

training chart manual



**FUNDAMENTALS
OF ELECTRICITY
AND MAGNETISM**

Delco Remy 

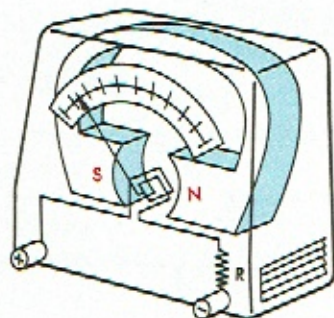
Besides reducing the magnitude of changing or transient voltages, capacitors are used in ignition amplifiers to store a charge of electricity, until the charge can be transferred to another part of the circuit. The functions of the capacitor in the various circuits, such as charging and ignition, are covered in more detail in training manuals relating to these subjects.

test meters

The use of test meters is an invaluable and essential aid in diagnosing troubles in an electrical circuit. If values of voltage, current and resistance are not measured with suitable test meters, only a guess can be made as to what type of defect exists in the circuit.

voltmeters

Most voltmeters are of the moving coil type which consists of a permanent horseshoe magnet and a movable coil. Current flowing through the movable coil reacts with the permanent magnetic field, causing the coil to turn against a slight spring tension. The relative movement of the coil is in direct proportion to the amount of current flowing in the coil, which in turn is proportional to the amount of voltage to which the voltmeter is connected. A pointer attached to the coil moves across a scale calibrated in volts to indicate directly the value of the voltage being measured.



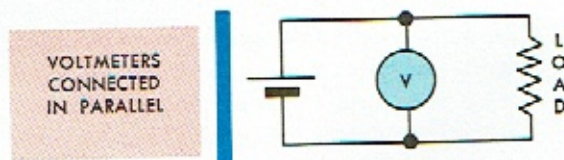
VOLTMETER

Because the moving coil is very small and sensitive, the current through the coil must be limited to safe values. To accomplish this, voltmeters are constructed with an internal resistor in series with the coil to limit the current to a safe value. The voltmeter scale is calibrated accordingly in order to indicate the true voltage.

The voltmeter resistance is often printed on the face of the meter, and usually is specified in ohms per volt. If the voltmeter resistance is 1,000 ohms per volt, and the 20-volt scale on the meter is being used, the voltmeter internal resistance is $1,000 \times 20 = 20,000$ ohms.

Voltmeters having a choice of scales have a selector knob to insert different resistor values in series with the moving coil. The selector knob would choose an internal resistance of 10,000 ohms for a 10-volt scale, thus adhering to the 1,000 ohms per volt specification. In general, the higher the ohms per volt rating the more sensitive the voltmeter.

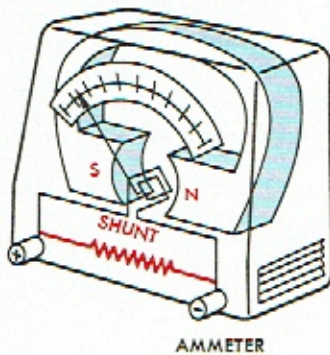
Voltmeters are connected across (in parallel with) the voltage to be measured. Since the voltmeter has a high resistance, adding this component to the circuit will change the total circuit current very little, and the voltage reading obtained indicates the true voltage present without the meter in the circuit.



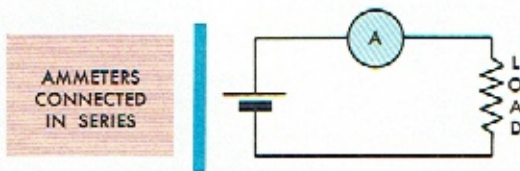
ammeters

Ammeters also may be of the moving coil type, and differ from voltmeters in that a low resistance shunt is used internally or externally in place of a high resistance. The shunt is connected in parallel with the moving coil, and conducts the major part of the current

being measured, leaving only a small portion to flow through the moving coil. The ammeter scale is calibrated in amperes to indicate the total circuit current, since the pointer deflection is directly proportional to the total current flow in the circuit.



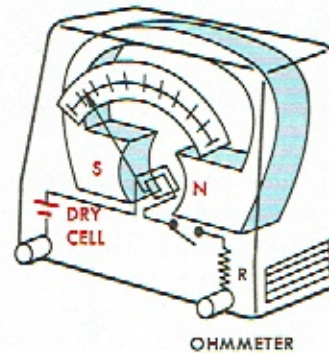
Since the ammeter has a very low resistance, it must be connected in series in the circuit, and never across the voltage source. If connected across the voltage source, such as a battery, the meter may be instantly damaged. Having a very low resistance, connecting the ammeter in series does not introduce any appreciable added resistance to the circuit that would alter the true current flow.



ohmmeters

An ohmmeter also may be of the moving coil type, and contains a resistor and dry cell battery connected internally to the moving coil. When the ohmmeter is connected to a resistor, the current flow through the moving coil is directly related to the value of the resistor, and the scale is calibrated accordingly to indicate the resistor value in ohms.

Ohmmeters should never be connected to an external source of voltage, as the meter movement may be damaged.



