Ten Common Wiring Problems

A master electrician details some frequently found mistakes that could cost you your house or your life

BY REX CAULDWELL

If I were an electrical inspector, I'd have a checklist ready for anyone who came into my office asking for an inspection. I'd smile, hand them a sheet of paper and say, "Don't call me until you have checked all your wiring against this list." In fact, *Code Check Electrical,* an expanded version of such a list written by a former building inspector, has been published by The Taunton Press.

In a perfect world, inspectors would catch every problem. In reality, they may catch a few, or even most, but probably not all. Finding every problem means tracing every wire, staring at every cable sheath with a magnifying glass and opening every outlet box, and inspectors just don't have that kind of time. Those of us who've been in the trade for a long time are aware of how inspectors are pressed for time. Bad electricians take advantage of this situation, but good electricians wire with professional pride and won't compromise their integrity. Make sure you get the latter to do your wiring.

Wiring errors that elude the scrutiny of the electrical inspector are usually there to stay. Sometimes a problem arises months or even years later after warning signs start to crop up. Then the homeowner either lives with the problem or spends a lot of hard-earned cash to straighten it out. Here are ten common electrical problems I see. You may want to give this list to the person doing the wiring, especially if it's your house that's being wired. □

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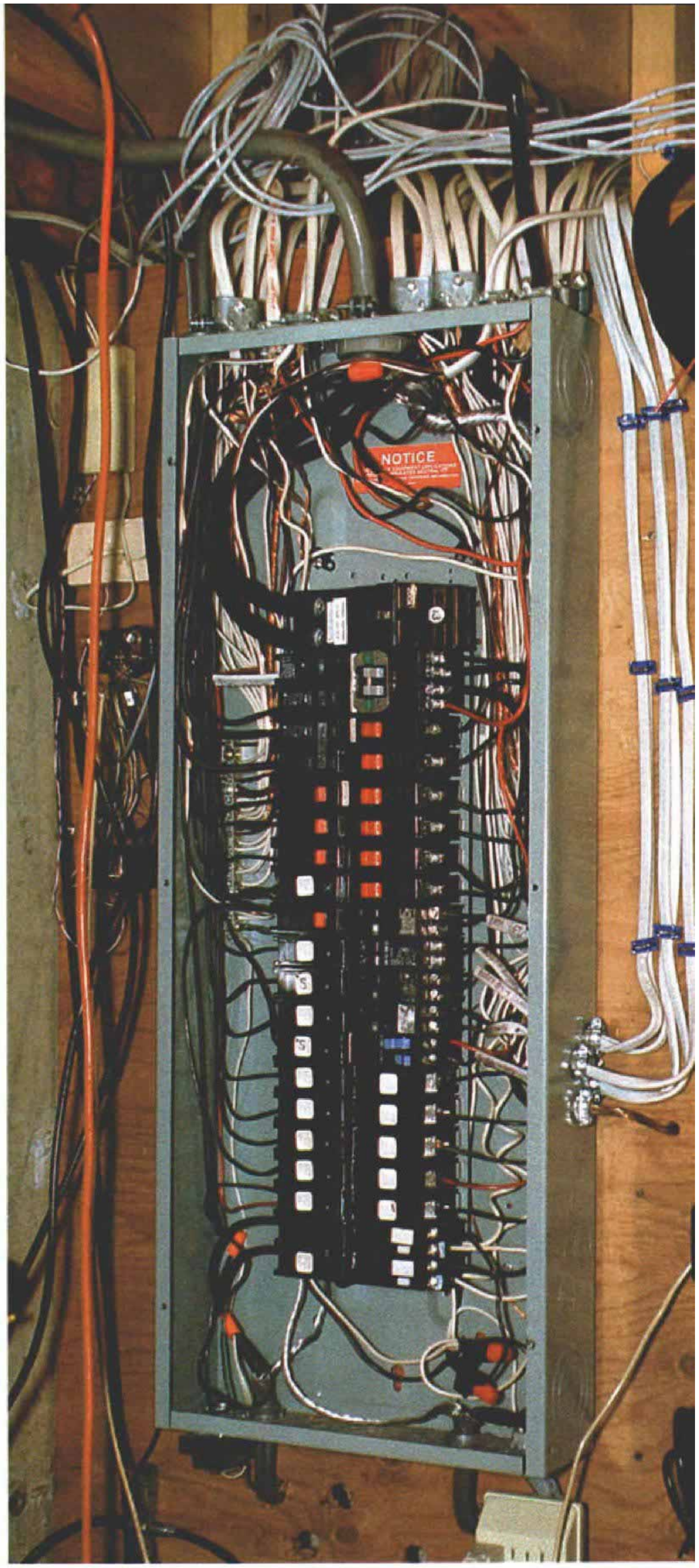


