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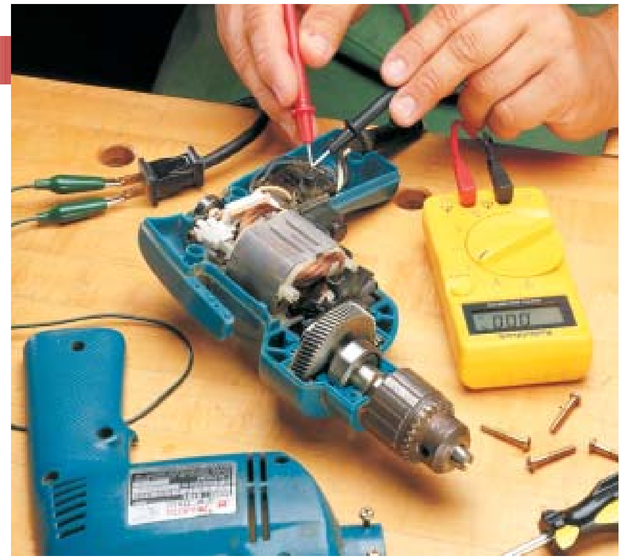
3-Step



Portable Power Tool Tune-Up

Squeeze the trigger on a drill and the chuck spins to life. Flip the switch on a router and the motor fires up in a heartbeat. It's easy to take these things for granted.

But with extended use, you may notice that a power tool isn't quite up to speed. Maybe it runs rough, or there's excessive sparking inside the case. Worse yet, you turn on the tool and nothing happens. That's usually when it gets stuck on a shelf — *gathering* dust instead of making it.

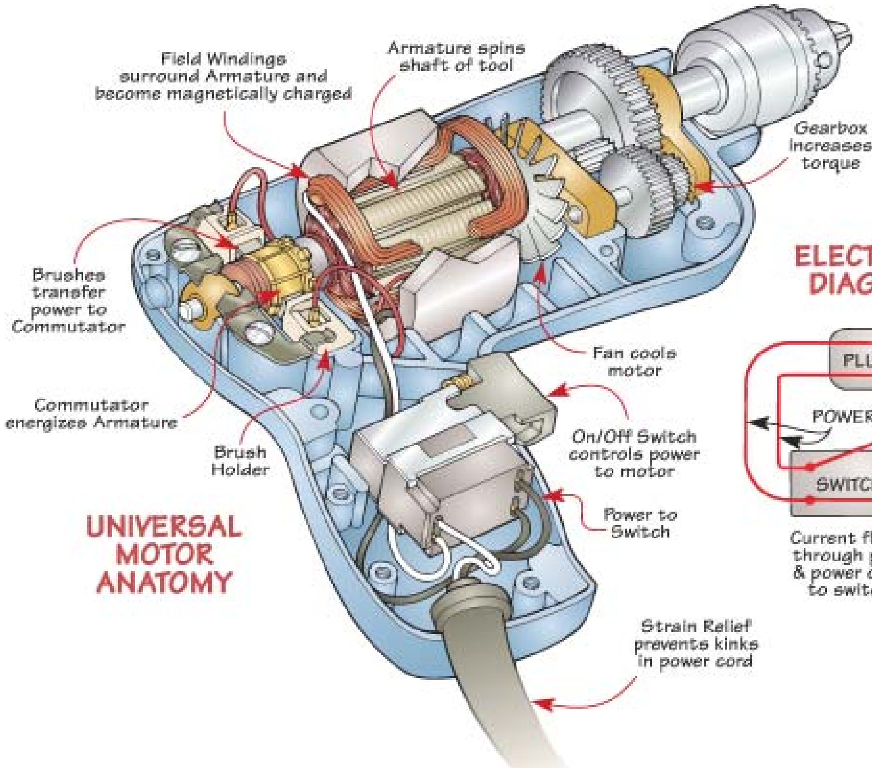
Of course, you could take the tool to a repair shop, but that can be expensive. Plus it's not always necessary. Sometimes a simple fix is all it takes to get a portable power tool running as good as new.

