Wiring Receptacles and Switches

Your client's life may depend on the quality of your work

BY BEN GILES

Like every other trade involved with building a home, electricians rely on production methods to deliver dependable, high-quality work. But probably no other trade is as closely linked to the health and safety of the home and its occupants. While most of an electrician's work is concealed behind sleek device covers, one bad connection can threaten the existence of the home, as well as the lives of anyone inside. Because so much depends on electrical work being done properly, I recommend calling a licensed electrician for every electrical task—no matter how small or simple it may seem.

Approaching every phase of a project with the same consistent patterns of work is the key to my crew working quickly and efficiently while producing reliable, safe, and foolproof results. It also allows any member of the crew to jump in at any phase of a project and to know exactly what to expect when he or she reaches into an electrical box. Wiring receptacles and switches are great examples of our approach; let's begin with receptacles.

PREPPING THE CONDUCTORS

We typically do the finish wiring after the drywallers have finished hanging wallboard and, in most cases, after the walls and ceilings have been painted or at least primed. To minimize the possibility of damage to the wires as the board hangers zip cut around the boxes, we leave the wires coiled up and pushed as far

Photos by Roe Osborn

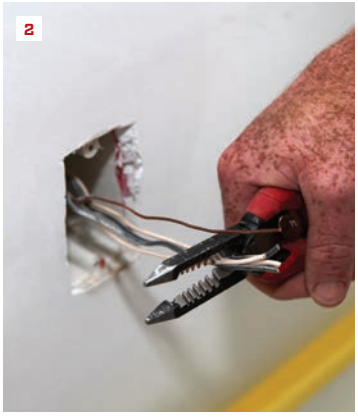
into the box as possible at the rough-in stage **(1)**. In new construction, we always wire the circuit-breaker panel after we've installed all of the devices, so we know the wires in the boxes are not live. If we're installing devices as part of a remodel or repair, we always begin by confirming that the electricity feeding the boxes that we're working on has been shut off.

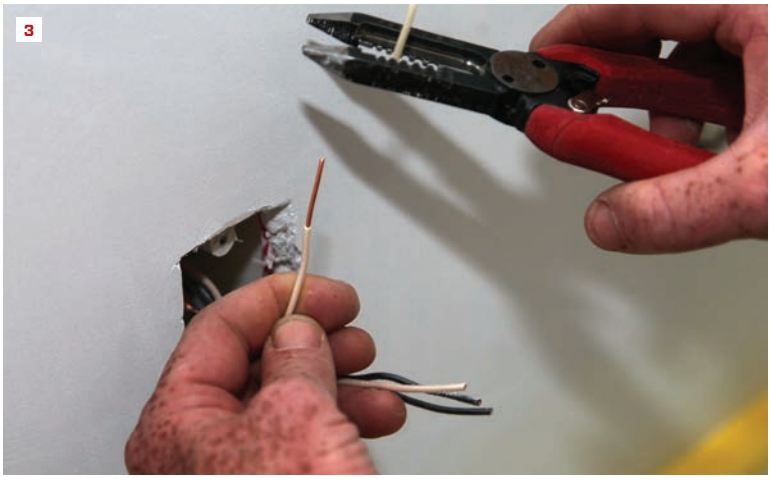
There is always a bit of debris left in the boxes from hanging the wallboard; we simply "finger sweep" the biggest chunks out. Then we reach in and pull out the wires, unrolling them until they extend out straight from the box. Different crew members may leave different amounts of wire at rough-in, but at this point, we cut all the wires to a length of 8 to 10 inches, except for the ground wire (or conductor), which we leave a couple of inches longer than the rest **(2)**.

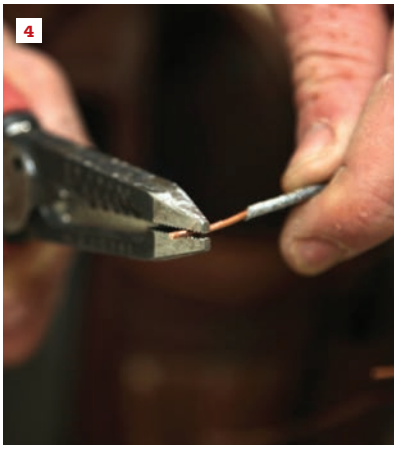
Next, we strip the ends of all the insulated conductors, exposing about 1 inch of bare copper **(3)**. My tool of choice for this task is a combination wire plier tool from Milwaukee that has a stripping feature for different gauges of wire and doubles as a pair of pliers for other tasks. I slip the wire into the appropriate hole for whatever gauge I'm working with, and the tool automatically cuts through the insulation without touching the copper conductor.

