1001 USES FOR THE Simpson MODEL 260

VOLT - OHM - MILLIAMMETER

SIMPSON ELECTRIC COMPANY
5200 West Kinzie St., Chicago 44, Illinois, EStebrook 9-1121
In Canada. Bach-Simpson, Ltd., London, Ontario

TABLE OF CONTENTS

PREFACE

☆ ☆ ☆

The Simpson Model 260 Volt-Ohm-Milliammeter has a wide acceptance in the fields of radio and TV servicing, and its use in these professions has become so common that the majority of service men know the instrument as a "Model 260." This is a rare condition. Usually any instrument becomes known primarily by a trade name, but in this unique case, the model number has become the trade name. The Model 260 is equally at home in an appliance service shop, in a telephone lineman's truck, in a factory, in a garage, in an airplane hangar, in a tool kit used for electrical installation, in a welding shop, or in literally dozens of other applications which become apparent as you become acquainted with this sturdy, compact, sensitive little package of electrical and electronic answers.

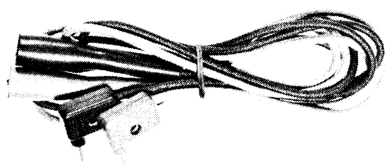
By telling you of some of the many uses which we have heard about from our customers, and by explaining to you some of the technical points about how it works, we hope to lead you into seeing some useful applications in your own particular field of work or your hobby, whatever that may be.

☆ ☆ ☆

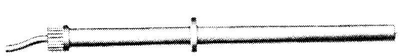
Printed in U.S.A.

THE 260 IS AVAILABLE WITH OR WITHOUT A ROLL TOP CASE

$38.95

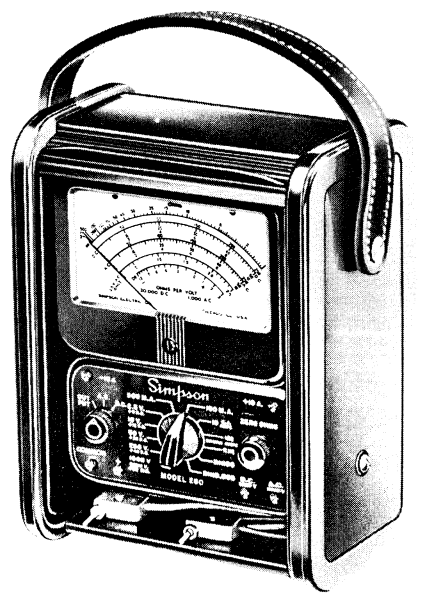


LEADS FURNISHED WITH 260



ACCESSORY HIGH VOLTAGE PROBE

$9.95



$46.90
WITH ROLL TOP

Figure 1. The Simpson Model 260 and Model 260 Roll-Top Volt-Ohm-Milliammeters; Accessory High Voltage Probe

WHAT IS IT?

The Simpson Model 260 is an indicating instrument which will read electrical quantities of voltage, current, and resistance. It is available either with or without a roll-top case, as shown in figure 1. A roll-top case provides added protection to the instrument and a storage compartment for the leads. A flick of the finger rolls the top up and makes the instrument ready to use. The protective roll top is quickly and easily moved down to protect the instrument face when not in use.

The Model 260 uses two switches to set up the circuit for whatever information is to be measured. It has a variety of ranges so that low, medium, and high values of each of these measurements can be read easily on the large dial. All the measurable values are marked on the single dial and are arranged so they are easy to read.

When the Model 260 is connected as a voltmeter, it has ranges for both D.C. and A.C. of 2.5, 10, 50, 250, 1,000 and 5,000 volts. With an accessory probe, which is available through the same store where you buy the Model 260, there is one more D.C. range possible which is 25,000 volts. The input resistance for all D.C. voltage ranges is 20,000 times the voltage of the range. This means that the highest amount of current which will pass through the meter circuit and deflect the pointer to the right hand side of the scale is only 50 microamperes. For A.C. voltage ranges, the input impedance is 1,000 times the voltage of the range. For A.C. voltages, then, the highest amount of current which will pass through the meter circuit is only 1 milliampere. These facts are important to you because you know you can measure a voltage without shorting it out and destroying it.

When the Model 260 is connected as a D.C. current meter, it has ranges of 100 microamperes; 10, 100, and 500 milliamperes; and 10 amperes. Due to the fact that current values as small as 1 microampere can be read on the 100 microampere scale, the ratio of current readings is 10 million to 1, and any current in this big range can be measured easily.

When the Model 260 is connected as an ohmmeter (for resistance measurements), there are batteries inside the case which furnish the power to make the unit operate. There are three ranges, and resistance values from a fraction of one ohm up to 20 million ohms can be read on the dial.

There are two other circuits which can be set up in this instrument. These are both related to A.C. voltage measurements and use the A.C. voltage circuits.

The first is called "Output." It separates A.C. voltage from D.C. voltage, when both are mixed together, and measures the A.C. part of the mixture alone.

The second is called "Volume Level in Decibels." Decibel measurements are based on wattage, and indicate the intenseness of the A.C. signal as it affects the human ear. Since, in sound work, there are standard values of impedance across which these voltages are applied, the wattage is proportional to the voltage with a fixed impedance, and therefore there is a relationship between the voltage and the decibel level. By definition, a power level of zero decibels represents 6 milliwatts developed across a 500 ohm line. This, then, also may be read in terms of the 1.73 volts required to develop the 6 milliwatts across the given load impedance. If the voltage is less than this amount, the decibel level is lower (or —), or if the voltage is more, the decibel level is higher. The actual mathematical value of decibels is based on a logarithmic ratio of any other voltage to this reference 1.73 volts. The Model 260 circuit is valuable to telephone men and sound engineers because this decibel scale is included.

The Simpson Model 260 does not have any A.C. current ranges, and there are many times when a technician wishes to read the amount of A.C. current furnished from a power source to any electrical device. Figure 2 shows a diagram of an extension cord which can be connected into the power source; when the device for which the current is to be measured is plugged into this extension cord rather than directly into the power source, any A.C. current from 100 milliamperes to 2.5 amperes can be read on the 2.5 volt

A.C. range of the Model 260. By changing the resistance value to 1/4 ohm, the current indication has four times the range, and currents up to 10 amperes can be measured. Leave the Model 260 connected as a 2.5 volt A.C. voltmeter, and multiply the reading on the A.C. voltage range by four. The resistors used for making up this extension cord need to be as accurate in resistance value as possible. Any lower or higher resistance value causes a corresponding error in the indicated current values. Use a one ohm ten watt resistor for the 2.5 ampere range. Four of these one ohm ten watt resistors connected in parallel will make a good 1/4 ohm 40 watt resistance to use for the 10 ampere range.

If the circuit for which the current is being measured is primarily resistive, the wattage can be approximated. Calculate the wattage by multiplying the current value by the line voltage. If the extension cord accessory shown in figure 2 is used across a 115 volt A.C. power source, current values can be read as low as 100 milliamperes, showing a power consumption in a resistance load of 11.5 watts, or it can be read as high as 2.5 amperes, showing a power consumption of 287.5 watts. With 1/4 ohm of resistance in the line cord, the current value can be read as high as 10 amperes, and this shows a power consumption of 1150 watts. On a 220 volt A.C. circuit, the same current indications measure almost twice as much wattage. The effect of placing the

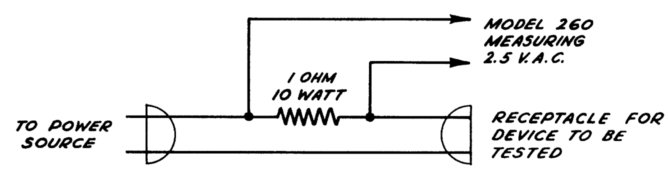


Figure 2. Extension Cord Circuit Used to Measure A.C. Current.

resistance in series with the load is only very slight: 2.5 volts is the largest drop which will occur across it and this represents a normal voltage fluctuation as far as the device is concerned.

WHO USES IT?

Radio and television servicemen are probably the largest volume users of the Model 260. The instrument is so well known throughout this industry that it has been accepted as the standard of measurement, and reference values of expected voltage in operating circuits have been based on the loading effect (or lack of it) using 20,000 ohms-per-volt voltmeters. Many manufacturers of electronic equipment furnish with their servicing literature a table of voltages at tube socket terminals, and other reference points in their circuit. These tables may be used as a trouble shooting reference to locate a fault in the circuit. In almost every case, a reference note with the table states "Voltages read with a 20,000 ohm-per-volt voltmeter." So it is natural that the men who use these servicing hints will invest in an instrument which will provide the required input impedance.

In speaking of radio and television servicemen, we usually think of the men who repair receivers. But there are many others who also fall into this category. The technicians and engineers at broadcast transmitters, the men who service police and other mobile and airborne communications equipment, and radio amateurs all find the Model 260 a desirable piece of equipment. Audio and sound system installers and engineers use the same instrument, and they make much use of the decibels readings.

Many schools and experimental laboratories use Simpson Model 260's as an all around instrument because of the variety of circuits and ranges available in the single portable unit. It can be set up as an indicating device at almost any point in any circuit and used as a scientific measuring device, or can be just as easily used to trouble shoot faulty circuits or to pretest circuit conditions before applying power.

