Six Pack of Trouble

Last month we popped the tops on four of the six cans in our electrical troubleshooting six pack. For those of you who weren't here for Part One, we'll mention that a six pack was chosen to represent the six basic types of electrical problems which can affect an electrical system.

If you remember that any electrical system circuit can be broken down to its simplest circuit, then you'll be able to apply the rules in these two articles to fix any car's electrical problem.

Our first four cans contained the following four circuit problems:

- An Open in the Voltage supply circuit.
- A Voltage Drop in the Voltage supply circuit.
- An Open in the Ground side of the circuit.
- And finally, a Voltage Drop in the Ground side of a circuit.

This month, we'll look at the Loads in a circuit. Since we've already looked at problems which affect the circuits connected to the Loads, the Loads themselves become our focus of attention as we open the final two cans.

Before we tackle the last two problem types, we should look back at the first four problems one more time. Admittedly, we attempted to isolate each problem in an effort to define it more clearly for you. But what happens when a circuit has more than one of these problems at the same time? It is possible.

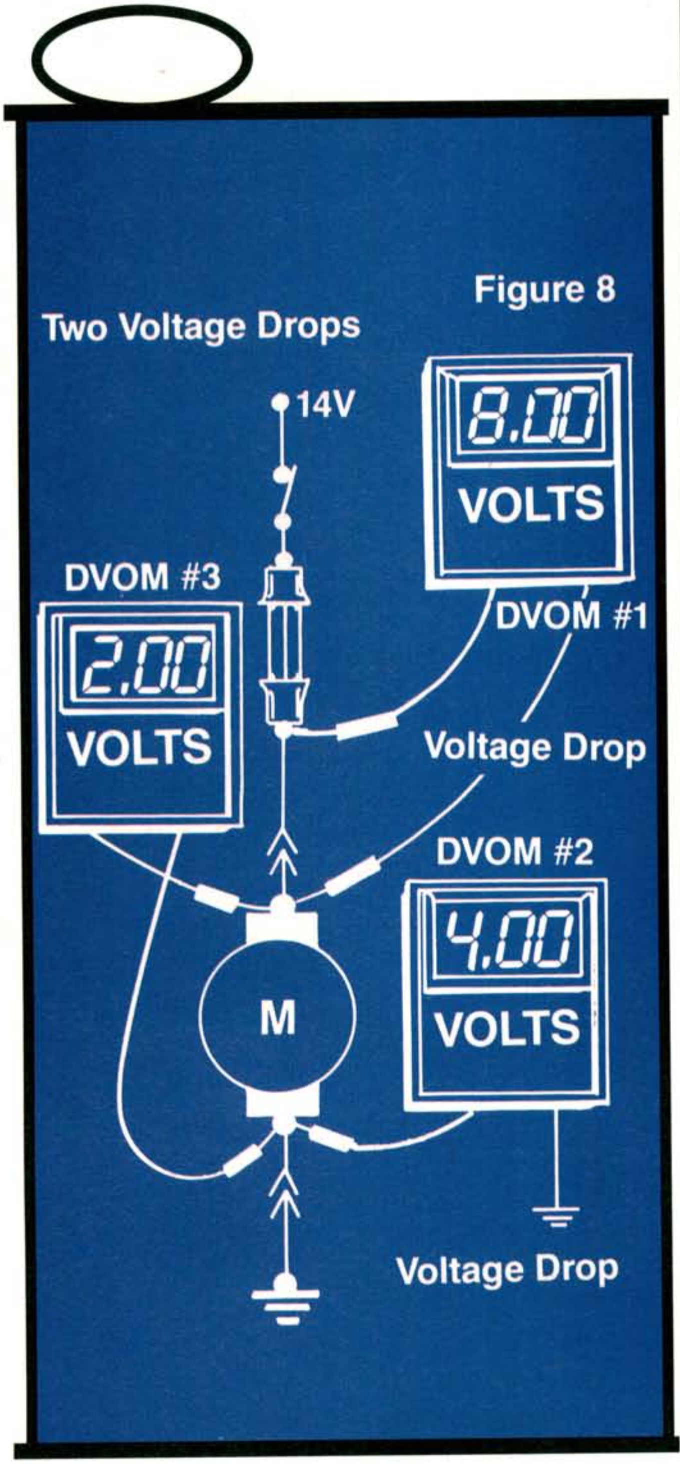


Figure 8 shows a circuit which combines two of the first four circuit problems:

A voltage drop on the voltage side of the circuit.

