with unethical methods for the purpose of gaining a few dollars. Shun these practices like you would the plague. Don't feel that you must meet this competition if it is not strictly honest. Your neighbors will catch up with these unscrupulous fellows soon enough. No man can stay in business long who does not have the full confidence of everyone in his community.

I want every man who carries the stamp of approval of the National Radio Institute to uphold the dignity of the Radio and Television profession and of this institution. NRI men are taught to conduct their business affairs in a manner which must be above reproach. We insist upon that principle, for only through strictly ethical practices is an NRI man worthy of the high regard in which our graduates are held.

"Honesty *is* the best—and only policy" in life and in business.

J. E. SMITH, *President.*

COMPONENT COMBINATIONS In Radio Receivers

By SEYMOUR D. USLAN

Reprinted from SUCCESSFUL SERVICING *through the courtesy of John F. Rider Publisher, Inc. and Mr. Seymour D. Uslan.*

FROM the point of view of the man who traces out the troubles in radio receivers and repairs them, variations in electrical and mechanical design always present a problem. He must acquaint himself with these innovations so that he can do a better job. The trend toward the use of new circuit constructions in the electronic equipment of today is on the increase. It is the purpose of this article to acquaint the reader with those special constructions that are used in the radio receivers of today.

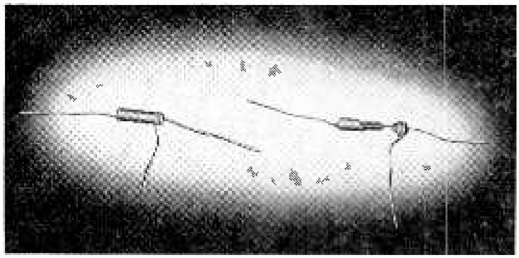


Fig. 2. (C) Photograph of a resistor-capacitor combination unit showing on the left, the whole unit, and on the right, a broken one with the resistor inside the ceramic capacitor.

In the Lear portable radio chassis P-10B for example, there are employed specially constructed resistance and capacitance units, called "C and R units." Most of these units are shown schematically as representing a single resistor and capacitor, but there are some that are shown representing two capacitors and one resistor. These units are not printed circuits but rather, separate resistors and ceramic capacitors so mechanically arranged into a single unit that it might at first be difficult for the radio serviceman to realize that more than one circuit element is represented by this unit.

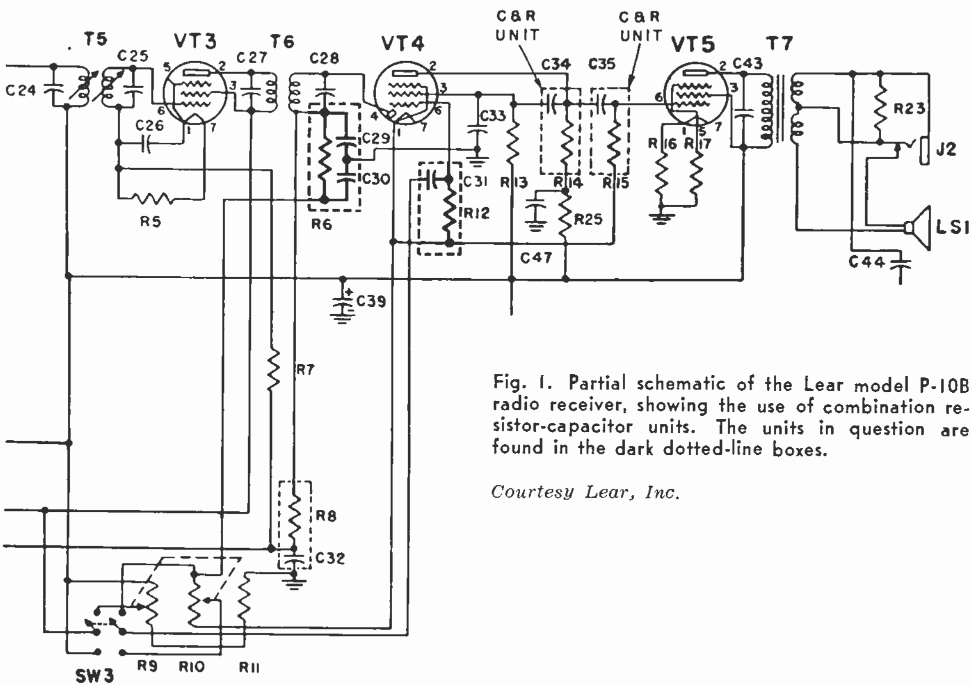


Fig. 1. Partial schematic of the Lear model P-10B radio receiver, showing the use of combination resistor-capacitor units. The units in question are found in the dark dotted-line boxes.

Courtesy Lear, Inc.

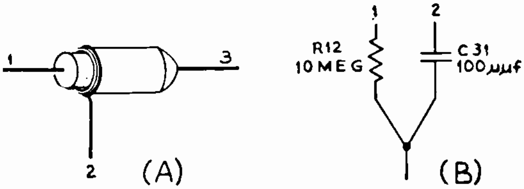


Fig. 2. (A) Drawing of the R12-C31 unit as it appears in the receiver. (B) Schematic representation of this unit.

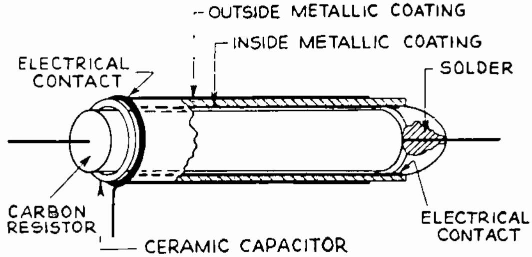


Fig. 3. Enlarged isometric cross-section of the R12-C13 unit.

The schematic diagram for a section of the P-10B chassis is illustrated in Fig. 1. The units of interest to us are shown enclosed in dashed boxes and are represented by the resistor-capacitor combinations of R8-C32, R12-C31, R14-C34, R15-C35, and R6-C29-C30. The relationship between the schematic representation and the physical unit is somewhat puzzling. In order to visualize the tie-in between the schematic drawing and the unit itself, we will study the construction of these units.

Single Resistor-Capacitor Combinations

Each unit consists of a single carbon resistor in conjunction with a ceramic capacitor. A drawing of the R12-C31 unit (R8-C32, R12-C31, R14-C34, and R15-C35 are identical) as it appears in the receiver is illustrated in Fig. 2(A), and the schematic representation for this unit is shown in Fig. 2(B). An actual photograph of two of the units is shown in Fig. 2(C) on previous page. This unit consists of a 10-megohm carbon resistor inserted inside a ceramic capacitor. One end of the resistor is soldered to one plate of the capacitor and this connection is brought out as a single lead, number 3 in Fig. 2(A). Lead number 1 acts as the other end of the resistor and lead number 2 is the other end of the capacitor.

In the circuit of Fig. 1 the common lead (3) of the R12-C31 unit is connected to the control grid of VT4, the other end of the resistor is connected to the cathode of VT4 and R15; the other end of the capacitor is connected to Switch 3 (Direction Finder switch). In order to understand fully the way the capacitor and resistor are combined, let us refer to the enlarged drawing of this C and R unit as illustrated in Fig. 3. From this isometric cross-sectional drawing the individual resistor and capacitor are readily evident.

The interesting constructional details of this unit, as well as of the others, is the ceramic capacitor. The capacitor has two separate metallic coatings. One coating is on the inside of the ceramic cylinder and the other coating on the outside of the ceramic. These two metallic coatings represent the plates of the capacitor. The exact amount of capacitance represented by this capacitor is determined by a number of factors. One factor is the dielectric material separating the two metallic coatings, which in this case is, of course, the ceramic material. The distance of separation between the metallic plates is another factor—the smaller the distance, the greater the capacitance. For the capacitor under discussion this means the smaller the thickness of the ceramic cylinder, the larger the capacitance. The final factor in determining the value of the capacitance is the common area between the two metallic plates; the greater this area, the higher the capacitance.

Since we are dealing with a cylindrical capacitor, this area is dependent upon two dimensions—the length of the metallic coatings that are common to each other and the diameter of the ceramic cylinder. The greater this length and the larger the diameter, the greater the area will be and, hence the larger the capacitance.

Coming back to Fig. 3, it can be seen that the resistor is not inserted all the way into the ceramic capacitor. At the right-hand end of the unit some solder is inserted into the ceramic cylinder and takes on the approximate shape shown in the drawing. This solder is used to make electrical contact between the metal end of the resistor and the inside metallic plate of the capacitor. In this manner one end of the resistor and one end of the capacitor are tied together. At the left-hand side of the ceramic, a piece of wire is wrapped around the outside of the capacitor a few times and then soldered to the outside metallic plate of the ceramic cylinder. This connection serves as the other lead of the capacitor. The metallic plates do not necessarily cover the whole length of the ceramic. The exact length is determined by the amount of capacitance desired.

In the drawing of Fig. 3, the heavy lines indicate the metallic coatings of the capacitor. After assembly this completed C and R unit is covered with a white coating of some insulating material.

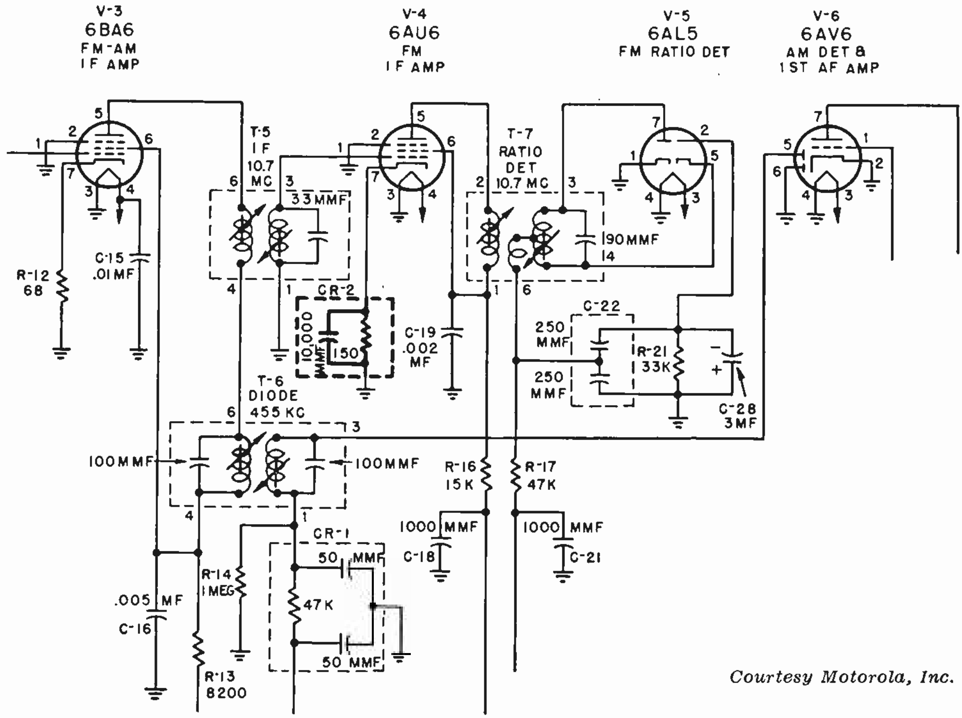


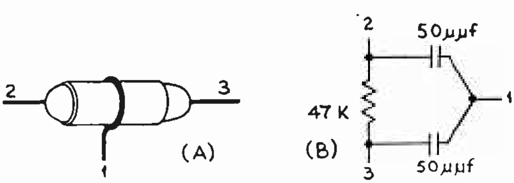
Fig. 4. Partial schematic of the Motorola radio chassis HS-211 and HS-230 with "CR" units.

Two Capacitor—One Resistor Combinations

The second unit of interest to us electrically consists of two capacitors and one resistor composing *CR-1,* in the partial schematic of the Motorola radio chassis HS-211 and HS-230 shown in Fig. 4. From the drawing of this unit as shown in Fig. 5(A), and the photograph shown in Fig. 5(C), it is difficult to conceive how it is equivalent to these three circuit components. The schematic diagram of this unit appears in Fig. 5(B).

This three-element unit only has three external leads. Lead number 1, around the middle of the unit, represents the common connection between the two capacitor components. Each of the other two leads represents the connection between one end of the resistor and one plate of the capacitor. Thus, there is a capacitance of 50 $\mu\mu$f between leads 1 and 2 and also between leads 1 and 3 of the drawing of Fig. 5(A). A 47,000-ohm resistance can be measured between leads 2 and 3.