There are many jobs around garages and filling stations which are being done easier and better with the aid of these instruments. Trouble shooting electrical circuits, identifying dead or low voltage batteries and battery cells, ignition circuit trouble shooting, and automobile radio installation and service are a few of these jobs. Another common application measures the current through a battery charging circuit.

Aircraft mechanics use the Model 260 for similar jobs to those mentioned for automotive mechanics. In addition, flight engineers carry this unit along to make checks and adjustments while their planes are in the air. Its portability and ruggedness, together with the fact that no power source is needed to make it operate, adapt it to the requirments of this type of service.

Electrical power and distribution stations have many uses for the Model 260. Naturally, it will not measure the tremendous amounts of current which are generated and handled, but it will check such things as insulation, continuity in windings, shorts and grounds, voltages on control boards, and many other various indications of what troubles exist and where they are located.

Telephone companies make extensive use of the Model 260 in the central offices and out on line work. Since no power source is required to make the tester operate for any electrical checks line crews can carry it up poles, into a home, through a local switchboard, or at any other point where they have to work in the general maintenance of the vast networks of this communication system.

The applications in industrial plant maintenance defy listing. With each plant there will be new and different uses. In general, however, most heavy industrial plants will have large high-horsepower motors which have starting controls. These starter control circuits need preventive maintenance in order to continue the plant's operation. Many starter circuits are electronic, while others are mechanical; but in either of these types, voltage and continuity checks will indicate many cases where faults are developing early enough to allow low cost repairs to be made before major breakdown causes expensive shut-downs and overhaul of the equipment. Many plants use sequence controllers with a large group of interlocking relays to perform automatic operations. These relays have contact points which have to make good electrical contact in order to operate the machines satisfactorily. Voltage and continuity checks are invalueable in checking the operation of these complex circuits.

In addition to these widely varied fields of application, there are many more in which electrical or electronic circuits are used. Every place where any of these circuits is put into use, a maintenance and servicing procedure has to be established on the equipment. In each of these applications, there is a job which can be done, and done well, with the aid of a Simpson Model 260 Volt-Ohm-Milliammeter.

Now, to list some of the unusual applications of the instrument and to see how it is used, let's look in on some of the spots from which we have had reports of these uses.

RADIO SERVICE

About 90% of the troubles which must be identified and repaired in radio service shops will be indicated with voltage and resistance checks within the circuit itself. Resistance checks must be made with the line voltage OFF, since the application of voltage from outside the Model 260 circuit when it is set to read ohms can damage the circuits inside the instrument. But, with no power applied to the radio set, the repair man can can check continuity, both with and without resistance, shorts, open circuits, grounds, bad insulation, leaky or shorted condensers, shorted turns in inductors and transformers, and open filaments in tubes and pilot lights. Voltage checks, following repair of circuit faults found and corrected with the resistance checks, will measure the actual voltages delivered to each element of every tube in the circuit, the voltage put out by the power supply, filament voltages across individual tubes, and output voltages (the A.C. component of mixed A.C. and D.C. voltages).

Occasionally there is a question about the loading effect of the voltmeter circuit when measuring low voltage high impedance circuits such as grid bias and Automatic Volume Control. When the range of the instrument is set at 2.5 volts, the resistance of the D.C. input circuit is 50,000 ohms, and when the range is 10 volts, the input is 200,000 ohms. For high impedance circuits, the shunting effect of the meter in parallel for voltage readings will actually reduce the amount of voltage in the circuit and cause an error in the reading. If the range is set at 50 or 250 volts, with an input resistance of 1 megohm or 5 megohms, the loading effect is reduced, and a more accurate value of the voltage present in the circuit will be read on the meter. The large size of the dial, and the clear markings still make it possible to read a voltage even though the meter deflection is small. In actual tests, the Model 260 set at the 50 volt range read substantially the same AVC voltages as were obtained on a Vacuum Tube Voltmeter set on the 10 volt range. The pointer will move with only a small part of the full scale voltage applied through the test leads. A simple and interesting check will prove that this is true: apply the test leads across a 1 1/2 volt flashlight cell with the meter range set for 5000 volts D.C. You can actually see the pointer move as the voltage is applied and removed. Of course, you would not measure 1 1/2 volts with this range, but the pointer movement shows you that the instrument will respond to very small voltage applications. Voltages as little as 1% of any full scale value are marked on the dial.

When taking random voltages in a receiver, the 1000 volt range can be used to advantage. In addition to furnishing a meter resistance of 20 megohms this provides ample insurance against driving the pointer off the right hand side of the scale. An occasional case of pointer overdrive, which is the result of applying more voltage than the maximum value of the range, will not cause any serious damage unless it is enough to burn out one of the series meter resistors. But repeated application of over-voltage values may injure the instrument itself and impair its accuracy. If the voltage indicates a value within a lower range, the position of the range switch can be changed to provide more deflection. Of course, consider the effect of increasing the loading when high impedance circuits are involved.

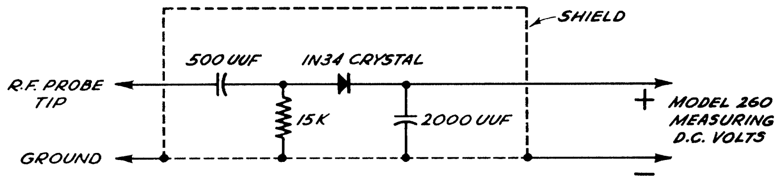


Figure 3. Circuit Diagram of a Crystal Probe to Indicate the Presence of RF up to 200 Megacycles.

The A.C. Voltage circuits are intended for measuring audio frequency voltages, and higher frequncies in an RF range will not be indicated nearly as well as audio frequencies. However, there are occasions when radio servicemen need to determine the presence of RF and its relative strength. A probe, such as the one diagrammed in figure 3, will rectify the R.F. voltage and produce a proportional D.C. voltage. Connect the probe leads across the R.F. source and measure the D.C. voltage output of the probe with the Model 260. This will not be an accurate value of the R.F. voltage, but will indicate its relative strength. Just holding the probe tip near the oscillator tuning condenser will produce a reading that will indicate whether or not the oscillator is working. Another example of the use of this accessory and the Model 260 was found in a typical A.C-D.C. receiver. The probe was placed on the plate pin of the I.F. amplifier tube when the receiver was tuned to a local broadcasting station, and the Model 260, set at the 50 volt range, read 15 volts. Detector probes similar to this are available commercially if you do not wish to build one yourself.

There is an alternate method which may be used to indicate whether or not an oscillator is operating. Connect an

800,000 ohm isolating resistor at the oscillator grid and connect the Model 260, set at 10 volts D.C., from the isolating resistor to B-. Use the negative lead at the isolating resistor and the positive lead at B- for this measurement. Read the voltage on the 50 volt scale of the Model 260. the isolating resistor serves two purposes; it isolates the oscillator output from the lead capacity of the meter, and it serves as a series multiplier resistor to convert the range from 10 volts to 50 volts. A working oscillator will produce from 5 to 15 volts in this test.

A really good job of alignment requires that an output meter be used in place of the relatively insensitive human ear to indicate that a maximum response has been tuned. The Model 260 output circuit is proper for this application. Set the small switch at the left hand side of the instrument at "OUTPUT" and the meter will be set to read an A.C. voltage. Place the range switch at 50 volts and connect the test leads to the plate of the audio frequency output stage and to ground. With a modulated signal generator output tuned through the i-f system, and the r-f system if desired, tune the parts for a maximum indication on the meter. The meter movement is damped enough to prevent "jitter" of the pointer, and yet will respond smoothly to changes in output voltages.

Three way portable radios contain 1.5 volt low current tubes, and manufacturer's instructions will usually state "Do not try to measure tube filament resistance with an ohmmeter." The reason is that many commercial ohmmeter circits will use 3 or 4.5 volts to power this circuit, and the low internal resistance of the ohmmeter circuit will allow enough voltage to be applied across these tube filaments to damage them by burning them out. Servicemen who own a Model 260 can disregard this warning because the high sensitivity of the meter movement allows the use of only 1.5 volts to power the instrument on the R x 1 and R x 100 ranges. Thus there is never any higher voltage present in the circuit than the tube filament itself will limit to a safe amount. Radio servicemen also use the ohmmeter ranges to check coils which are suspected of having shorted turns or opens. Even iow resistance windings will indicate these conditions in many cases. The lowest value of resistance which can be read with the scale markings on the R x 1 scale is 1/5 of an ohm. Thus most coil windings can be checked for the amount of resistance in the coil. If it is lower than normal, the turns have become shorted at some internal point. Naturally, if there is infinite resistance in the coil, even when the resistance range is increased, this indicates an open circuit inside the coil. In either case, repair or replacement is necessary.

There are several uses for the current ranges of the Model 260 in radio servicing. Grid emission is difficult to identify, and yet it will contribute distortion, low sensitivity, squelch effect, and short tube life to the circuit. Unsolder the lead to the grid of a suspected tube and connect the meter in series with the grid lead, with the positive meter lead at the grid and the negative meter lead attached to the lead which was unsoldered from the tube socket. Set the small switch at the left on the Model 260 at D.C. and the range switch at 100 microamperes. It there is any grid emission, the pointer will move into the scale, and frequently will indicate a gradually increasing amount of current as the set continues to operate. On the other hand, a large input voltage which swings the grid positive will make the meter read backward with these connections. Other current ranges of the Model 260 are useful to determine the current draw from a battery in a portable receiver. Open the A lead and place the meter in series with it to check A battery current drain, or open the B lead and use the meter in series to check the current drawn through it. When the switch is turned off, there should be no current through either of these batteries. If the batteries of the portable seem to have a shorter than normal life, measure the current through them when the switch is on and when it is off. These tests will often solve many puzzling cases involving battery life.

