ELEMENTS
OF
RADIO SERVICING

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PREFACE

The field of radio servicing has reached adulthood. Receiver circuits have become so complex that the day of the tinkering repairman is over. Definite and intricate areas of information are a necessity, but perhaps even more important is an approach to servicing. It is the dual purpose of this book to furnish both the information and the approach required for successful radio servicing, especially for the beginner.

It is assumed that the reader has acquired an elementary background of radio theory prior to delving into service work. Nevertheless, elementary theory is presented in this book wherever it serves to make more clear a particular procedure.

Design theory has been eliminated, since it is felt that such theory does not fall within the province of the serviceman. It is axiomatic that the serviceman must never redesign a receiver brought in for repair, unless so advised by the receiver manufacturer.

A book of this size could not possibly cover all the variations in radio receivers, so the authors have confined their survey to the most widely used practices of the past ten years. It is felt that on this basis the serviceman will be able to comprehend other variations.

William Marcus
Alex Levy

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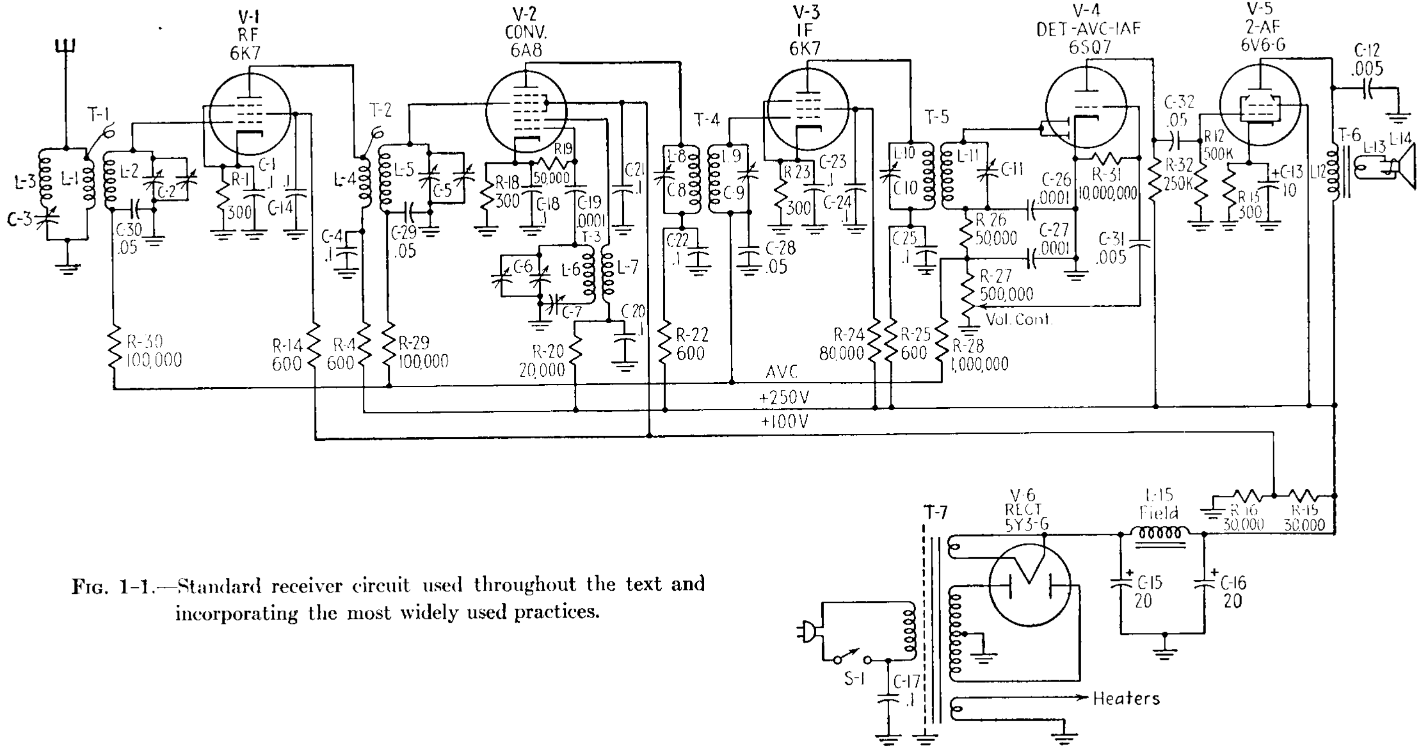


FIG. 1-1.—Standard receiver circuit used throughout the text and incorporating the most widely used practices.

CHAPTER 1

INTRODUCTION

Functional Servicing.—Thinking, especially in the solving of problems, involves the application of random bits of information to a particular situation. Two distinct elements are involved in this procedure. The first is that sufficient information to draw from is available. The second is that the information necessary for the solution is applied to the particular problem. The first element is a static one; the information may be compiled in a book for continuous reference. The second element is a dynamic one and cannot be assumed to develop from the first element unless specific exercise is provided.

Too many servicing manuals and books are organized on the premise that servicing skills can be developed if only enough bits of information are presented. In this respect, they fail to develop functional skills. The learner finds his path a slow and uncertain one.

The purpose of this book is to apply the psychology of learning to radio servicing. Basic information is presented at all times. In addition, the information is so organized that it develops whole dynamic procedures for application to specific radio troubles.

Scope of the Book.—It would be impossible to present in any small book procedures for servicing all types of radio receivers, as well as all the variations of each type. For this reason, the scope is restricted to the most widely used receiver—the superheterodyne.