This unit is employed as the diode filter in the



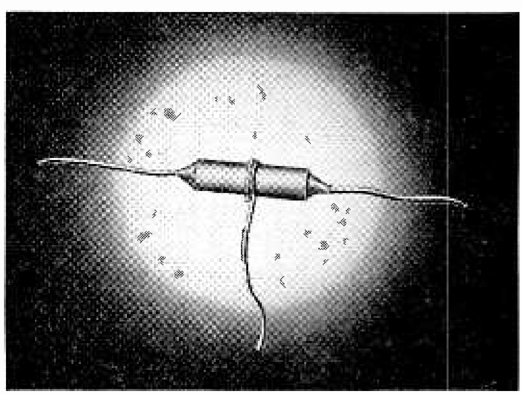


Fig. 5. (A) Drawing of a unit composed of two capacitors and one resistor. (B) Schematic representation of this unit. (C) Photograph of this unit.

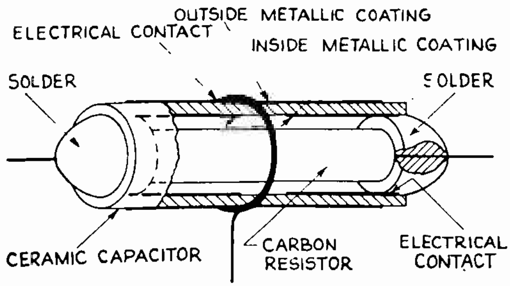


Fig. 6. Detailed isometric cross-section of the unit composed of two capacitors and one resistor.

AM detector circuit of the receiver, as can be seen in Fig. 4. When wiring this special construction into the circuit, lead number 1 must be grounded. Since each capacitor is 50 $\mu\mu$f in value, it does not matter which of the other leads is connected to the detector transformer; even if leads 2 and 3 were interchanged, the circuit of this unit would still be the same.

Let us examine the construction of this double capacitor and resistor combination. A detailed isometric cross-sectional drawing appears in Fig. 6. A single carbon resistor and one ceramic cylinder is used to form this special filter network. The interesting thing about this unit is the method of plating the ceramic.

The outside of the ceramic is covered with a metallic coating, as shown by the heavy solid line in the drawing. The inside of the ceramic also has a metallic coating, as indicated by the heavy lines; however, this coating is not continuous but is split at the center. Considering the ceramic capacitor as is we find that we have three separate plates.

Centered inside the ceramic cylinder is the carbon resistor. At each end of the unit some solder is inserted. Each end of the resistor, therefore, makes electrical contact with a separate metallic plate at the inside of the ceramic. A piece of wire is wound around the outside of the ceramic and soldered to the metallic coating. This latter wire is centered on the unit. From the drawing of Fig. 6 we find:

1. That the outside metallic coating represents the common plate of the two capacitors, with the center wound wire as its connecting lead.

2. That a capacitance exists between either end of the unit (which represents a connection between one end of the resistor and one of the other plates of the capacitor) and the center lead. This capacitance is determined primarily by the common area of the two metallic plates of the capacitor, the distance between the plates, and the length of the inside metallic plate.

After assembly this unit is covered with a white insulating coating similar to the other C and R unit.

Parallel Capacitor-Resistor Unit

A drawing of the *CR-2* unit in the Motorola schematic as it normally appears is shown at (A) in Fig. 7, in conjunction with its schematic diagram which appears in part (B). It consists of a single carbon resistor inserted inside a ceramic capacitor. In this unit, however, there are only two exposed leads indicating that the resistor and capacitor are already in parallel.

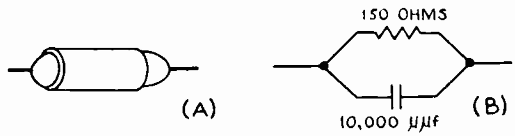


Fig. 7. Drawing and schematic of the Motorola CR-2 unit.

Each end of the resistor is soldered to a different plate of the capacitor. A detailed isometric cross-sectional drawing of this unit appears in Fig. 8. The heavy lines on the ceramic indicate the metallic plate of the capacitor. The interesting detail about this unit is the method of making contact between each end of the resistor and the plates of the capacitor.

At the right-hand end, the solder which is inserted inside the capacitor makes electrical contact between the inside plate of the capacitor and the resistor. The left-hand end of the unit has the same physical appearance as the right end. However, from Fig. 8 we see that the outside metallic plate of the capacitor is *flush* to the left-hand end of the ceramic and continues for a short distance on the inside of the ceramic, but does not make contact with the inside metallic coating. By placing some solder inside this end of the capacitor, there is effectively an electrical contact between the outside plate and the other end of the resistor. The capacitance of the capacitor is determined in the same manner as that of Fig. 3.

Units such as these will probably be used in greater quantities as time goes on. From the manufacturing viewpoint, their use saves time in assembly operations. For example, the three components of the diode filter of Fig. 5 would normally require 6 separate connections, 2 for each components; but only 3 are required with this special unit.

This also means that the serviceman would have less work to do if all of the components have

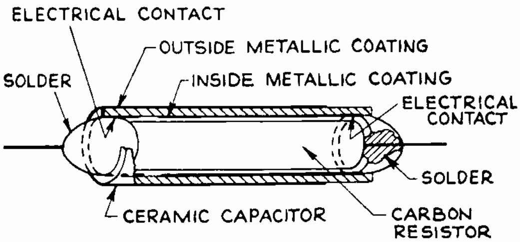


Fig. 8. Cross-sectional diagram of the CR-2 unit.

to be changed. However, this is not the usual case. Thus, if any one element in these special C and R units were to become defective, the complete unit would have to be changed. If these special units are not available, then standard components of proper size and ratings can be used if there is enough space for them.

n r i

Our Cover Photograph

Judging by the looks of the intent group of technicians in our cover photo, one would surely conclude that Television repairing is fascinating work. This photo was posed in the Television shop of NRI Graduate Paul G. Miller, 329 West Wayne Street, Maumee, Ohio. Graduate Miller appears on the left. Others in the photograph are Eldon Flogans and Robert F. McCullough. Graduate Miller recently wrote:

"After the fifteenth lesson, I began doing repair jobs, and by the twenty-eighth lesson, I had earned enough to completely pay for my course and $50 more. Thanks to NRI, I am now the owner of the Miller Radio and Electrical Appliance Company. The training which I received from NRI enables me to do fast, thorough, and practical repairs.

"Thanks to you and your training, I grossed over $40,000 in the TV field in one year. Almost every week boys come to me asking about training in Radio and Television. I tell them all to write to you, and I also state to them that if they will take your course and follow it, they can have employment with me. I am sending the new photo so that you will be better able to show prospective students what our school can do. I was formerly an automobile worker."

n r i

Radios (wireless receiving sets) in Use

More than half the radios now in use would appear to be located in the United States, according to the data given in the UNITED NATIONS STATISTICAL YEARBOOK for over 110 countries. Between 1938 and 1950 the number of radios estimated to be in use in the United States more than doubled. Among the larger countries a notable increase occurred in Italy where there were 3 times as many radios in 1950 as in 1938. The greatest percentage increases over prewar took place in the less developed countries. Thus, between 1938 and 1950 the number of radios (in thousands) rose from 39 to 133 in French Morocco, from 2 to 35 in the Dominican Republic, from 3 to 20 in Nicaragua, from 64 to 343 in India and from 46 to 301 (1949) in Turkey.

n r i

New Tube Test Data for Model 69 NRI Tube Testers Which Were Purchased Before March 15, 1952

Read carefully. If you received your Model 69 Tube Tester from NRI after March 15, 1952, you received the latest revised chart in your instrument. For those who purchased their Model 69 Tube Testers from NRI *before* March 15, 1952, the latest revised paper roll chart filler is now available from NRI for one dollar, postpaid.

The new chart is easily installed. All you need to do is remove the front panel of the instrument by taking out the screws found in the four corners of the panel. Closely observe the mechanical operation of the old roll chart before removing it. Fasten the new roll chart to the wooden rollers using scotch tape. Test the operation of the rollers before putting the instrument back together.

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Enclosed is $1.00.* I received my Model 69 before March 15, 1952. Please send me a new paper roll chart filler, postpaid.

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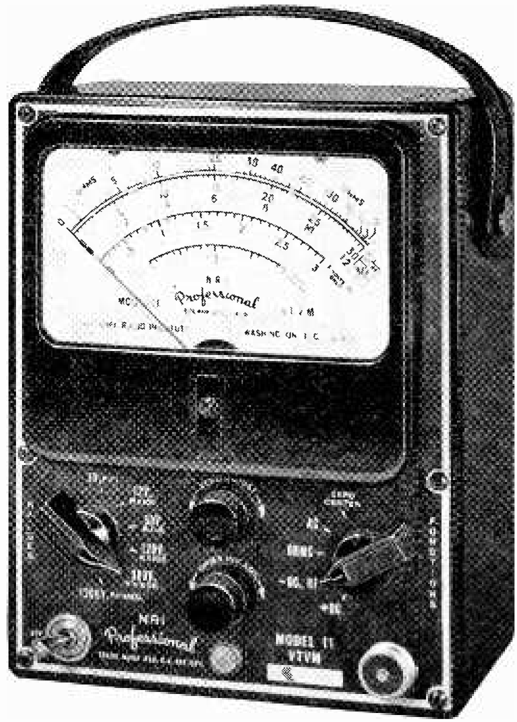
*If you live in the District of Columbia, please enclose an additional 2c for D.C. sales tax. (Total $1.02.)

Introducing the New NRI Professional Vacuum Tube Voltmeter



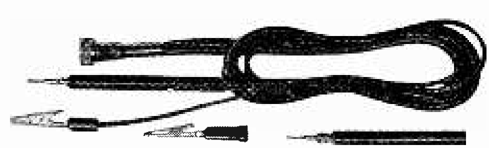
WE believe this VTVM is the top performer among low-priced Vacuum Tube Voltmeters. It's accurate, good looking, easy to operate. It has a wide selection of ranges, is stable and dependable, light in weight, small and compact. Only because we buy these VTVM's in large quantities direct from a well-known instrument maker, are we able to offer this value exclusively to NRI men.

The Advantages of a Vacuum Tube Voltmeter

Essentially, a VTVM uses the amplifying ability of vacuum tubes to increase greatly the sensitivity of the basic voltmeter. The NRI Professional VTVM, Model 11, uses a sensitive 200 microampere meter movement in a balanced dual triode bridge vacuum tube circuit, which results in a constant input impedance of 11 megohms on all dc voltmeter ranges. This means that you can ignore the loading effects of the dc voltmeter even when making measurements in critical radio and television circuits. AC volts and resistance are also measured with the sensitive circuit. The meter movement is electronically protected against reasonable overloads.

Provides Five Basic Types of Measurements

1. *DC Volts*—Six ranges, 0-1200 volts, provide for all basic dc measurements in Radio and Television. With High Voltage TV Probe (available at extra charge), dc range is extended to 30,000 volts. Voltmeter polarity switch eliminates reversing leads. For correct polarity just change polarity switch. Detachable 1 meg isolating probe for dc measurements minimizes capacitive effect of leads on critical circuits.
2. *AC Volts*—Six ranges, 0-1200 volts, cover power frequencies, audio frequencies, and supersonic frequencies. Frequency response flat from 25 cycles to 1 mc ± 3 db up to 3 mc, with input capacity of 225 mmf.
3. *Ohmmeter Measurements*—Up to 2000 megohms in six overlapping ranges. This permits measurement of extremely small and large resistances. Tests condensers for leakage and opens. Low ohms scale for checking coil windings. One zero adjustment serves all six ranges.
4. *Zero Center Scale*—Shifts electrical zero of the dc voltmeter from left end of scale to center of scale in a jiffy. A very important type of measurement in balancing FM and TV discriminator circuits, or in making measurements of unknown polarity. Six ranges 0 to ± 600 volts.
5. *Output Measurements* in connection with alignments. High dc sensitivity makes the Model 11 ideal for avc output measurements. DC blocking condenser on ac ranges permits measuring signal at plate of output tube.



Universal test leads. Insulated alligator clip. Detachable isolating probe for dc measurements. Included with each Model 11, VTVM, as standard equipment, at no extra charge.

Eighteen Separate Ranges

DC Volts	AC Volts	Ohms
0-3	0-3	0-2000 (20 ohms center scale)
0-12	0-12	0-200K (2000 ohms center scale)
0-30	0-30	0-2 Megs (20,000 ohms center scale)
0-120	0-120	0-20 Megs (200K ohms center scale)
0-300	0-300	0-200 Megs (2 Megs center scale)
0-1200	0-1200	0-2000 Megs (20 Megs center scale)

Panel: Handsomely etched, black enameled field, contrasting white aluminum characters.
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Tubes: One 12AU7; One 6 x 4, selenium rectifier.
Power Required: Operates only on 50-60 cycles, 110-120 volts ac.
Warranty: Standard 90 day RTMA warranty.

Compare the NRI Professional VTVM with other instruments of this type. For quality and price you will find yourself coming back to the NRI VTVM as your best buy. We sincerely believe this instrument is unsurpassed in quality at this low price.