A voltage drop on the ground side of the circuit.

This type of compound problem is especially common when both the voltage and ground connections are contained in a single multipin connector. If the entire connector becomes loose or corroded, both sides of the circuit are affected.

The blower motor in **Figure 8** is turning very slowly. DVOM Number 1 is showing a voltage drop of eight volts.

But this particular motor is turning so slowly, that we suspect another problem. DVOM Number 2 shows voltage also exists on the ground side of the motor. (A perfect ground here would read 0.0 volts). An additional four volts is being dropped by a bad ground.

If we add the two voltage drops together (eight volts on the source side and four volts on the ground side) and subtract those 12 volts from the 14 volts of source voltage, we find that there are only two volts left to power the motor.

A third voltmeter placed across the motor terminals while it's running will verify our math.

What we learn from this can be very important. A trained eye will notice that the motor should turn faster, even with only six volts of source voltage available to the motor. To the untrained eye, repairing the voltage drop on the source side may seem like enough. The motor will pick up some speed. But the four volt drop on the ground side will still keep the motor from reaching full speed.

To avoid this mistake, it is necessary to check both sides of the circuit to confirm that all problems are repaired.

Now let's move on to our final two cans.

Types of Problems Affecting Loads

Let's take a moment to redefine a Load:

A Load is something which performs work when current passes through it. Voltage is dropped across the Load as this happens.

Once again, our illustrations will show a simple DC motor in a series circuit. The motor can represent any load, from a starter motor to a sealed beam. As we proceed, remember that a voltage drop is not necessarily a bad thing, even though we use voltage drop tests to check for circuit problems.

If the voltage drop occurs only at the load, and the load is not damaged, then work is performed. This is a good voltage drop. The starter cranks the engine, or the sealed beam lights the way home.

We've already discussed what happens when the voltage drop occurs in the wrong part of the circuit (an open circuit being the ultimate voltage drop).

Now we'll look at what happens when the Load itself is damaged, and cannot perform work.

This brings us to our final two cans:

- **An open circuited Load, and**
- **A shorted Load.**

Can Five — An Open Circuited Load

Figure 9 shows an open circuit in our Load, the DC motor. The rest of the circuit is fine.

The switch and fuse on the voltage side are good. All connections on the voltage side are clean and tight. We find the same thing on the ground side of the Load.

We have source voltage going into the Load, and a check of voltage on the ground side shows zero volts.

But the motor is dead. Since we've eliminated the voltage and ground sides of the circuit, the motor must be defective. In this case, it's open. You replace the motor, and it works.

But you're not done yet if you're a thorough troubleshooter. Even though the replacement motor is running, it is important to check the circuit again. After all, with an open-circuited motor, it was impossible to properly load the circuit. So it was equally impossible to test for voltage drops with the old motor in the circuit.

Take time to check both source voltage and ground voltage with the new motor installed and running. Check for full source voltage going into the motor, and a voltage drop of 0.1 volt on the ground side as assurance that you've performed a complete repair.

The sixth and final common circuit problem is classified as a Shorted Load. This is shown in **Figure 10.** The Load is dead. There is no voltage on the voltage side of the motor.

Tracing back through the circuit, we find source voltage at the end of the fuse closer to the source (**Figure 10A**). The end of the fuse closer to the load shows NO voltage.

