Electric Appliance Tools and Testers

YOUR CAREER IN APPLIANCE REPAIR

Ever since there have been machines, there have been repairmen. They used to be called “tinkers,” and people made jokes about their profession. In the highly computerized and mechanized world of today, however, the tinker has been replaced by the skilled professional technician, a very important person indeed in today’s world.

Our world is a world of small machines that do helpful work, such as washing clothes, mixing food, and cleaning the house. Since machines do break down at times, skilled repair technicians, like the one shown in Figure 1, are needed to get them working again.

The demand for really capable repair technicians is growing every day, and more and more skilled technicians will be needed in the future. There will always be plenty of work for the person who can repair appliances. Master this profession, and you won’t have to worry about being out of a job.

All you need to know is how these appliances work and what you must do to make them work again when they break down. They are all very simple, and you need to know only a few basic facts. They use

FIGURE 1—An Appliance Repair Technician at Work
electric heating elements, small motors, and simple mechanical parts. All these are easy to test and replace. You’ll need only simple tools and test equipment.

**Getting Started**

This is the first of a series of texts in a course that will show you how to locate trouble in electrical appliances and how to fix that trouble quickly and easily. You’ll learn how to test electric circuits and electrical appliances and how to use hand and power tools properly for quick and easy repairs.

When you build a house, you start with a good solid foundation. The same is true when you build a career. In this course you’ll begin with the fundamental principles of electricity, then you’ll go on to study first the simpler electrical appliances, and finally the more complicated ones. Study this first part of the course very carefully, and don’t hesitate to go back and refer to it later on. Once you’ve mastered it, the rest is easy.

By the time you finish this first series of texts, you should be able to handle small repair jobs on many electrical appliances and start earning money as a repair person. As your skill grows with study and practical experience, you’ll be able to handle bigger and bigger jobs. You’ll learn the methods used by professionals, and with study and practice, will become a skilled craftsperson in this important field.

**Pay Attention to Details**

As you study these texts, you’ll find that we stress details; for example, how to fasten a wire under a screw. There’s a very good reason for this. No matter what size a job is, it will be made up of little details, every one of which is important. One small detail which isn’t handled exactly right can keep the whole device from working. It can even cause serious problems or damage, such as a short circuit. Careful attention to the smallest details of a job is the mark of the skilled craftsperson.
There are right and wrong ways to do any job. We’ll show you the right ways, which are the result of many years of professional experience. Whenever possible, we’ll show you the wrong ways, too, so that you can avoid them. If you know about a mistake, you can avoid making it. To become a skilled technician, a real craftsman, you must form a set of good work habits so that you do even the little details right from the very beginning. Be proud of the quality of your work.

**Trouble Diagnosis**

We’ll show you the most important skill of all: diagnosis of the cause of trouble. Correct diagnosis depends on a good understanding of the basic theory of operation of the appliance. Like a detective or a doctor, you must take basic knowledge and apply this knowledge to locate the cause of the trouble. Take, for instance, an electric heater. It should get hot when an electric current passes through it. If it doesn’t, you’ll know instantly that the circuit is open because of a broken connection somewhere inside the unit. So you apply continuity tests to find out exactly where the circuit is broken. Find this spot, fix it, and the job is done.

This sounds almost ridiculously simple, and it is, once you realize that the real cause of the trouble will be a broken wire, a switch that won’t work, or a missing bolt. Remember that simplicity is the key to fast, accurate diagnosis of all troubles. You must understand how the basic unit should work so that you will be able to find out why it doesn’t work.

As you go along, you’ll find that diagnosis gets easier and easier. *Practice* is the key to perfection in this career as in everything else. Learn the basic theory behind electric circuits and how to apply this theory in practical work. Theory is only the preparation for practice. If you have a solid foundation of theory, the actual work will be a lot easier.