* * *

Optional Accessories

High Voltage TV Multiplier Probe available at Extra Charge. Extends dc volts range to 30,000 volts for SAFE high-voltage TV measurements. Molded polystyrene head, heavy-duty bakelite handle with two-inch high voltage barrier. Ceramic, helical film-type cartridge multiplier resistor. Over-all length 12½ inches. Instructions included. Price, $8.00.

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Crystal Detector High Frequency Probe available at Extra Charge. Gives positive peak voltage values for sine-wave voltages up to a maximum peak value of 120 volts. Frequency range up to 250 mcs. Well-made probe, shielded lead, and connector. Instructions included. Price, $6.65.

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Introduction to Radar Techniques

By the Engineering Department, Aerovox Corporation

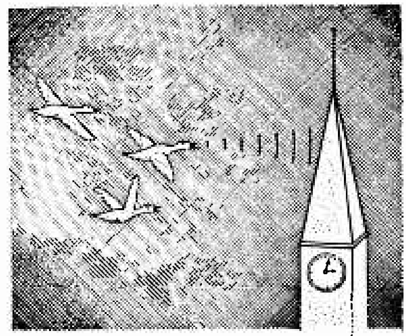
Reprinted through the courtesy of the *Aerovox Research Worker*

The Radar System

THE use of Radio Detection and Ranging, more commonly abbreviated "RADAR," played an important part in determining the outcome of World War II. Although overshadowed in the final stages of the hostilities by the more spectacular atomic bomb, few military tacticians doubt that radar played a more decisive role in securing Allied victory. Even more important is the fact that this electronic instrument is finding an ever-widening sphere of usefulness in peace time applications. Radar has become a permanent part of the field of radio, not only as a dependable aid to marine and airborne navigation, but also as a valuable adjunct to meteorological stations throughout the world. Its use as a traffic control device for measuring the speed of automobiles traveling on highways has also been announced. Such uses are only a few of the many which will ultimately be found for this principle. Radio technicians in coastal areas have already found a lucrative field of endeavor in the installation and maintenance of marine radar equipment on fishing boats and ferries. In short, radar has emerged from the laboratories and military field of operations, and has become a part of the everyday civilian scene.

Historical Notes

Historically, the use of the basic radar principle, i.e., the detection of surrounding objects or obstacles by echoes reflected from them, is not new. In nature, the radar system has been used for as long as wild geese and other migratory birds have navigated through darkness and overcast by "honking" or making other sounds whose echoes warn of approaching obstacles. See Fig. 1. Bats too, are credited with masterful blind navigation by uttering a series of short, supersonic squeaks and interpreting the echoes from these in terms of range and bearing information. Man has utilized the same scheme to some extent in navigating rivers and harbors. Old skippers of ferries, river boats, and coastwise steamers have been known to develop a remarkable faculty for determining their bearings despite fog or darkness by listening to distinctive echoes of the boat's whistle bouncing off shore lines or passing craft. Many such men of long experiences and practiced ear claim to be able to differentiate between rocky or wooded coast lines, as well as glean a good estimate of the size and type of a passing vessel, by the nature of the returned echo.



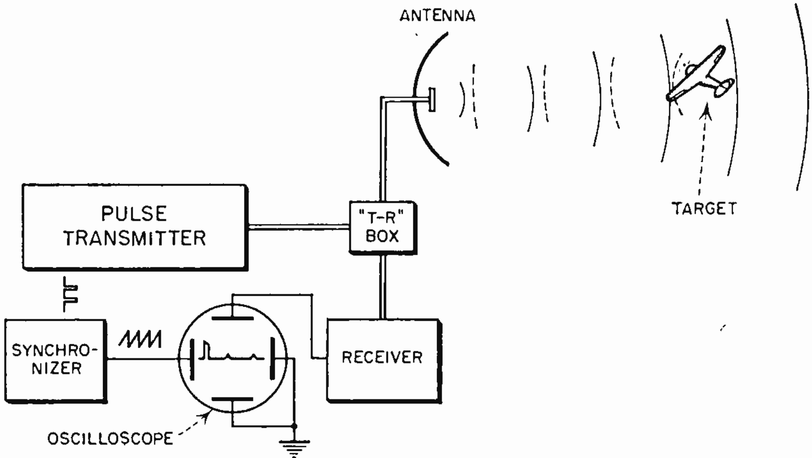
EARLY AIRBORNE RADAR

Fig. 1

The first use of electronic radar is attributed to Sir Watson-Watt in England, in 1935, although the technique of detecting the echoes of short pulses of radio frequency and energy had been used much earlier (1925) by Breit and Tuve to measure the height of the ionosphere. This work suggested the possibility of obtaining echoes from aircraft and other objects smaller than the ionosphere to a score of workers in several major countries. As a result, successful radar systems were developed almost simultaneously during the late thirties in France, England, Germany, and America.

The Basic Radar System

The fundamental elements of a radar system are shown in Fig. 2. Very short pulses of radio frequency energy which recur at regular intervals are generated by the transmitter. These intense "bursts," which may be only one *millionth* of a second in duration, are radiated by the antenna in a narrow beam. These waves propagate through space with the speed of light and, upon striking a reflecting object, are returned to the receiver as an echo. The output of this receiver is connected to the vertical plates of an oscilloscope. The horizontal plates of this 'scope are driven by a linear, saw-tooth sweep generator which is synchronized with the transmitter pulses in such a manner that the sweep starts across the face of the 'scope at the time of each transmitter pulse. Received echoes then form small vertical "pips" on the base line which represent



COMPONENTS OF ELEMENTARY RADAR SET
Fig. 2

reflecting objects at distances indicated by their positions on the time base. See Fig. 3.

Since radio waves travel in space at a constant velocity, the range of a target indicated on the display oscilloscope may be accurately determined by measuring the time elapsed between the transmission of a pulse and the reception of an echo. This is easily done since the 'scope sweep is linear with time and so can be calibrated directly in range. The range of a target in yards is thus related to the echo time by:

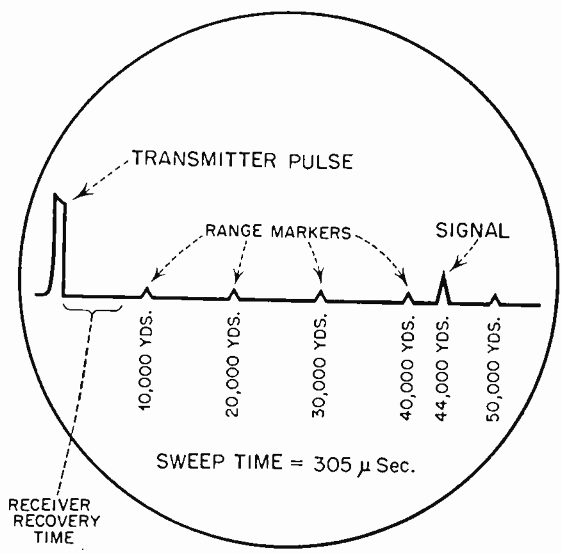
$$\text{(1)} \qquad \text{Range (yds.)} = \frac{327.5t}{2}$$

Where:
t is the echo delay time in microseconds
327.5 is the free-space velocity of radio waves (yds./sec.)

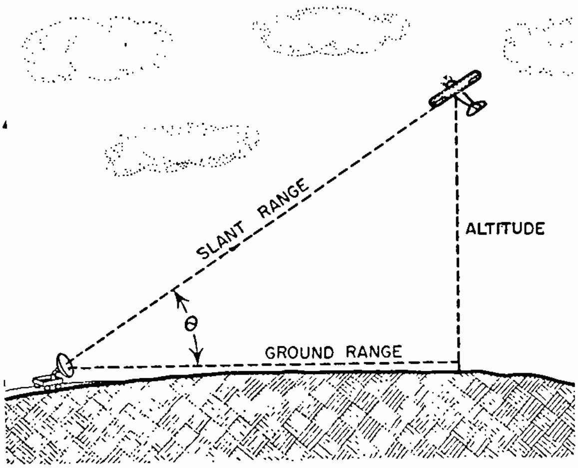
Note that the distance traveled by the waves (velocity times time) is divided by the factor 2 for the actual radar range since the waves must travel this distance twice going to the target and returning.

To facilitate measuring range, the time base is frequently provided with *range markers,* as illustrated in Fig. 3. These range calibration points are formed by feeding a pulse signal into the vertical deflection plates. The repetition rate of these pulses is chosen to correspond to time intervals which represent convenient increments of range, such as 5000 or 10,000 yards. Markers of this type insure accurate ranging, even when the time base departs from linearity.

The angular bearing, or *azimuth,* of the target is determined by the directional position of the antenna. Information on the elevation of aircraft is obtained in the same manner. The range indicated in this case is called the "slant range." The ground range and altitude are then gotten by simple trigonometry, as shown in Fig. 4. The accuracy of these measurements is limited by the beam width of the antenna pattern. In practice, beam widths of less than one degree are achieved by using large, highly directional antennas and very short operating wavelengths. Although some radar sets have used separate



DETAILS OF "A-'SCOPE" PRESENTATION
Fig. 3



ALTITUDE = (SLANT RANGE) (Sin θ)

GROUND RANGE = (SLANT RANGE) (Cos θ)

Fig. 4

antennas for the functions of transmitting and receiving, the arrangement illustrated in Fig. 2 is much more convenient. Both transmitting and receiving is done with the same antenna by using a system of automatic switching known as "duplexing." By this method, the receiver is effectively disconnected from the common transmission line during the "on" time of the transmitter and so is protected from overload and burnout damage by the high power transmitter pulses. Between transmitter pulses, the receiver is automatically connected to the line and the transmitting tube is isolated to prevent its absorbing some of the received signal. Duplexing is usually accomplished by using a gas-filled switching device known as a "transmit-receive tube" or, more simply, a "T-R box."

The method of displaying information illustrated in Fig. 3, known as an "A-'scope" presentation, is only the simplest of many possible types. Although used universally on early radar equipments, it was soon replaced or supplemented by more advanced kinds. One of the most useful of these is the *Plan Position Indicator,* or "PPI," depicted in Fig. 5. This type displays a map of the terrain surrounding the radar set in polar coordinates, with the set at the center of the oscilloscope face. To do this, a radial sweep originates at the center of the tube and is rotated angularly about this point in synchronism with the position of the antenna, which is continuously scanned in azimuth. Received signals are used to intensity modulate the electron beam so that a bright spot is "painted" at the range and azimuthal position of each target. The use of long persistence phosphors enables the 'scope to retain these images until renewed by another antenna scan. The radial sweep is produced by a rotating electromagnetic deflection system which is synchronized with the antenna angle by an electrical or mechanical linkage. Presentations of the PPI type are especially useful for navigational radar.

Limits of Radar Performance

The range of radar equipment is determined by many design factors. The minimum range at which a target may be detected is limited by the duration of the transmitted pulse and the *recovery time* of the duplexing system. If the transmitted pulse is too long, echoes from objects at close range will be returned while the transmitter is still operating and the receiver is blocked by the TR system. Since the TR tube requires a finite time to recover after each pulse is sent, the receiver also remains inoperative for a short time after the completion of the pulse. The result is a "blind spot" in the immediate vicinity of the radar set which is usually of little consequence, since long range operation is the most important in most applications.

The maximum range obtainable from a radar set of a given design depends upon such factors as transmitter power, size of the target, gain of the antenna, sensitivity of the receiver, operating wavelength, etc. These factors have been related by what is commonly called the "radar equation."

The "Radar Equation"

$$R_{max} = \sqrt[4]{\frac{P \delta A^2 f^2}{4 \pi S_m \lambda^2}} \qquad (2)$$

Where:

R_{max} is the maximum range in miles

P is the peak transmitter power (watts)

δ is the reflecting area of the target

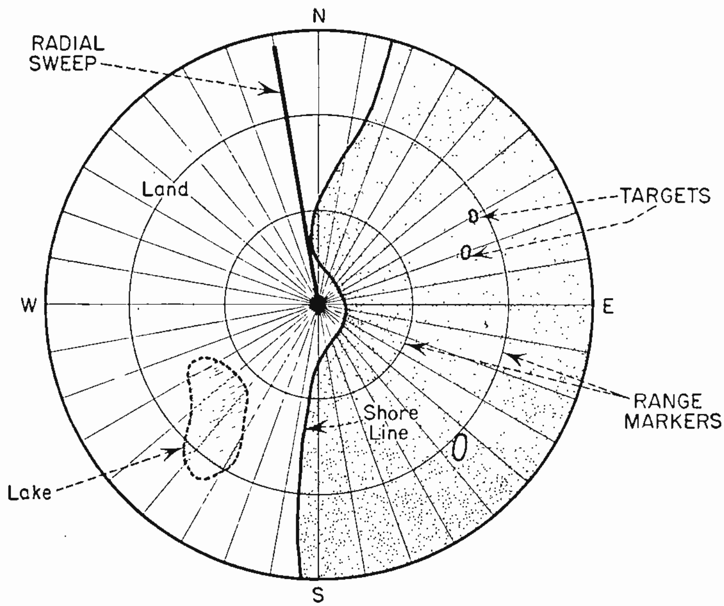
A is the antenna aperture (sq. ft.)

f is an antenna illumination factor (between .5 and 1.0)

S_m is the minimum signal the receiver will detect (watts)

λ is the operating wavelength (ft.)