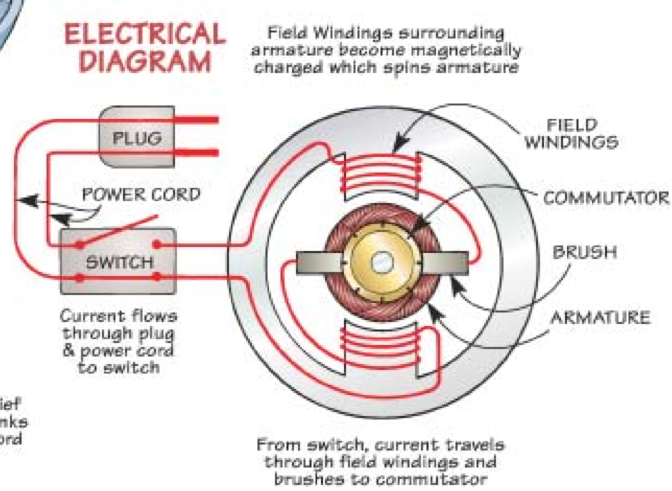
Power Problems – If there *is* a problem, quite often it can be traced back to one thing — an interruption in the *electrical current* that flows into the tool, through the switch, and on to the motor. Now don't worry. You don't have to be an electrical engineer to troubleshoot problems with a power tool. But it *does* help to know some motor basics.

Universal Motor – First of all, the type of motor used in a portable power tool is a *universal* motor. (See drawing below.) This is a lightweight motor that produces lots of torque and spins at a high rate of speed.

To accomplish this, electrical current from an outlet travels through the *plug* and *power cord* to a *switch*. When you flip the switch, the current flows through a pair of *brushes* that rub against a *commutator*. This sets up a magnetic field that spins an armature — *and* the shaft of the tool.

Three-Step Tune-Up – At least that's how it's *supposed* to work. But if there's a "break" in the loop, that's when problems develop. The trick is finding it. To do that, I use a simple, three-step tune-up which is explained in the rest of this article.





1. Visual Check-Up

If a tool runs intermittently (or not at all), check the obvious things first. A damaged plug or power cord like those shown at right can affect the performance of a tool. Plus they can cause a serious electrical shock, so it's worth taking a few minutes to replace (or repair) damaged parts.

▲ *Check for Damage. To avoid the possibility of a serious electrical shock, replace a plug if it's missing the grounding prong (shown at left) or a power cord with a break in the outer sheath (right).*

REPLACING A PLUG

The first step in replacing a plug is deciding which one to buy. As a rule, I get a replacement plug that's the same type as the old plug.

Type of Plug – For a double-insulated tool, this means getting a plug with *two* prongs. (A double-insulated tool typically has a plastic housing like the drill in the photo on page 2.)

But be sure to use a *three-prong* plug if that's what the tool came with. The grounding prong on this type of plug is especially important in preventing "stray" current from energizing the case of a metal-bodied tool.

The drawing below shows a typical, three-prong plug. Notice that the terminals are color-coded, so it's easy to see which color of wire is connected to which terminal. I also like how the cable clamp and clamp terminals keep the wires from wiggling loose.

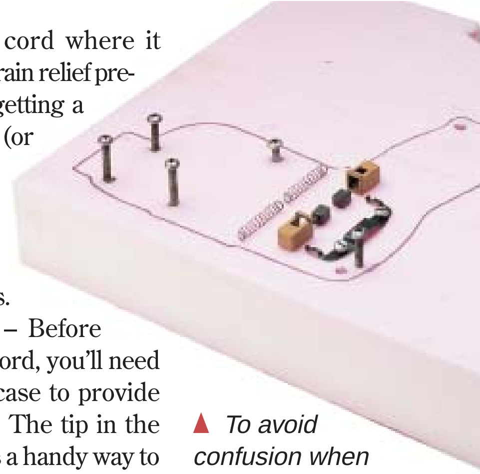
POWER CORD POINTERS

It's no wonder that a power cord gets damaged. It gets tugged on, scuffed up, and wrapped around the tool like a tourniquet. If the damage is obvious (like a break in the outer sheath), it's time to repair or replace the cord.

If the rest of the cord looks okay, you can cut it off below the damaged part and reconnect it to the switch. If the cord is frayed or cracked, it's better to buy a new one. Just be sure to get a cord with the same number and gauge (diameter) of wires as the existing cord.

Strain Relief – Either way, you may have to get a new strain relief. This is a thick, rubber "boot" that's molded around the cord where it enters the tool. The strain relief prevents the cord from getting a kink that could bend (or break) the wires inside. Note: You can get strain reliefs like those shown at left at many hardware stores.