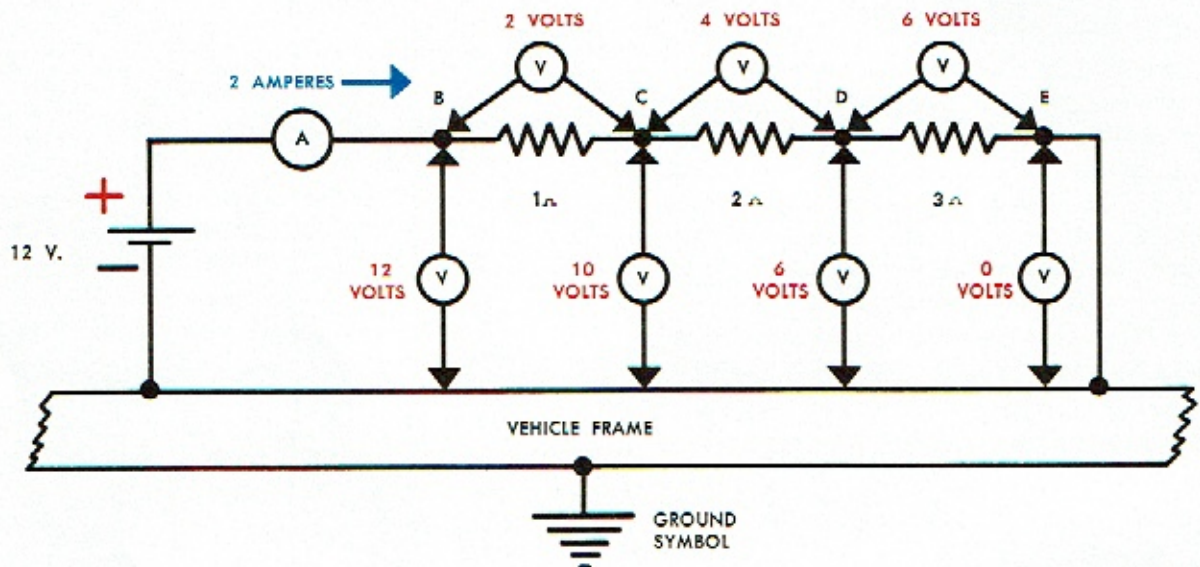
test procedures

Test procedures usually involve using meters to determine if any part of the circuit is open, grounded, or shorted.

An open consists of a break or interruption in the circuit such as a wire that has come loose, or a slip connection that is not making contact.

A ground occurs whenever any part of the wiring circuit inadvertently is touching the vehicle frame. A ground involves accidental

If any part of the circuit should become open, the ammeter would read zero current. If the open occurred in the one-ohm resistor, a voltmeter connected from C to ground would read zero. However, if the voltmeter is connected instead to points B and C, the reading will be 12 volts. The reason is that the battery, ammeter, voltmeter, two-ohm resistor, and three-ohm resistor are all connected together to form a series circuit. The two-ohm and three-ohm resistor have very