By means of this relationship, radar system designers can reasonably predict the performance of a proposed equipment. Note that the range varies as the *fourth* root of the other factors. This arises since the signal traverses the path twice, so that the received signal is inversely proportional to the fourth power of the distance rather than the familiar inverse square law of one-way transmission. For this reason, very high transmitter powers and very sensitive receivers are needed for satisfactory radar operation. Fortunately, the pulsing technique required for ranging also makes possible the generation of peak powers of far greater magnitude than could be obtained by continuous wave oscillators. Pulse powers of hundreds of kilowatts are in common use.



TYPICAL "PPI" PRESENTATION

Fig. 5

The Magnetron Transmitting Tube

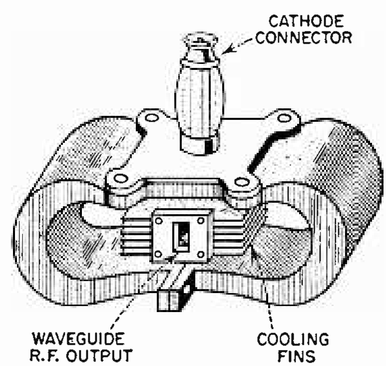
The previous section of this article discussed the functioning of the generalized radar set and enumerated the factors which determine its performance. This section of the article describes the magnetron transmitting tube which is almost universally used as the high power rf generator in modern radar practice. A simplified theory of its operation will be developed and some practical aspects of magnetron design and operation will be discussed.

The magnetron tube is remarkably well suited to fulfilling the requirements of the pulsed radar system for short pulses of very intense rf energy at very high frequencies. It is probable that no other electronic development contributed as substantially to making microwave radar possible and practical. As a consequence, the magnetron has emerged since 1940 from the status of a laboratory curiosity to a highly developed vacuum tube category having dozens of standardized types. Pulsed power outputs range from a few watts to several million watts at frequencies extending from a few hundred megacycles to well over 30,000 megacycles. Operating efficiencies as high as 85% at 1200 megacycles have been reported by reliable observers. The physical appearance of a typical magnetron tube is illustrated in Fig. 6.

A magnetron is a diode electron tube in which a strong magnetic field is used perpendicular to the direction of electron flow. It is capable of generating extremely high frequencies at good efficiency because the frequency-limiting effects of electron transit time, which limit conventional negative-grid triodes to about 3000 megacycles, are reduced by the action of the magnetic field.

A further advantage is gained from the fact that the resonant circuits are usually contained within the vacuum envelope of the tube, thus reducing lead inductance.

Fig. 7 shows the internal structure of a microwave magnetron. A cylindrical cathode is mounted in the center of a solid copper anode bearing a number of resonant circuits machined in its inner surface. Each of these "cavities" is the equivalent of a parallel resonant circuit tuned to the desired magnetron operating frequency. The evolution of such microwave resonant circuits from the conventional parallel L-C circuit is demonstrated in Fig. 8. An external circuit may be coupled to these resonators by an inductance loop as in the low-frequency case. The entire



TYPICAL RADAR MAGNETRON

Fig. 6

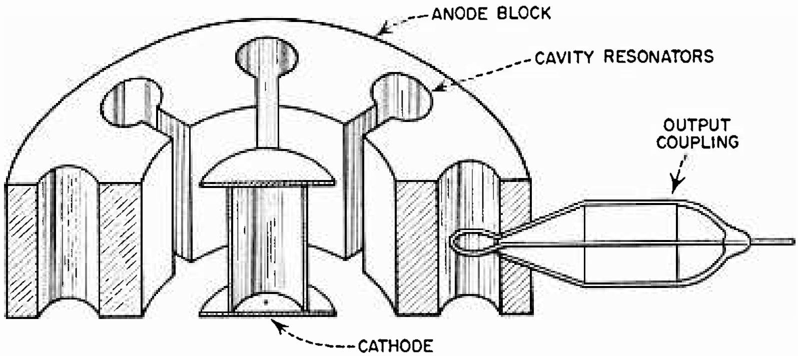


Fig. 7

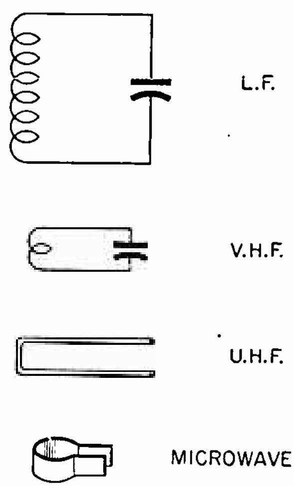
assembly is enclosed in a vacuum-tight metal envelope and evacuated. A magnet, which may or may not be an integral part of the magnetron, is used to apply a magnetic field in a direction parallel to the cathode.

Theory of Operation

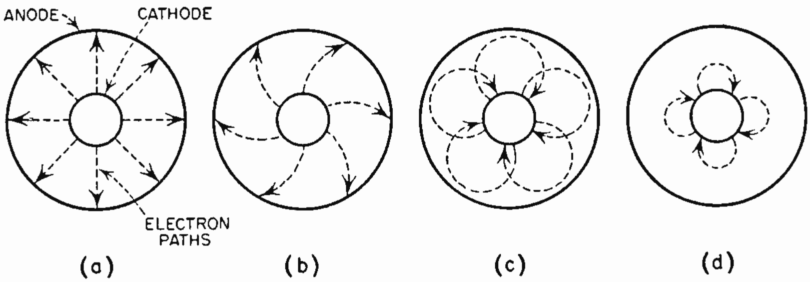
In any oscillator or amplifier tube the electrons possess energy of motion, or *kinetic energy,* which was gained from the applied dc voltage. This kinetic energy is converted to useful radio frequency energy when these electrons travel against a retarding rf field so that their velocity is reduced. In a triode, rf energy is added to the "tank" circuit by electrons which flow between the grid and the plate while the latter is at the negative part of the rf cycle. Electrons which are not decelerated by the retarding rf field dissipate their kinetic energy in the form of heat upon striking the anode. If all of the electrons could be slowed by the retarding rf field to zero velocity before reaching the anode, all of the energy gained from the dc field would be converted to rf energy, and the efficiency of the tube would be 100%. Such is far from the actual case.

Triodes are severely limited at high frequencies because, for maximum energy conversion, the electrons must traverse the space between the grid and plate while the retarding field there is maximum. This dictates that the *transit time* should be less than about one-tenth of the period of one rf cycle for good efficiency. Electrons which are not so optimally phased do not interact with a strong retarding field and so are wasted. In going between the cathode and plate, the electrons in a triode have only one chance to interact with the rf field.

In the magnetron, the mechanism of energy conversion is much more perfect, however. Electrons may take the period of many rf cycles to reach the anode and may interact with a strong retarding field almost continuously during this time. How this can occur is illustrated in Figs. 9 and 10. In the absence of a magnetic field, the electrons in a magnetron would flow radially from cathode to anode as in any diode. See Fig. 9a. However, when a slight magnetic field is applied parallel to the axis of the cathode, the paths of these electrons are bent as in Fig. 9b. As the magnetic field strength is increased, a critical value is reached at which electrons no longer reach the anode, but describe a loop, or *orbit,* and return to the vicinity of the cathode. This is the condition called "cutoff," since no current reaches the anode. (Fig. 9c.) If the magnetic field is increased further, the electrons orbits become very small as in Fig. 4d. Theoretically, the electrons return to the surface of the cathode with zero residual energy in a non-



EVOLUTION OF CAVITY RESONATOR
Fig. 8



ACTION OF MAGNETIC FIELD IN DIODE
(Field Perpendicular to Paper)

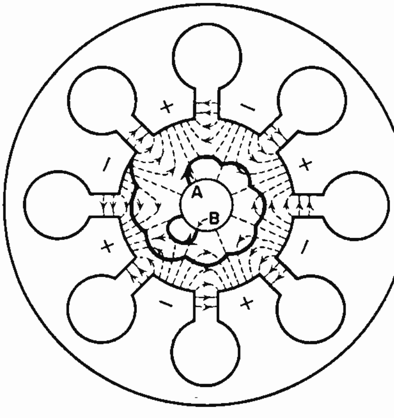
Fig. 9

oscillating magnetron such as we have been discussing. This is because the electrons lose as much energy returning to the cathode against the dc field as was gained from it during the outward travel.

The above considerations are true of a *static,* non-oscillating, magnetron. When rf oscillations, such as might be started by noise voltages or other transients, are present in the cavity resonators, these conditions are greatly modified. The rf voltages associated with these oscillations produce fringing electric fields in the *interaction space* between the cathode and anode which extract energy from the whirling electrons in a truly remarkable manner.

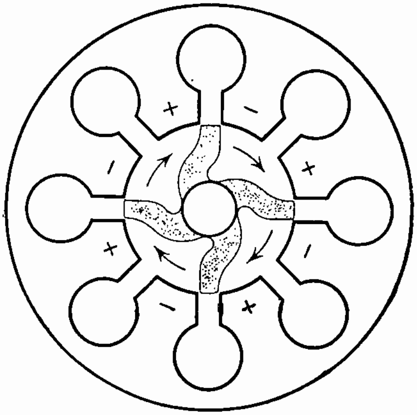
Fig. 10 shows the instantaneous distribution of these fields within the magnetron interaction space. The arrows indicate the direction of the force which the fields exert on an electron. The electric fields vary sinusoidally with time, so that one-half cycle later the arrows are reversed. It will be noticed that retarding fields exist across each alternate gap. An electron starting from point "A" travels against the rf field during its first orbit, and so delivers energy to the resonant circuit. Having delivered part of its kinetic energy, it no longer can return to the cathode surface but comes to rest some distance from it. It is then re-accelerated by the dc field and, since the fringing rf field has reversed in the meantime, passes the next resonator gap against the rf field. This process continues with the electron progressing closer to the anode with each orbit and converting part of its kinetic energy to rf energy each time it passes a gap. Thus, an in-phase electron has many chances to deliver energy to the oscillating circuit and reaches the anode surface with little residual energy to be converted into heat.

Conversely, consider an electron emitted at point "B" in Fig. 10. Here the fringing field is such as to accelerate the electron. Since the rf field does work on the electron, energy is subtracted from the useful output of the tube and its efficiency is reduced. However, such out-of-phase electrons are eliminated from the interaction space after only one orbit since, in gaining energy from the oscillating circuit, they have more than enough energy to reach the cathode on the return trip. The result is that these electrons bombard the cathode and dissipate their residual energy as heat. This gives rise to two effects which are unique characteristics of magnetrons. One effect is that the returning, or *back-bombarding,* electrons dislodge other electrons from the surface of the cathode. This *secondary emission* greatly enhances the current normally available from the cathode, making higher power possible. The other effect is that the bombarding electrons sometimes dissipate enough heat at the surface of the cathode to permit the normal cathode heating power to be disconnected without interrupting operation. Thus, in the magnetron, even the otherwise wasted electrons are utilized



PATHS OF ELECTRONS
IN MAGNETRON

Fig. 10



ROTATING SPACE CHARGE IN MAGNETRON

Fig. 11

to improve the over-all efficiency of the tube.

Of course, the above discussion assumes that the electrons which are delivering energy rotate around the cathode at a velocity which will keep them in step with the alternating rf field. This *synchronous* velocity is achieved by adjusting the operating voltage E for a given magnetic field B since the rotational velocity of the electrons is equal to E/B. Thus, the electrons in a magnetron which are phased so as to deliver energy to the resonators remain in the interaction space during many rf cycles while the out-of-phase ones are eliminated after one orbit. The net effect of this *electron sorting* is to build up a whirling space charge pattern having the general shape shown in Fig. 11. Since most of the electrons are in the regions of retarding rf fields at any instant this pattern has half as many "spokes" as there are resonators in the anode.