These are some of the uses for a Model 260 in the radio servicemen's shop. In addition to these, there are many more uses, but most of the more specialized applications have been listed. As long as voltage measurements, resistance and continuity checks and current readings form the fundamental

methods of trouble shooting, and they will for a long time to come, the Simpson Model 260 will continue to be the serviceman's most dependable single piece of test equipment, because it measures all of these characteristics.

TELEVISION SERVICE

New techniques are required for servicing the more complex circuits of television receivers. But these are added over and above the general techniques required for radio servicing. For that reason, most of the information listed under Radio Service also applies to the uses of the Model 260 for TV work.

There are some special applications in TV servicing for which the same instrument can be used to advantage. Foremost of these is a check of the amount of voltage in the high voltage circuit furnished to the cathode ray tube. Set the Model 260 for a range of 1000 volts D.C. and attach the accessory high voltage probe on the end of the positive lead. The actual range of the instrument is increased to 25,000 volts D.C. The resistance of the meter circuit is 500 megohms. This circuit allows a measurement of the high voltage circuit directly and with a minimum loading effect. This resistance is great and the loading effect is less than is obtained with standard VTVM circuits used for the same range of voltage readings.

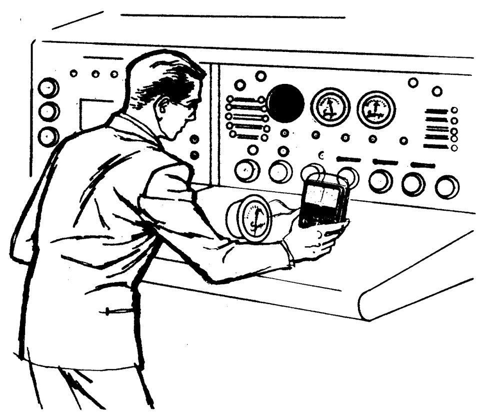
If there is a slight leakage in the AGC bypass condensers, they can cause a variety of troubles which are difficult to identify. The R x 10,000 range provides an indication of resistance up to 20 megohms and the actual leakage resistance can be measured with the Model 260 in this circuit. Leakage resistance higher than 20 megohms will not usually cause any noticeable trouble in the AGC action. Like AVC voltages in a radio, AGC voltages in a TV set may be measured with the range of the Model 260 set at 50 or 250 volts D.C., with a minimum circuit loading effect.

The Model 260 can be substituted for a VTVM where it is called for in alignment of the sound section of a TV receiver. Again, to prevent circuit loading effects, use a high meter range for D.C. voltage measurements. Sometimes the TV serviceman has trouble in these measurments due to the lead capacities introduced across the circuit. When this is true, he places a series resistance between the signal source and one of the leads to isolate the capacity from the TV circuit. This will reduce the actual voltage indicated by the meter, but the exact amount of voltage here is not the important factor; the adjustments are tuned for a maximum voltage output, whatever that may be.

The fact that many TV repairs are made in the homes where the sets are located, rather than in the service shop, is a strong point in favor of the use of a Model 260. So much actual testing can be done with this instrument alone that it reduces the amount of test equipment which service man must take along with him on these calls. This sensitive but extremely rugged meter can take the bumping, jolting, and extreme temperature changes encountered in such service calls. It requires no service outlet for voltage, and no period of warm-up. Its accuracy is permanently built in and is not dependent on changeable characteristics of vacuum tubes. It works just as well checking the voltages in the set in the living room or up on the snow-covered roof to determine whether or not the actuating voltages are reaching the rotator motor.

COMMERCIAL BROADCASTING STATIONS

Most standard transmitters have a variety of indicating instruments on the front panel or panels of the equipment to indicate operating conditions of the circuits inside the transmitter. But there are always some circuit conditions which are not metered by the front panel indicators. These can be checked with the voltage or current indications of the Model 260. Another very important use is a re-check of the meter indications on the front panel. These meters are in constant use during the operation of the equipment, and are subject to deterioration over a long period of time. The Model 260 is used as a standard to recheck the indications of these panel meters when their indications seem to be wrong. Connect the Model 260 as a voltmeter and connect the test leads in parallel with the voltmeter circuit of the transmitter. Watch for external series multiplier resistors for panel voltmeters, and connect the Model 260 in parallel with the entire meter circuit including these external multiplier resistors. Then compare the readings on the two meters. If they are the same, the panel meter is indicating satisfactorily, but otherwise it is not and the fault should be corrected. To use the Model 260 as a standard for D.C. current meters, open the circuit leading to the panel meter and connect the Model 260 in series with this lead. Look out for external shunts in this circuit, and connect the Model 260 in series with the entire panel meter circuit. Then compare the values read on the two meters. Similar readings indicate satisfactory opera-



tion, while different values indicate an error in the panel meter.

Standby equipment often does not have separate meters of its own. The Model 260 can be used here to perform the metering functions to check this equipment while the main transmitter is on the air.

Trouble shooting is similar to the procedure outlined for radio receiver service shops. Usually, the voltages are higher, the currents are higher, and the resistances are lower than those in radio receiver servicing, but the same instrument can be used on higher voltage and current ranges and on the low resistance ranges to provide the same trouble shooting advantages.

The complete portability of the Model 260 makes it easy to use for checking feedlines for breakdown. It can be used all the way along the lines, through the tuning house, and out at the base of the transmitter tower. It is also used for checking various line voltages and their fluctuation due to varying loads. Out in the field, when operating remote transmission equipment, the Simpson 260 is used to check voltage sources to determine whether they furnish A.C. or D.C. and to measure the voltage present before connecting any equipment into the power source. Hundreds of dollars worth of expensive transmitter equipment is often saved through this simple test.

The Model 260 is also used to check telephone lines carrying the program from the studio to indicate a possible unbalance which will produce a hum at a receiver tuned to the station. The ohmmeter circuit provides a quick and dependable continuity check for tube filaments, pilot bulbs, cables, connectors, and the myriad of other component parts all used in the complete operation of the transmitter. And the voltmeter is always available to check the condition of batteries used in portable equipment.

TELEVISION TRANSMITTERS

The engineers in a television station use the Simpson 260 for all the purposes that radio engineers do, and for more special applications besides. The cameras used in television have complex electronic circuits inside the case, and these must be kept in good condition to insure operation during transmission. The power supplies set up voltages from 1000 to 1500 volts to power the camera tube. The basic sweep circuit and the creation of synchronizing pulses require carefully adjusted voltages and close tolerances on the value and operation of each component part. Again, the Model 260 furnishes the ranges required, and the accuracy needed to test the circuit conditions of the equipment. With the high voltage probe, the high voltage used for the cathode ray tubes in the monitors can be checked.

The ohmmeter is just as important for making continuity checks and to measure resistances around a TV transmitter as it is in any electronic work, but its accuracy is especially valuable to check plate load resistors of the peaked video amplifiers whenever the response of the amplifier is suspected of a change.

The Output meter circuit can be used to indicate the strength of the audio frequency sound circuits, and can also be used to measure the strength of synchronizing pulse voltages.

RADIO AMATEURS

The radio amateur has to be a combination transmitter and receiver engineer and serviceman as well as an operator to completely operate his station. Many amateurs build their own equipment—at least their transmitting equipment — and all have occasion to test, repair, and tune their receivers and transmitters. The Model 260 is ideally suited to the needs of the amateur in any of these cases. For testing, the voltage and current ranges are used the same as the radio station engineer uses them. He can use the Model 260 to take the place of instruments which are not included on his front panel, or he can recheck the indications of the instruments that are in service while transmitting or receiving. For repair, all that can be said for the radio serviceman can also be said for the radio amateur. He has, in this single instrument, all the voltage, current and resistance measurements needed to completely examine the operation of each circuit and component part in the entire receiver or transmitter. For tuning, refer to the standard tuning procedures for tuning methods in any transmitter, and you will see that grid and plate current indications are used to indicate the peak tuned condition for each stage from the oscillator through to the power output. Most transmitters will include the essential grid and plate current meters for the final amplifier stage, and some will provide a means for metering each grid and plate in the entire strip. But for those circuits where the grids and plates are not all metered, use the Model 260 for tuning and see how much easier and more definite you tune the transmitter.

The power input to the final amplifier stage can be measured after tuning is complete. The final amplifier plate current either is, or can be, measured. With the Model 260, measure the amount of voltage applied to the plate of the final amplifier tube. This voltage value, multiplied by the current value, is equal to the wattage delivered into the plate circuit of the final amplifier stage.

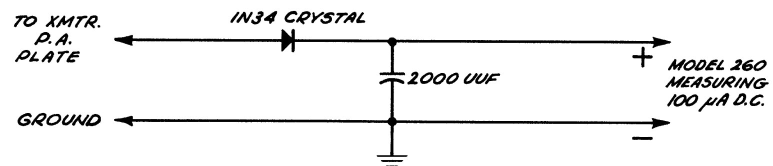


Figure 4. Accessory Circuit for Neutralizing a Transmitter with a Model 260.

