Wiring Stoves and Dryers

Code now requires a four-slot receptacle to provide both 120 volts and 240 volts

BY REX CAULDWELL

Whatever Benjamin Franklin might have thought about making the wild turkey America's national emblem, he is rumored to have cooked one of these birds with electricity as early as 1749. Officially, though, the electric stove was invented in 1896, and by 1917, it had appeared in the Sears catalog. Wiring back then was quite simple: Two wires were all any appliance needed to work. *Ground* was something you built your outhouse on. Many decades and electric-code changes later, wiring is considerably more complicated.

Wiring an electric stove or a clothes dryer is not the same as hooking up other appliances. These devices actually use both 120v and 240v, and as a result, they are wired differently than appliances using either one or the other. Although there's nothing new about that, there have been recent changes in the National Electric Code affecting dryers and stoves. Since 1996, electricians have been required to use four, not three, conductors for these two appliances. (Some states have not yet adopted this part of the code.) As a result, you may have a stove or dryer in your own house that is improperly wired.

Voltage at the service panel starts with windings in the transformer

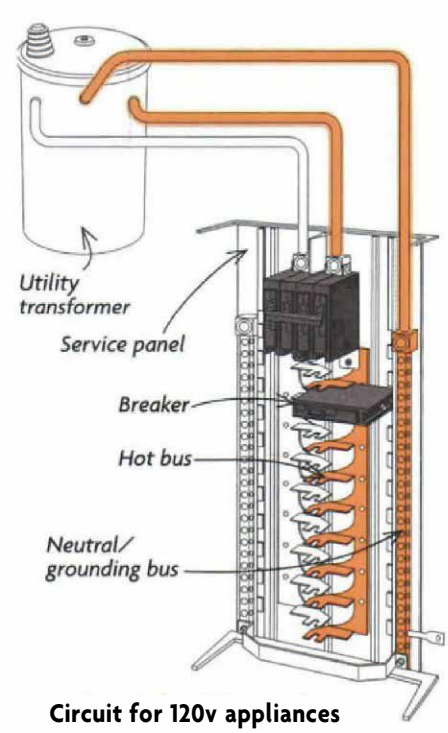
You can't truly understand how electric stoves and dryers are wired unless you understand where the power for them comes from. Your service panel is fed by a utility transformer, which has two basic windings: a primary and a secondary. The full-transmission voltage, normally around 7200v and up, is applied across the primary winding. Voltage on the secondary winding is directly proportional to the number of windings—fewer windings, lower voltage.

These step-down transformers, called *cans,* have three side terminals (drawing facing page). Approximately 240v is available across the two end terminals. The center terminal, also called the center tap, goes right to the

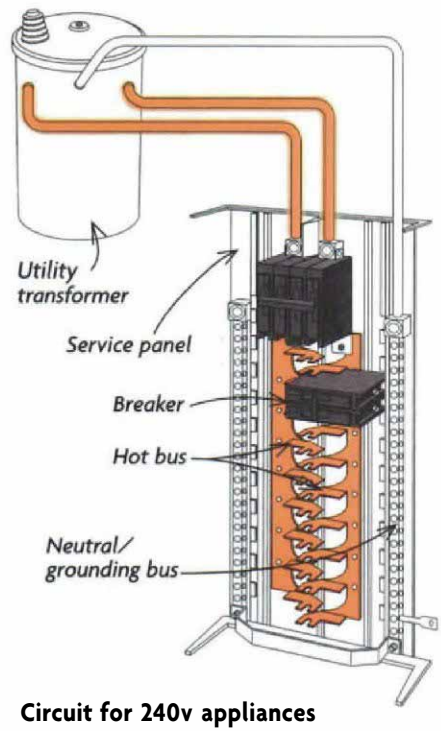
This stove receptacle does not meet code. With only three conductors and three receptacle slots, the ground wire and the neutral leg of the circuit end up sharing a common conductor. As of 1996, the practice is no longer permitted by the National Electric Code.