Practical Considerations

Although the above discussion applied to both pulsed and continuous-wave magnetrons, the former type is used exclusively in radar applications. In such usage, a rectangular voltage pulse is applied between the cathode and anode of the magnetron. This voltage has a peak amplitude ranging from about 3 kilovolts to over 60 kilovolts for different magnetrons. For convenience, since it is difficult to isolate the anode from the output transmission line and antenna parts, the anode is usually grounded and the cathode is pulsed *negatively.*

The duration of the voltage pulses is usually very short, ranging in different applications from about one-quarter to ten *microseconds.* These pulses are applied at regular intervals called the *pulse repetition rate.* Pulse rates ranging from 200 to 5000 p.p.s. are commonly used. The product of the pulse duration in microseconds and the pulse rate in p.p.s. (pulses per second) is called the "duty cycle." This factor defines the ratio of time the magnetron is oscillating to the time it is off. Many radar magnetrons operate at 1000 p.p.s. and a pulse duration of 1 microsecond, or a duty cycle of .001. This means that the magnetron is "on" only 1/1000th of the time. The *peak* current drawn during the pulse may be of the order of tens or even hundreds of amperes, although the *average* current as indicated by a dc meter in series with the magnetron would be much lower, being the peak current times the duty cycle for essentially rectangular pulses.

A *performance plot* of a typical pulsed magnetron is shown in Fig. 12. It shows the power output and efficiency of the magnetron as a function of applied peak current and voltage for various fixed values of magnetic field. From such data, the radar designer can select an appropriate operating point to meet given requirements. Notice that power output and efficiency increase with increasing magnetic field. The shaded area indicates regions of instability due to internal arcing.

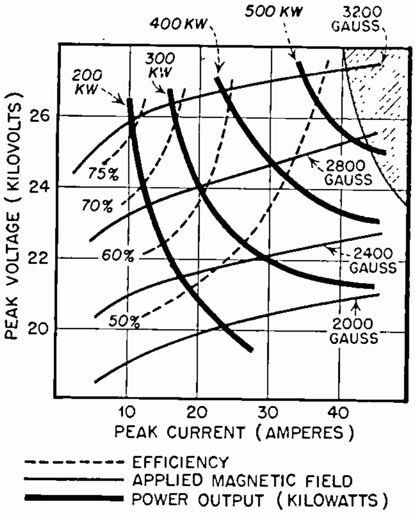
Although the modern magnetron has been instrumental in extending the limit of efficient radio frequency generation at least one-hundred times, it is encountering the same kind of limitations above 30,000 megacycles which confine conventional triodes to the frequencies below 300 megacycles.

The Pulse Modulator

The following section discusses the means employed to generate the high voltage dc pulses which are applied to the magnetron. This equipment is variously known as the "pulse modulator," "pulser," or "keyer." The techniques used in this equipment to generate pulses which may be as much as 60 kilovolts in peak amplitude and yet only *one-millionth* of a second in duration are typical of radar practices, and so are of interest here.

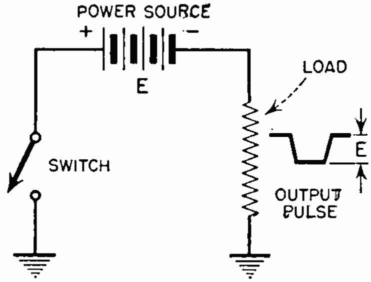
The basic function of the modulator in a radar set can be illustrated by the elementary circuit of Fig. 13. In this circuit, a source of emf such as a battery is periodically connected to the load circuit for short intervals by a switch or key. The pulse of voltage which appears across the load circuit will be essentially rectangular if the distributed inductance and capacitance of the circuit is low and this pulse will have a duration equal to the time the switch is closed. For reasons explained previously, most radar modulators are designed to give a negative pulse.

In actual practice, the circuit of Fig. 13 is not practical because of the high internal impedance



TYPICAL MAGNETRON PERFORMANCE PLOT

Fig. 12



ELEMENTARY PULSE MODULATOR CIRCUIT

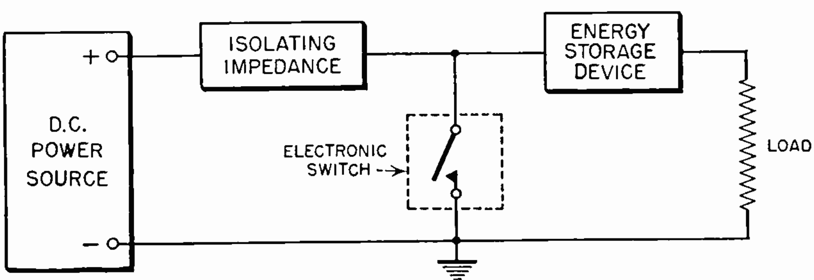
Fig. 13

of the battery or other power supply and the difficulty of forming very short pulses mechanically. For these reasons, the circuit is usually modified as in Fig. 14. Here the energy from a dc power supply is used to charge a storage device such as a capacitor or *pulse network*. This stored energy is then recurrently connected to the magnetron load circuit for short intervals of time by an electronic switching device. This switching device may take the form of a high vacuum tube or a gas thyratron. Which form of switch tube is used determines the general category into which any particular modulator design falls. Since the characteristics of these two types differ considerably, they will be considered separately.

The "Hard Tube" Modulator

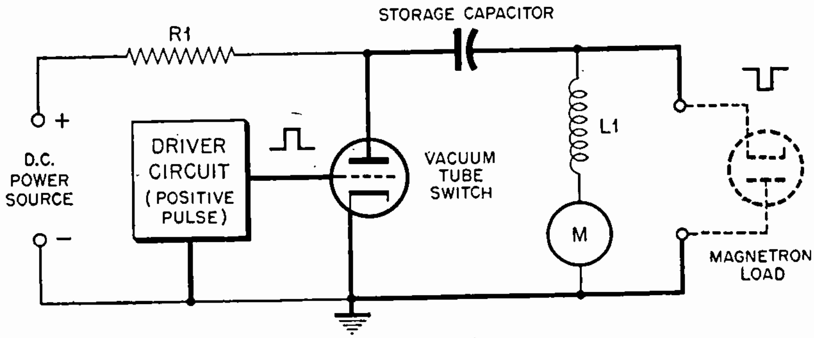
Any form of pulser or modulator which utilizes high vacuum tubes for the function of switching the high pulse currents required by the magnetron is classed as a "hard tube" modulator. The simplified circuit of a pulser of this type is shown in Fig. 15. In this type, the grid of the vacuum tube, which is normally biased to cutoff, is driven positive by a pulse from a "driver" circuit. The storage device is thus connected to the load circuit for the duration of the positive driver pulse, and a negative pulse appears across the load. The storage device is usually a large capacitor which is capable of supplying the energy needed by the load during the pulse with only a small drop in voltage. This voltage drop is frequently only a few per cent.

The storage capacitor recharges from the dc source in the interval between pulses. This *interpulse interval* is usually very long compared to the duration of the pulses. This makes it possible to isolate the dc recharging circuit (shown in light lines in Fig. 15) from the pulse circuit (heavy lines) during the pulses by means of isolating elements such as LI and RI, which have very high impedances for short pulses. The average current drawn by the magnetron is measused by the meter (M) indirectly, since this meter indicates the current from the dc source required to replenish the charge on the storage condenser. This current is equal to the mag-



GENERALIZED PULSER CIRCUIT

Fig. 14



BASIC "HARD TUBE" PULSER

Fig. 15

netron average current since the condenser discharges only through the magnetron.

The tube or tubes in the output stage of a hard tube modulator must be capable of withstanding an anode voltage equal to the voltage of the required output pulses. They must also be capable of conducting the peak pulse current required by the magnetron. In radar practice, large transmitting type triodes or tetrodes are usually employed. Types having tungsten or thoriated-tungsten filaments are the most practical for this application because the high voltages involved make the use of oxide coated emitters somewhat marginal. The pulser tubes are usually biased to cut-off or beyond, so that plate current flows only during pulses.

The driver circuit used to drive the modulator tubes to conduction during pulses may be one of several types. In one system the rectangular pulses are formed at low level by a small gas tube or blocking oscillator and amplified to the required driving level by several hard tube stages biased to cut-off. Another method utilizes a medium power hard tube in a special blocking oscillator circuit to form the driver pulses. A third approach makes use of a small thyratron pulser, of the type to be discussed later, to drive the hard tube final stage. In any of these driver systems, the pulse repetition rate is determined by a "trigger" pulse which is introduced into the first driver stage to insure that the transmitter pulse is synchronized with the range sweep on the oscilloscope. This synchronizing pulse is usually generated in the display section of the radar system. (In Fig. 2 this pulse is generated in the "synchronizer".)

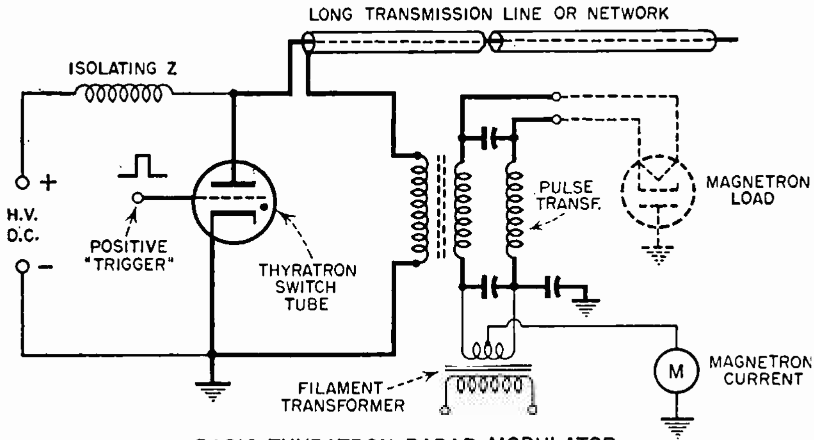
The Thyratron Modulator

Radar pulsers which use gas-filled tubes for the purpose of pulse switching are known as "thyratron" or "line type" modulators. The gas most frequently employed is hydrogen. Relatively small tubes are capable of conducting peak pulse currents of hundreds of amperes with small voltage drop. In addition, only a small trigger pulse is required to drive thyratrons to heavy conduction. The thyratron differs from the hard tube, however, in that the grid loses control after conduction has been initiated. This characteristic results in the basic circuit of the thyratron-type modulator differing considerably from that of the vacuum tube modulator, as illustrated in Fig. 16.

Since the grid of the thyratron is incapable of interrupting the plate current at the end of the driver pulse, the storage device must be of a type which discharges entirely during each pulse.

Otherwise, the gas in the thyratron would remain ionized as long as a voltage existed across the tube. A simple capacitor like that used for energy storage in the hard tube modulator cannot be employed, since the discharge pulse would be exponential in shape rather than rectangular. However, if a length of open-circuited transmission line is charged to a high voltage and suddenly connected to a load impedance equal to its characteristic impedance, an essentially rectangular current pulse flows through the load. The duration of the pulse so formed is equal to twice the time required for an electrical impulse to travel the length of the line. This time is determined by the *propagation constant* for the type of transmission line used. In actual practice, the transmission line is usually replaced by the *artificial line* made up of lumped inductances and capacitors for all but very short pulses. This is because an actual line is inconveniently long for the pulse lengths most frequently employed, whereas the simulated delay line, or *pulse forming network* as it is sometimes called, is quite compact even for 10 microsecond pulses. Fig. 17 shows one of the possible connections for a pulse network and some of the design constants involved.

The pulse forming network will deliver maximum energy to the magnetron only if its im-



BASIC THYRATRON RADAR MODULATOR

Fig. 16

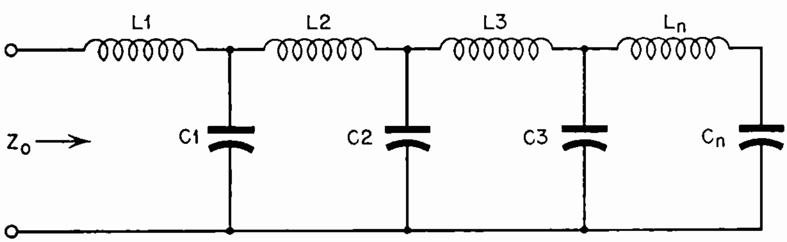
pedance matches that of the magnetron. Since the usual magnetron impedance is between 500 and 1000 ohms, while the design of the pulse line is most practical for low impedances of 25 or 50 ohms, an impedance matching device must be used between the line and the load. This requirement has led to the development of the *pulse transformer,* which transforms the impedance of the magnetron load to that of the source. The transformer is specially designed to pass the square pulses. It is carefully designed to minimize leakage inductance while maintaining shunt inductance at a maximum. A special core material having very thin laminations is used to obtain sufficient permeability to pass frequency components up to several megacycles present in pulses having fast rise time. Pulse transformers which faithfully reproduce pulses ranging from a few hundredths of a microsecond to about 10 microseconds are available, although individual designs are satisfactory over a much smaller range. Turns ratios from about 2:1 up to something like 6:1 are practical. The physical appearance of a typical pulse transformer is shown in Fig. 18. As indicated in Fig. 16, the secondary of the transformer is usually *bifilar* wound. This means that the secondary consists of two wires wound as one. This permits the magnetron heater current to be sent through the secondary windings of the pulse transformer from a filament transformer having low voltage insulation. Otherwise, a specially built low capacity filament transformer, insulated for the full pulse voltage would be required.