Neutralizing the final stage is important to obtain the maximum operating efficiency of the transmitter. The Model 260 is used for this operation with an accessory which is easy to build. The diagram is shown in figure 4. To use it together with the Model 260 for neutralizing, first disconnect the B+ power lead to the plate of the final amplifier stage. Then connect the accessory leads across the plate-to-ground circuit in the transmitter, and the Model 260 leads across the output of the accessory. Set the range of the Model 260 at 100 microamperes. Then turn on the transmitter. Any reading on the meter will indicate that energy is being fed through the grid-to-plate capacity of the final stage. Adjust the neutralizing capacitor for a minimum indication on the 100 microampere range of the meter, and the transmitter is properly neutralized. Turn off the transmitter, remove the metering connection and reconnect the power lead for the plate voltage. The transmitter is now ready for operation with an assurance that the neutralization of the final stage is set properly.

The volume level meter is most useful for testing the speech amplifier and modulator circuits. Where a 500 ohm line connects the driver amplifier to the modulator stage, the meter can be connected to read directly the db (decibel) output of the driver stage. Furthermore, if the meter is left across this line while the point of 100% modulation is checked with an oscilloscope, a reference value for maximum volume level in terms of output voltage will be established for future use.

Transmitting tubes cost money, and one of the best ways to protect the tube and assure long life of it is to see that the filament voltage applied across it is maintained at a safe level. There are different values of filament voltage applied across the various tubes in most equipment, and seperate indications for each filament voltage would again involve an expense for a group of panel meters. For the amateur who has a Model 260, this is not necessary because the AC voltage ranges of the instrument will accurately measure every filament voltage in the transmitter, and periodic rechecks of these voltages will assure maximum tube life.

For the radio amateur who builds his own transmitter, there is a variety of uses for the Model 260. Of course, checking continuity and resistance of all circuits before applying any voltage is an obvious check during the construction of the unit, and when the voltage is first applied, a voltage and current check will help to analyze the general circuit operation. But there is one very different way in which he can use his Model 260. He can make up a meter circuit for his critical voltage and current readings which will use only one or two basic meters plus a switching arrangement and permanent conections inside the transmitter. He can create his own variety of full scale values for the indications on this meter, and each range can be calibrated with the

help of his Model 260. For example, suppose the final plate current should be 100 milliamperes for best operation, but it should not be allowed to go over 120 milliamperes as a protection to the tube. The basic movement which he is going to use could be a 1 milliampere D.C. movement with an internal resistance of about 50 ohms. He can choose a full scale value of 125 or 150 milliamperes, and then go about shunting the basic movement so that the full scale value of current through the movement and its shunt (in parallel with each other) will move the pointer to full scale. Use the Model 260 in series to measure when the proper current passes through the new meter circuit. Then, with the full scale value of current passing through the circuit, adjust the shunt until the reading on the 1 mil meter is full scale. The same meter can be changed into a 125 or 150 volt voltmeter by disconnecting the shunt and adding a series resistor to the meter movement. Since it is a 1 milliampere movement, the total resistance necessary in the circuit will be 1000 ohms per volt. With this calculation, it is possible to determine the approximate value of resistance to be added in series with the meter resistance to set up the desired full scale value. After the approximate value of resistance has been added, apply some voltage across the input to cause a deflection on the meter. Connect the Model 260 across the same voltage source and adjust the series resistance of the new meter circuit so the indicated voltage agrees with the reading on the Model 260. These 125 and 150 values were given for an example only. Almost any range can be established on the new meter circuit with the indication of value on the Model 260 used as a reference or standard.

Finally, there are dozens of points about amateur transmitters which should be checked frequently, but are usually not because there is no built-in meter connected to them. As an example, plate and screen voltages of a crystal oscillator may increase beyond the safe amount for the crystal itself. Continued application of too much voltage can fracture the crystal and make it useless. The grid drive requirements of pentode transmitting tubes are critical to assure maximum tube life and performance. The Model 260 should be used to measure these currents wthen there is no panel meter to show what they are. Leaky coupling capacitors can change the bias on speech amplifier tubes enough to distort the waveform of modulation and produce a garbled signal. The Model 260 can be used to spot these conditions quickly and easily. With a signal passing through the amplifier, the output meter, connected across electrolytic bypass condensers will indicate whether or not they are filtering this signal. If there is an A.C. hum in the output of the modullation circuit, and the output meter connected at the output of the power supply indicates that it is not present there, ground the microphone input and connect the output meter set on a low range, at the plate of each successive stage in the audio amplifier circuit. The tube which is causing this can be located by the fact that it will be the first stage which produces a reading on the meter.

In short, there are many special uses for a Simpson Model 260 around radio amateur transmitters and receivers, and its ranges are excellent for all these applications.

COMMUNICATION EQUIPMENT

POLICE, FIRE DEPARTMENTS, EMERGENCY VEHICLES, TAXICABS, BUSSES, TRAINS, BOATS, and AIRPLANES are all included in the fast growing list of two-way communication system installations Even PRIVATE AUTOMOBILES can now obtain this service from the telephone company in many areas. Each installation represents a complete transmitter and receiver, plus some kind of power supply. The dispatcher also requires all these items, and usually they are operated at relatively

higher power than the mobile equipment which he has to contact. Also, the ARMED FORCES use all varieties of communications equipment, from walkie-talkie units to high powered beamed transmitters which will send a signal half way around the world.

In each of these installations there is a use for the Model 260. All the Armed Forces have recognized this adaptability for years, and there are thousands of Model 260's which follmen assigned to all branches of work where they encounter electrical and electronic circuits.

The general uses are the same as were outlined for radio servicemen, transmitter engineers, and radio amateurs combined. There are many unique variations of power which are encountered in servicing this type of equipment. Many are powered from batteries, and the battery condition has to be checked to maintain the usefullness of the equipment. Some are powered from motor-generator units which furnish almost any voltage, either A.C. or D.C., and with a wide variety of frequencies. Some operate from a vibrator power supply which is in turn powered from an automobile or airplane battery system. But in every case, the amount and type of input voltage can be measured and identified with a Model 260. In many cases there is a tendency to have large line voltage fluctuations, especially from temporary or remote installations, and these can be checked frequently, or even constanly with a Model 260.

In a new installation of a police transmitter in one of the Chicago suburbs, a Model 260 was connected at the base of the transmitting tower and left there during the first month of operation. In periodic checks, the constant D.C. voltage value of 4000 volts was used as an indication that the transmitter was operating satisfactorily. After the month of operation in this manner, and the assurance that the transmitter was continuing to function properly, the Model 260 was disconnected and brought back into its normal variety of uses in the constant servicing and repairing of their mobile equipment at the police garage. It was, and still is, available for this specialized checking in addition to its normal uses around the service shop.

SCHOOLS AND EXPERIMENTAL LABORATORIES

High school physics students in the laboratory rarely use a Model 260, because they are just beginning to learn about electricity and all these measurement capabilities are not immediately required.

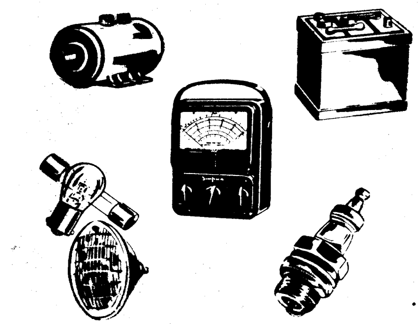
It is easier for them to use single-range meters with only one set of dial marks for each measurement in the circuit which they connect. However, the Model 260 is ideal for the INSTRUCTOR to use in rechecking the students' circuits, in trouble shooting them, in checking experimental setups before any voltage is applied, or in performing his own experiments. In each case, the single instrument has the wide range of circuits which will quickly duplicate any of the meter circuits of the single range instruments without their bulkiness and other features which interfere with the instructor's convenience. Hundreds of dollars worth of equipment and much valuable time can be saved by him when he uses the Model 260.

In COLLEGE AND RADIO SCHOOL LABORATORIES, the picture is different. Here the students are capable of appreciating and safely using a Model 260 Volt-Ohm-Milliammeter for their variety of circuit checks. Furthermore, most of these students will eventually be working in a position where they will be using the Model 260 to advantage, and the use of it during their training is highly practical. That is why Simpson Model 260's are used in the electronic and electrical laboratories of most leading colleges and universities in the Country. Radio and television trade schools also use many of these instruments for student experiments.

The Model 260 does the same fundamental job in EXPERIMENTAL AND RESEARCH LABORATORIES. All of them are using, in one form or another, electrical and electronic circuits. Whenever the technician, physicist, researcher, or engineer in a laboratory needs to know the value of an A.C. voltage,D.C. voltage, resistance, current, or audio frequency power level, the compact and durable Model 260 is always handy with dependable answers.

AUTOMOBILE GARAGES AND SERVICE STATIONS

There are a lot of applications for the Model 260 around AUTOMOTIVE REPAIR SHOPS and places where gasoline driven engines are repaired. The most obvious among these is measurement of battery and generator voltages both under load and with no load applied. The internal condition of the cells in a battery may be such that a voltmeter will register normal voltage across each cell with all the electrical equipment and the ignition turned off, and still will not have enough force to turn over the engine with the starter. The trick is to measure the voltages across the cells when a heavy load, such as the starter, is connected. At that time, the individual ability of each cell will be indicated by its voltage output. Worn or dead cells can be identified easily and definitely, and the requirements for correcting the trouble are obvious. If the cells are worn, and produce a low voltage, the battery



needs to be recharged. If any cell shows a voltage at or near zero under the load of the starter, the cell is dead and the battery will probably not take a charge, but needs to be replaced.