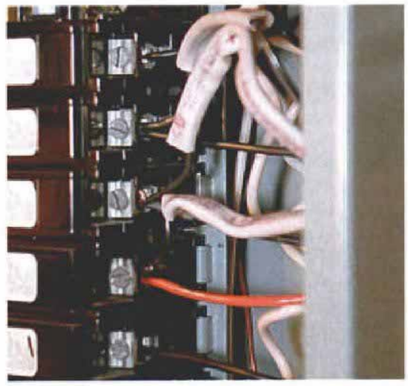
No vacancy. While not physically overcrowded, this poorly designed box has been added to and is overloaded with more cables than breakers. Classic symptoms are two wires under one breaker screw and dual breakers in a panel not designed for them.

1 Small, overloaded and poorly designed main panels

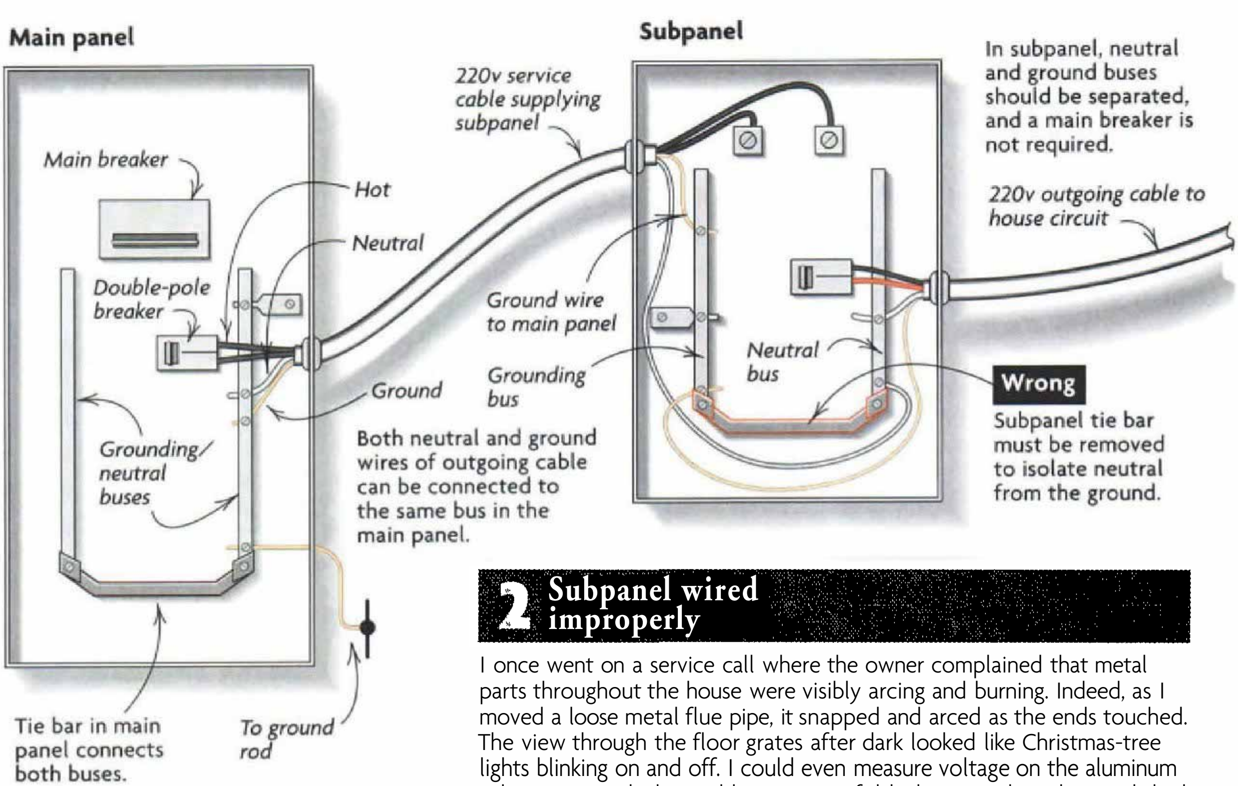
Overloaded main panels are booby traps for unsuspecting electricians. You take the last retaining screw out of the panel cover—pow! A tangle of wires comes springing out from their prison, and you wonder how you'll ever get them back in (photo left). In addition to having too many wires entering the box, close inspection reveals multiple wires on the breakers, another dangerous code violation (photo right). The fault here is usually shared by homeowners as well as contractors. Homeowners want the cheapest price for their house or their work, and contractors are typically only too happy to cut corners to get the work. The end result is that a contractor installs a small, junky panel that's barely big enough or already too small the day it's installed. Adding circuits later without upgrading the main panel is a dangerous proposition.

