Is Your Old Wiring Safe?

Inspect the electrical panel and exposed wiring to identify safety risks and upgrade options

BY CLIFFORD A. POPEJOY

Some materials used in old houses are better than their modern counterparts, like three-coat plaster versus drywall. When it comes to electrical wiring, though, older does not mean better. Electrical materials and safety devices have improved considerably over the past century.

Is old wiring safe? It may be. Or it may present a shock, electrocution, or fire hazard due to deterioration from age, poorly executed modifications, or lack of capacity to meet modern power demands. Older wiring that's in good shape, however, can continue to serve, and selective upgrades can be used to meet today's needs.

A visual inspection of the panel and exposed wiring is the first step in evaluating an electrical system. Although I can't possibly describe everything that could go wrong with old wiring and how to fix it, I can describe some of the signs of an electrical system that needs repair or replacement.

Get to know your old wiring

When electrical wiring first was installed in new homes, the wires were run on a series of porcelain knobs and tubes. In a knob-and-tube system, the splices were soldered and wrapped in electrical tape. Junction boxes, if there were any, were small.

Timeline photos: Scott Phillips. Drawings: Dan Thornton

125 YEARS OF ELECTRICITY IN HOMES

1879

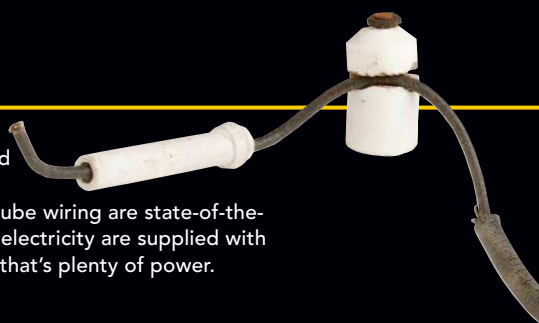
Thomas Edison invents the first practical lightbulb.

1896

An increasing number of fires caused by poor electrical installations leads to the development of the National Electrical Code (NEC).

1910s

Electric light begins to replace gaslight and kerosene lamps. Fuse boxes and knob-and-tube wiring are state-of-the-art. Houses that have electricity are supplied with 30 amps at 120v, and that's plenty of power.