Crack the Case – Before installing the power cord, you'll need to "crack" open the case to provide access to the switch. The tip in the margin at right shows a handy way to keep track of which screws go where.



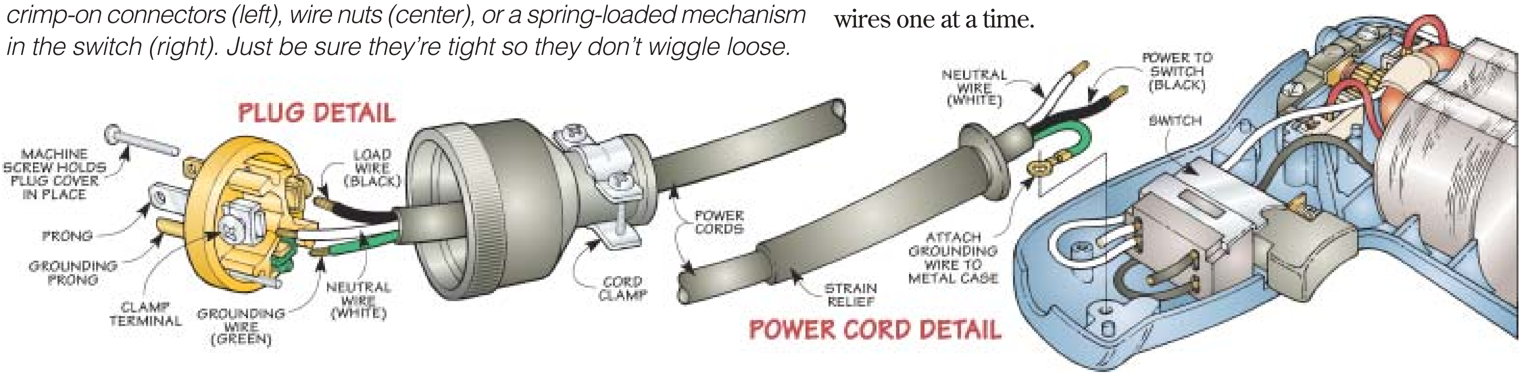
▲ *To avoid confusion when reassembling a tool, draw an outline of its shape on a piece of foam insulation. Then stick screws (or other parts) in their proper location.*

Connectors – Once the case is open, you can see how the wires in the power cord are connected to the switch. As you can see in the photos below, there are several different types of connectors that might be used. It just depends on the tool.

Color Cues – What's more important is to know which color of wire gets attached to which terminal on the switch. To avoid confusion, I leave the old wires in place until I'm ready to connect the wires in the replacement cord.

Install Power Cord – To do this, start by slipping the replacement cord through the strain relief as shown below. Then remove the outer sheath of the cord and strip the insulation off each wire. After slipping the cord and strain relief into the case, connect the wires one at a time.

▲ *Connectors. The wires from the power cord may be attached with crimp-on connectors (left), wire nuts (center), or a spring-loaded mechanism in the switch (right). Just be sure they're tight so they don't wiggle loose.*



2. Test for Continuity

Meter Check – Touching the two probes of a multi-meter together should produce a zero reading — just like when checking for continuity.

This device ► has an indicator light that glows to show continuity. It costs about four dollars at an electrical supply company.

A visual inspection can pinpoint *some* electrical problems in a power tool. But what if everything *appears* to be okay, and the tool still won't run?

Here again, the problem is often the same — an interruption in the flow of electricity. Only this time, the interruption in the loop may be hidden.

Continuity – So how do you find out where the problem is? By testing for *continuity*. This shows whether the electrical current travels in a *continuous* path, or if there's an interruption along the way.

Multi-Meter – To do that, I use a simple testing device called a *multi-meter* like the one shown in the photo above. This is a digital meter with several settings that can be used to diagnose different problems. But to check for continuity, you'll only need to dial in a single setting — the one that measures the amount of electrical *resistance*.

Ideally, the meter should read *zero* resistance. In other words, the current flows unimpeded. To check whether the meter itself is working, touch the two probes together. This should also produce a *zero* reading.