The solution

Install a large, intelligently designed panel. Be sure to include a main panel large enough to handle current needs comfortably with room to grow. If the main panel in your house is physically overloaded, you can either start with a new panel or have a subpanel properly installed; both options are expensive jobs but cheap insurance.



One wire at a time. Breakers should never have more than one wire connected to them, unless approved by the manufacturer.



2 Subpanel wired improperly

I once went on a service call where the owner complained that metal parts throughout the house were visibly arcing and burning. Indeed, as I moved a loose metal flue pipe, it snapped and arced as the ends touched. The view through the floor grates after dark looked like Christmas-tree lights blinking on and off. I could even measure voltage on the aluminum siding to ground. The problem was twofold: The neutrals and grounds had been intermixed on a subpanel, and the house's ground wire (grounding electrode conductor) had been disconnected from the ground rod (cut by a lawn mower).

The solution

The neutral wires in a subpanel have to be kept isolated from the ground wires, unlike the main panel where the neutral bus (the wiring bar where the neutral wires are attached) is connected to the ground-wire bus (drawing above). If neutrals and grounds are intermixed on the subpanel, the grounding system ends up in parallel with the neutral system all the way back to the main service panel, which means neutral current will be flowing through metal water lines, ductwork, gas lines, the metal skin of the house, etc. This situation is dangerous, especially to tradesmen working around and under the house. If the neutral breaks, all its current ends up flowing back to the main panel on the grounding system.

Drawings: Scott Bricher

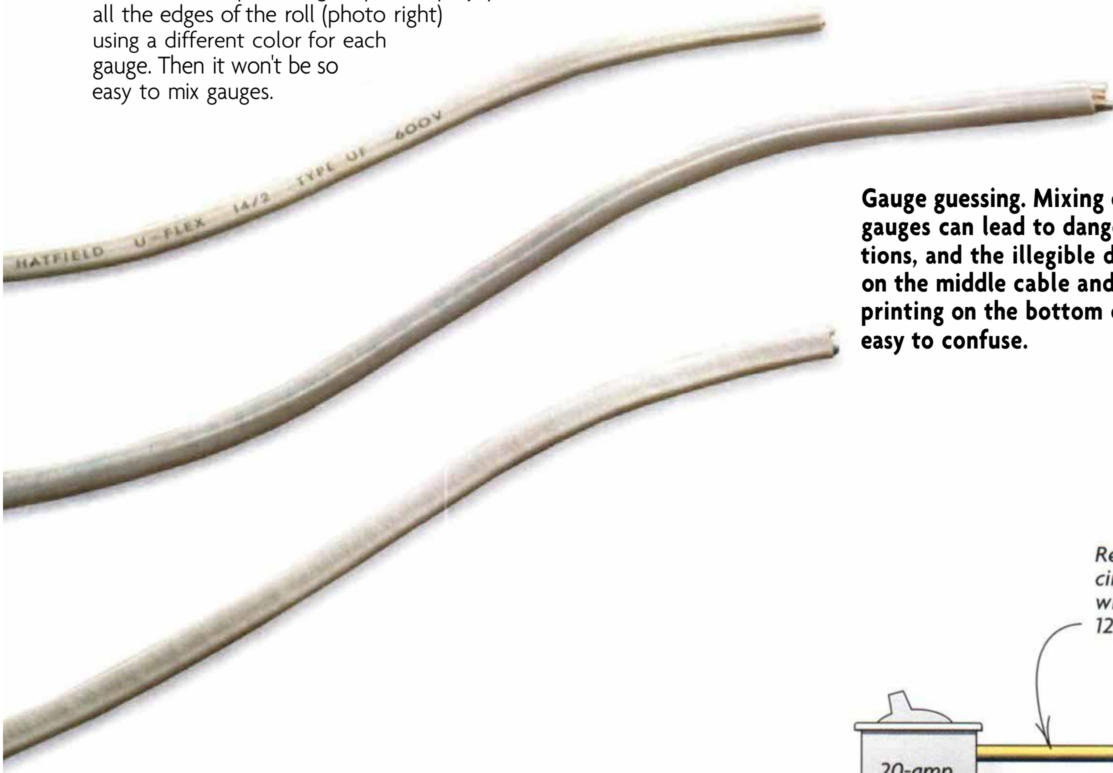
3 Accidentally using the wrong gauge of cable