If you have studied basic electricity before, you know many of the principles already. However, we will explain the basic laws every now and then, as a reminder, and give you examples of these laws in use. Before long, you’ll find yourself applying them without even stopping to think.
SAFETY IN YOUR WORK

Electricity is very useful but it can be very dangerous. If you are careless with electricity, and take chances, it can kill you in a split second. The ordinary 115-volt home power supply can give you a painful, if not fatal, shock. You can, however, work safely with electricity if you use the right methods and always give electric circuits the respect they deserve.

When working with electricity, as you will be on all electrical appliances, you will always be in danger of getting a shock. The only way you can be sure of your safety is to develop a set of automatic safety habits. Safety precautions are very simple, and if you forget to take them you will probably be reminded by a nasty shock.

You may see a skilled electrician handling electricity with what looks like carelessness. It is not. From long practice, and possibly a few shocks, he has learned what he can and can’t do and so he acts automatically. For example, he never touches a wire unless he knows definitely that it is not connected to a source of electricity. When he works on the wiring of one circuit, he goes to the switch box, opens this circuit, and then ties a tag on it. The tag signals anyone coming by not to close the switch because an electrician is working on that particular circuit. When he starts working on the actual circuit, he makes tests to be sure that there is no voltage on the wires. Learn to make these “double checks” a habit, and you’ll save yourself a lot of trouble, and maybe even your life.

Grounded Circuits

When any part of an electric circuit is in contact with the ground, or earth, the circuit is said to be a grounded circuit. The contact may be made at a water pipe, at the pole, or through a wire leading to a rod buried in the earth. Some grounds are intentional, and others develop as a fault of a circuit. An intentional ground provides protection from shock. All modern outlets have a ground connection. It is a path for conducting the current to the ground. A schematic
A diagram of a grounded circuit is shown in Figure 2. The ground is shown by the standard symbol of three short horizontal lines.

A person working with electric circuits is sometimes in contact with the ground. If that person touches an energized, or hot wire (wire energized by electric current), the circuit can be completed through the body to the ground. Even a small amount of current can cause a shock which may be mild or severe, depending on circumstances. If a person touches a grounded wire (a wire connected to ground), nothing happens, because there is no current flow through the grounded wire and there is no voltage difference between the grounded wire and the person.

**Grounded Wiring in Houses**

Most houses have three wires leading to them from the distribution-line pole. This is a 230-volt alternating-current (AC) supply. One of these wires is grounded at the pole and at the house, as shown in Figure 3. The other two wires are always hot. You can measure the full 115-volt AC line voltage between either hot wire and any grounded object—a water pipe, gas pipe, or steam radiator.

If you are standing on a cement floor, wearing leather soled shoes, and touching a water pipe or gas pipe, a TV antenna, or any grounded object, you can get a severe shock by touching a hot wire. How do you know which wire is hot? You don’t, unless you test it. Figure 4 shows what could happen if you don’t test. Leather shoes do not fully insulate a person from the ground because leather is a good conductor of electricity, especially if it is wet. Even without touching the grounded water pipe, a person will receive a shock because he is a link.
between the hot wire and the ground. If he were not in contact with the ground, touching the hot wire would not cause a shock.

**Protection Against Shock**

The skilled electrician always makes sure that he is not grounded before he does any work on electrical wiring. To ensure this, wear rubber- or composition-soled shoes. With the small appliances you will be working on, you can be absolutely safe only if *you pull the plug out* of the wall outlet before you do anything to the appliance. If the plug is lying on the workbench where you can see it, you can be sure that it is safe to work on the appliance. It will be safe, of course, only if the plug pulled out is the right plug. If there are several objects on the bench at the same time, you just might have pulled out the wrong plug. “Might” isn’t good enough. Follow that line cord from the appliance all the way to the end, and make sure it is not plugged in. Be safe rather than sorry.

If there is any doubt about the presence of voltage, the skilled electrician tests the wires. There are several test instruments that tell whether any voltage is present, and they’re all very simple. One is just a little neon lamp with insulated leads. A great many electricians carry one of these in their shirt pockets to have it handy all the time.