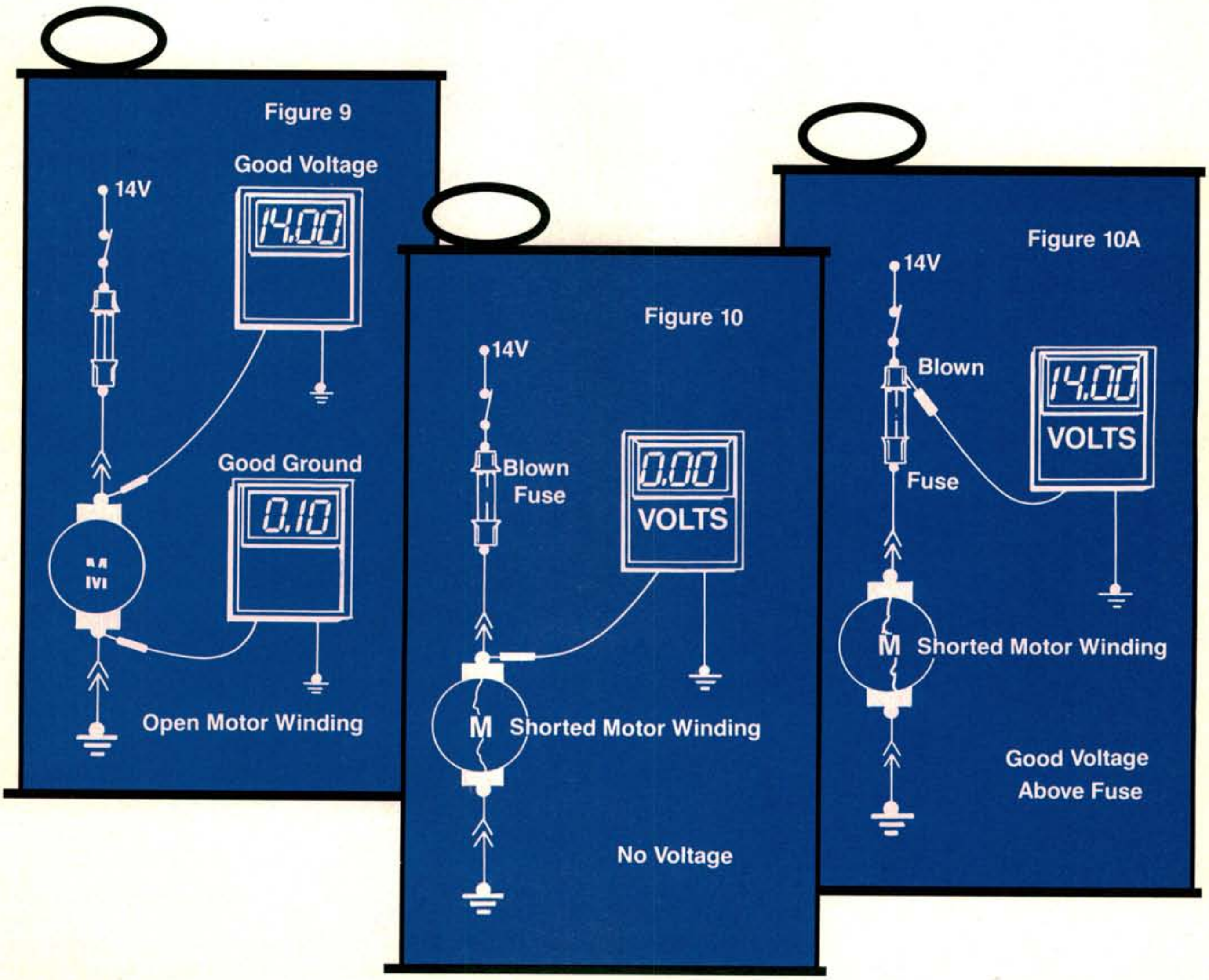
This tells us that the fuse is blown.

What caused the fuse to blow?

Too much current has passed through it.

Where did the excessive current flow come from?

Either the motor, or some part of the voltage side of the circuit is shorted to ground.