Many manufacturers of NM (nonmetallic sheathed, aka Romex) cable emboss the wire gauge on the cable sheathing instead of printing it clearly (photo below). Reading the gauge on embossed cable or cable with the gauge dot-printed is difficult, and it's easy to confuse gauges and to install the wrong size wire, such as 14 ga. on a 20-amp circuit.

The solution

All electricians and even do-it-yourselfers should refuse to buy cable that doesn't have its wire gauge conspicuously marked. The best solution would be to have manufacturers color-code the cable sheathing for a specific wire gauge, for example, white for 14 ga., green for 12 ga. and red for 10 ga. This improvement would be a real boon to inspectors. A simple glance at the sheath color would tell whether code was followed. If you can't get cable with the gauge printed clearly on it, take the cable out of its box and keep it in a tight roll. Then stand the roll up or hang it up, and spray-paint all the edges of the roll (photo right) using a different color for each gauge. Then it won't be so easy to mix gauges.

Do-it-yourself color coding. If all you can get is wire with the gauge embossed instead of clearly printed, spray-paint the roll of cable a specific color for each gauge. Here, neon green indicates 12 ga.



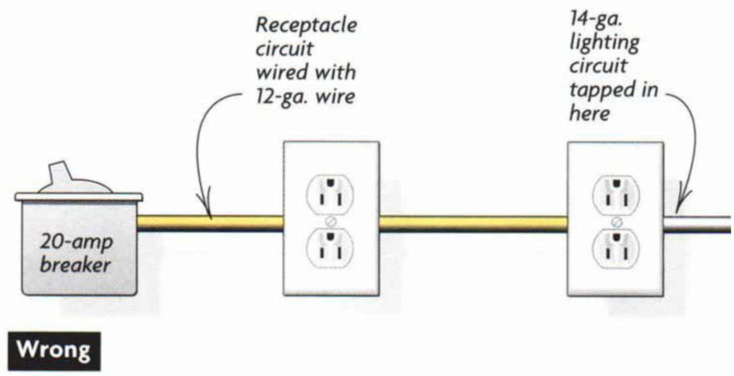
Gauge guessing. Mixing or mistaking gauges can lead to dangerous situations, and the illegible dot printing on the middle cable and embossed printing on the bottom cable are easy to confuse.