All the individual variations could not be given. Therefore, a standard circuit, based on the most widely used practices, is presented as the basis for study. This circuit is shown in Fig. 1–1. In all probability, there is no receiver that incorporates all the features indicated; but for study purposes, such a standard circuit will be found invaluable. Throughout this book, the standard circuit is broken down and analyzed by stages, in accordance with the plan described in the following section.

All modern practices could not possibly be indicated in one schematic diagram. Therefore, a section on widely used variations in design is included in each chapter of stage analysis. It is felt that enough information will be obtained from the standard circuit and the variations sections to understand and service any other variation.

Finally, the latter part of the book is concerned with important topics that could not be handled in connection with the standard circuit. These topics are the AC/DC power supply, the auto power supply, the service bench, etc. Each of them is important enough to merit a separate chapter.

Organization of Dynamic Material.—In order to make the material of this book dynamically functional, information is presented in the sequence that it would be used practically in servicing a superheterodyne receiver. Instead of proceeding from stage to stage in the order that a radio signal would pass from the antenna to the speaker, the stages are presented in the order that a serviceman would investigate a defective receiver. Standard radio-servicing procedures are given for each stage. In addition, simple practical tests performed by servicemen on the bench are presented. These tests are based on years of practical servicing experience.

Each stage is analyzed in a similar manner. The outline of analysis is presented below:

1. Quick check for normal functioning of the stage.
2. Typical or basic circuit schematic.
3. Function of the stage.
4. Function and common value for each component part.
5. Normal test data for the stage.
6. Common troubles encountered in the stage.
   a. How they are found.
   b. Special problems involved in replacement of components.
7. Variations from the typical stage that are frequently used; special trouble-shooting procedures in these variations.
8. Summary of tests including outline of procedure to be followed in tracing various symptoms to their cause.

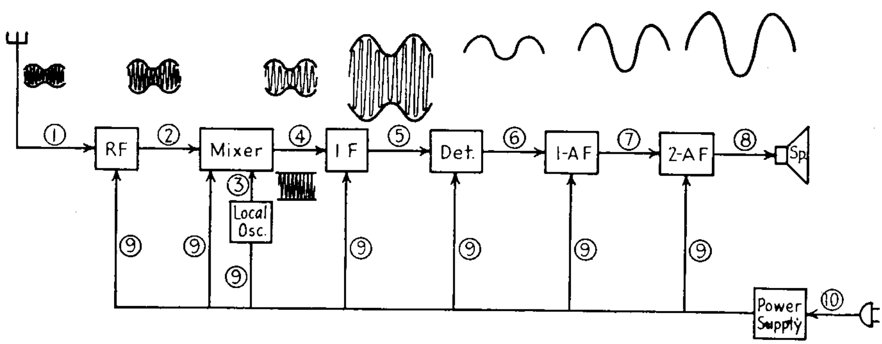
The organization of the information, as outlined above, is the method by which the material information will become quickly functional. A little practice in its use will assure a quick practical approach to radio servicing problems.

It should be understood that this book is not intended to be an encyclopedia of radio servicing. Once the method of attack is mastered, reference to service notes distributed by radio-receiver manufacturers will be more useful than before. Where an unusual circuit is encountered, such notes will prove to be of great value.

CHAPTER 2

SUPERHETERODYNE RECEIVERS

Block Diagram of a Superheterodyne Receiver.—Before the stage analysis of the superheterodyne receiver is presented, it is advisable for the serviceman to have an overview concept of how it works. This picture will be obtained readily from a block diagram. Each block represents a stage that will be shown later in schematic and more detailed form. The accompanying wave forms or pictures of the types of electric currents show how each stage alters the signal entering it. It will be seen later that some of these stages may be omitted or that two stages may be combined into one. The block diagram of the superheterodyne receiver is given in Fig. 2–1.



1. *RF* (550 to 1,600 kc)—modulated at audio frequencies.
2. Tuned and amplified *RF* (550 to 1,600 kc)—modulated at audio frequencies.
3. Unmodulated *RF* (*RF* ① + 455 kc).
4. *IF* (455 kc)—modulated at audio frequencies.
5. Amplified *IF* (455 kc)—modulated at audio frequencies.
6. Audio frequencies (50 to 10,000 cycles) for high-fidelity receivers.
7. Amplified audio frequencies (50 to 10,000 cycles) for high-fidelity receivers.
8. Amplified audio frequencies (50 to 10,000 cycles) for high-fidelity receivers.
9. DC *B*—supply.
10. 110-volt, 60-cycle AC supply or 110-volt DC supply.

FIG. 2–1.—Block diagram of a superheterodyne receiver with associated wave forms.

How the Superheterodyne Receiver Works.—An analysis of the block diagram shown will clarify this matter. Down the antenna come the modulated RF carrier signals of all stations within the receiving area of the set. In the broadcast band, they vary from 550 to 1,600 kc. Before passing through the RF stage, one station is selected by tuning and its signal is passed on. The modulated RF carrier signal is a high-frequency wave modulated or varied by a lower frequency wave known as the "audio modulation." The audio modulations represent the useful component that will eventually drive the speaker.

The RF stage merely amplifies the station to which we are tuned and passes the amplified signal with its audio modulation on to the mixer. The audio modulation retains the same wave form as the signal received at the antenna.

The mixer and local oscillator work together as a team. Often the two stage functions are performed by one tube, which is called a "converter." The local oscillator is a generator of unmodulated RF waves, automatically adjusted to a frequency of about 455 kc above that of the received station RF frequency. When the output of the local oscillator is mixed with the RF station frequency in the mixer stage, the resulting output of the mixer is at a frequency of 455 kc, with the same audio modulations as that of the original signal that came down the antenna.