TRACING POWER TO ITS SOURCE

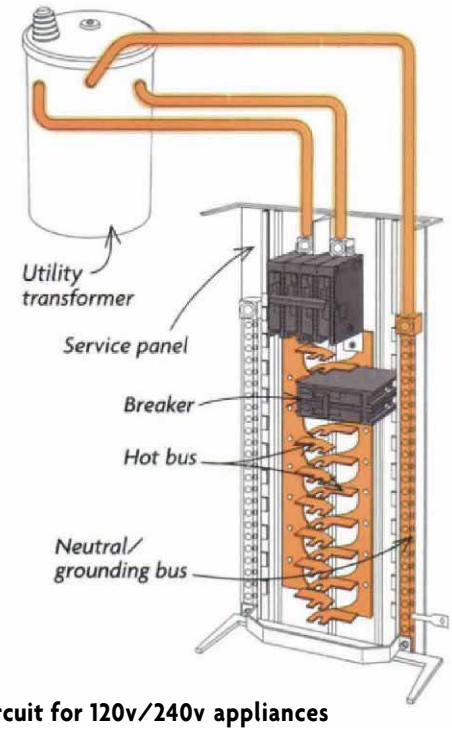
Unlike most electrical appliances, electric stoves and dryers use both 120v and 240v, which originate from different taps on a utility transformer. Circuits in the main service panel that produce 240v tap the transformer's two outer terminals; 120v circuits use one outside terminal and the transformer's center tap. Four-conductor circuits supplying both 120v and 240v use all three.



Circuit for 120v appliances



Circuit for 240v appliances



Circuit for 120v/240v appliances

center of the secondary winding. (Transformers in some parts of the country may be a little different.) You get half the voltage, or 120v, between the center tap and either of the two outer terminals.

Why is this important? Because the voltage you get in a circuit depends on which two terminals are used. Circuits of 120v pull power from the center tap and one of the two end terminals. The black conductor can be traced back to one of the transformer's two end terminals, and the white conductor goes to the center tap.

Heavy appliances and tools need 240v. They pull power from the can's two end terminals. But electric stoves and dryers need both 120v and 240v. Current from the 240v terminals feeds the electrical-resistance elements. The 120v power is used for lights and controls. As a result, these appliances need three insulated wires plus a bare ground. Those connected to the transformer's end terminals are black and red. The white wire goes back to the center tap at the transformer.

Current code is better, but choose stove wire gauge carefully

Prior to 1996, stoves and dryers were being wired in a variety of ways, most of them wrong. Not only was the code unnecessarily complicated, but few installers knew what to do with the ground. Receptacles had three slots (inset photo, facing page). Electricians spent years lobbying for change, and in 1996, the National Fire Protection Association finally relented. In the meantime, millions of appliances had been made with the frame of the appliance as part of the hot return in the circuit. Odds are good that you have one of those appliances in your house.