Comparison of Modulator Types

Because of the differences in basic circuits, the performances of the two general modulator types differ considerably. Each has certain disadvantages not inherent in the other. The important characteristics may be compared as follows:

(*a*) *Efficiency.* The thyratron type is inherently the most efficient. It requires fewer stages and consequently less drain from power source. The voltage drop in the switch tube is less than in the hard tube case, resulting in less power dissipation.

(*b*) *Impedance Sensitivity.* The hard tube modulator has the ad-



$Z_0 = \sqrt{L/C}$ $\qquad t = 2n\sqrt{LC}$ = pulse length

$L = L1 = L2 = L3 = L_n$

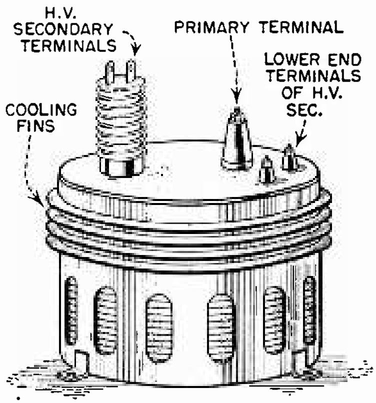
$C = C1 = C2 = C3 = C_n$

SIMPLE LUMPED CONSTANT PULSE NETWORK

Fig. 17

vantage in this respect since it can operate fairly efficiently into load impedances varying over a wide range. For good efficiency and satisfactory pulse shape, the line type pulser must match the load impedance to within about ± 30%. Thus, the line modulator has a disadvantage in applications where many magnetron types are encountered, such as laboratory testing.

(c) *Adaptability.* The hard tube modulator is the most adaptable to different pulse durations and repetition rates. Since the pulses are formed at low level, small components can be switched



TYPICAL PULSE TRANSFORMER

Fig. 18

for varying pulse durations. In the line pulser the pulse forming network and, in some instances, the pulse transformer, must be changed to effect a change in pulse duration. In addition, the pulse line is usually designed for operation only over a small range of repetition rates.

(d) *Voltage Requirements.* The thyratron modulator requires a lower voltage dc supply since the pulse transformer steps the pulse voltage up to the required level. In the hard tube system, the dc source must furnish a dc voltage equal to the required pulse voltage.

(e) *Arcing Behaviour.* In case of internal magnetron arcing, the hard tube modulator is more severe than the thyratron type since the entire charge of the storage capacitor can discharge through the magnetron, with damaging effects on the magnetron cathode. The energy stored in the pulse forming network, on the other hand, is only the amount required for each pulse.

As a result of these characteristics, the thyratron pulser is usually favored for field radar applications where its greater efficiency, simplicity, and light weight give it the advantage. The hard tube modulator is useful in laboratory applications because of its versatility and in instances where very high repetition rates make the gas tube type inapplicable.

GENERAL COMMENTS—BY THE EDITOR

The preceding article is one of the best discussions of basic radar principles which we have seen. A few concluding comments will help to complete the picture of the radar system in the mind of the beginner who may be receiving his first introduction to the theory of this equipment.

It will be helpful to review the introductory section of the preceding article entitled "The Basic Radar System." The heart of the basic radar system is of course the "magnetron" tube. (The theory of operation of this tube was incidentally one of our most closely guarded secrets during the major part of World War II.) Not only were the theory and operation of the magnetron discussed in the article, but also the method of "keying" or sometimes called "pulsing" the magnetron. As the operation of this particular part of the radar system is rather unfamiliar, it was discussed in detail. In thinking of the entire radar system, form a mental picture of the illustration shown in Fig. 2. The magnetron tube and the pulse modulator circuit are included in this particular illustration in the section labeled "pulse transmitter."

We cannot go into a detailed discussion of the radar receiver or the synchronizer section of the radar system. However, a few comments concerning the typical radar receiver will be of interest.

The basic receiver uses the superheterodyne principle. The frequency of the returning echo is essentially the same as the frequency of the short burst of radiated energy produced by the magnetron. Therefore the radar receiver must be capable of receiving, amplifying, and detecting signals of a very high frequency, usually in the micro-wave region. The local oscillator of the radar receiver is frequently a klystron type tube, which makes use of cavity resonators in producing the local oscillator signal necessary for superheterodyne detection.

The incoming radar signal, or echo, is converted to an i-f frequency which falls in the same range as typical Television receiver i-f frequencies. The i-f amplifiers are very similar. A video detector and video amplifier section are also employed in the radar receiver similar to the type of amplifier used in Television receivers. The i-f and video section of the radar receiver must be capable of handling a wide band of frequencies, because the incoming echo is a pulse containing many frequencies. We know from theory that a pulse of energy theoretically contains a great number of harmonic frequencies in addition to the fundamental frequency. In order that the incoming echo may be amplified and applied to the presentation scope with as little loss of signal as possible, every effort is made to design an excellent receiver for the radar system.

The synchronizer section in the radar system acts as the control center for the entire radar. Pulses are generated which initiate the short burst of energy coming from the magnetron which in turn sends energy from the radar antenna. At the time that the synchronizer momentarily turns on the magnetron transmitting tube, the synchronizer also starts the sweep of the presentation scope. It is absolutely essential that the operation of the magnetron transmitting tube and the sweep of the presentation scope be perfectly synchronized. Keep in mind that it takes a definite time for the sweep of the "A-scope" presentation tube (Fig. 3) to travel from left to right across the face of the tube. In the illustration shown in Fig. 3, the time required for the sweep to travel from left to right across the face of the tube is 305 micro-seconds, or 305 millionths of one second.

At the same time the sweep is traveling across the face of this tube, the burst of radar energy is traveling away from the radar antenna, striking a target, and an echo returning to the antenna. This also takes a definite number of micro-seconds. If in this particular illustration it should take exactly 275 micro-seconds for the radar pulse to leave the magnetron, leave the radar antenna, strike a target, return to the antenna, pass through amplification in the receiver, and be applied to the vertical deflection plate of the presentation scope, a signal would appear at 44,000 yards on the oscilloscope. Should this time take approximately half of 305 micro-seconds, the signal would appear approximately in the middle of the trace. In the radar system the electronic circuits are designed so precisely that the time required for a pulse to reach a target and return to the radar antenna can be measured almost to perfection. It can be measured so accurately that it is not at all uncommon for radar equipment to give range measurements with an accuracy of plus or minus 25 yards, or even less. In getting accuracy of this type, more complex and precise circuits and methods of presentation on an oscilloscope are used than have been shown in this article. However the general principles are similar.

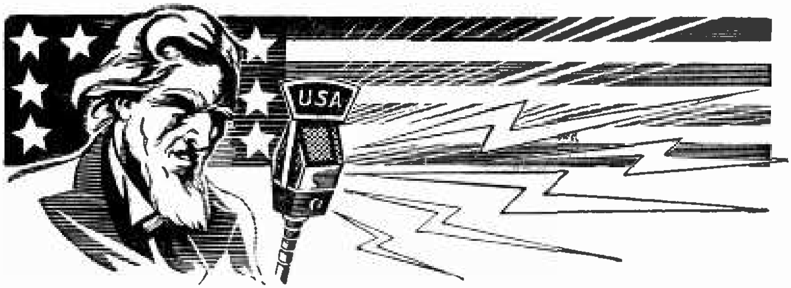
Any student who is interested in the specialized field of radar will find it profitable to learn all that he can about basic Television principles. Radar and Television have many things in common. Basic circuits, such as multivibrators, video amplifiers, pulse amplifying and separating circuits, and other circuits are common to both Television and radar. A knowledge of antenna and transmission line theory is essential in both fields. A technician with a firm grasp of these principles which, incidentally, are covered thoroughly in your NRI course, is in an excellent position to progress rapidly in either civilian occupations or in military service.

—— n r i ——

Syracuse, N. Y.—General Electric's television pioneer, Dr. E. F. W. Alexanderson, photographed as he made his first appearance in the media he developed. This picture was taken 25 years to the day after Dr. Alexanderson had electricified the world with his announcement that the transmission of moving pictures by radio was now possible. The venerable and still active scientist, holder of over 300 patents in the electronics and allied fields, was the guest of Fred Waring on his regular CBS show. In the background, offering an example of 25 years of General Electric television progress, can be seen the modern G-E 24 inch console television receiver and three inch octagonal receiver, one of Dr. Alexanderson's earliest experimental models. In spite of the many years he had spent working to perfect the art, this was the first time Dr. Alexanderson had stepped before the television cameras.

—— n r i ——

In addition to collecting blood for civilian use, the Red Cross acts as official coordinator of all blood-collecting for our armed forces.



THE VETERAN'S PAGE

Devoted to news items and information of special interest to veterans taking NRI courses under the GI Bill of Rights.

There's No Place Like the Top

The *top* of the hill is where you get the best view.

The *top* of the social heap is where you get the respect and admiration you deserve.

The *top* in earnings gives you the comforts and luxuries of life.

Yes, it's swell to be at the top.

All great teachers use symbolism. Commonplace objects or situations are used to picture situations in the imagination. Climbing a hill step by step is likened to climbing the social ladder or climbing higher and higher month by month on the wage scale.

In climbing a hill each *step* is easy enough in itself. If one looks at a hill, climbing it seems hard, but if he quits looking at the hill and *starts doing* what he can—walking calmly upward—he finds himself at the top. No *one* step is too hard so long as he conquers *each step* and keeps going.

So it is with your course. Each lesson is a step in your climb to the top. Each step puts you nearer the top. No *one* lesson is so stiff that you can't pass it IF THAT ONE LESSON is the only thing between you and success.

If taking one step after another is all you need to do to climb a high hill, isn't it as sure a way to success to just keep doing one lesson after another?

There is another way of encouraging yourself to go on. Remind yourself:

"THERE'S ALWAYS ROOM AT THE TOP."

There may be many who start the climb, but not all will reach the top. They give up; they delay; they make excuses. As there are many climbers who start but don't reach the top, so there are students who give up for reasons which a more determined person would have overcome. *Starting* is easy; keeping on is harder. The reward, the prize, the *top* is enjoyed only by those who doggedly keep on refusing to let THIS lesson be the one that stops them.

Lest you should be discouraged by achievements of those about you if they seem to outstrip you, think about a foot race. There is more than one prize. A share of the joy of achievement goes to the man who was second, and third, and even fourth. And the one who was second today may be first tomorrow. There is no disgrace in not running first, but only in giving up!

Now, this is the veterans' page. What's said above could apply to *any* student who's chosen Radio and Television as his ladder for climbing to the top.

But here is something which is *particularly important* to *you*—to those receiving education under the GI Bill of Rights!

As a GI student this is your last race; this is your last chance. You will probably never again have the *same* opportunity to get ahead—to reach the top. If you should interrupt training before you graduate it is unlikely the course can be reopened under the GI Bill. (Unless you were discharged less than 4 years ago.) Keep going—no matter if you must slow down—keep going!

Quantitative

Study of Radio

By GEORGE J. ROHRICH

NRI Quality Control Chief

George J. Rohrich

OFTEN it is necessary to know *how much* of a given part is required or used. This part of the work deals with *measuring* the *quantities*. It is helpful to know what is meant by such words as *quantity, measurement, unit, number* and *quality.*

Quality: *Quality* is that which is peculiar to any object, which distinguishes it from any other object.

Property: *Property* is that quality which is *pointed out exactly* to belong to one particular object. Thus, *length* is a property of a wire. *Resistance* is another property of a wire.

Quantity: *Quantity* is that property of a thing or substance which allows *exact measurements* to be made. Therefore, the word *quantity* really includes both a *unit* and a *number*. Therefore, *length* as well as *resistance,* are also *quantities,* because each can be measured.

Unit: *A unit* is a standard quantity with which all others of the same kind are compared. A unit is used for purposes of *measurement* and in terms of which the total amount is stated. A single unit is usually given a *numerical value* of 1. Thus, in counting eggs, the *unit* is *one egg*. In selling cloth by the yard, the *unit* is *one yard.* In measuring short distances the *unit* is *one inch*. In measuring electrical resistance, the *unit* is *one ohm*. In measuring electrical *potential difference,* the *unit* is *one volt.*

Numbers: Repetitions of the units are expressed by *numbers*. A *number* is a distinctive mark which shows *how many* single units are in a *quantity*. These distinctive marks are written 1, 2, 3, 4, 5, 6, etc., with which you already are familiar, and are known collectively under the general name of *numbers*. It is obvious that these marks will have the same meaning, whatever the nature of the unit counted.

Measuring: *Measuring* a quantity consists of *comparing* that *quantity* with another one, which is known to be expressed in *units* and *numbers*. For instance, when you *measure* the length of a table, you *compare* it to the length of a ruler. *Length* is a *quantity* because measurements can be made of it. When you *measure* the resistance of a wire, you can *compare* it to the resistance of another wire.