The 455-kc signal is then fed into the IF stage, which is fixed-tuned to about 455 kc. Here the signal is amplified and fed into the detector. The audio modulations still retain the original wave form.

The detector stage removes the 455-kc RF component from the audio modulation component and passes the latter into the first audio stage. This detector is frequently referred to as the "second" detector, and the mixer or converter is called the "first" detector.

The audio component enters the first audio stage, where its voltage is amplified. It still retains the same wave form as that of the original audio modulation on the station carrier.

The second audio stage amplifies the audio signal even more, developing sufficient power to drive the speaker, which is a power-driven device. The audio signal still retains its same wave form at the input to the speaker. The speaker response is a series of sound waves.

Power for the entire receiver is usually obtained from a 110-volt, 60-cycle AC source or a 110-volt DC source. The power supply will rectify the AC supply, where such power is supplied, and will filter the rectified voltage to obtain a fairly smooth direct current, which now becomes our *B* supply. Where 110-volt DC power is furnished, the power supply will merely filter it to obtain the *B* supply. In portable sets the *B* supply is obtained directly from batteries.

Using the Block Diagram.—It is important that the block diagram shown in Fig. 2–1 be committed to memory before going on. Where test instruments are used, the input and the output waves of each stage will determine how to make proper settings. This is especially important in signal-substitution methods where a signal generator is used.

CHAPTER 3

SERVICING PROCEDURE

Receiver Servicing Systems.—When a radio receiver is brought in for servicing, the demand made of the serviceman is that he put the set back into normal operation. The means is of relatively no importance to the customer. Although this end also becomes the aim of the serviceman, he is confronted with a more immediate goal. What method shall he follow in locating the defect?

The various techniques that he uses can be grouped into a few systems of procedure, which are listed below:

1. Reliance on sight, touch, smell, and past experiences with the same type of receiver.
2. Part-substitution method.
3. Voltage measurements across components.
4. Point-to-point resistance measurements.
5. Electrode-current checking.
6. Signal substitution.
7. Dynamic-signal tracing with a vacuum-tube voltmeter and oscilloscope.

The first system is a self-evident one. Wherever a component appears to be broken or burned, or smells as if it has been overheated, or feels too hot, the assumption might reasonably be made that it is defective and should be replaced. Similar difficulties previously experienced with the same type of receiver might guide the serviceman. Unfortunately, too many defects will not result in extremes of breakdown. Also, the defective component is not disclosed as the cause of the receiver failure or the result of some other defect. Finally, experience as the guide can at most be a helpful rather than an infallible aid.

The second system involves the substitution of a part, known to be good, for a similar part that seems to be defective in the receiver. The weakness in this procedure is that it is too time-consuming by itself and may be useless where the trouble involves a number of defective components.

The third system is one in which voltage measurements are taken across various components. When the observed values are compared with normal voltage data, defective components are readily found. There are several weaknesses in this system when used alone. The time required to make all voltage checks in a modern complex receiver makes it extremely inefficient. At the very best, it may be used alone for making routine checks. In addition, many defects will not alter voltage readings to an extent that would indicate where the defects may be found.

The fourth system is similar to the third, except that resistance measurements are taken with an ohmmeter across the various components, rather than voltage measurements with a voltmeter. Used alone, this system has the same weaknesses as the voltage test.

The fifth system is one in which current measurements are made in various portions of the receiver to locate deviations from normal values. It is not often used, because it involves either the opening of circuits to insert ammeters in series, or the use of special adapters.

The sixth system is a popular one. A signal, similar to the one normally encountered in operation, is fed into the input of a stage, and the result at the output is then observed and compared with normal expectations. It is not suitable when used alone, since it primarily locates a defective stage without indicating the defective component.

The last system is one that involves expensive equipment and complex techniques. Commercial instruments are of various types, but most attempt to analyze the stages of the receiver under actual working conditions. Basically, all are combinations of vacuum-tube voltmeters, capable of making measurements without loading the circuits tested, and are excellent for measuring weak signals in the order of microvolts. The signal indicators are of various types: oscilloscopes, electron-ray tubes, loudspeakers, meters, etc. These instruments readily indicate loss of gain of stages, distortion, intermittents, regeneration, oscillation, noise, and other conditions. However, they still require supplementation by the multimeter and the signal generator.

Which Servicing Procedures Shall We Use?—No one of the servicing systems referred to in the above section can be used with speed and efficiency when taken alone. Experience has shown that it is most efficient first to determine the defective stage by means of a signal check and then carefully to analyze that stage for defective components.

This book assumes that the intelligent and combined use of the first four systems listed, plus the signal-substitution system, will give a highly efficient trouble-shooting procedure. Reference to the stage analysis in later sections will give great facility in the proper combined use of the suggested systems.

What instruments should the serviceman have? To follow the suggestions that are recommended, a voltmeter, an ohmmeter, and a signal generator are required. Two of these are combined in one popular instrument called a "multimeter," which combines a voltmeter, ammeter, and ohmmeter in one unit, with a switching device to obtain the desired function as well as the proper range.

Order of Use of Instruments.—The advantages of the recommended procedures will become evident with use. The general rule to be followed in servicing a receiver is, first, to use the signal generator in order to locate the defective stage or interstage components. The voltmeter and ohmmeter are then applied in order to close in for the kill, that is, the determination of the actual defective components.

The latter part of this book breaks down a typical superheterodyne receiver into its stages and gives procedures for testing the normal operation of each one. For each stage, typical test voltage and resistance measurements are listed for comparison with those actually found in the defective receiver. In addition, where possible, practical methods of testing stages are listed.