But there is much more to the electrical system of a modern automobile than the battery and starter circuit. There is an ignition circuit, a generator and voltage regulator circuit, a lighting circuit, and in many cars there is an electrical drive to open and close windows or to operate the panel indicating instruments. Then there is a circuit to the horn, to the radio, to the cigar lighter and clock, and to the fan in the air conditioning system. Different types of automobiles will have various electrical appliances attached to them such as directional signals, automatic temperature controllers, foot button radio tuning, auxiliary power switch under the accelerator, solenoid operated gear shifting, and a large variety of other electrical equipment. Each piece of added equipment requires another control and distribution circuit from the power source in the battery and generator circuit. Each new circuit increases the number of potential electrical system troubles in the automobile, and the Model 260 adapts easily into an ohmmeter or voltmeter which will help to locate the faults which develop. Usually, one wire circuits are used to carry the "hot" voltage through switches and control circuits to the light, motor, or relay or solenoid, and the other side of the unit is grounded so that the return path for the current is through the car body. If the insulation becomes frayed, or any connection point is bent so that the "hot" lead is grounded to the car body, the short circuit will cause a sudden heavy current drain on the battery and generator system. If the circuit is fused, the fuse will blow and all the equipment connected through the same fuse will be immediately cut off until the fault is corrected and the fuse replaced. Folks have come to look on automobiles as necessities, and the service station attendant or mechanic who has the proper tools to complete trouble shooting his jobs quickly and accurately, will save time for himself and his customer and increase his income.

The ohmmeter circuits of the Model 260 can help locate

open or high resistance circuits which prevent proper operation of the electrical equipment in the automobile. In many cases, continued vibration will loosen connections all through the car, and each loose connection invites dirt or oil film deposits on the metal surfaces which should be in good electrical contact. This results in poor, intermittent, and eventually, no operation of the part which the circuit feeds. Many cases of dim headlights and intermittent tail lights can be traced to this type of fault. To check any continuity or resistance, be sure the battery in the car is disconnected as a protection to the Model 260. Then test the resistance of the entire circuit, across the switch contacts, at each lead connection, and across the light bulb, motor, or other part which does not function properly. The high resistance can be located and defined. Once a trouble is defined, its correction is usually simple and quick.

Even if the repair man uses his Model 260 for nothing other than checks in the electrical distribution system, the instrument is a valuable asset. But there are many other less obvious jobs which it will do as easily and accurately as these. There are, for example, checks in the ignition system which may be made with the Model 260.

To see how ignition system checks can be made, take the case of a car which will not start, although the starter spins the motor briskly. Of course, the old time mechanic will say that a screwdriver from the head of the spark plug to a point near ground will show, with a spark across the gap, that there is a voltage being delivered for a spark. But with modern high-compression engines, this indication is no longer adequate. In fact, it always did leave the mechanic short of some vital information. First, use the 10 volt D.C. range of the Model 260 to see whether voltage is present between the low voltage coil terminal and ground when the ignition switch is turned on and the breaker points are closed. There should be about 6 volts on this test. Next, measure the voltage across the breaker points in the distributor case at a time when the points are open. This should also be about 6 volts. Now turn the engine over a little until the points are closed. At the time the points close, the voltage across them should drop to zero. If it does not drop all the way to zero, the surfaces of the points must be dirty or corroded, or there is some other reason why they are not making good electrical contact. Assuming the voltage does drop to zero when the points close, the next step is to check for leakage through the condenser which is in parallel with the breaker points. Turn off the ignition switch to remove the car battery voltage from the ignition circuit, and then connect the Model 260 leads, with the meter circuit set at R x 1000 across the breaker points. When the points are opened, there should be an infinite resistance across them, and the pointer will indicate the far left end of the dial scale. This is the same place where the meter reads zero for all indications except resistance. If the pointer moves into the scale to indicate any value of resistance at all, there is some leakage in the condenser, and the condenser must be replaced. On the other hand, if the resistance check reads infinite, as it should, the condenser is OK. It is very unusual, but possible, that a leakage resistance read across open breaker points found in this manner does not occur in the condenser, but is a high resistance short in the wiring leading into the low tension circuit at some point. To be sure, re-test the leakage resistance reading across the condenser alone after you have removed its lead from the connection point in the distributor case. If the condenser itself does not show leakage, then the fault is in the circuit and must be located and eliminated. The reason that no leakage can be tolerated across the open breaker points is that, at the time they are opened and high voltage is supposd to be produced for an instant spark, the current through the leakage path will slow down the rapid collapse of the magnetic field around the secondary coil, and too low a voltage will be induced in this secondary. If the voltage is too low, a poor spark, if any at all, will be the result in the engine.

If there is no trouble which has been identified in the ignition system with the tests so far, the next step is to remove the high tension lead which connects into the center of the distributor cap. Connect the Model 260 as an ohmmeter across the circuit from this lead through the secondary and

then the primary of the ignition coil to ground. In some cars, the breaker points may be located between the low end of the primary winding and ground. If this is true, the points must be closed to assure a continuity. The resistance of this path will vary with different models and brands, but there should be continuity with some value of resistance in the circuit. If the check reveals an open circuit, it may be at one of the connection points or it may be in the ignition coil windings. Localize it with the ohmmeter across the parts of the circuit. If the engine still fails to fire after these tests are complete, you can be reasonably sure that the fault is not in the ignition system.

For another trouble condition, and a typical trouble shooting procedure, consider the case when the starter barely turns over the engine. Leave the ignition key off and connect the Model 260, set for 10 Volts D.C., at the terminals of the battery. Then operate the starter and read the battery voltage while the starter is connected. If the reading is at least 5.1 volts at this time, the battery is probably OK. If not, check across each individual cell (with the starter connected) and you will be able to spot a weak or "dead" cell. The weaker the cell is, the lower its voltage will be under the starter load. If the battery is producing enough voltage, connect the voltmeter leads across the circuit from the grounded battery terminal to the frame of the starter. Reduce the Model 260 range to 2.5 volts D.C. for better indications in this test. Now push the starter switch again. There should be not more than a very small fraction of a volt across this path. If there is any appreciable voltage, check the ground lead of the battery for good connection to the battery and to the frame of the car, and then the mounting of the starter frame. There should be good clean mechanical joints at all these connections to insure good electrical continuity through them. If the loose or dirty contact can not be seen, measure the voltage from battery post to ground strap, from ground strap to car frame, from the frame to the engine, and from the engine to the starter case. Whichever of these connections is at fault, the voltage across it will serve to identify it. Similar tests across the starter switch, or solenoid points, and between the battery's ungrounded terminal and its cable, etc., on the "hot" side of the voltage line will indicate poor contact in this circuit. If the battery delivers a full five volts across the starter terminals while the starter is connected, and the starter still does not turn rapidly as it should, the trouble is probably in the starter itself. It should be taken out of the engine for testing. Again, use the Model 260 on a resistance setting to test for shorts, open windings, and grounds in the armature, field coils, or commutator.

When the panel ammeter shows that there is no charging of the battery while the engine is running, or if the ammeter registers in the discharge area, the Model 260, set for 10 volts D. C. again, will help to recheck this and to locate the trouble. First connect the voltmeter across the output of the generator armature terminals and determine whether or not the generator is producing a voltage, and if it is, measure the amount of voltage. If the generator voltage reads at or below the battery voltage, the generator is not operating correctly and is not performing its normal functions. If the engine speed is increased, the generator voltage should increase with it. If the voltage output from the generator is only 1/4 to 1/2 volt, and fails to build up beyond that point, there is probably a faulty or open connection in the voltage regulator or in the field coils of the generator. If there is no voltage output, check the brushes and commutator, and if you find they are satisfactory, see whether the field poles are demagnetized. This loss of residual magnetic strength in the field poles is very unlikely except when the generator has been unused over a long period of time. If the generator has no residual magnetism, "flash" the field by applying the battery voltage across the terminals of its field coil. Just touch the terminals quickly while the engine is running, and the armature should immediately generate a voltage. If the generator is putting out a normal voltage, see whether this voltage is present at the voltage regulator and then at the cut-out. If it reaches the cut-out, measure the voltage across the terminals between the heavy leads. There should be zero voltage across these terminals. If there is any voltage

across these points, they are not making good electrical contact. An open circuit, or a high resistance connection through the energizing coil of the cut-out can prevent the points from closing, or dirty or pitted contact surfaces can prevent good electrical contact through them. Lower than normal voltage output from the generator can be caused by similar conditions in the voltage regulator.

If, on the other hand, the voltages all read normally, and the circuit appears to be functioning properly, the panel meter may be operating incorrectly, or its connections may have become loosened or dirty.

An indicated high rate of charge is normal for a short time after starting an engine, but this should not last for long if the battery itself is in a good state of charge. If a continued high charging rate is indicated, measure the output voltage of the generator. A higher than normal voltage from the generator indicates faulty operation of the voltage regulator, or that its regulating action is shorted out.