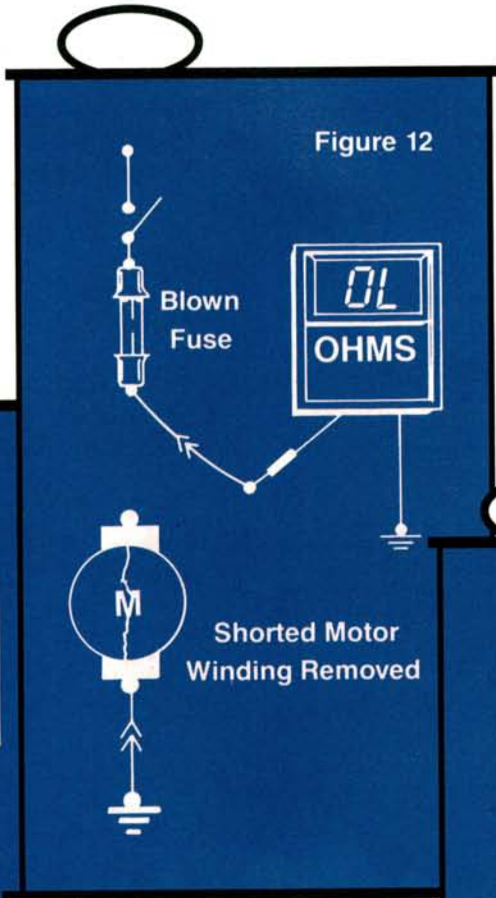
The Last Can —The Shorted Load

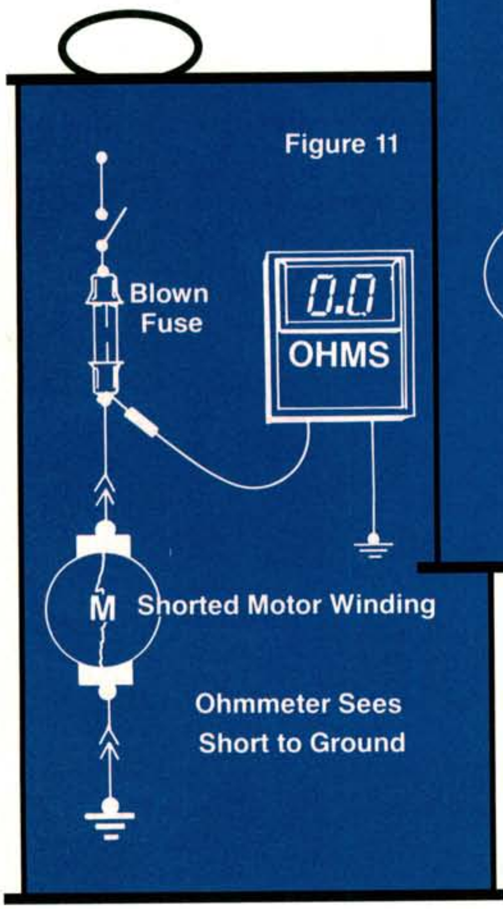
Finding the Short—Method One

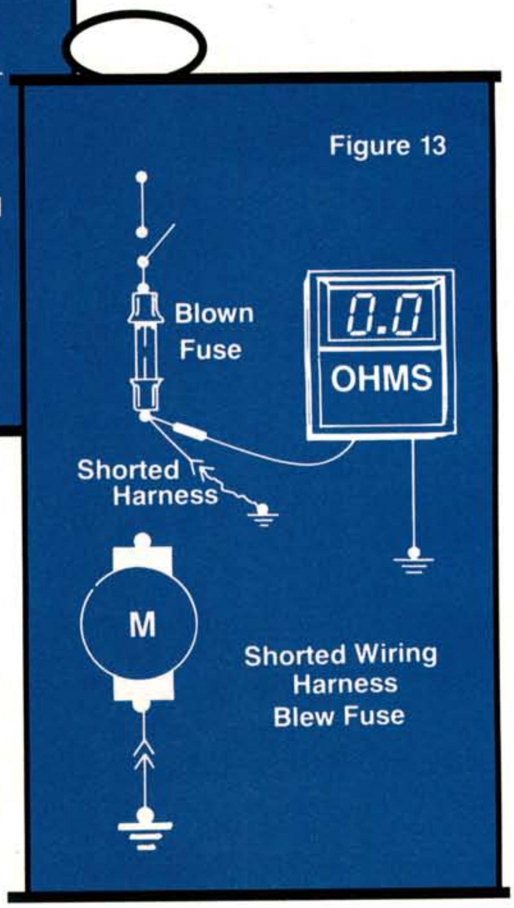
Finding the short is a job for our ohmmeter, as shown in **Figure 11**. If we test between the "dead" end of the fuse and ground, and get a low resistance reading (only a few ohms), we know we have a short to ground. Tracking the exact source of the short can be done in two different ways, depending on which part of the circuit is easier to reach.