Finally, the order of presentation of the stages analyzed is, in general, the order in which a serviceman would be expected to subject the defective receiver to analysis. It is felt that in this way he will use this book with a more functional approach to his problem.

The question might arise at this time as to the place of a tube tester in a service shop, since many receiver defects may be due to faulty tubes alone. A word with regard to this matter will explain the lack of emphasis placed on that instrument.

There are two types of tube testers: the mutual-conductance type of tester and the emission tester. In the first, a small designated change of grid voltage is applied to the tube. The resulting change of plate current determines whether to call the tube good or bad. In the emission tester, the current flow or emission that results when the filaments are heated and a fixed voltage is placed on the plate determines whether to call a tube good or bad. Emission decreases with the age of the tube. In addition, both types of testers have circuits for determinating whether there is leakage or a short between the tube elements.

The tube tester is suitable for testing rectifier tubes. However, for other tubes, it does not measure their operation under the same dynamic conditions that they encounter in actual operation. Tubes that test good in it may be poor in actual receiver operation. A far better check for the serviceman is to hook up the signal generator and an output meter to the receiver and observe the output. Then substitute a good tube for the one believed to be bad and compare the two outputs. Of course, where the customer brings only his tubes for testing, the tube tester is the instrument to use, its limitations being understood.

CHAPTER 4

MULTIMETERS

A Typical Multimeter.—The multimeter is one of the radio serviceman's constant companions. It is the instrument that finally localizes troubles in the receiver after the defective stage is found. A typical multimeter is shown in Fig. 4-1. Its purpose is primarily to

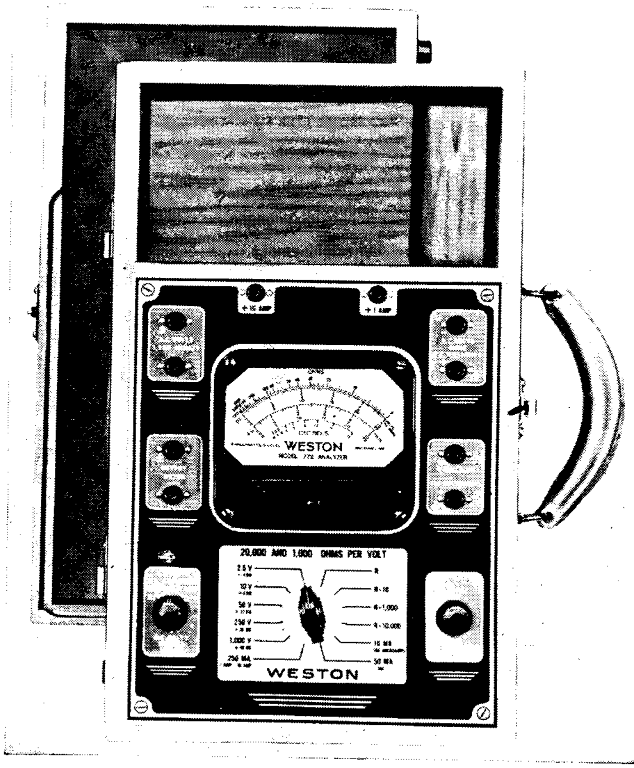


FIG. 4-1.—The Weston Model 772 multimeter.

make voltage, current, and resistance measurements throughout the receiver.

To perform its functions, the multimeter is a milliammeter, voltmeter, and ohmmeter combined in one case. In addition, it is designed to furnish various ranges of current, voltage, and resistance measurements. To select a particular function and a particular range from the instrument, a front-panel selector switch is provided. Each position of the switch is labeled for that purpose.

In describing the components of the multimeter, it is better to treat the voltmeter and ohmmeter as though they were separate. Nothing will be said about the milliammeter as a current-measuring device, since few servicemen will make such measurements without adapters. The only principle to be kept in mind, when currents are measured, is to be sure to be on the correct range. A good policy is to start at the highest range and switch down to lower ones until the correct one is reached.

General Principles of the Voltmeter.—The purpose of a voltmeter is to indicate the potential difference or voltage between two points of a circuit. This is accomplished by connecting the two input terminals of the voltmeter to the two points to be tested in the circuit. The placement of the voltmeter, in parallel with the circuit to be measured, brings up some interesting factors that will be described later.

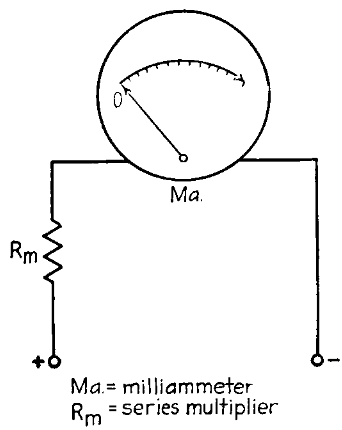


FIG. 4-2.—A basic voltmeter.

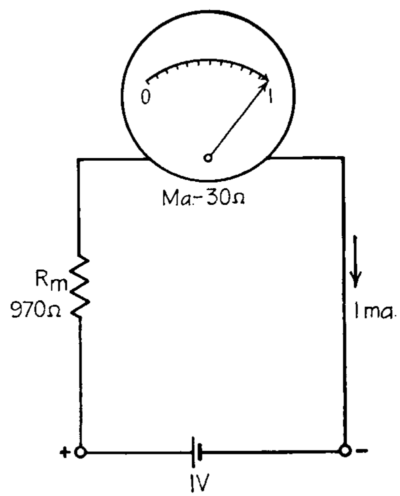


FIG. 4-3.—Voltmeter with 0- to 1-volt range at full-scale deflection.