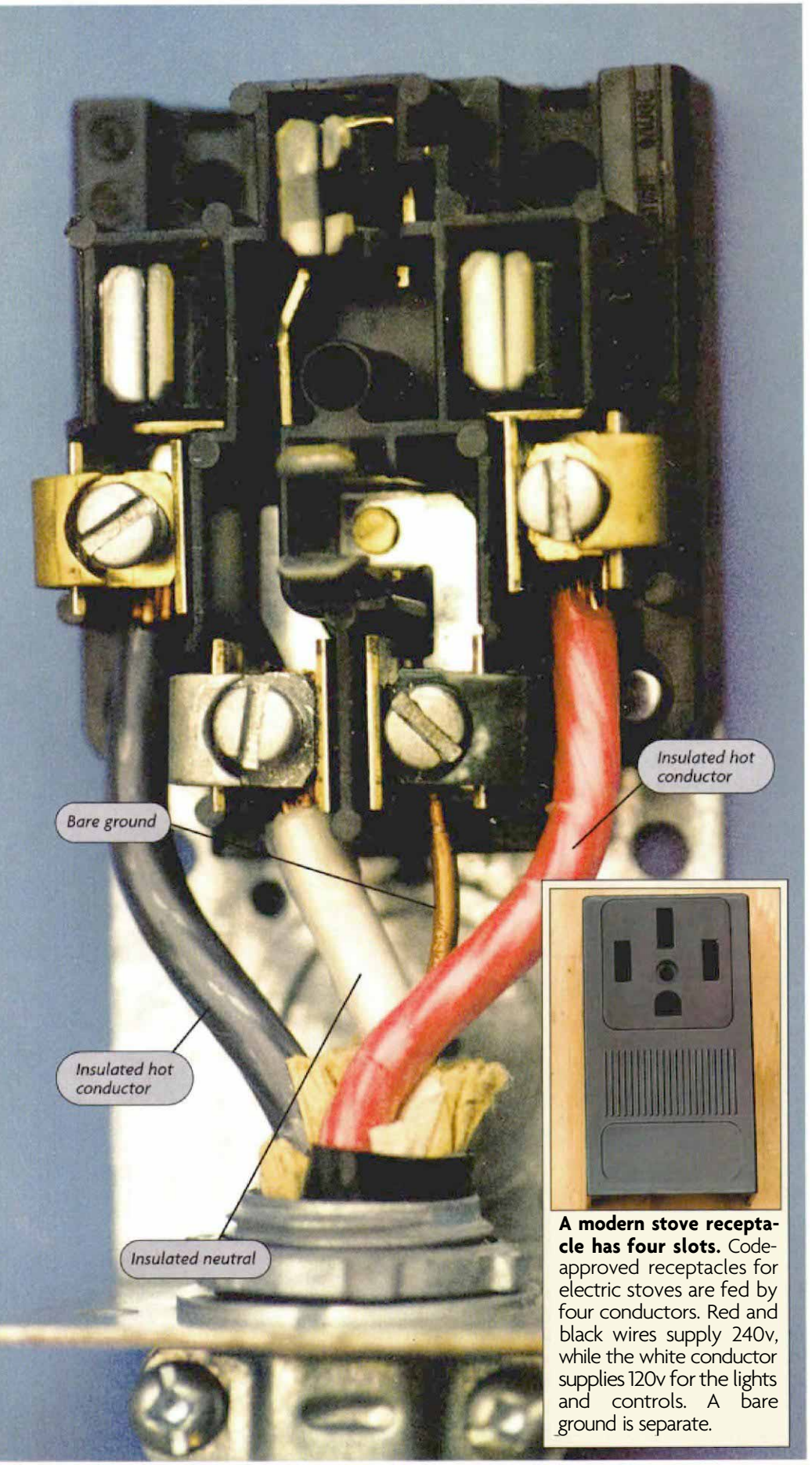
After the code change, it became simple. Where the code has been adopted, you are required to have three insulated conductors and a frame ground all the way from the appliance to the service panel. All you have to do is get the gauge of the wire right, which can be more complicated than it looks. The National Electric Code allows the typical stove to be "derated." That means you don't have to use the rating of the stove as an absolute reference to size the wire and the breaker. If the rating (found on a plate on the stove) is not more than 12kw (12,000 watts), you can wire the stove as if it would draw 8kw, the logic being that all burners and the bake unit will not be on at the same time.

Hogwash. Anyone who believes that hasn't had a family get-together over the holidays. Using the 8kw reference, the code assumes the most current the stove will draw is about 33 amps, which is why many stoves are fused at 40 amps. But a stove can pull more current than that when everything is running full tilt. Also, as stove elements burn out, they may be replaced with higher-wattage elements. The wattage begins to creep up; before long, it surges past the 40-amp mark.

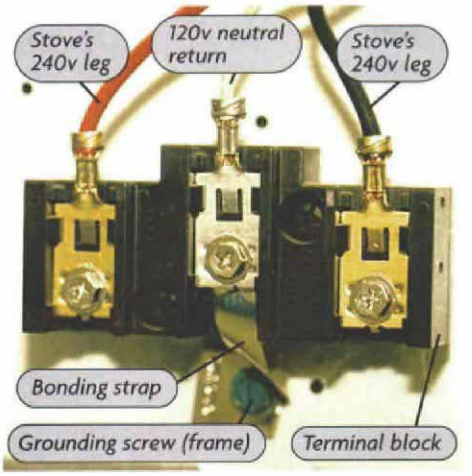
Smaller, less-expensive stoves have small elements (or maybe one large one) and a low-wattage bake element. These appliances may draw about 6kw, within the 8kw limit. Larger, more-expensive stoves with bigger elements can easily go over the 12kw reference. The problem is that electricians often don't wire for a higher-wattage stove because neither they nor the building inspectors who check their work know which stove a homeowner is going to pick. The result is that the stove circuit may have 8-ga. wire, suitable for a 40-amp breaker, when it really requires heavier 6-ga. wire suitable for higher-wattage stoves. If you want to stay out of trouble, use 6-ga. copper, three insulated conductors with a ground and a 50-amp fuse. Wire conservatively to stay out of trouble.