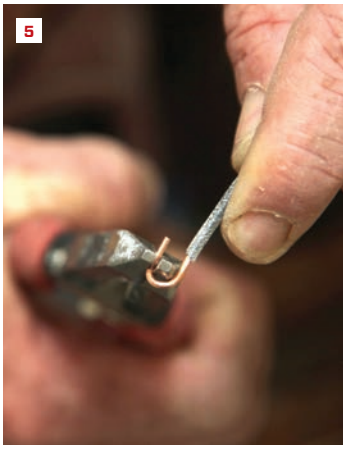
After stripping the ends, I curl, or loop, them. Using the pliers end of the combination tool, I grab the stripped conductor about 1/8 inch from the end **(4)** and rotate the pliers so that the copper curls around the jaws in a U-shape **(5)**. When this is done correctly, the end of the bare wire will be even with the end of the casing.

It is essential to curl the wires properly. Otherwise, if the end of the bare copper is curled beyond the insulation, the insulation can wind up under the terminal screw and interfere with the connection; and if the end of the curl is short of the insulation, too much bare conductor will be left exposed in back of the device, which increases the possibility for a short circuit. I've stripped and curled tens of thousands of conductors, so the process is second nature to me; however, I've seen it done incorrectly many times.

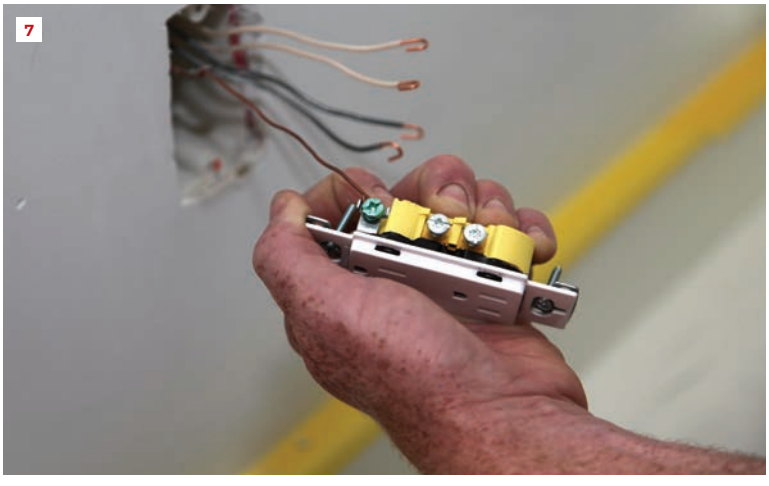


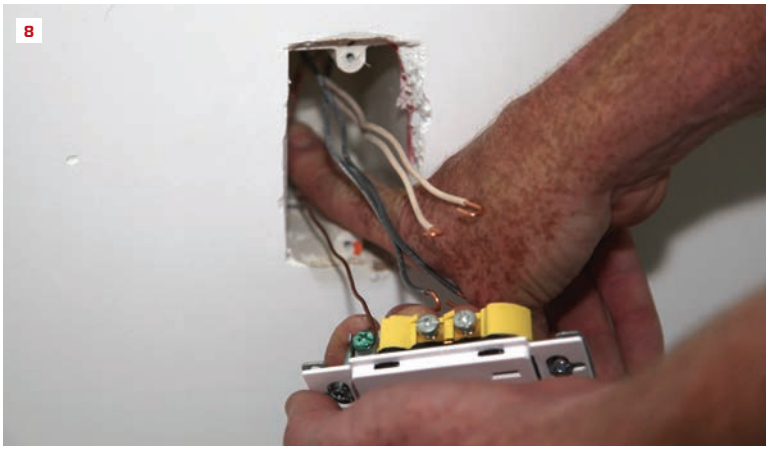






After rough-in, wires, or conductors, sit in the box, ready to be attached **(1)**. The author cuts the conductors, leaving the ground slightly longer **(2)**. Wire strippers remove an inch or so of insulation from each conductor **(3)**. To form a loop, grab the end of a conductor with pliers **(4)** and twist it into a U **(5)**, making sure the bare end is even with the end of the insulation.





The author attaches the ground conductor first. After slipping the loop around the grounding screw **(6)**, he catches the end of the wire on the metal tab next to the screw and rotates the device to close the loop **(7)** for a better connection. He then tucks the ground conductor into one of the back corners of the electrical box **(8)**.

CONNECTING THE CONDUCTORS

With the ends of the conductors curled properly, we're ready to attach them to a receptacle. When connecting conductors, I hold the receptacle across my left palm (I'm right-handed), with my fingers slightly bent in a loose fist and the back of the receptacle facing away from me. Holding the device in this manner keeps the screws accessible and keeps the device secure in my hand while I tighten the screws.