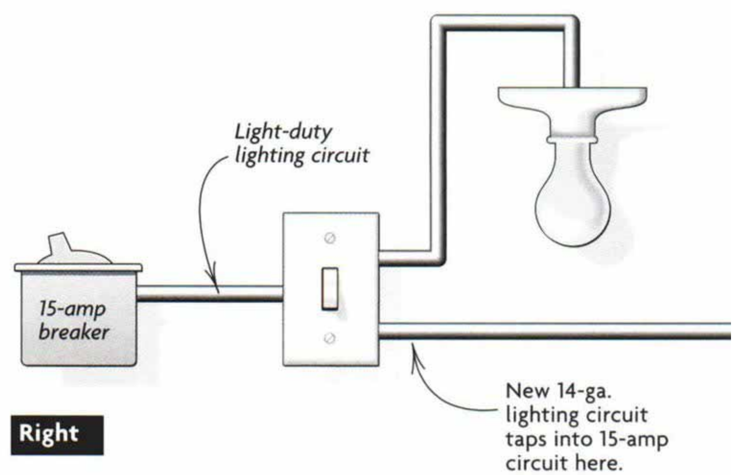
4 Using 14-ga. wire on a 20-amp circuit

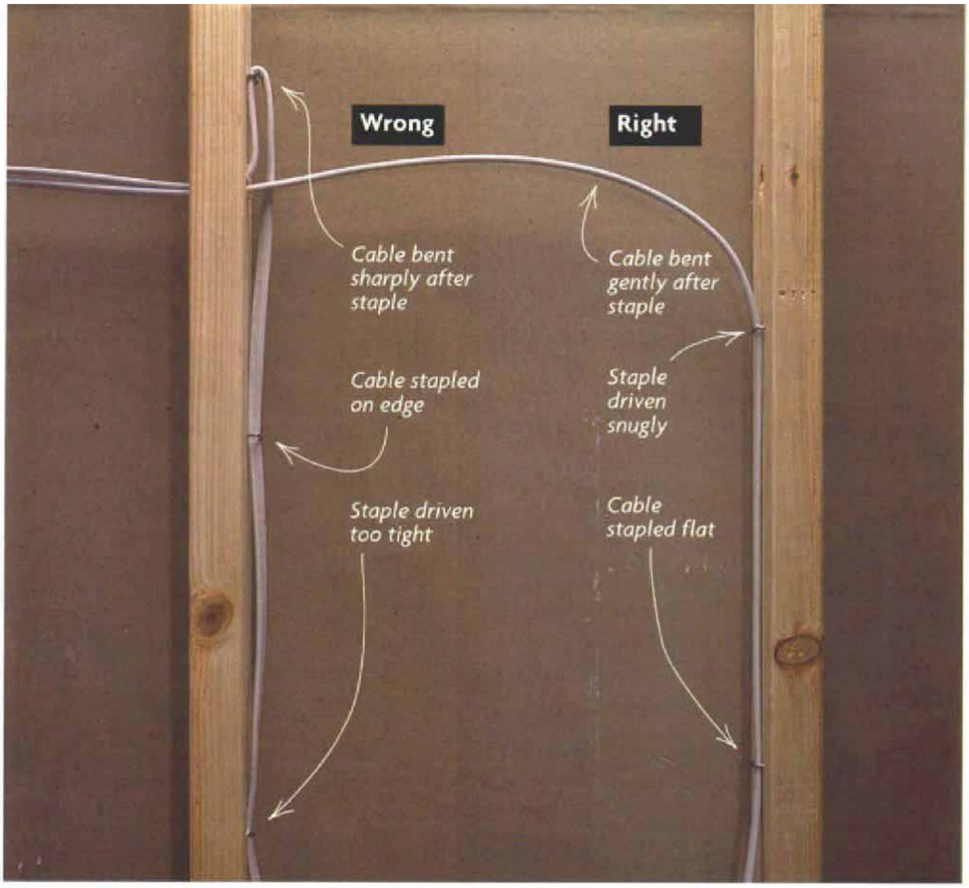
One of the side effects of not being able to read the wire gauge is inadvertently putting 14-ga. wire on a circuit controlled by a 20-amp breaker. But a more-likely scenario is that a lazy electrical contractor has tapped into a convenient 20-amp circuit to supply a lighting circuit typically wired with 14-ga. wire to keep down costs. Using 12-ga., 20-amp circuits for lights that pull only 1 amp to 2 amps is a waste of money. But using 14-ga. wire on common receptacle and switch circuits that have a 20-amp fuse or circuit breaker is a code violation (drawing right).

The solution

Think ahead and feed the lighting circuit from an adjacent light-duty bedroom circuit that is typically fed with 14-ga. wire on a 15-amp breaker.