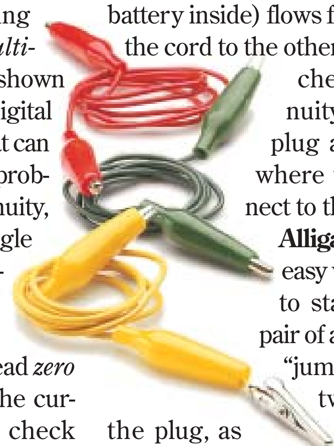
Editor's Note: The meter shown here (Model 22-806) is available from *RadioShack* for about $24 . For a less expensive device that tests continuity only, take a look at the photo in the margin.

Two Tests – No matter which device you use, there are *two* separate tests to make — one for the power cord and one for the switch.

CHECK POWER CORD

I usually start with the power cord. If there's a break in one of the wires *inside* the cord, it's not always visible on the outside. The only way to find out is to hook up the multi-meter.

The idea is to check whether current from the meter (there's a small battery inside) flows from one end of the cord to the other. This requires checking continuity between the plug and the points where the wires connect to the switch.



Alligator Clips – An easy way to do this is to start by using a pair of alligator clips to "jump" across the two prongs of the plug, as shown in Step 1 below. (Alligator clips like the ones shown above are available at most electronic supply stores.)

After hooking the clips to the prongs, the next step is to locate the ends of the wires that connect to the switch. That's easy if the terminals on the switch are exposed as in Step 1. But if the wires go straight into the switch, you'll need to pull them out. Most likely, the wires are held in place with a spring-loaded mechanism. To release each wire, stick a needle into the slot next to it. Then push down and pull the wire loose.

Once you've located (or exposed) the ends of the wire, touch the probes to them to check for continuity in the power cord. Remember, the meter should read zero if the cord is okay. If not, replace it as shown on page 3.

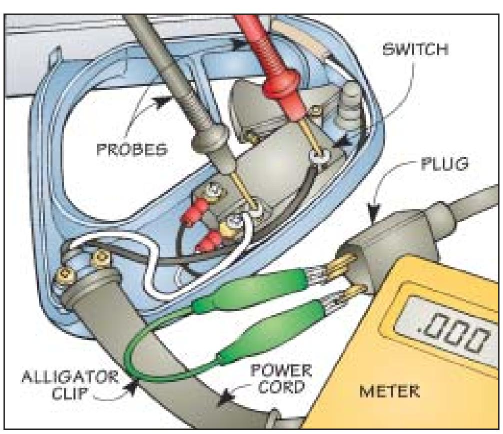
TEST THE SWITCH

The next step is to see if the switch works. Again, it may look fine. But after switching it on and off hundreds of times, a switch may wear out.

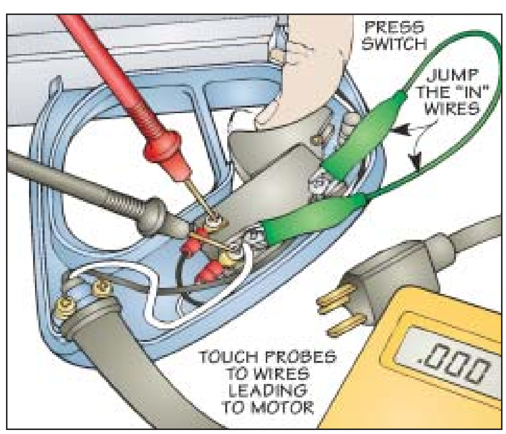
To test the switch, the procedure is basically the same. This time, you're checking whether the current from the meter flows through the switch when it's in the "on" position.

A look at Step 2 shows an easy way to do this. Start by attaching alligator clips to the points where the wires from the power cord connect to the the switch. (These are the same two points you touched the probes to in Step 1.)

Now locate the two wires that *leave* the switch and go to the motor. Touch the probes to these two points, and press the switch to the "on" position. Again, a *zero* reading indicates the switch is good. If it's broken, it's best to order a new switch from the manufacturer.



1 *To check continuity in the cord, attach clips to the prongs of the plug. Then touch the probes to the terminals where the wires from the power cord connect to the switch.*



2 *Now test the switch. To do this, attach the clips to the terminals where the power cord enters the switch. Then touch the probes to the wires leading to the motor and press the switch.*

3. Inspect Brushes

Okay, so what if there's continuity in the power cord and the switch, but the tool *still* runs rough? Or not at all? It's time to inspect the brushes.

Carbon Blocks – There are two brushes. Actually, the word "brushes" is a bit deceiving. They're solid blocks of a carbon-graphite material that rub against the commutator.