One of the first rules of electrical work is always to feed the conductor loops clockwise around the contact screws, which ensures that the loops close down around the screws as they are tightened. The first conductor I attach is the ground. On most receptacles, the green grounding screw is on a metal tab that branches out from the receptacle, so the ground conductor tends to be the most susceptible to loosening or becoming detached.

To help make sure that doesn't happen, I close the ground-conductor loop before tightening the screw. First, I slip the loop around the grounding screw and catch the free end of the loop on the little metal tab that extends up next to the screw **(6)**. While pulling the receptacle toward me to keep the loop against the shaft of the screw, I twist my wrist slightly to close the loop **(7)**. Then I tighten the screw with a regular screwdriver. I try to avoid using a mechanical driver that can overtorque the screw and weaken the conductor.

Next, I gently push the ground conductor along one side of the box and into a back corner **(8)**, putting the ground in its own area in the box. Pushing it in separately minimizes the chances for unintended contact between it and the other conductors in the box. The extra length that I left on the ground conductor when I cut the conductors makes this step easier.

Without changing the orientation of the receptacle in my hand, I slip the loops of the white neutral conductors around the silver-colored screws. With the regular contact screws, I do not try to close the loop as I did with the ground. I pull the device toward me so that the conductors are properly seated around the screw post, and I firmly but gently tighten the screws,

applying snug pressure with a regular screwdriver **(9)**. Then I turn the receptacle over and repeat the process with the black supply conductors around the brass screws on the other side **(10)**.

ATTACHING THE RECEPTACLE

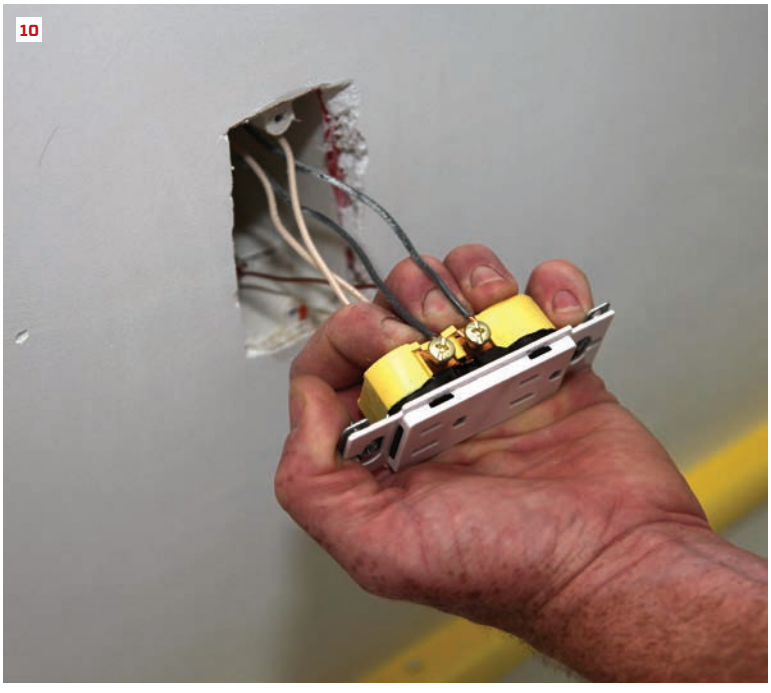
At this point, I've securely attached the conductors to the receptacle, and I'm holding the device 6 to 8 inches from the box, with all the conductors extended straight out. To put everything neatly into the box while placing the minimum amount of stress on the connections, I push the conductors down into a lower back corner of the box, away from where I had pushed the ground conductor **(11)**. The conductors are now all extending from the lower part of the box. Holding them against the bottom of the box with a finger, I rotate the receptacle into a vertical position with the other hand and lift it, which lets the wires fold gently around my fingers **(12)**.

Following this simple procedure ensures that all the conductors are tucked as far back into the outlet box as possible and are not bunched up against the back of the device. This minimizes the chance of a short circuit occurring when a bare conductor touches a screw on a device or another bare conductor in the box.

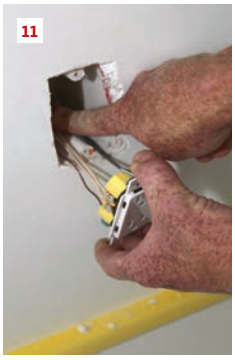
When the conductors are all tucked neatly into the box, I start the top attachment screw and drive it partway into the hole in the box. Then I drive the bottom screw most of the way into its hole **(13)**. As I make the final torque on each screw, I position the device so that the screws are centered on the slot. If the stud that the box is attached to has been installed straight and plumb, the cover plate should look like a properly hung picture. For this part of the process, I typically use a screw gun, taking care not to overtorque and strip out the screws.