Shorts and grounds are measured with the ohmmeter circuits of the Model 260. If a particular circuit fuse blows out each time its circuit switch is turned on, first disconnect the car battery. Then set the Model 260 range switch for R x 1 and connect it from the fuse clip (away from the battery side) to the car frame. The reading will probably be near zero ohms. Leave the ohmmeter connected in this position and methodically move wires, wiggle connections, etc., in the affected circuit one at a time until the ohmmeter pointer swings back to the left. When this happens, the short has been cleared and you can inspect the area to see why it was present. If the circuit is one which normally draws heavy current, such as the headlights, the normal resistance is quite low. In these circuits, it will help to disconnect the low resistance device so the circuit will show a very high resistance when the short is cleared.

In some cases, a short is not enough to blow a fuse, but causes the battery to discharge while the car is not in use. The current may be strong enough to be indicated on the ammeter of the car, or it may be only a fraction of an ampere, and not be noticed on the panel meter. If this is suspected, disconnect the cable from the ungrounded battery post and measure the resistance from this "hot" cable to ground with the Model 260 set for resistance. The resistance value here should be at least several hundred ohms; the exact value will depend on the age of the car, condition of insulation, and the number of continuous drain accessories which are on the car. An example would be an electric clock, which is not consuming current all the time, but frequently turns on its own switch for winding its spring. With the ohmmeter connected, move wires and connections until the short is located and cleared. It is cleared, as before, when the pointer swings back to the left on the ohms scale.

There is another unusual, but practical, use for the Model 260. In order to assure a good spark at high speeds, the breaker points must be closed most of the time, and only be opened long enough to break a circuit and cause a spark each time it is needed. In different brands of equipment, this relative amount of time during which the breaker points are closed is measured as a percentage of the time between sparks. On one set of equipment, this percentage needs to be 80% for best performance, while on another it is 60%. The Model 260 can be used to measure this percent of dwelling time for a set of operating points. Disconnect the low tension lead from the ignition coil, and connect the test leads of the Model 260 to this lead and to the connection from which it was detached. This places the Model 260 in series with the low tension circuit of the ignition coil. Connect the Model 260 for its 10 ampere D.C. range and then turn on the ignition switch of the car. There will be a current reading on the meter if the breaker points are closed. If they are open, and there is no current reading, either turn over the engine until they are closed, or short out across the points in the distributor case with the end of a screwdriver, or some such convenient piece of metal. Be sure to make a good contact, but be careful to prevent bending the points or damaging them in any way. This current value will be used as a reference. Now start the engine and measure the current through the same meter circuit again. It

will be less current than the reference value, and the smaller current value, divided by the reference value obtained above will indicate the relative time during which the breaker points are closed. Change the fraction to a percentage, and this result is the percent of dwelling time. If degrees of dwell are desired, multiply the number of degrees of engine rotation per cylinder by the percentage of dwell time.

Rather than trust your eye to determine the exact time when a set of points open (during timing, for instance), use the ohmmeter setting of the Model 260 and conncet one lead to each point. The instant the points open, the resistance jumps from zero to infinity, and this is one of the best methods known for identifying this condition with precise accuracy. The ohmmeter can also be used to trace wires through cables, to check fuses, lamp bulbs and cigarette lighter elements, for testing switches and relays, for finding the ground in a radio antenna, and for many other uses which will suggest themselves to an experienced mechanic. Owning and learning to use a Simpson Model 260 Volt-Ohm-Milliammeter will do more to take the headaches out of servicing automobile, truck and bus electrical systems than any other piece of test equipment can do.

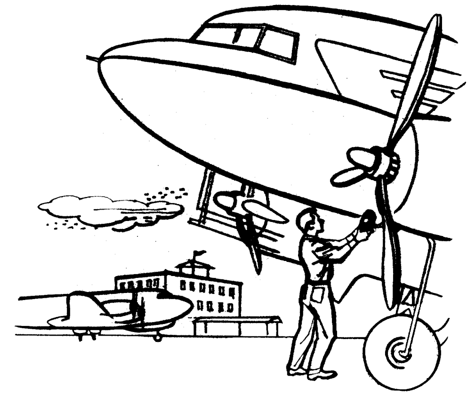
More and more garages and automobile service shops are getting into AUTOMOBILE RADIO installation and service. There are special techniques involved in servicing car radios over and above those standard radios. The polarity of power input must match the system of the battery circuit in the car. Some brands ground the negative terminal of the battery, while others ground the positive terminal. The power input to the radio requires that either a negative, or a positive, grounded circuit be applied to it, but it will not operate when it is put into a car with the opposite grounding system. The radio usually will contain a vibrator power supply to create its own high voltage. The filtering of this high voltage uses different values of component parts than are found in home radios. Some have electrically actuated circuits to change the tuning between selected station frequencies. The antenna system has to be mounted in, but insulated from, the framework of the car. The Model 260, with its many ranges of voltage, current, and resistance readings all quickly available, will help identify electrical characteristics for all these problems as well as the standard kinds of radio servicing problems which are common to car radios, too.

The 1953 lines of cars in several brands adopted 12 volt battery systems rather than staying with the 6 volt systems which have been almost universal for so many years. The increased battery voltage is necessary because of the increase in the number of electrical units in use in the modern cars. This will allow operation of more equipment with less current than the 6 volt systems would allow. Whenever you are working on a 12 volt system, use the 50 volt range of the D.C. Voltmeter circuit rather than the 10 volt range mentioned in the text. Voltage readings at all points in the circuit can be expected to double, and resistances of individual circuits will be about four times as great. The currents will be half as great as in similar circuits of a 6 volt system.

General GASOLINE ENGINE POWERED EQUIPMENT servicing problems will be similar to many of the problems listed for automobile servicing. In most cases, the system will have a battery. There will be an ignition circuit, which may be either the type used in automobiles or one which uses a magneto. The magneto system is very similar in operation, except that a rotating permanent magnet is used to generate a voltage and send a current through a low tension circuit; then when this current is maximum, breaker points open and the magnetic field collapses rapidly around a secondary winding to produce a high voltage for the spark. The same condenser is included across the breaker points to help collapse the field rapidly. The voltage and current in this type of ignition system is A.C. instead of the D.C. of a battery ignition system, so the current measurement method of measuring dwell percentage time of the breaker points can not be used on this system. All the continuity checks of the system are the same as in a battery ignition system, however, and the critical measurements are the same.

AIRCRAFT SERVICE

The electrical systems in AIRPLANES are similar to those in automobiles, except for the fact that there is more voltage, a larger distribution system, magneto ignition, and usually multiple generator operation (at least one on each engine). The servicing suggestions, using the Model 260, for automobile maintenance and repair, all apply to aircraft maintenance and repair as well. Voltage and continuity checks of the various systems in planes will spot troubles in the same way as they do in automobiles. In addition, the compactness and availability of so many circuits and ranges makes the Model 260 easy to carry into the crowed areas of the plane where checks must be made periodically, and to have each meter circuit where and when it is needed.



There are extensive books of theory and service procedures which have been written about the subject of aircraft electrical maintenance. The mechanic who performs these services often has to become a specialized technician to perform the electrical service alone. And, as his jobs multiply, he becomes increasingly appreciative of his Model 260 Volt-Ohm-Milliammeter because it still has the necessary ranges and accuracy which he needs for each new application. On multi-engine planes, he must "parallel" the generators. This process consists of measuring, very accurately, the output voltage of each generator under load at the point where they are all connected together to see that each one produces the same voltage as the others, and shares the current load in operation. If any generator voltage is slightly lower than the others, it will not supply current into the distribution circuit of the plane, and the other generators have to share the current which the one does not furnish. Worse than that, though, the low voltage generator actually takes current from the system, acting as a motor rather than as a generator, and increases the total demand for current from the remaining generators. On the other hand, a slightly high generator voltage from one unit will cause it to try to furnish all the current demands of the entire plane, and this can, and frequently is, enough to burn out the windings on its armature during flight. The fact that these problems can come up while the airplane is flying makes accurate adjustments and inspection checks much more important than they would be in a similar system in a fixed position, anchored to the ground. The larger planes will also have auxiliary power plants on board which are gasoline driven motor-generators available for auxiliary and emergency use. If they are to be used for auxiliary service, their output voltage must be adjusted to the same value as the main generators on the engines, in order to complete paralleling all the available generators on the plane.

Most large airplanes have an alternating current voltage system in addition to the direct current system. This is powered by an inverter, which is an A.C. generator driven by a D.C. motor. The output voltage furnished to this system, and its frequency, will vary from one installation to another, but the A.C. voltage ranges of the Model 260 can be used to measure the voltage from any of these inverters, and through its distribution circuits. A.C. voltages are furnished to some types of position indicating devices, to radio equipment, to flourescent lighting fixtures, and on commercial passenger planes, to convenience outlets in the washrooms.