Figure 12 shows Method One. Start your tests right at the fuse (or fusible link as the case may be). Disconnect the wire right at the load (the motor in this case). Then check again between the "dead" end of the fuse and ground.

- **If the meter now reads infinity, the motor itself is shorted to ground.**
- **If the meter still reads continuity to ground (low ohms), the short is in the wiring between the fuse and the load (Figure 13).**







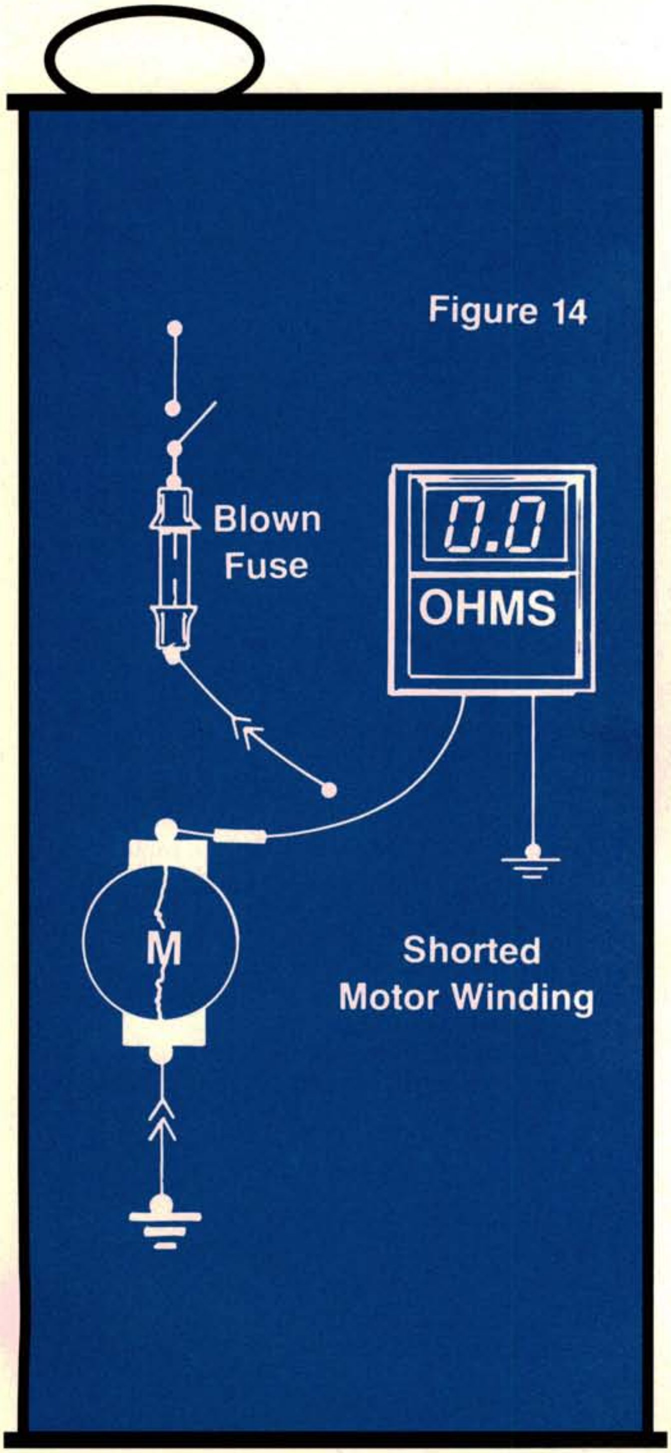