To keep the brushes in contact with the commutator, they're attached to springs. These spring-loaded assemblies fit into a metal brush holder, one on each side of the commutator.

Brush Power – A wire leading to one of the brushes (or holder) supplies power from the switch. When you flip the switch, the brush feeds power to the commutator. With use, brushes wear down and don't make good contact with the commutator. This causes a loss of power or excessive sparks.

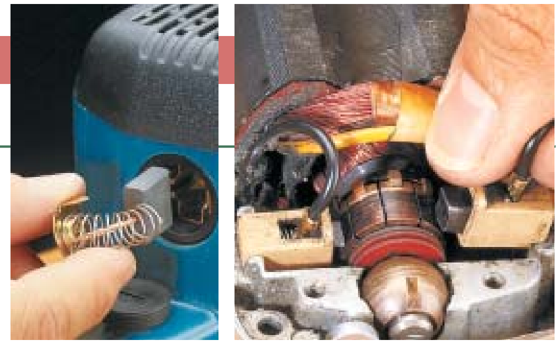
Remove Brushes To inspect brushes for wear, you'll need to remove them. Depending on the tool, access to the brushes is either on the *outside* or *inside* of the case. (See photos above.) Note: To ensure even wear, reinstall the brushes on the same side of the tool they came out of.

After removing the brushes, you may find they're chipped or burned. (See margin.) But a more likely problem is they're too short. The brushes simply wear down past their useful life.

What's the minimum length of a brush before it needs to be replaced? Sometimes there's an indicator marked on the brush. If not, a good rule of thumb is to replace the brushes when they're *shorter* than they are *wide*. Note: Replacement brushes are available from the manufacturer and some hardware stores.

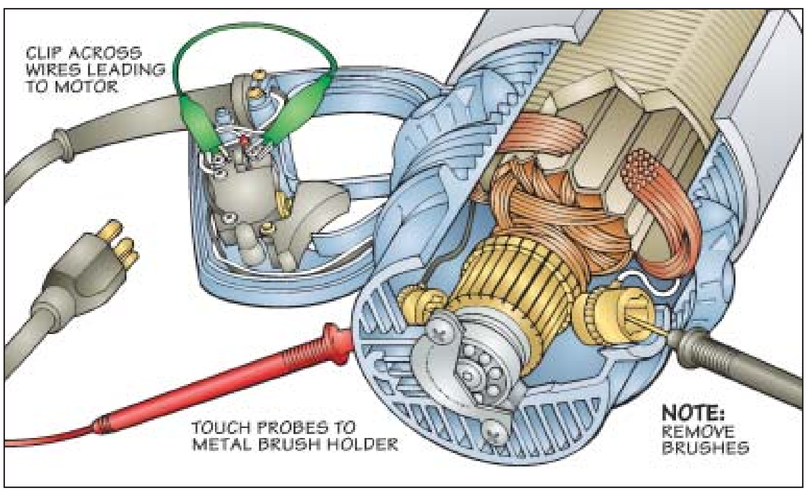
Final Check – With new brushes installed, the tool should run like a top. If it doesn't, there may be a more serious problem with the copper windings in the motor. If the tool has been overheated, the insulation on the windings may have melted. This can cause the windings to "short out."

To check, use an alligator clip to "jump" across the two wires leading from the switch to the motor. Then remove the brushes and place the probes against the metal holders. If the meter doesn't read zero, your best bet is to replace the tool or take it to a repair shop.



Brush Access – A removable cap makes it easy to take out some brushes (left). The only way to remove other brushes is to open the case (right).

▲ *Occasionally, you'll find a chipped or burned brush that needs to be replaced. More often, the brush is worn to the point that it's too short.*



An Ounce of Prevention

When it comes to taking care of the electrical components of a tool, prevention is the best cure.

Blow Out Dust – For example, dust can prevent a tool from breathing. This causes it to overheat which can damage the motor. So I remove as much dust as possible by turning on the tool and blowing air through the intake slots (Photo A).

Cord Wrap – Even a simple thing like how the power cord is wrapped around a tool can keep problems from cropping up (Photo B).

A. Remove Dust – With the tool running, blow air through the intake slots to remove packed-in dust.

B. Cord Wrap. To reduce the strain on a power cord, make a large loop before wrapping it around the tool.