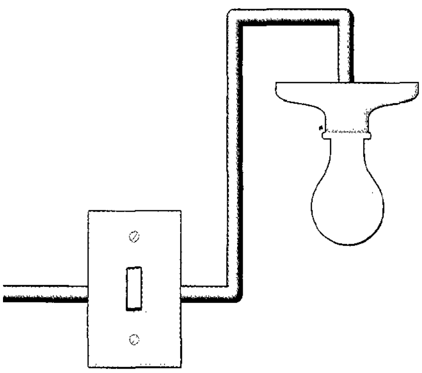


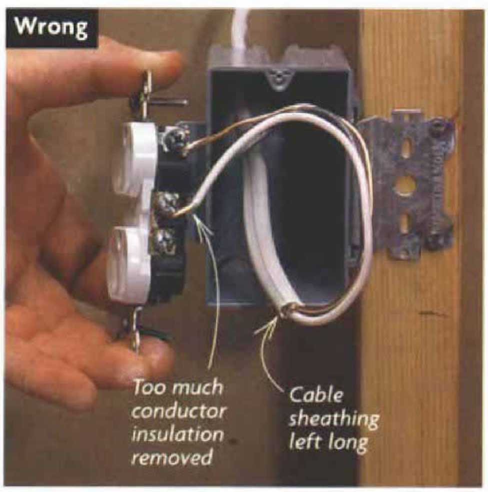


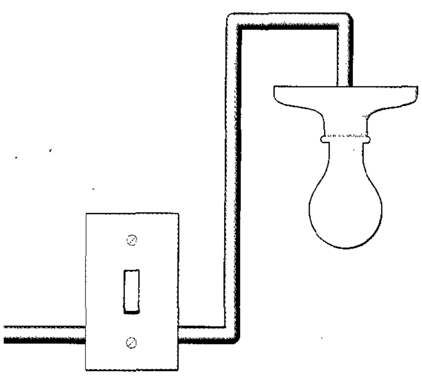


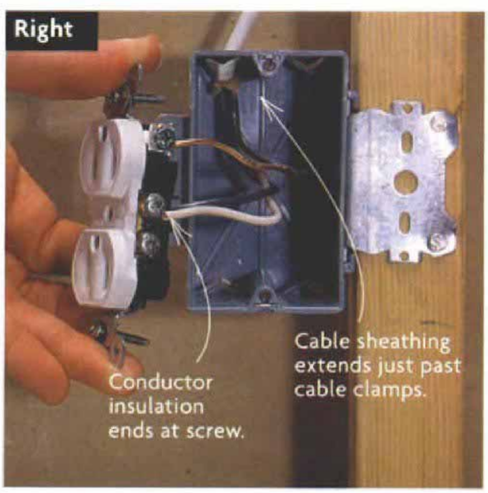
5 Improperly stapled cable

I never have an apprentice staple cable unless I've given specific instructions on how, or perhaps more important, how not to staple a cable along its route (photo left). First, cable staples should be driven snug, not tight. One extra hammer blow can send a metal staple cutting through the cable's sheathing and the conductors' insulation, creating a direct short across the conductors within. Second, the staple should be driven against the cable's flat side, not on its edge. Last, never bend the cable sharply after the staple.







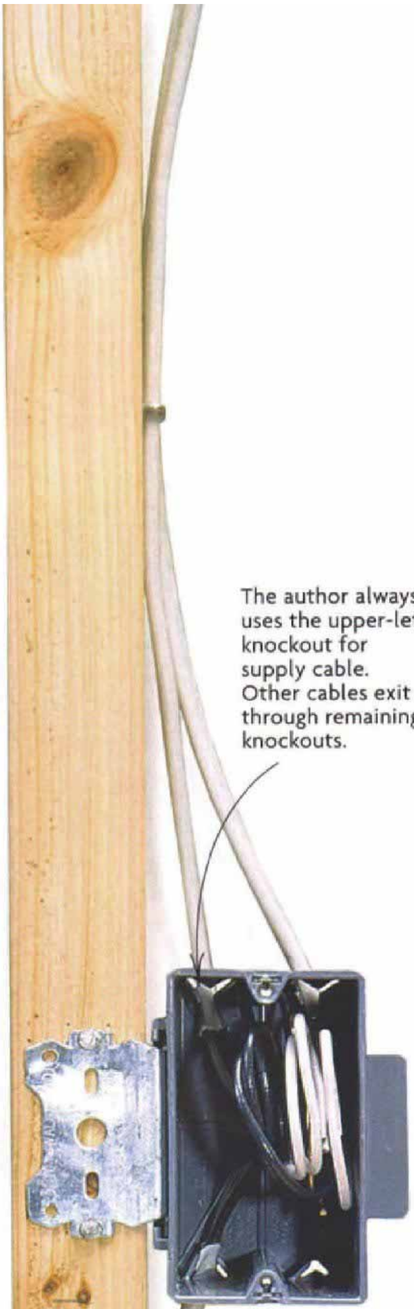


6 Not trimming conductor insulation and cable sheathing to the right length

Few pros make these mistakes, but they're common among do-it-yourselfers. Extra sheathing left on the cable takes up needed space in the box leading to overcrowded conditions that can bend and break wires. Extra insulation removed from a conductor can leave exposed wire in the electrical box (center photo).

The solution

After the cable enters the box, the sheathing should all be removed except for the last fraction of an inch that the box clamp grabs onto (bottom photo). Removing only about $\frac{1}{2}$ in. of the conductor insulation is just enough to wrap around the screw. While you're at it, wrap clockwise.



The author always uses the upper-left knockout for supply cable. Other cables exit through remaining knockouts.