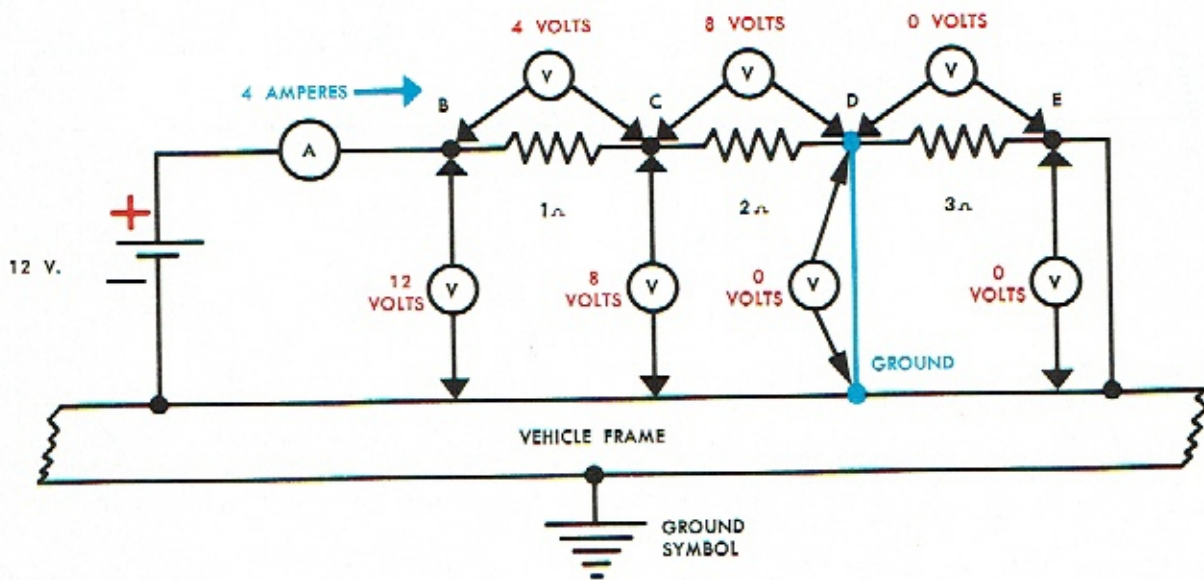
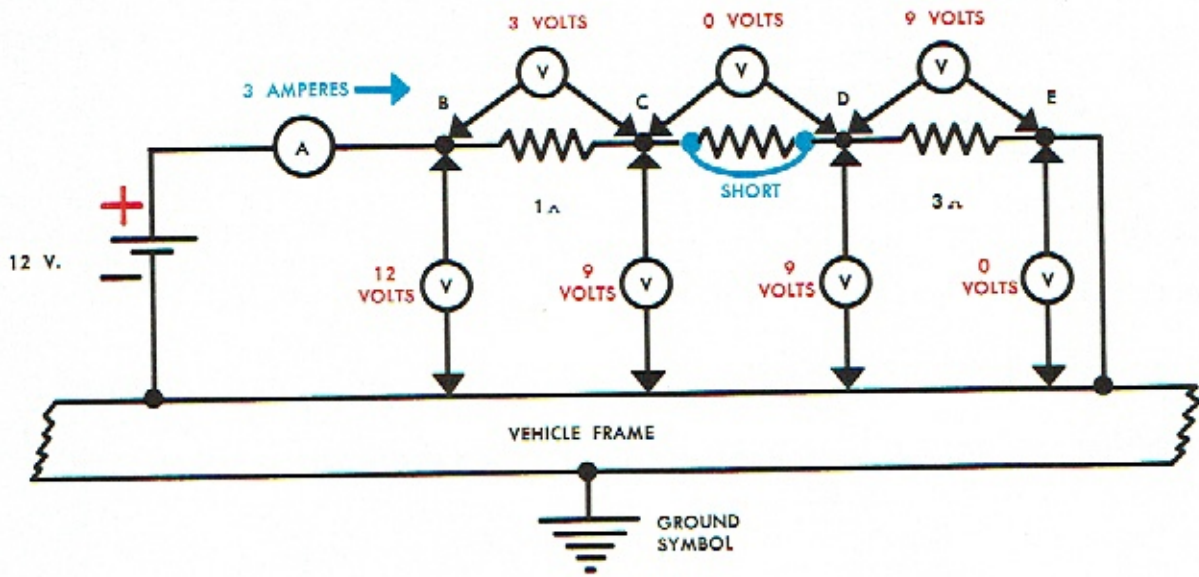
or unintentional contact between copper and the iron frame.

A short occurs when copper touches copper, such as when wiring insulation between two wires fails and the wiring makes contact.

An ammeter, and a voltmeter connected in a circuit at the different locations shown, should give readings as indicated when no part of the circuit is open, grounded, or shorted. The meter readings indicated can be verified by Ohm's Law.

little effect on the high resistance circuit, and reduce the current flow through the high resistance voltmeter a negligible amount, hence the pointer deflects to indicate 12 volts.

To illustrate this type of 12-volt meter reading further, if the two-ohm resistor were to become open instead of the one-ohm resistor, a voltmeter connected from point C to ground would indicate 12 volts, since the one-ohm resistor in series with the high



resistance of the voltmeter has negligible effect. If an open should occur between point E and ground, a voltmeter connected from points B, C, D, or E to ground will read 12 volts. A voltmeter connected across any one of the resistors, from B to C, C to D, or D to E, will read zero volts, because no voltage drop occurs with no current flow as indicated by a zero reading on the ammeter.

If the two-ohm resistor should become completely shorted, the ammeter will read three amperes, since $I = \frac{E}{R} = \frac{12}{1+3} = 3$ amperes.

The other voltmeter readings will be as shown. The application of Ohm's Law will verify these readings.

If point D should become grounded, the ammeter will read $I = \frac{12}{3} = 4$ amperes. No current will flow through the three-ohm resistor, and a voltmeter connected to the various points will give readings as illustrated.

The above examples illustrate how a voltmeter and ammeter may be used to check for defects in a circuit. An ohmmeter also may be used, with the 12-volt battery disconnected, to measure the ohmic values of each resistor. A high reading indicates an open or poor contact inside the resistor, and a low or zero reading indicates a partial or complete short circuit.

The service technician who has a good knowledge of electrical fundamentals, and knows how to use test meters, will soon find that his job becomes much easier.

the Delco-Remy education program

The Delco-Remy Education Program is designed to provide to mechanics and students up-to-date technical information on automotive electrical equipment.

This manual, one of a series, is a part of the program. Used in a classroom in conjunction with training charts, these manuals aid in explaining the theory of operation and construction of electrical units.

Also available to servicemen and students is a series of Maintenance Service Bulletins. They serve as a reference in the maintenance and testing of electrical units.

Test Specification Booklets contain service test data for the electrical units manufactured by Delco-Remy. These booklets are designed for automotive electricians engaged in maintenance and testing.

Strip films with records and film booklets cover the basic operation and maintenance of units in electrical systems. There are many pictures and a wealth of information in diagrams and legends.

Other booklets cover various phases of maintenance and testing procedures for Delco-Remy electrical units and their related circuits.

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DIVISION OF GENERAL MOTORS CORPORATION