So just how dangerous is it to have the neutral and ground together? Overall, dryers

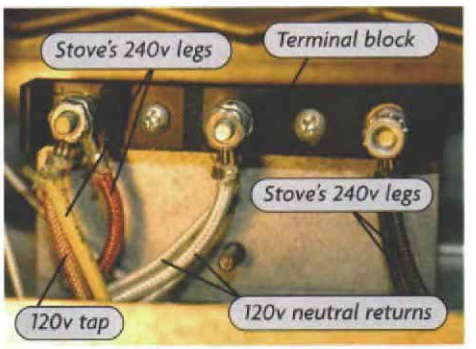
Drawings: Ron Carbone



A modern stove receptacle has four slots. Code-approved receptacles for electric stoves are fed by four conductors. Red and black wires supply 240v, while the white conductor supplies 120v for the lights and controls. A bare ground is separate.



Terminal block for a freestanding stove. A freestanding stove may have a terminal block like this one. When adding a four-conductor pigtail, remove the bonding strap and attach the bare ground to the grounding screw.



Terminal block for a built-in range or oven. A built-in is wired directly to an electrical circuit, not plugged into a wall receptacle, and is fed by a four-conductor cable. The bare ground would be connected to the threaded stud at the bottom of the block.

and stoves have a good safety record. If the floor around either appliance is insulated, such as it would be with linoleum over wood, then chances are slim that you would even feel a shock. However, if the appliance is in the basement and you are standing on bare concrete or worse (water), I think you should have an electrician change the old-style wiring over to a four-conductor system.

Wiring a freestanding stove

Electricians are now required to use three-conductor cable with ground to supply the stove receptacle. I use NM-B cable. It will have black, red and white insulated conductors plus a bare ground (photo left). The black and red conductors provide 240v to the stove elements; along with the white, either

black or red provides 120v power for the clock and timer. The ground wire in the NM-cable connects the ground bus in the service panel to the frame of the stove.

The most important thing to remember is that the neutral and ground are to be separate. This condition means that a four-conductor pigtail must be used from the appliance to the receptacle, not the older three-conductor pigtail, and the bonding strap on the stove must be removed (photo top right, facing page). This point is especially important if you bring an old stove into a house with new wiring.

Hard-wired stoves

For a drop-in range and a built-in oven (or two), wiring is different. If you haven't added more than two built-in ovens, you simply total the nameplate rating of the range and the oven (or ovens), and call it one unit. The wire from the breaker to the junction box that feeds the range and the oven will go through the same design criteria as a freestanding stove. The pigtails can be smaller in gauge than the main feeder cable. That is, you can fuse the circuit at 50 amps (which requires 6-ga. cable) and have the pigtails to the individual appliances at 12 ga. as long as the appliances pull no more than 20 amps each.

Appliances usually come with pigtails installed at the factory. All you have to do is splice them together at one master splice. Be sure to use a splice box large enough for all the wires. If for some reason the pigtail is missing and you have to install your own, just follow two simple rules: Install a pigtail with a large-enough gauge to serve the individual load, but never less than 12 ga., and make it as short as possible. You will need two insulated hot conductors (one black and one red), one insulated neutral (white) and one ground (photo bottom right, facing page). Be sure to pull the frame-to-neutral bonding strap off the appliance.