Computed quantities: The value of any *property* can also be determined from the relation which it bears to *two* other quantities. Thus the *length* of an object can be determined if the *area* and the *width* of that object are known in the proper units. Likewise the *resistance* of a wire can be determined, if the *potential difference* across the wire, and the *current* through the wire, are known.

When a quantity is determined from its relation to two or more other quantities, then the value is *computed,* by using arithmetic.

Therefore, we have *two ways* for determining the value of a quantity. One way is to *measure* the quantity. A second way is to *compute* the quantity.

This part of the work will deal with the methods used in *measuring* some of the electrical quantities. However, a few things will first be pointed out about the computations of *resistance* and *conductance,* in order to point out the use of *equations.*

All quantities are measured in some convenient *unit*. A *unit* is a *specified amount* of a physical quantity. A unit is used as a basis of measurement for each kind of physical quantity.

A *unit of length* is the *inch*. Therefore, when *measuring* the length of a table we could *compare* it, in *units of inches*. There are other units of *length*. Thus, we could measure the length of a table in units of a *foot, yard, mile, meter, kilo-meter, mega-meter, centi-meter, milli-meter* or *micro-meter*.

A *foot* is equal to 12 inches. We can write this: 1 foot = 12 inches. Therefore, the sign (=) means *is equal to*. With this sign we will show the *equality* of the *units*. This will be expressing the *units of length* in the form of an *equation*. An *equation* shows, that the *amount* on one side of the "equal mark," is *equal* to the "other amount" on the other side of the mark.

Equations of Units of Length

1 foot	= 12 inches.
1 yard	= 36 inches.
1 mile	= 5280 feet.
1 meter	= 39.37 inches.
1 kilo-meter	= 1000 meters.
1 mega-meter	= 1,000,000 meters.
1 centi-meter	$= \frac{1}{100}$ of a meter.
1 milli-meter	$= \frac{1}{1000}$ of a meter.
1 micro-meter	$= \frac{1}{1,000,000}$ of a meter.

Notice in the above table that *kilo* means *one thousand*. *Mega*, or *meg*, means *one million*. *Centi* means *one hundredth part* of one unit. *Milli* means *one thousandth part*. *Micro* means *one millionth part*. These *multiples* of a unit are used with all other electrical and Radio units and have the same values, indicating the *number of times* that the *basic unit* is being *multiplied*. In the above table, the *basic unit*, to which the *multiple* is applied, is the *meter*.

Now we will give the *basic units* in which *electrical and Radio quantities* are measured.

Units of Electrical and Radio Quantities

Quantity	*Basic Unit*
Resistance	Ohm
Conductance	Mho
Capacity	Farad
Inductance	Henry
Impedance	Ohm
Current	Ampere
Potential difference	Volt
Power	Watt
Frequency	Cycle

The above basic units are used in *multiples*, as occasion demands, just as they were given for the multiples of length. A common multiple for measuring resistance and impedance is the *megohm*, measuring a *million ohms*. A common unit of conductance is the *micromho*, meaning one-millionth part of a mho. Common use also requires the multiples of the other units expressed in *microfarad, milliampere, microvolt, kilowatt, kilocycle and megacycle*.

Derived Quantities and Units

Many quantities are related to *two* or *more* other quantities. In other words, some quantities are drawn from another source.

Therefore, the *unit* of the related *quantity* also will bear a relation to at least *two other* units. For instance, the *area* of a table top can be found from a "measurement of the length" and a "measurement of the width." By measuring the length, then measuring the width, then *multiplying* the two, the *result* will *be equal to* the *area*. This can be expressed in an *equation* as follows:

Area = Length x width.

The sign × means *multiplied by*. The quantity of *area* is a *derived quantity*. It is derived from *two quantities* of length.

There are many *units* of area because there are many units for length. A few of these will be given in the following equations.

1 square inch	= 1 inch × 1 inch
1 square foot	= 1 foot × 1 foot
1 square foot	= 12 inches × 12 inches
1 square foot	= 144 square inches
1 acre	= 1 yard × 4840 yards
1 acre	= 22 yards × 220 yards
1 acre	= 4840 square yards

In the above table, the *unit of area* is derived by *multiplying* the value of two other units.

In many cases, a quantity is derived by *dividing* two or more quantities. Thus, it would be possible to find the *length*, if the *area* and the *width* were known. The length is equal to the *area* "divided by" the width. Expressing this in an equation, it is:

length = area ÷ width

This equation can also be written:

length = area/width

or the same equation can be written:

$$\text{length} = \frac{\text{area}}{\text{width}}$$

Each of the three signs, ÷, /, and —, mean *divided by*. Thus 1 ÷ 2 is the same as 1/2 or ½. Note that the numerical value for "one-half" is written in either of the above three ways. Thus you will see that a derived quantity, or a derived unit, may involve "simple multiplication" or "simple division."

All of the quantities which are expressed in the table of "units of electrical and Radio quantities" on page 24 are *derived* quantities.

Thus *resistance* and *conductance* are derived from the relation of *current* to *potential difference*. Expressing the relation for resistance in the form of an equation:

$$\text{resistance} = \frac{\text{potential difference}}{\text{current}}$$

This equation was first given by Doctor Ohm, a German physicist, and the equation is known as "Ohm's Law." He discovered the existence of resistance, by noting that the *current* in a circuit *varied in proportion* with any change in the *potential difference*. He *measured* the potential difference in *volts*. Then he *measured* the *current* in *amperes*. This was done again and again with increased and decreased potential differences. In each case, he found that by dividing the potential difference by the current, the *same number* appeared as the result. He reasoned further that *something* was *resisting* the flow of *current* in the circuit. This *quantity* he called *resistance*.

Therefore, if the value of the potential difference *units* is known in *volts*, and if the current *units* is known in *amperes*, then the resistance can be *computed* by dividing the number of volts by the number of amperes, or

$$\text{ohms} = \text{volts} \div \text{amperes}$$

The *conductance* of a circuit expresses the capability for *conducting* electricity. Therefore, it expresses an opposite factor to *resistance*. *Conductance* therefore is expressed in an equation by:

$$\text{conductance} = \frac{\text{current}}{\text{potential difference}}$$

The *unit* of conductance is the *mho*. You will note that it is spelled backwards from the "unit of resistance," which is the *ohm*. It is pronounced as *mo*.

The equation for *computing* the amount of conductance is given by:

$$\text{mhos} = \text{amperes} \div \text{volts}$$

Compare the above equation with Ohm's Law. You will see that either the *resistance* or the *conductance* can be *computed* when the number of amperes and the number of volts is known. Therefore the *property* which expresses the capability of conducting a current can be expressed in units of ohms or mhos.

The conductance also can easily be *computed* from the resistance. Divide 1 by the resistance. Thus, if "the resistance" is equal to "two ohms," then "the conductance" is equal to "1 ÷ 2." Therefore a "2 ohm resistance" has a "conductance of 1/2 mho."

$$\text{mhos} = \frac{1}{\text{ohms}}$$

A "100 ohm resistance" has a "conductance of 1/100 mhos" and a "1/5 resistance" has a "conductance of 5 mhos."

Incidentally, a "1/5 ohm resistance" has a "conductance of five million micromhos." This follows from the fact that "one micromho" is equal to "one millionth of a mho." Then a "million micromhos" are equal to "one mho" and "five million micromhos" are equal to "five mhos."

Resistance can also be computed from conductance:

$$\text{ohms} = \frac{1}{\text{mhos}}$$

The reason that we sometimes speak of "resistance" while another time we may speak of the same thing as a "conductance," is the fact that it is easier to *compute* the value of many other quantities by using the "value of resistance" in some cases, while "the value of conductance" in another case may simplify another computation.

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Employment Opportunities

Central Tire and Supply Co., 518 Central Ave., Connersville, Ind. Seek a student or graduate interested in assuming complete charge of Television Department.

Ideal Cement Co., Devils Slide, Utah. Need one full-time and one part-time electronic technician for maintenance of electronic control equipment, and electrical maintenance. $1.74 per hour. Write to H. Straight, who is assistant plant manager and an NRI Grad.

Broadcasting stations requesting qualified technicians are as follows. A first-class radiotelephone license is required.

Station WIAM, Williamston, N. C.
Station WMID, Atlantic City, N. J.
Station WPAX, Thomasville, Ga.
Station WLCK, Campbellsville, Ky.
Station WWSO, Springfield, Ohio.
Station KCOM, Sioux City, Iowa.
Station WBGR, Jesup, Georgia.
Station KENA, Mena, Arkansas.

To save time, please write direct to the above addresses when making application or inquiry.

You Can Do What These NRI Graduates Are Doing

Started from Scratch—Now Radio Station Studio Engineer

"I am taking this opportunity to tell you how much I like the NRI course and what it has done for me. I didn't know a thing about Radio when I started your course just a year and a half ago. Before I finished the Servicing course I was making $20 to $30 a week servicing Radios.

"I am now working on the NRI Radio and Television Communications course, and already have a job as Studio Engineer at Radio Station KMMJ in Grand Island, Nebraska. We hope to have TV soon. I am greatly pleased that I picked NRI for my training. Today I am a Studio Engineer. Thanks for the swell training and all the cooperation you have given me."

BILL DELZELL,
Box 363
Central City, Nebraska.

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Getting More Radio and TV Work than He Can Do

"I began servicing when I received my third experimental kit. The NRI kits are the making for Radio. They give you confidence in yourself and the 'know-how.'

"I have a little shop in my home and am doing spare time work at present. I do quite a bit of Television work and really like it better than Radio. Am getting more work than I can do at the present time, and plan to go in for full time servicing just as soon as I can get the right location. You will be hearing from me again."

CHARLES R. DUKES,
RF 2, Box 117
Spencer, Oklahoma.

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Brother Graduates from NRI, Operate Spare-Time Radio and Television Shop

"At the present time my brother, Mike, also a graduate of your fine school, and I operate a part-time Radio and Television shop. We plan to go into full-time in the very near future. We say that your experimental kits are the best for getting a man started in servicing because they put all your learning into practice. In other words, a person is not afraid to get right into a complicated circuit after working with your kits. We made a nice sum of $2,645.35 during the past twelve months. Without fine training such as yours we could never make that kind of money. We recommend your course to anyone who wants to make good."

JOHN ROMAN,
1464½ Sherwood Ave.,
North Tonawanda, New York.

Mike Roman (left) and John Roman

Enrolled During Third Year High School While Member of Science Club

"Just think! A little over two years ago all I knew about Radio was how to turn it off and select a station. Now, after two short years, I have been offered a job with a Radio service shop in St. Henry, Ohio.

"During my third year in high school, as a member of the Science Club, we were required to work on a project. Three other boys besides myself who couldn't decide on a project took a chance at Radio. We built a cigar box Radio. Of course, it didn't work but it was a step in the right direction for me. A few weeks later I enrolled for your Radio Servicing course. Before completing the course I had repaired many radios and built a TV set."

GERALD DROESCH,
RFD 1,
St. Henry, Ohio.

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Netted $2800 in One Year From Spare Time Sales and Service

"Before enrolling with NRI, I was manager of a general store, making a fair living. I still manage the store, but also have a very good spare time Radio business in with a jeweler who looks after taking in Radios and making sales during the daytime. I do the repair work at night. Last year I made a net profit of $2800 in spare time. I am looking forward to a full time job as soon as Television comes to our district, in the near future."

"I cannot say too much for NRI. If one is willing to study, the staff of NRI is more than willing to teach you. Thank you, Mr. Smith, for what you have done for me."

BRUCE DURRELL,
Knowlton,
Que., Canada.

n r i

Earnings Enabled Him to Pay For Course Before Completing It

"I would like to express my appreciation for the splendid cooperation that I have received from you. I took the course on a monthly payment plan. About the twenty-fifth lesson I began to service Radios in my spare time and made well over the monthly payments. Therefore, I figure the NRI course paid for itself before I completed half of the training. I am now employed by a local radio shop."

ELFERD EIDSON, JR.,
Box 143,
Springfield, Tenn.

n r i

As space permits, from time to time, we plan to devote a page or two in NR-TV News to short success stories such as above. They are taken from testimonial letters we have on file. Photographs and letters of this kind are always greatly appreciated by us. We feel we should pass them on to our readers for the inspiration to be gained from a reading of them.

N.R.I. ALUMNI NEWS

Chapter Chatter

Baltimore Chapter, meeting on the second and fourth Tuesday of each month, goes right along merrily making progress. The club-room atmosphere at Baltimore Chapter is contagious. Old timers like to come down regularly just to rub shoulders with members and talk things over. In these days of fast moving developments in Radio and Television certainly there is plenty of good subject matter to be discussed.