Essentially, the voltmeter is a D'Arsonval galvanometer in series with a fairly high-ohmage resistor. The latter is commonly called the "multiplier." Figure 4-2 shows a basic voltmeter. The size of the multiplier determines the range of the voltmeter. A brief analysis will make this point clear.

Begin with a galvanometer that gives full-scale deflection at 1 ma (0.001 amp). Such an instrument is usually called a "one-mil milliammeter." Assume that it has an internal resistance of 30 ohms. What must be the resistance of the multiplier to convert it into a 0 to 1 voltmeter? When so converted, 1 volt placed across the milliammeter and multiplier will drive 1 ma through it to give full-scale deflection, as shown in Fig. 4–3. Using Ohm's law, determine the resistance that will give this condition.

$$R = \frac{E}{I} = \frac{1}{0.001} = 1{,}000 \text{ ohms}$$

Since the milliammeter has a resistance of 30 ohms, the multiplier R_m must have a resistance of 1,000 minus 30, or 970 ohms. An instrument of this sort is called a 1,000-ohms-per-volt voltmeter, because

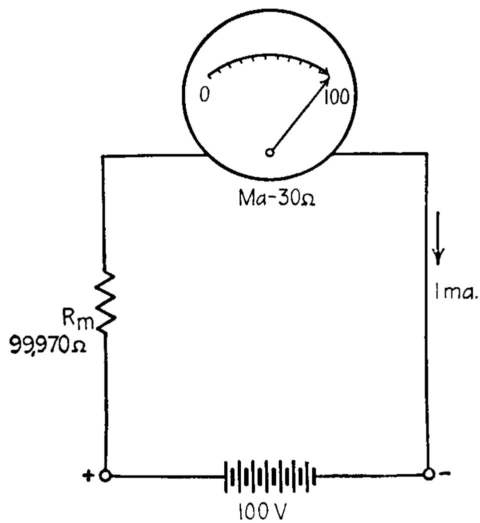


FIG. 4–4.—Voltmeter with 0- to 100-volt range at full-scale deflection.

1 volt is applied across 1,000 ohms: (1,000/1) = 1,000. This designation is an indication of its sensitivity.

Suppose that it was desired to convert the same milliammeter into a voltmeter of 0 to 100 volts. What must be the resistance of the multiplier? By similar reasoning, 100 volts now placed across the milliammeter and multiplier will drive 1 ma through it to give full-scale deflection, as shown in Fig. 4–4. Using Ohm's law for the total resistance,

$$R = \frac{E}{I} = \frac{100}{0.001} = 100{,}000 \text{ ohms}$$

Again subtracting the milliammeter resistance from the total resistance, we find that the multiplier must have a resistance of 100,000 minus 30 = 99,970 ohms. Its sensitivity is still found to be 100,000/100, or 1,000 ohms per volt. A switch is usually provided on the multimeter to give a voltmeter of different ranges by cutting in different multipliers. Such a switching device is shown in Fig. 4–5.

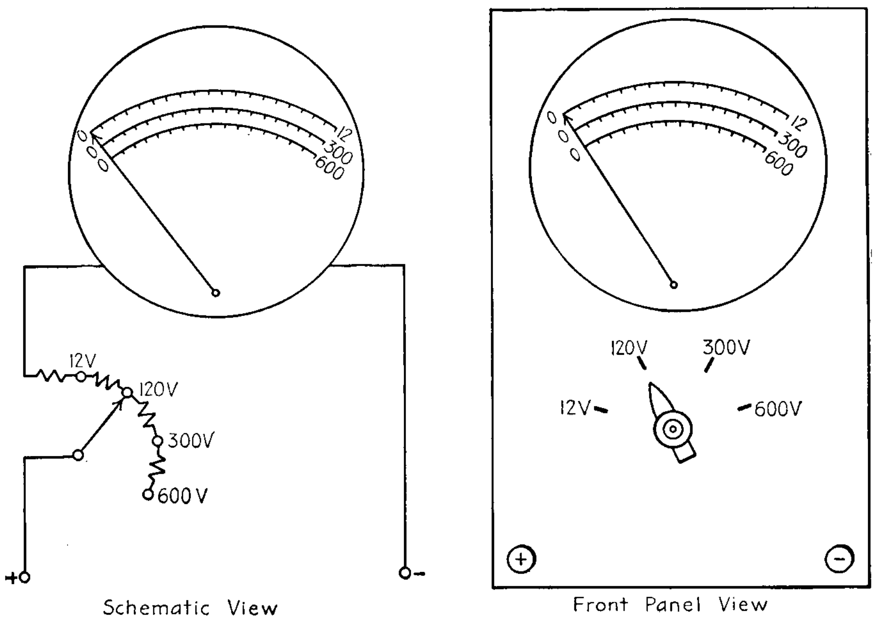


FIG. 4–5.—Multirange voltmeter showing range switch.

In using various voltmeters, the serviceman may be surprised when he measures the voltage across two points of a circuit and obtains two different readings. His first impulse might be to say that one of the instruments is inaccurate. Yet they may both be right, and the serviceman must interpret his results more carefully.