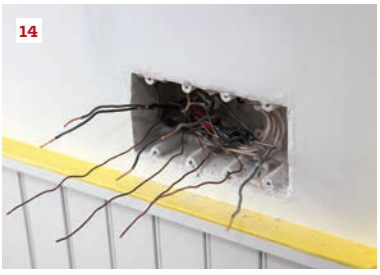
SWITCHING TO SWITCHES

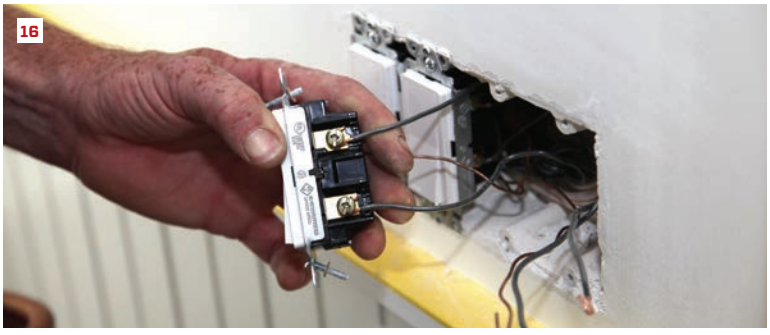
Because this article is focused on basic installation techniques, I will stick to single-pole switches, where just one switch operates the circuit. Three-way and four-way switches are a topic best dealt with on their own. My approach to wiring

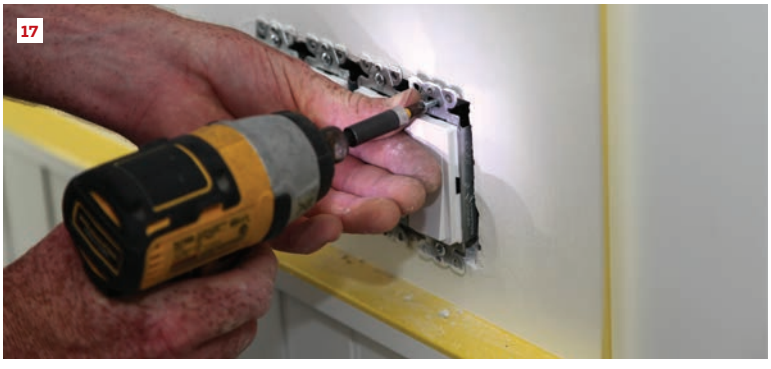


Holding the receptacle firmly in his hand, the author slips the loops for the neutral (white) conductors around the silver-colored screws and snugs the screws by hand **(9)**. After flipping the receptacle over to the opposite side, he slips the hot (black) conductors over the brass screws and snugs them down tight **(10)**.









The author pushes the conductors into a back corner of the box **(11)**, then folds them around his fingers **(12)** before attaching the receptacle **(13)**. Conductors are grouped in pairs for switches **(14)**. The ground attaches to one side **(15)**, and the load and supply conductors attach to screws on the other side **(16)**. Switches then screw into place in the box **(17)**.

single-pole switches is much the same as for receptacles, with the exception that the neutral conductors do not get attached to the device (they are wire-nutted together in the box at rough-in). Instead, a hot, or supply, conductor is attached along with a load conductor that runs to whatever is being switched.

By code, both of these conductors must be a "hot" color (anything but white), and it can be confusing if all the non-neutral conductors in a box are black—especially when there are multiple switches in the same box. However, we give ourselves a leg up at rough-in by stripping the ends of the hot conductors before curling up the wires and pushing them into the box. When it's time to install the switches, it's just a matter of pulling all of the conductors out of the box and separating the ones with the stripped ends from the rest.

Before I start stripping and curling the ends of the load conductors, I extend one hot conductor out for each switch in the box, keeping the hot conductors to the lower part of the box. Then I extend a ground and a load conductor for each switch, keeping them toward the upper part of the box **(14)**. When the conductors have been sorted, I strip and curl the ends the same as I did for the receptacles.

As with the receptacles, the first conductor I attach is the ground **(15)**. If the device has the ground screw mounted on a separate metal tab, I again close the loop before tightening the screw. With the devices in this project, the ground screws were mounted on the sides, so closing the loop was not necessary. After attaching the ground, I flip the device over and attach a supply conductor and a load conductor to the screws on that side **(16)**.

I attach each switch to the box as I finish attaching the conductors **(17)**. I try to center the attachment screw in the slot on the device. If there are multiple switches, I leave the attachment screws snug but slightly loose so that the devices can be adjusted side-to-side a tiny bit, if necessary, when the covers go on.

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