Mr. Charles H. Becker, one of our members, gave us an excellent talk on TV Deflection Circuits, using multi-vibrator and blocking-oscillator circuits. Chairman H. C. Voelkel is doing a fine job keeping things moving.

Another good service man and also a member of this Chapter, Mr. Joseph T. Hasselberger was the principal speaker at one of our meetings and gave us a very interesting talk on "Resistances in Parallel." Following this talk there was an interesting discussion on the subject.

We regret to announce that one of our very loyal members, Mr. Frank J. Orban, passed away recently. He made several valuable contributions to our Chapter such as radio testing instruments, tubes, and was always liberal in supporting any activity of the Chapter. Mr. H. J. Rathbun, past President of the NRI Alumni Association and former Chairman Elmer Shue were with Mr. Orban just before he passed away. This fine man is deeply mourned by all of us in Baltimore Chapter.

We extend a cordial welcome to all students of the National Radio Institute who live in this area. It is not necessary to be a graduate of NRI to attend Chapter meetings. Remember, we meet on the second and fourth Tuesday of each month at Redmens Hall, 745 West Baltimore Street.

On the occasion of a visit by the Executive Secretary of the NRI Alumni Association refreshments were served. It was good to see a number of old timers at this meeting, who have not been attending regularly. All make the excuse that they are extremely busy but we should remember that some time must be set aside for recreation and inspiration.

Philadelphia-Camden Chapter is having a very good year. The new officers were sworn in by former Chairman Norman Kraft. They are, Chairman, Laverne Kulp; Vice Chairman, Fred Seganti; Recording Secretary, Jules Cohen; Financial Secretary, Al Lemper; Treasurer, the ever reliable Charles J. Fehn; Librarian, Ray Weidner and Sgt.-at-Arms, Ray Stout.

New members are Earl Colgain, Robert H. Walton, Charles M. Trigley and Maron C. Tracey.

Mr. Bernie Bycer, service manager of the Perfect Television Co. gave us a very interesting talk on TV High Voltage Troubleshooting. Vice President Harvey W. Morris who is in charge of Television servicing at the fine shop of Henry Whelan here in Philadelphia, took over several meetings and discussed television servicing problems in general. These discussions are very interesting because they give all the members an opportunity to ask questions.

Mr. L. L. Menne, Executive Secretary, was a recent visitor. He gave us information pertaining to the proposed law to license radio and television service men in the state of Pennsylvania. This bill contained a number of objectional features and was not brought before the Pennsylvania Assembly for action, according to reports. Apparently it died in committee.

Philadelphia-Camden Chapter meets on the second and fourth Monday of each month at the K of C Hall, Tulip and Tyson Sts. in Philadelphia.

Anyone desiring information pertaining to the Chapter is requested to contact Mr. Jules Cohen, Secretary, 7124 Souder, Philadelphia, phone Fidelity 2-8094.

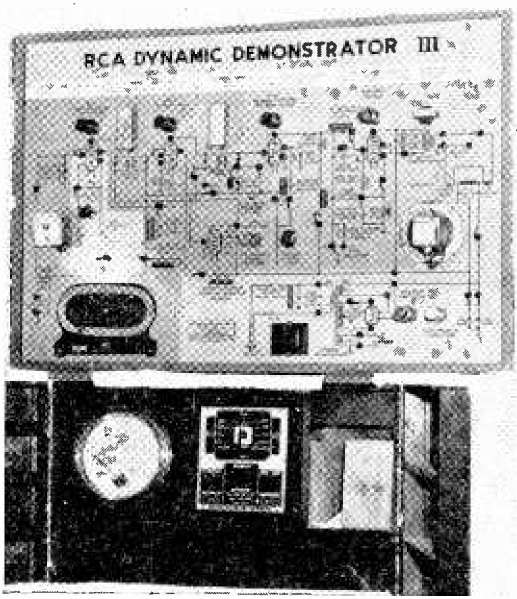
Detroit Chapter is making big plans for the annual social meeting to be held in June. This is planned to be the big event of the year. Members will receive further information through the office of the Secretary.

A big turnout greeted Mr. L. L. Menne at his recent visit to Detroit Chapter. He paid high tribute to our own F. Earl Oliver, Vice President of the NRI Alumni Association, for excellent work at a recent meeting of Chicago Chapter. Refreshments were served at this meeting.

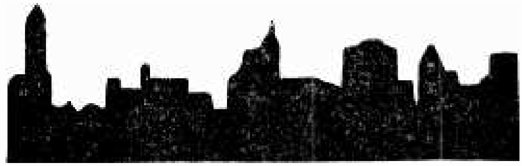
For future meetings we have scheduled speakers from RCA, Philco, and a tape recording by John F. Rider.

At one of our stag parties, held in Windsor, our Bob Mains took some motion pictures in color. This film was run at a recent meeting and brought back pleasant memories to all who attended that stag.

Detroit Chapter meets on the second and fourth Friday of each month at Electronics Institute, 21 Henry Street, in Detroit.



A photo of the RCA Dynamic Demonstrator board which is a part of the demonstration equipment proudly possessed by New York Chapter.



New York Chapter skipping along with an average attendance of about 60 and crowding a lot of activity into each meeting, is going along as smoothly as ever.

James J. Newbeck, our member with NBC, continues his series of lectures on Television. In a recent meeting Mr. Newbeck discussed "Intercarrier Sound Systems." The chapter has purchased a television set to aid our lecturers when speaking to our members.

We had a great time at a special meeting held for the purpose of having our Executive Secretary come from Washington to administer the oath of office to Mr. Alex Remer, President of the NRI Alumni Association and to Vice President Louis J. Kunert, both of New York Chapter. We had an unusually good attendance at this meeting which was addressed by Mr. Menne, Mr. Frank Zimmer, Mr. Alex Remer, Mr. Lou Kunert, our Chairman, Mr. Bert Wappler, after which our very popular Mr. Thomas Hull, Jr. conducted our Radio Clinic. Mr. Hull is a thoroughly practical man and his clinic, held regularly, is extremely popular with our members.

Another of our members, Mr. Frank E. Manz, gave us a very good talk on his experiences in Radio Servicing. These discussions of bread-and-butter problems, such as radio and television men encounter in their daily work, are very interesting and beneficial.

New York Chapter meets on the first and third

Mr. L. L. Menne administers the oath of office to President Alexander M. Remer and Vice President Louis J. Kunert.

Bert Wappler (second from left) and Lou Kunert (right) display Medallions presented to them by the Executive Secretary of the NRI Alumni Association, Past President Frank Zimmer and 1952 President Alex Remer give an official touch to the ceremony. Mr. Wappler, Chairman of New York Chapter, and Mr. Kunert, Vice President of the NRI Alumni Association, were honored for their outstanding work during last year.

Thursday of each month at St. Marks Community Center, 12 St. Marks Place, between Second and Third Ave. in New York City.

Chicago Chapter, under Chairman Mead, Secretary Webber and Treasurer Adamson is finally in high gear and going places. We were delighted to have a visit from Mr. F. Earl Oliver, of Detroit, Vice President of the NRI Alumni Association who came to one of our meetings accompanied by Executive Secretary Menne. Both of these men delivered interesting talks to our members who were interested in hearing what other Chapters are doing.

The Chapter has added some new equipment including a Television Receiver. Mr. Adamson has undertaken the job of cutting down the receiver cabinet to permit a more revealing view of the Television chassis as well as to allow the parts to be more accessible.

Chicago Chapter has laid out a program following the NRI Manuals on Practical Training in TV Servicing. These sessions are very popular with our members.

Mr. William Duebel, an enthusiastic member, proposed a plan of action to stimulate chapter attendance. He suggested that members use our blackboard to draw or sketch circuits in which they have servicing problems. Other members of the group, who may have had a similar circuit condition and who know the solution, could volunteer information. It was suggested by Mr. Duebel that members, in this way, would look forward to Chapter meetings with more enthusiasm than if they assumed that they might be called upon to speak on specific subjects. In furtherance of this suggestion Mr. Duebel kindly volunteered to take the initiative in originating such programs.

Members are always encouraged to bring in a radio chassis on which they may need help. The purpose of the meetings is to give the members an opportunity to do practical servicing.

Mr. Dan Scholz, Mr. Joseph Kalvin and Mr. Ted I. Smith have been appointed a committee to select a site and make other necessary arrangements for holding our picnic this summer. Dan Scholz, by the way, is a very capable young man and an enthusiastic speaker. He has been of much aid to Mr. Adamson in introducing defects in our TV receiver and in explaining to our members how these defects may be corrected.

New members are Michael J. Marinovich, Edward Narva, Edward C. McCarroll, and Michael J. Lauletta. Secretary Ilamae Webber reminds all members that they can get information regarding the meetings by phoning Chairman Mead, Superior 7-4100. Meetings are held on the second and fourth Wednesday of each month, 33rd Floor, Tower Space, in American Furniture Mart Building, 666 Lakeshore Drive, Chicago. Please use West entrance.

n r i

If You Are An NRI Graduate

When writing to NRI, please sign yourself "GRAD." You'll save us some handling time, and we'll be able to give *you* prompter service. Include your student number—this way: *Grad 112 YK 61.*

Here And There Among Alumni Members

We are proud to hear that NRI Graduate Benjamin Wolfe is now manager of the "T" Street branch of Sylvan Radio & TV Co., Washington, D. C.

n r i

Graduate John F. Donnelly, of Bayton, Texas writes that he does instrument repair work with a large oil refinery and that NRI training has greatly helped him in his work.

n r i

Charles H. Stamey of Ventura, California, recently sent us a clipping which showed his installation as Commander of Ventura Chapter No. 24, DAV. We congratulate Commander Stamey on this honor.

n r i

Ronald M. Lawrence of Ypsilanti, Michigan, has just received his amateur general class license. His new call letters are W8HGS. He said the examination was easy after completing his NRI course.

n r i

Graduate S. G. Philipowich, of Wawa, Ontario, Canada, tells us that he has just finished building the Public Address system described in the February-March 1950 issue of NATIONAL RADIO-TV NEWS. According to Philipowich, the system works very good.

n r i

Alumnus Leroy M. Long, of McCoysville, Penna., mentions in a recent letter that he has been employed for the past several years by the Westinghouse Radio and Television Plant located in Sunbury, Penna. Mr. Long is in the Test Department.

n r i

Graduate Wallace J. Balla, of Norwalk, Conn., visited NRI. Balla had on a shiny new uniform, having just completed training as a commercial airline pilot. Radio is his spare time hobby.

n r i

Louis M. Meyer, of Concord, California, is home again after fourteen months duty, including Korea, with the Navy. He is glad to be back at his civilian job, with the "old radio business" on the side.

n r i

NRI Alumni Association Vice President Claude W. Longstreet of Westfield, N. J. wishes to thank our Alumni members for having re-elected him to office. He says he feels greatly honored to be associated with such a fine group of men.

n r i

Graduate John L. Zimmerman, of Coral Gables, Florida, has accepted a new position with the Jefferson Service Company of Miami. He reports making top pay as a bench TV serviceman and is very happy working for the largest organization of its kind in Florida.

n r i

NRI Graduate Anthony W. Mollish, of Raleigh, West Virginia, is now making a nice salary with a coin machine company, and operating his own spare-time servicing business. Since graduating from NRI, Mr. Mollish has been able to quit his job as a miner, and is quite pleased in his new work.

n r i

Joseph A. Butkiewicz, of Wayne, Mich., writes that his NRI course proved a great aid in securing his first-class commercial operator's license, and recently his extra amateur license. Butkiewicz is a Radio operator with Capital Airlines.

n r i

Graduate Cecil J. Giunipero recently left Station WHJB, Greensburg, Penna., to accept a position on the technical operating staff of WNBF-AM-FM-TC in Binghamton, New York.

n r i

Graduate Alfred Potter, Jr., of Staten Island, N. Y., is now a maintenance engineer with the American Broadcasting Co., working at the ABC Television center.

n r i

Graduate T. L. Kidd is now Electronics Quality Control Engineer with the Boeing Aircraft Co., Wichita, Kansas. His work is in connection with Radar, Fire Control, and Communications equipment.

n r i

Steve Solo, of Detroit, Mich., now has the amateur call WN8IEC, and is about ready for his Class B license. He is an electronics technician and electrician for the Ford Motor Car Co.

n r i

Peter Corpion, of the Bronx, N. Y., sends us one of his very impressive business cards. Is doing a fine business.

n r i

Wm. D. LoPatriello, of Buffalo, N. Y., writes that he now has a spare-time Television business in his home.

n r i

R. E. Fischer, of San Antonio, Texas, reports that Fischer's Radio Service is doing well. He also mentions a desire to became acquainted with other NRI men in San Antonio.

n r i

Alumnus Clyde C. Cook, of Millbrae, Calif., now has a 2nd class radio-telephone license and amateur call W6GBV. Says the examination was easy because of the preparation the NRI Course gave him.

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

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