Finding the Short—Method Two

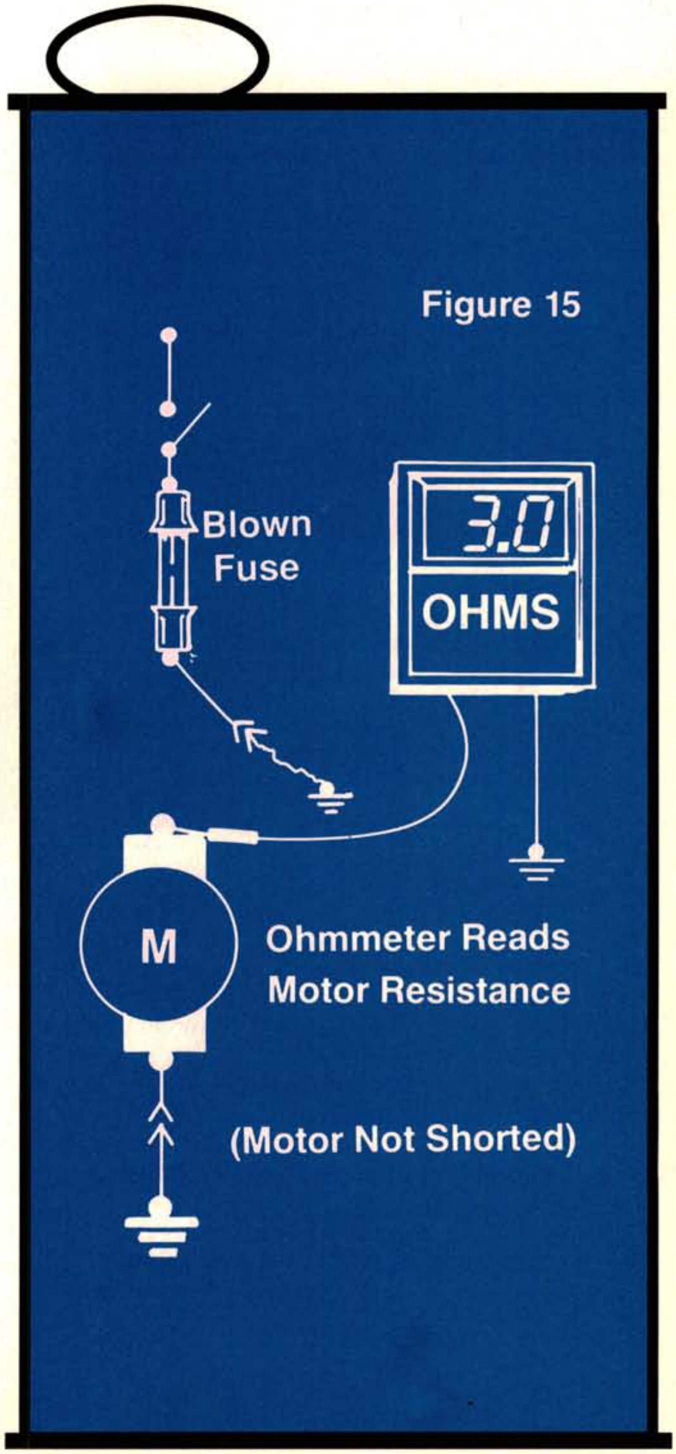
The second method is a time saver when the load side of the motor is easy to reach. Disconnect the circuit at the load before testing at the fuse.

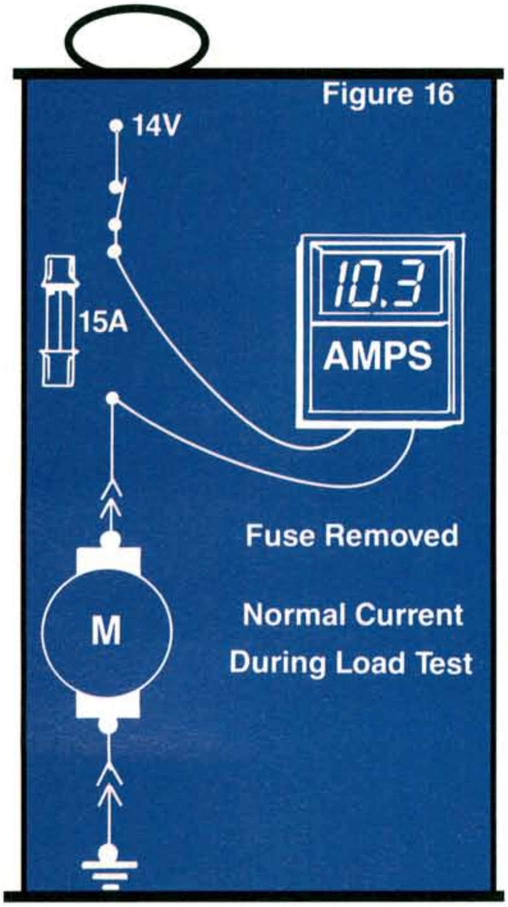
•Place the ohmmeter leads between the load terminal and ground (Figure 14). If it reads low ohms, you know the Load is shorted. The ohmmeter reads a short to ground, even with the motor disconnected.