There is one unique safety system which is installed on many large planes, but is used so seldom that it may be neglected unless the electrical maintainer has a convenient

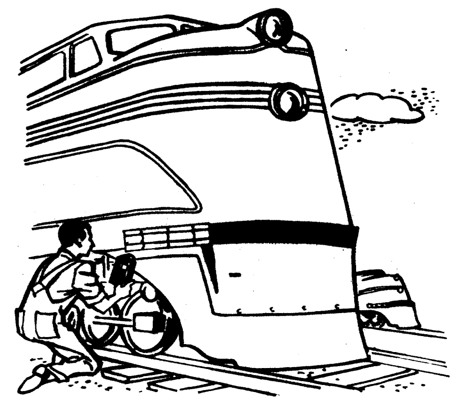
meter to use in tracing the circuits of the system. This is a circuit which will blow a horn over the pilot's head if the wheels are not down and locked when he throttles his engine down for a landing. Of course, the system must be entirely automatic to do a safety job. There are limit switches attached in the mechanical linkage of each retractible appendage on the bottom of the plane, and these switches, all in parallel, are closed until the gear snaps into its locked position ready for landing. Then there is a switch which will be actuated by each throttle linkage in the pilot's compartment, and these are all in parallel with each other. They are normally open, but will be closed when the throttle retards the speed of its engine. Now, if any landing gear is not down and locked, throttling down any one engine, or all engines together, will press a switch to complete a horn circuit and blast a warning in the pilot's ear. This system has been responsible for saving many lives by warning a pilot that his landing gear will collapse unless he remedies the situation. Of course, if the maintenance man fails to check on the condition of the electrical circuit of this system, it can easily be defective and fail to provide the warning for which it was intended. This is characteristic of many such circuits on modern airplanes, and everyone who flys depends directly or indirectly on the men who periodically check and recheck the voltages, currents, and continuities and resistances of all the complex and widespread electrical circuits in planes.

During flight, large planes carry one man on the crew—a FLIGHT ENGINEER—whose duties consist of watching a large group of indicating instruments to constantly check on the operation of the vital components of the plane. Most of his indicating instruments are electrical, and many of them measure electrical characteristics of the plane's operation. If he sees an indication of trouble on his instruments, his duties then extend to maintenance and repair while the plane is still in flight. With a Model 260, he is able to go into fuse and junction boxes to trace the affected circuit and locate and identify the source of trouble. He may need to measure D.C. voltage, A.C. voltage, or continuity or resistance, or he may need to measure more than one of these qualities as he goes through the circuit check, but he has them all in the one single case of his Model 260, and he can operate more efficiently and quickly than if he had to go back through the plane to get another instrument, or worse yet, to look at the junction or fuse and decide that it "must be OK because it looks OK". He cannot afford to work in that manner when his life and the lives of his fellow crew members are in danger.

Other electrical and electronic components and systems on a plane to which the Model 260 is applied form an amazing list. But here are some of them: intercom; direction finding; radar; blind-landing; fuel booster pumps; anti-icers; propellor controller and fast feather pump; fuel level, temperature, and pressure indicators operating autosyn or selsyn instruments; thermocouple instruments to measure engine temperatures; automatic pilots; fuel transfer pumps; remote controlled power switches and solenoids; electronic control of turbo-supercharger waste gate; servo-mechanisms; and alarm bells. Of course, not every airplane flying has all these circuits and systems, but all planes will have some of them, and there are many more which are added to the operation of some of the sky-giants. Any airplane electrical operating equipment list appears fantastic, but even more fantastic is the fact that there is one instrument which can be used to indicate electrical and electronic conditions of every one of these circuits. The Simpson Model 260 Volt-Ohm-Milliammeter has some voltage range and some resistance range always available to match each requirement in testing and trouble shooting any circuit in the entire fantastic list.

COMMERICIAL TRANSPORTATION

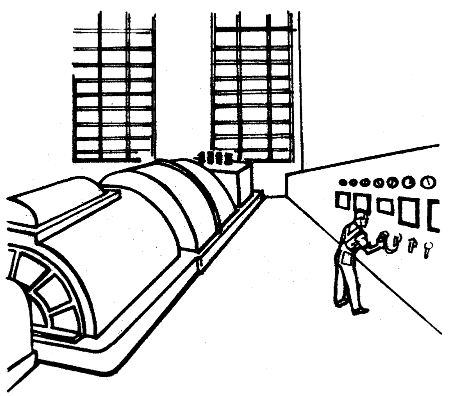
Other vehicles are used for commercial transportation besides cars and airplanes. TROLLEYS, BUSSES, TRAINS, and SHIPS all have elaborate electrical systems. In fact, street cars and some trains operate entirely from their electrical pickups. Their motive power and speed controls, air conditioning and temperature control circuits, lighting, intercommunication systems ranging from the buzzers on street cars to the complete telephone or radio system on the modern train, and pressure pumps for air and hydraulic systems all operate from electrical input. Diesel trains work the same way, except that they use their diesel engines to drive electric generators and carry their own power plant right on board rather than pick it up from the distribution from a fixed power station. There are many large ocean going vessels in use today which operate completely on the electrical output of a big generator system. The engine room has been changed into a high power generating station. The propellors and rudder are driven by huge electric motors. And the same generator furnishes power for all the other operating devices on board the entire ship. Some furnish enough power to answer the electrical needs of an average city.



Each of these varied types of installation will have distribution systems, fuses and circuit breakers, and operating parts which are all subject to the same general kinds of electrical faults possible in any other system. And, since the Model 260 can measure any A.C. voltage from zero to 5000, any D.C. voltage from zero to 25000, and D.C. current from zero through one microampere to 10 amperes, and any resistance from a fraction of one ohm through 20 million ohms to infinity, most of the electrical characteristics of all these circuits can be measured and identified with it. If there is any radio or other electronic equipment installed, the same meter will help to service them too. It fits into all the problems of installing, maintaining, and trouble shooting the generating and distributing systems as well as the appliances which they serve.

POWER GENERATION AND DISTRIBUTION

There are some higher voltages and currents involved in the operations of large power generator installations than can be measured with a Model 260. These large values are the first which anyone associates with its normal operating characteristics. However, there are many automatic and manually controlled circuits which have to be used to regulate the output from the main generation system, and these will operate within the ranges available on the Model 260. Voltage, resistance, and continuity measurements are made with the Model 260 on these control circuits during installation, maintenance, and trouble shooting procedures to help identify correct and incorrect circuit connections and conditions.



Before a new unit sub is placed in operation, a precheck of the entire layout will help to insure satisfactory service from the minute the main switch is closed. The Model 260 is used to measure the voltages applied across relay coils, and the amount of voltage which will close them or allow them to open up. Then it will measure the resistance values of the

relay voltage dropping resistors, and for continuity in the resistance-capacity type relays. It will detect under voltage conditions at the relay points, faulty insulation, broken windings and poor connections, and a lot of other potential trouble makers in the components and connections of the unit sub before they are responsible for interrupted service to the customers at a later time.

The method used to measure INSULATION RESISTANCE is a simple one and is easy to apply whenever a strong voltage is present in a circuit. After measuring the voltage present at junction points or terminals, move one probe back over the insulation on the lead to the contact point just used. If there is any reading on the voltmeter, a ratio of this reading to the circuit voltage is the same as a ratio of the voltmeter circuit resistance to a value which is the sum of the meter resistance and the insulation resistance. By proportion, this last value can be calculated, and then the insulation resistance is the difference between the calculated amount and the meter circuit resistance. As an example, suppose that a 100 volt D.C. value is read across two terminals in a circuit. The Voltmeter circuit of the Model 260 is set to a range of 250 volts for this measurement, and has a resistance of 5 megohms. Moving the positive probe back over the insulation around the positive power lead to a physically weak spot in the insulation, the Model 260, still set on the 250 volt range, reads 10 volts. The ratio of the two voltage readings is 10 to 100 (or 1 to 10). Then the 5 megohm meter resistance is 1/10 of the total resistance through the meter plus the insulation, and this total value must be 50 megohms. Subtract the meter resistance of 5 megohms, and the remaining 45 megohms is the value of insulation resistance which is indicated.

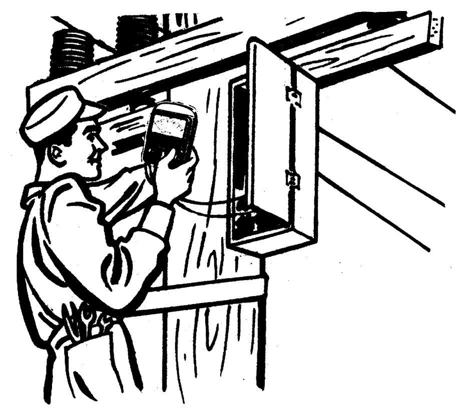
Probably one of the most important uses for a Model 260 is highlighted in times of disaster when extensive damage has been done to electrical installations over a large area by floods, electrical storms, tornadoes or hurricanes. Then every SALVAGE CREW must have a dependable and sturdy multimeter, such as the Model 260, if it is to work rapidly and safely. Wires must be checked for voltage before they are handled. Motor, relay, and solenoid windings must be tested for grounds and shorts caused by moisture or physical damage before any voltage is applied to them again. Power lines can be checked for proper voltage before they are used. Dangerous shorts can be detected and eliminated. Usable and useless equipment can be quickly identified and sorted. Past experiences like the great floods in the Ohio Valley have shown the emergency values of the Model 260, and they only add to the impressive day-to-day list of normal uses for the instrument.