The explanation for this condition lies in the different sensitivities of the voltmeters. The example given above was for a 1,000-ohms-per-volt voltmeter. Commercial voltmeters with different sensitivities have been made. There are voltmeters with sensitivities of 100, 125, 1,000, 2,000, 2,500, 5,000, 10,000, 20,000, and 25,000 ohms per volt. For example, let us assume that a galvanometer requires 50 microamperes (0.00005 amp) for full-scale deflection. What must be the size of the total resistance to give a voltmeter with a range of 0 to 1 volt? From Ohm's law,

$$R = \frac{E}{I} = \frac{1}{0.00005} = 20{,}000 \text{ ohms}$$

The sensitivity of this voltmeter is 20,000/1, or 20,000 ohms per volt. Similarly, with the same basic movement, we could convert it into a voltmeter with a range of 0 to 100 volts. From Ohm's law,

$$R = \frac{E}{I} = \frac{100}{0.00005} = 2{,}000{,}000 \text{ ohms}$$

The sensitivity is still 2,000,000/100, or 20,000 ohms per volt. Now, consider the following circuit in Fig. 4-6, across which 60 volts are dropped.

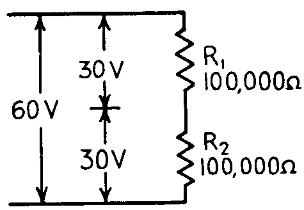


FIG. 4-6.—Voltage distribution across two equal resistors.

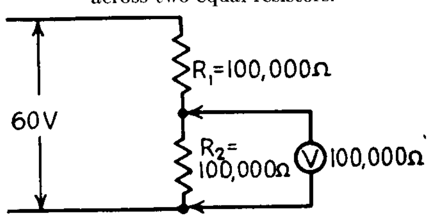


FIG. 4-7.—Measuring voltage with a 1,000-ohms-per-volt meter.

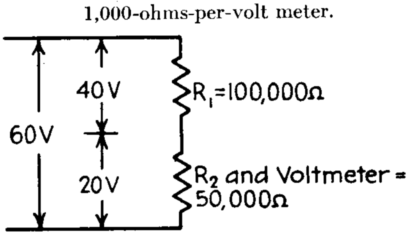


FIG. 4-8.—Voltage distribution resulting from loading the circuit with a 1,000-ohms-per-volt meter.

Since $R_1 = R_2$, the voltage dropped across each is equal and is 30 volts. If the 1,000-ohms-per-volt voltmeter is connected across R_2, we have the condition indicated in Fig. 4-7. The voltmeter and R_2 are equal in resistance and in parallel. The combined resistance of the parallel branch is now 50,000 ohms, and the circuit now appears as in Fig. 4-8. Since the two resistors are now not equal, the voltage divides differently, (100,000/150,000) × 60, or 40, volts across R_1, and (50,000/150,000) × 60, or 20, volts is dropped across R_2 and the voltmeter. The voltmeter reads 20 volts. If the 20,000-ohms-per-volt voltmeter is substituted for the 1,000-ohms-per-volt voltmeter, the condition indicated in Fig. 4-9 prevails. The combined resistance of the voltmeter and R_2 is

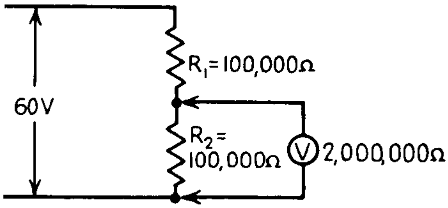


FIG. 4-9.—Measuring the voltage with a 20,000-ohms-per-volt meter.

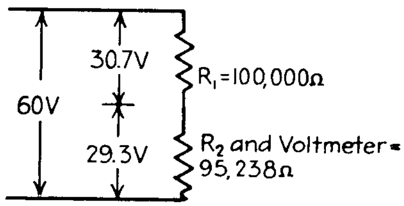


FIG. 4-10.—Voltage distribution resulting from loading the circuit with a 20,000-ohms-per-volt meter.

about 95,238 ohms. The circuit now appears as shown in Fig. 4-10. Across R_1, (100,000/195,238) × 60, or about 30.7 volts are dropped. Across R_2 and the voltmeter are dropped (95,238/195,238) × 60, or about 29.3 volts. The voltmeter reads 29.3 volts. In both cases above, the effects of change of current when the voltmeters were connected have not been taken into consideration because the relative results would still exist.

Which voltmeter was correct in its reading? If interpreted properly, both gave correct results. The serviceman may use either of the two voltmeters of different sensitivities, but at all times he must interpret his results. Generally, it is true that, when the voltage across a high-resistance circuit is measured, the voltmeter of the higher ohms-per-volt sensitivity will give a more accurate reading. However, many radio manufacturers often give voltage tables in their service data, and specify "Readings taken with a 1,000-ohms-per-volt voltmeter"; and some multimeters have switches for changing from 20,000 to 1,000 ohms per volt for the above purpose.

Where the voltage is measured across a low-resistance circuit, the difference in readings between the voltmeters of different sensitivities is not so great. This fact is tabulated in Fig. 4-11.

To summarize, the voltmeter of higher sensitivity gives the more accurate readings, especially when measured across high-resistance circuits. Thus, when cathode voltages across a resistor of several hundred ohms are measured, the 1,000- and 20,000-ohms-per-volt voltmeters will give about equally accurate results. However, when voltages in the plate circuits across resistors of hundreds of thousands of ohms are measured, the voltmeter of greater sensitivity will be the more accurate, and the limitations of one of low sensitivity should be kept in mind. The 1,000-ohms-per-volt voltmeter may be used almost everywhere, except in very high-resistance circuits like the AVC bus and the actual cathode to control grid voltage in the audio stage, where the usual grid load is 500,000 ohms. A 20,000-ohms-per-volt voltmeter will give a reading on the AVC bus, but it will load the circuit and throw off its operation. For best measurement in this case, a vacuum-tube voltmeter, with a high internal impedance in the order of 15 megohms, will load the circuit least by