7 Using outlet boxes that are too small

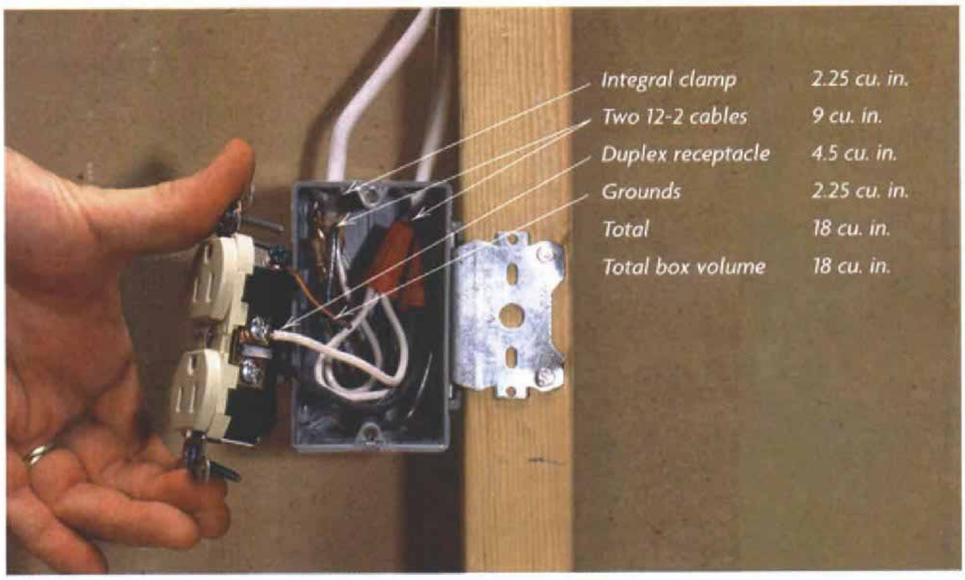
Everything in an electrical box—GFCIs, timers, dimmers, common switches, receptacles, wires—occupies space or, more appropriately, volume. Wire connectors and integral clamps take up volume as well. Some people think that all these things can fit into any box they happen to pick up or the cheapest they can lay their hands on. The result is that wires are bent, cut and broken as too many things get stuffed into a small-volume box.

The solution

Use the size-requirement chart at right and buy the appropriate size box (photo below). Otherwise, always purchase the deepest box available, 3½ in. deep, and never use the metal handy boxes that are only 1½ in. deep. They aren't good for anything except cutting through wire insulation.

14-ga. cable, each conductor	**2 cu. in. (1 volume unit for 14 ga.)**
12-ga. cable, each conductor	**2.25 cu. in. (1 volume unit for 12 ga.)**
All grounds in a box	**1 volume unit of the largest conductor in the box**
Cable clamps	**1 volume unit of the largest conductor in the box**
Receptacle or switch	**2 volume units of the largest conductor in the box**

Note: No extra volume is added for wire connectors or things that need extra depth, such as dimmers and GFCIs. But whether allowed for by code, these things do take up extra volume, another reason always to use a high-volume box.



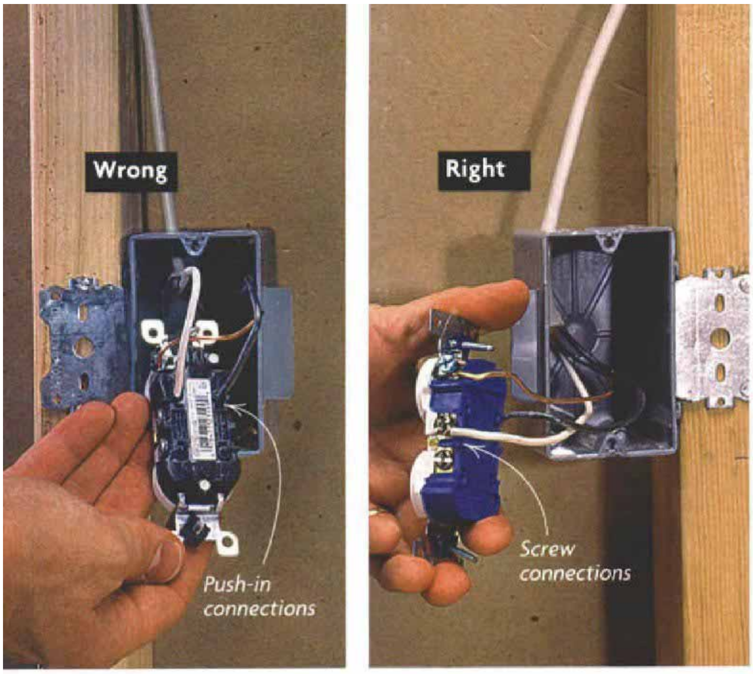
Maxed-out electrical box. Everything that goes inside an electrical box takes volume, and the box should be sized accordingly. An 18-cu. in. box such as this one has the volume stamped on it.