In some of the less heavily populated areas of the country, electric power is still relatively new. In some cases the power lines may be strung across miles of distance between farms or ranch houses. When the remote location does receive electric power, the people who live there naturally want to install new appliances and devices to help them live better. A case of this type comes from a story we received from an appliance store in South Dakota. They sold, among other things, a new automatic washing machine to the customer, and installed it and checked it out as working OK at the customer's home. The same customer invested in some other electrical equipment which required a large current during normal operation. So did a couple of his neighbors several miles down the road, on the same power distribution line. One day, for no apparent reason, the customer found that the automatic washer would not operate, and so they called the store in the city to come and fix it. After the normal trouble shooting procedures showed no apparent trouble, the service man switched his Model 260 to A.C. volts and found that the power line voltage available was only 90 volts. This was caused by the fact that the long distribution leads for power, together with the rapidly increasing demands for power along the line, had reduced the voltage at the end of the line down to a small amount. The solenoids and relays which operate the automatic sequences of these washers will not actuate at this low a voltage, and thus the trouble was identified—not in the appliance, but in the available voltage. Needless to say the custom has now been adopted by all the appliance repairmen in the areas affected in this manner of checking the line voltage as a pri-

to be measured in testing and maintaining the equipment. mary source of trouble. It answers lots of questions in a hurry.

TELEPHONE WORK

Telephone lines do not carry the high voltages or the heavy currents which power lines do, but the tiny currents which they do carry are of extreme importance. The Model 260 has long been a favorite piece of test equipment among the men who service telephone equipment. The ohmmeter circuits will help to locate and identify shorts, grounds, and crossed wires, the resistance of relay coils, leaking capacitors, loose and dirty connections, and faults in switchboards and telephone instruments. The A.C. and D.C. voltage scales are used to measure the voltages in the power circuits, required voltage and available voltage across the many relay coils and coils of such devices as distributors, line finders, directors and connectors, alarm systems, and the many other devices hidden within the operation of such a system. The general public is well aware of the fact that a telephone rings, but relatively few know that the telephone company has to generate and distribute a special voltage to make it ring. This voltage and its distribution has to be checked and tested frequently to insure continued service. The A.C. voltage ranges of the Model 260 will measure the necessary information. The 2.5 volt D.C. range is used to check the terminal voltage of individual wet and dry cells. Every telephone company has,



among its power equipment, a very large capacity battery of wet cells which is capable of furnishing all the power requirements of the company for several hours on an emergency basis. These wet cells are usually arranged on specially built racks in an air-conditioned battery room, and can be connected into the power circuit on a moment's notice if the main generator and the standby generator should suddenly go out of operation at the same time. This can happen in the case of a power failure, because most of the generators are rotated by electric motors which operate on power from a commercial power source. And so this giant battery is kept continuously in the best possible condition, always ready for emergency use. A trickle charge passes through these cells constantly from the main voltage source of the station. The voltage of each cell is measured and recorded to detect a deterioration of any cell in the battery, so that it can be replaced quickly, maintaining the emergency insurance which is its function.

Output voltages have to be measured frequently in telephone work, and the Model 260 output circuits are ideally suited to these measurements. The voltage used as a carrier in local telephone circuits is D.C., and the voice modulation superimposed on it is A.C. So to check the ability of any part of the network to respond to, or to create, the sound modulation, the output circuit, which measures only the A.C. component of this mixture, will indicate a necessary characteristic.

New developments in the field of long distance telephony have added complex electronic circuits to the list of items which the service man must install and maintain. He now has to service and install microwave transmitters and receivers, together with their power supplies, and to maintain fixed frequency oscillators to use as carriers through coaxial cables. Again, as in all the electronic applications listed in so many other fields of every day work, the Model 260 is used to indicate all the necessary circuit characteristics

INDUSTRIAL PLANT MAINTENANCE

The maintenance of a modern industrial plant involves as much work in the electrical and electronic circuits as it does in the mechanical devices which it uses. There are control and power circuits for almost any major operation which can be devised. Many of these will involve automatically operated sequence controls for performing all the tasks of producing an item from raw materials without the constant attention of an individual operator. Two or three men may operate a printing press a city block long, printing a hundred thousand pages of three or four color copy on both sides of the sheet every hour. To illustrate an application of automatic production (automation) a piece of steel rod can be placed between the jaws of a machine, a button pressed, and the operator can go away to perform some other duty. When he returns after a fixed time, the machine will turn itself off and stand ready to repeat the job on the next piece of rod. In the meantime, the machine may have finished the rod for use in fabricating some delicate and expensive device, or it may have been heat treated under controlled conditions of temperature, humidity, and time. It may have been polished and plated, sliced, split, bent, drilled, or any one of hundreds of other possible operations may have been imposed on it, with a fixed sequence and combination determined in the orginінal design and set-up of the machine which does the job. But an oil film or a little dirt accumulation over the surface of one pair of relay contacts can stop the entire process at any point along the line. There may be a thousand of these relay contacts involved in the sequence controlling of a

single automatic machine, and many of the relays, in addition to making some particular portion of the operation take place at the exact time when it is needed, will also send voltage into a circuit which operates the next item in the sequence. There may be an added series switch, which is actuated at the limit of movement of the material being machined, or it may be a time switch, but it will delay the start of the next operation until the present one has been completed. Trouble shooting and maintaining these complex control boxes full of relays and switches is easier when the compact Model 260 is used to measure the voltages, resistances, and continuities of the circuits.

Many different size electric motors are required in the operation of any industrial plant, and the voltage requirements may be almost as varied as their sizes. As an example, one small plant is using one or more motors with each of these voltage input requirements: 110 volts A.C., single phase; 220 volts A.C. single phase; 220 volts A.C. split phase; 220 volts A.C. three phase; and 440 volts A.C. three phase. In addition, there was a 12 volt D.C. source distributed to a number of places where it was needed in the operation of the lines. This variety of voltages, all distributed through the same general area, demand that voltage measurements be made when locating the leads of any one particular supply. The Model 260 has all the ranges necessary for this variety of voltage measurements in the sample plant.

The motors installed in the plant mentioned in the paragraph above are assigned to heavy duty operations, and sometimes are strained beyond their ability so that they overheat and burn out a winding, or produce some similar result. In any case, they become defective, and are removed and replaced as quickly as possible. Of course, they usually reduce the mechanical loading to protect the new motor from burning out in the same operation. One day, not long ago, they had a burn out in a 220 volt three phase motor, and went about replacing it in the normal manner. When its replacement was placed into service, under even a reduced mechanical load, it burned out very quickly. Trouble shooting the situation included voltage checks with a Model 260, and

the source of the trouble was very easy to spot with this instrument. It turned out that a center-ground on one of the three phases of the input voltage circuit had reduced the voltage available on one leg of the three phase circuit to only 110 volts. This out of balance condition caused abnormally high currents to flow through the windings using the other two phases to compensate for the weaknesses in the low voltage source. This very unusual, but possible, condition cost the plant two expensive motors before it was identified with the Model 260, and then eliminated. Results like this help explain the attitude reflected by a plant manager in his testimonial concerning his experiences with the Model 260. He said, "My maintenance men are primarily mechanical, and were afraid to tackle most of the electrical problems. Recently I furnished each of these men with a Model 260 and helped explain what it was and how to use it. After that, they experimented on the circuits around the shop. Now you can't take a Model 260 away from any of these men, and they are doing an excellent job with the electrical maintenance problems which come up all the time."

Adjustment and repair of electronic devices such as process controls, steam controls, voltage controls, speed controls, intercommunication systems, relaying and welding controls, and smoke detection circuits, together with the servo-mechanisms which they actuate and control, require voltage, continuity, and resistance measurements. These can all be made with the Model 260. Many special industrial circuits, using thyratrons and ignitrons, and even the brand new transistors, offer more opportunities for the maintenance man to use his Model 260 for the advantages which it offers.

ELECTRICAL INSTALLATION

There are many problems which the installation electrician faces and which the Model 260 will help solve in a hurry. The ohmmeter will quickly identify a short inside conduit, BX, or Romex. A single flashlight cell connected across a complete input circuit in a new wiring job will furnish 1.5

volts through the entire circuit which may then be read with the Model 260, set at the 2.5 volt D.C. range, at the junction boxes, outlets, and switch connections along the line. This serves to identify continuity, proper color coding of the wires, the absence of shorts, correct switching action, and a general assurance that the system will work as it should when power is applied to it. On three wire systems leading to appliances like stoves, and between "three-way" switches, different voltages can be applied from batteries on each side of a ground or reference wire to help identify each of the three wires at any junction or outlet along the line. Use the Model 260 on the 10 volt D.C. range to measure either of the battery voltages, and apply 1.5 volts on one pair of wires, and 3 volts on the other.

The voltmeter circuit of the Model 260 can be used to detect and identify unwanted voltages on the frame of a piece of electrical equipment. The voltmeter or the ohmmeter can then be used to locate the short or leakage which is causing this trouble.

OTHER USES

The appliance repair shop, the hobby store, the hotel and building maintenance department, railroad signal crews, heating contractor, photographer, theatre projection and sound equipment technicians are all among others who stand side by side in using this testing meter to provide the answers which they need for their electrical and electronic installation and maintenance problems. The wide range of settings possible for each of its measurement capabilities, its accuracy and dependability, its ruggedness and portability, and its small outside dimensions but large easy-to-read dial, all provide reasons why the Simpson Model 260 Volt-Ohm-Milliammeter is the must for the men who work in any part of the electrical and electronic industry.

SIMPSON ELECTRIC COMPANY

5200 WEST KINZIE STREET • EStebrook 9-1121 • CHICAGO 44, ILLINOIS

IN CANADA: BACH-SIMPSON, LTD. • LONDON, ONTARIO

260 4-53 25M SP Printed in U.S.A.