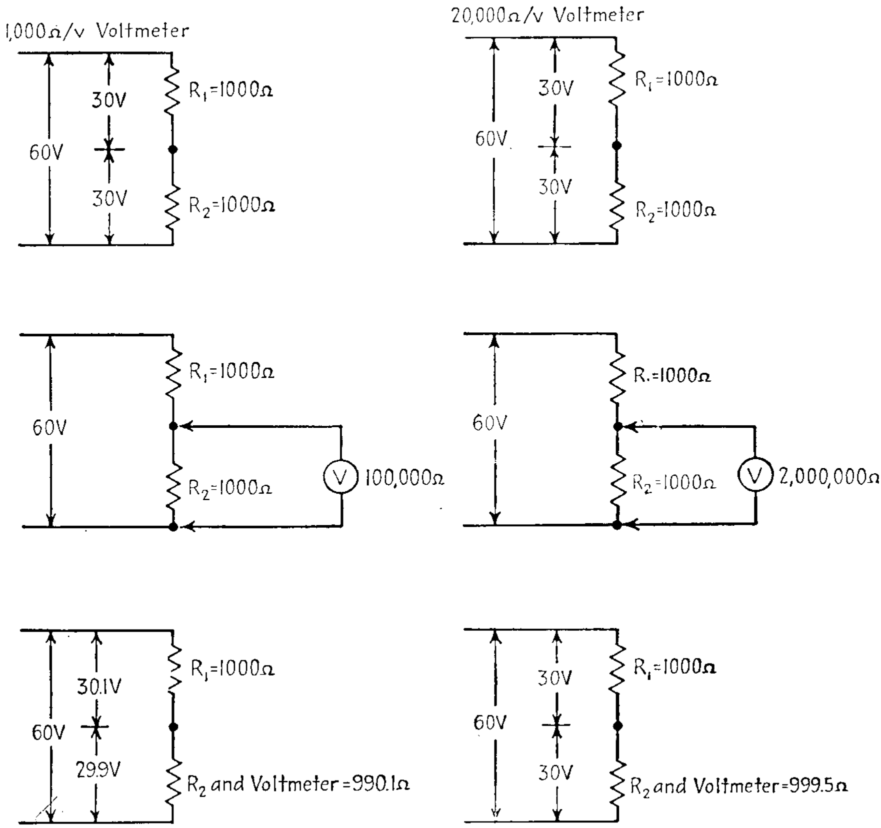


FIG. 4-11.—Comparison between a 1,000-ohms-per-volt meter and a 20,000-ohms-per-volt meter in a low-resistance circuit.

drawing only an infinitely small current. Regardless of which meter is used, the results must always be properly interpreted.

The voltmeter section of the multimeter is usually designed for various ranges of AC as well as DC voltage measurements. The voltmeter is converted into an AC meter by placing a rectifier in the circuit, as shown in Fig. 4–12. The rectifier converts the alternating current to direct current, which is then read on the DC meter. Different ranges of AC voltage may be measured by use of the range switch, as was done for the DC voltmeter. The rectifier is switched in and out of the circuit by a separate switch, one position of which is marked AC and the other DC.

Several considerations must be kept in mind when using the voltmeter. When used as a DC voltmeter, polarity must be observed.

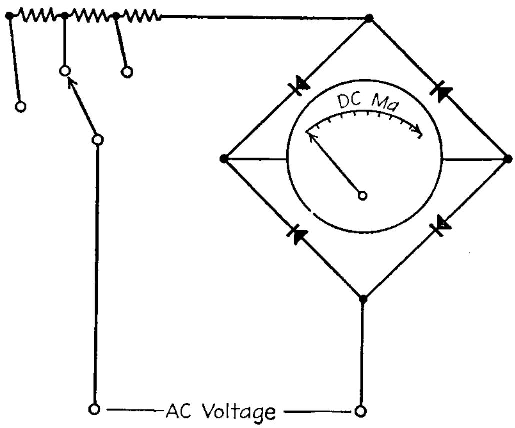


FIG. 4-12.—Typical multirange AC voltmeter.

There is a positive terminal and a negative terminal. The test leads are color-coded, one red and the other black. The usual convention is to connect the red lead to the positive terminal and the black lead to the negative terminal. It is advisable to clip the black, or negative, lead to the *B* minus of the power supply or the chassis, and to tap the red, or positive, lead to points to be tested in the receiver. This latter step should be done with one hand to avoid severe shocks.

When using the instrument as an AC voltmeter, such polarity need not be observed. Either terminal may be connected to any point. The rectifier takes care of the polarity required by the voltmeter itself.

A final important precaution to remember is that a high voltage, applied across the voltmeter when it is switched to a low-voltage range, will burn out the meter. Good practice is to switch to the highest range and then to decrease the range by steps until the proper one is attained. Of course, voltmeter readings in the receiver are always taken with the power from the mains turned on. Voltage measurements on a receiver are usually taken with the volume control turned full on, and the tuning dial in an off-station position.

General Principles of the Ohmmeter.—The ohmmeter is an instrument indicating the amount of resistance that a component offers to the flow of a direct current. When used to make such measurements in a radio receiver, the power must be shut off if we do not wish to ruin the ohmmeter by placing an external voltage across it.