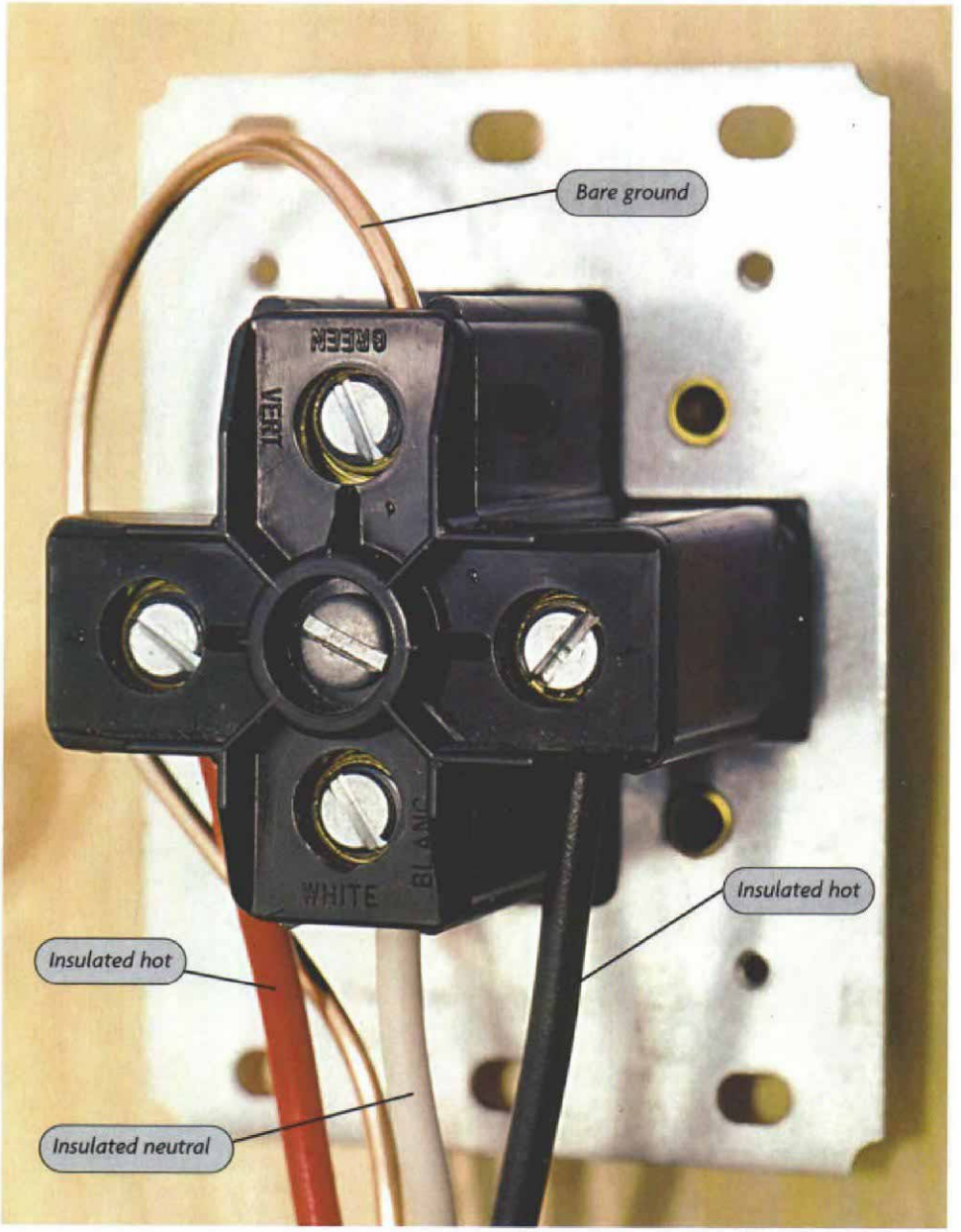
Wiring a dryer

A dryer rated at 5kw draws 20 amps of current. In real life, almost all dryer loads are 4500w, which is around 18 amps (check the plate). Just as with stoves, the 1996 code change means you can forget about wiring dryers with service-entrance cable or with 10-2 with ground. Simply use 10-3 NM-B with ground on a 30-amp breaker.

The 10-3 with ground cable will have black, red and white insulated conductors plus a bare ground. The black and red are the two hot wires that provide power for the heating element. The controls (timer, buzzer, etc.) are normally designed for 120v (photos above, right). To provide power to these devices, the appliance will tap off one of the two hot cables (either the red or the black) and then use the white wire as a return to the panel. Because the white wire is derived from the center tap of the utility transformer, the voltage across either the red or black conductor and the neutral is 120v.

These days, the pigtail that comes with an appliance may not be the proper one. These pigtails are installed by the distributor, not at the factory, and the people who put them on don't know code. Check them carefully. □

Rex Cauldwell is a third-generation electrician and a master plumber in Copper Hill, Virginia. His book *Wiring a House* was published by The Taunton Press in 1996. Photos by the author.



Dryer receptacles also need four conductors. A new-style dryer receptacle, also prompted by a 1996 code change, should be fed by four-conductor cable.