**How to Use a Neon Tester**

You can get a neon tester at any electrical supply store or hardware store. This tester consists of a small neon lamp which is built into a clear plastic housing and has two flexible test leads with insulated grips, as shown in Figure 5.
If you touch the test leads to the two sides of an AC line at 115 volts, the neon lamp will glow brightly if AC voltage is present. This test will not tell you exactly how much voltage is present, but it will tell you that voltage is present and that the line is hot. This tester is quite sensitive. Only a very small amount of current is needed to make the neon lamp light. You can hold one test lead in your hand and touch the other lead to either side of an AC line. When you touch the hot side, the bulb will glow, but perhaps only dimly. The circuit is completed through your body, but the current is so small that you won’t feel it.

**A Safe Place to Work**

Always make sure that your workbench and shop are safe. The floor must not be grounded, that is, made of cement or earth. A dry, wooden floor is a good insulator, and so are many modern floor coverings, such as vinyl tiles and most linoleum. If you must work in a basement or in a cement-floored room, make a platform of wooden boards to stand on. This platform can be covered with a wide strip of cheap composition flooring, which is mostly asphalt and a good insulator. Use anything to keep your feet off the grounded floor. Use wooden stools, and make the bench itself out of wood rather than metal.

Develop the habit of staying away from grounded objects. Don’t lean over anything to check an electric circuit while resting one hand on a water pipe or other metal object. The professional electrician, from long habit, keeps his free hand and all the rest of his body out of contact with any object. The object might be grounded, and he doesn’t want to find out the hard way. *Large appliances*, such as washers, dryers, and heaters, are *always deliberately grounded* to protect the user from shocks. This grounding is one of the important facts you must check when working on these appliances.

Since one side of practically all electric power circuits is connected to ground, you must avoid bodily contact with a ground while working on any electrical appliance or instrument. Equally important, be careful when other people, especially children, are nearby. Should another person
contact both you and the ground while you are working on an electrical device, either one or both of you could receive a dangerous shock.

**Safe Tools and Test Equipment**

Your test equipment and tools must also be safe. Test equipment should have well-insulated test prods and leads, so that tests can be made without danger. Instrument cases are made of an insulating plastic material. Test clips, which you will use on many jobs, must have thick rubber or plastic insulators so that you never touch the metal of the clip.

Your hand tools, screwdrivers, pliers, socket wrenches, should have insulated handles. Older tools have bare metal handles while newer tools can be bought with plastic-insulated handles for maximum safety. Most electricians also use nut drivers which have plastic covers on each handle.

For certain jobs, you will have to use heavier tools with bare metal handles or grips; automotive socket wrenches, for example. When you use such tools, make sure that the appliance is completely disconnected from the line; that is, make sure that you can see the disconnected line plug. Test the appliance for voltage if you are unsure.

In electrical work, there is no such thing as being too safe. Don’t think that it is childish to take precautions or to check and double-check a circuit to make absolutely sure that it is not energized before you do anything to it.

Don’t take chances. Any unnecessary chance could result in a very painful shock or even in death. Electricity is a good friend and a faithful servant, but it can be awfully hard on fools. Don’t be one.
Self-Check 1

At the end of each section of Electric Appliance Tools and Testers, you’ll be asked to pause and check your understanding of what you’ve just read by completing a “Self-Check” exercise. Answering these questions will help you review what you’ve studied so far. Please complete Self-Check 1 now.

1. When can you expect an electric shock?
   ____________________________________________________________

2. What should you check before touching any wire?
   ____________________________________________________________

3. What is a ground?
   ____________________________________________________________

4. What kind of floor usually provides insulation from ground?
   ____________________________________________________________

5. What should be done before working on an electric circuit?
   ____________________________________________________________

6. Why should the plug be pulled out before working on an appliance?
   ____________________________________________________________

7. What is the purpose of a neon tester?
   ____________________________________________________________

8. What does it mean when the neon lamp glows brightly?
   ____________________________________________________________

9. What should you look for in tool handles?
   ____________________________________________________________

10. What is the main rule for working safely with electricity?
    ____________________________________________________________

Check your answers with those on page 75.