Basically, the ohmmeter is a milliammeter that requires current to energize it. Since the power in the receiver is off, another driving source of voltage is required. A battery is included in the instrument itself for this purpose. To compensate for any change in battery voltage as time goes on, a zero-adjusting rheostat is included. A basic circuit for an ohmmeter is shown in Fig. 4–13. The component

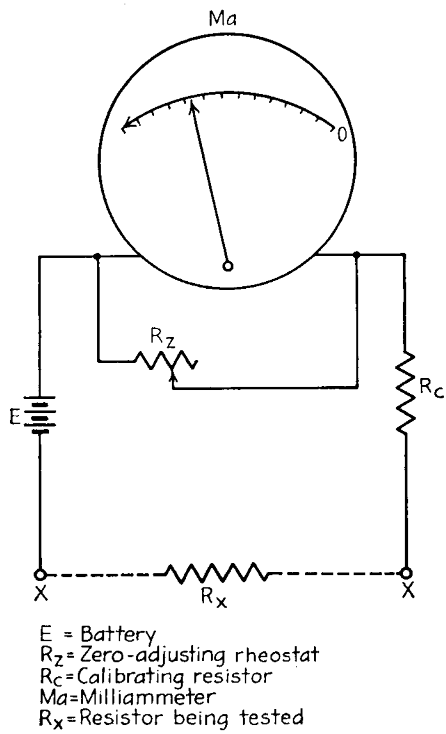


FIG. 4–13.—Basic ohmmeter circuit.

to be measured is placed across the points marked *x*—*x* in the figure. If the component has practically no resistance, the milliammeter will be fully deflected. The higher the unknown resistance, the less the amount of current through the milliammeter, and the less the deflection. For this reason, the zero of the ohmmeter scale is at the right and the scale increases toward the left.

Unfortunately, the scale is not linear; that is, the units are not equal. Values of resistance at the upper, or left, end of the scale are very crowded and hard to read. For this reason, a switching device is included to give various ranges. In some ohmmeters, the switch markings and scales present a problem in reading. For this reason, an example in reading would be of great value. Figure 4–14 shows the ohmmeter scale of a typical multimeter, with the meter needle

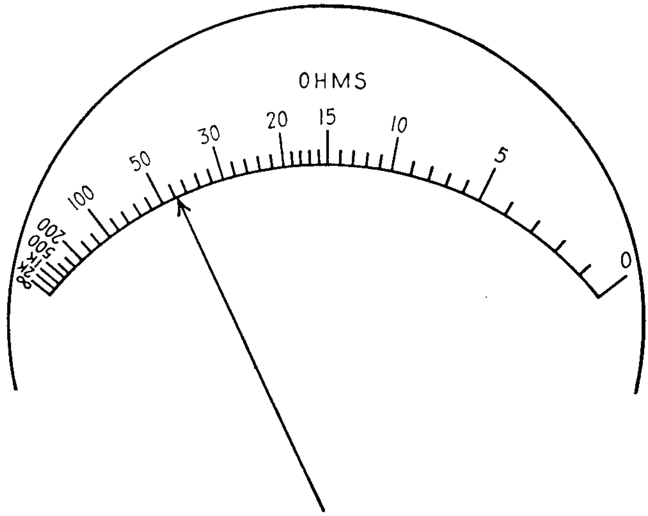


FIG. 4–14.—Typical ohmmeter scale.

indicating a particular reading. Note that the left end of the scale shows 2K. The letter K stands for 1,000. Unfortunately, owing to previous practice, the letter M is often used for 1,000. This latter practice leads to confusion. For example, 2M ohms equals 2,000 ohms, while 2Mc equals 2,000,000 cycles. It therefore becomes necessary for the serviceman to interpret the meaning of M in schematics. This book will use K for 1,000 and M for 1,000,000.

The ranges of such an ohmmeter are 0 to 2,000 ohms; 0 to 200,000 ohms; and 0 to 2 megohms. The switch ranges are indicated in either of two ways by multimeter manufacturers. These are shown in Fig. 4–15.

The switch designation in Fig. 4–15*B* is more convenient, since it tells directly by what value the scale reading must be multiplied in order to get the true reading for each range. It is suggested that, if the ohmmeter of the servicemen has scale indications as indicated in Fig. 4–15*A*, he paste over the ranges multipliers similar to those at *B*.

Now what is the reading if the switch of our meter is at *R*? Here the scale is read directly as 43 ohms, approximately. If the switch is at the *R* × 100 range, the reading is 43 × 100, or 4,300 ohms.

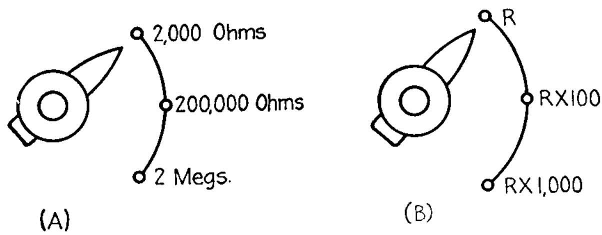


FIG. 4-15.—Typical ohmmeter range switches.

When the switch is at the *R* × 1,000 range, the reading is 43 × 1,000, or 43,000 ohms.

A good rule to follow is to select the range that gives the resistance reading about the middle of the scale. Of course, since a battery is included in the ohmmeter and is properly polarized, no polarity need be observed when the resistance of components is measured.

A final word must be said about making resistance measurements in the receiver with an ohmmeter. The serviceman must be sure that there is no parallel branch across the component that he is measuring. Reference to a schematic of the receiver being tested will aid in such determination. When in doubt, disconnect one terminal of the component under test. The serviceman will also encounter difficulty where an electrolytic condenser is in parallel with a tested unit. Normally, condensers are practically infinite in resistance to direct currents. But electrolytic condensers have a fairly low leakage resistance (from 1 to 50 megohms). The rule to follow, where such is the case, is to measure the resistance of the component, then reverse the ohmmeter prods, and measure again. This is done because the polarized electrolytic condenser will show less leakage in one direction than in the other. Use the higher of the two readings obtained as the reading for the unit being tested. If there is any doubt, disconnect one terminal of the component, as for parallel resistors.