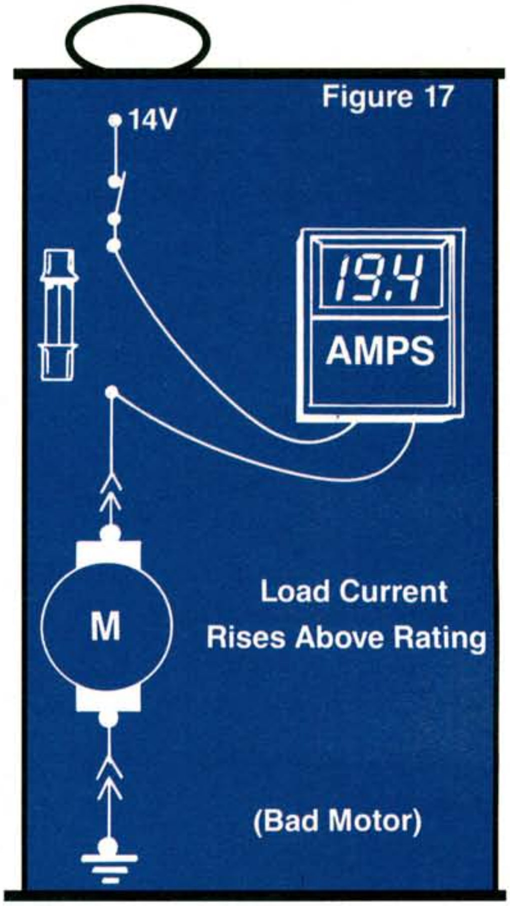
•If the motor is good, but there is a short in the wiring between the fuse and the Load, the meter will read the resistance of the motor winding (Figure 15).

•At this point, you'll want to go back to the fuse and double check between the end of the fuse and ground. Once again, a short to ground in the wiring will give you a low ohms reading.









Load Testing the Motor Circuit

The examples shown here were Hard Failures. Each circuit shown in our examples was BAD in no uncertain terms—and stayed broken during our tests.

In the real world, we all know that the intermittent problem is the one which makes us old and gray before our time.

Let's say a fuse is blown. You replace it and the circuit functions again.

Oh boy. Now what?

- **Was the fuse fatigued from repeated heating and cooling?**
- **Did an intermittent short to ground overload it just long enough for it to blow?**
- **Most importantly, will the fuse blow again if you return the car to the customer?**

The answers lie in one more test which should be performed when an intermittent short is suspected. In other words, if a fuse was blown, but the replacement fuse doesn't blow too, perform this test. Using an oversized fuse is cheating.

This procedure is called Load Testing the Circuit. You can perform this test on any circuit, not just a motor. Use an ammeter to measure the current flow through a suspect circuit.

Figure 16 shows our ammeter connected in place of the fuse. With the switch closed, the circuit is complete as current passes through the ammeter's 20 amp range. If the anticipated load will be larger than the 20 amp range of your digital ammeter, then you may want to use an inductive meter accurate to the range of current flow being measured.

As the motor runs and gets hot, the amount of current should stay fairly constant if the motor is good. The amount of current which should flow will depend on the rating of the motor.

- **If current is always greater than the motor's rated consumption, or**
- **If the current flow increases as the motor warms, the motor will probably blow another fuse, and should be replaced (Figure 17).** This motor probably has worn bushings or bearings which allow the armature to contact the stationary windings.

If the current draw stays constant, try one more thing. Whenever possible, try moving the wiring harness with your hand. Watch for a rise in current which could be caused by a harness fastener which has cut through the harness, exposing it to ground.

All Six

Now that all our cans are open, we hope you recycle the empties on a regular basis to help you diagnose electrical, and electronic circuit problems.

—By Vince Fischelli