8 Forgetting to bring in the power-supply cable

This item could be comical if you're not the one who has to fix the problem. And if you think it will never happen to you, don't be so sure. I see this problem most often when one electrician picks up a job after another quits. The second electrician assumes that the first electrician ... well, you know the end of that story. Besides the embarrassment of having a circuit or circuits with no power, the final result is that you go fishing, not with a pole and bait, but fishing cable under the wall trim and through finished walls.

The solution

The simple answer is to wire outlet boxes with a plan, and never change that plan. I always bring the power-supply cable into the outlet box through the same knockout every time (photo left). I use the upper-left knockout. Cables that feed other receptacles and switches come into the outlet box anywhere else. Then all I have to do is stroll casually along the wall and just glance at the switch and receptacles boxes. If there is a cable in the upper-left knockout, I know I remembered to bring in power.



9 Back-wiring receptacles and switches

One of my pet peeves is receptacles and switches that allow you to attach wires by pushing them into the little holes in the backs (photo left). Although these connections are allowed or ignored by the National Electrical Code, which I still don't understand, these ill-conceived outlets usually make a poor electrical connection. (UL has banned push-in connections from 12-ga. circuits.) I refuse to install these outlets even when they are supplied by the homeowner. The problem with this type of design is that the wires can pull out after a while, creating open connections or, even worse, loose connections. Receptacles that had been working fine suddenly have no power. Or the loose connections cause a receptacle to generate heat, even with nothing plugged in.

The solution

Check the receptacles and switches in your house and replace every one where push-in connectors have been used. Replace them with high-quality outlets and switches that use screws as connectors (photo right). In my area, a good outlet costs about $2, better ones $5 and the best $10.

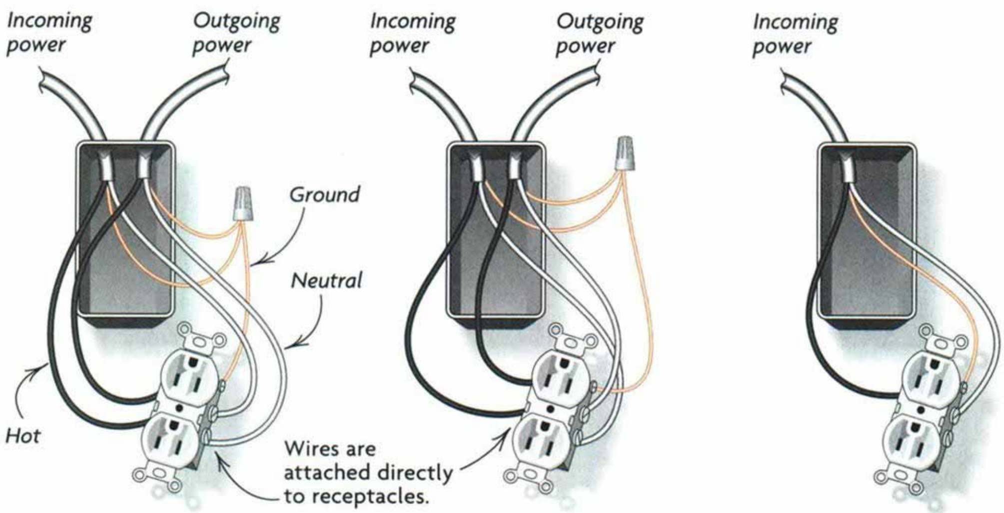
10 Receptacles wired in series

I get service calls all the time complaining of whole strings of receptacles that suddenly have stopped working. In my mind's eye, I know what to expect as soon as I open the first box: Wires from both incoming and outgoing cables are anchored to the receptacle screws or more than likely pushed in the back. This way of wiring receptacles is known as series wiring (drawing top right). Although series wiring is the most common way of wiring outlets, you also have to put up with its problems. If a receptacle breaks or is removed or if the wire pops out of the little hole in back of the outlet, all receptacles downstream will stop functioning.

The solution

Use a parallel system (drawing bottom right) to wire receptacles. With this system, wires from incoming and outgoing cables are connected together along with pigtails (short connecting wires) that supply the receptacle. The last receptacle in the string can be wired directly without pigtails.

Receptacles in series



Receptacles in parallel