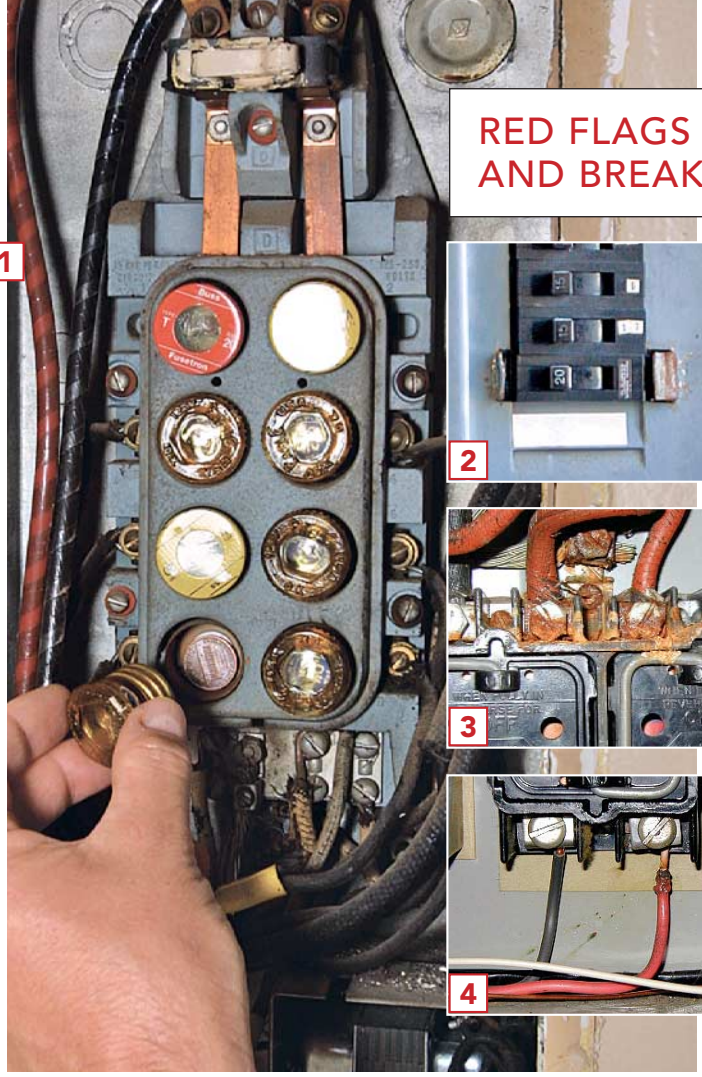


Armored cable, or BX, also was used in early electrical systems. Originally designed to protect the wires inside, the armor also acted as the grounding conductor in later versions of the cable.

Loomex, a predecessor of the nonmetallic (NM) sheathed cable used today, became available in the late 1920s. Nonmetallic cable first had only two wires with a tar-soaked cotton jacket. Later, a grounding wire and plastic sheathing were added. The insulation on the wires was made more heat resistant in 1984. This cable, used widely today, is labeled NM-B.

When current travels through a wire, the friction creates heat that can damage the wire's insulation. Consequently, all wiring is protected by fuses or circuit breakers. In early electrical systems—5-, 20-, 25-, and 30-amp—Edison fuses provided this protection.

The second generation of overcurrent protection is the circuit breaker. A circuit breaker is a switch that senses when there's too much current and opens, interrupting the circuit. The advantage of breakers is that they can be reset after the problem has been fixed. If a fuse melts, it has to be replaced. When I inspect old wiring, I begin at the fuse box or breaker panel.



RED FLAGS IN THE FUSE BOX AND BREAKER PANEL

1 *Coins or slugs behind the fuses.* *In this case, a penny is not a sign of good luck, but rather a sign that the wiring may have been damaged by the bypassed overcurrent protection.*

2 *Hacked panel covers.* *Circuit breakers are designed to work only in specific panels. To save money, mismatched and oversize breakers may have been installed, and the panel cover modified to fit.*

3 *Rust.* *On screws, wire, armored cable, or the box itself, rust is a sign of deterioration. Rust can create poor connections and potential safety hazards.*

4 *Melted wire.* *Exposed copper wire is dangerous because it can cause arcing, shock, and electrocution. Melted insulation is a sign of overheating.*

First, inspect the panel

As greater demands were made on old electrical systems, fuses would melt due to overloads. People often installed an oversize fuse, or installed a coin or metal slug to bypass the fuse and keep it from melting. When I evaluate a fuse box, I take out each fuse and look for a coin or slug. If I find one, I know the wiring on that circuit probably is damaged and needs to be evaluated further before it can be deemed safe.

Likewise, if I find a bunch of 30-amp fuses in a box, there is a good chance the circuits are overfused. Thirty-amp or larger circuits are used for 240v appliances or for subpanel feeders, so there should be only a pair of 30-amp or larger fuses for each of these circuits. I also check the gauge of the wires on each circuit to determine if the fuse size is appropriate. If the homeowner intends to keep the fuse box as the main panel or as a subpanel, I install type-S inserts before I replace the fuses. The inserts make it impossible to install oversize fuses.

Homeowners with newer electrical panels sometimes install oversize circuit breakers on overloaded circuits. Using the coffeemaker and toaster at the same time no longer trips the breaker, but it's likely that the wiring has been overheated and damaged as well.

I've also found electrical panels missing covers. This makes resetting a breaker unsafe. And I've seen the cover notched to accommodate a breaker not designed for the panel. This is dangerous because breakers and panels work together as a system, and only breakers listed for use in a specific panel are acceptable. If the cover is missing or has been

Photos 3, 4: Dennis Robitaille

1920s

By the end of the decade, two-thirds of American homes have electricity.

1930s

Electrical appliances and tools are common. Armored cable (BX) comes into common use, but knob-and-tube wiring still is widely used. Service grows to 60 amps, 240v, and breakers start to replace fuses.

1940s

Postwar building boom accelerates changes. Loomex, a nonmetallic (NM) sheathed cable, is used more widely. Knob-and-tube is phased out because installation is too labor-intensive.

hacked up, I buy a new one or have a new one made, replace the mismatched breaker, and carefully inspect the wiring for that circuit.

Inside all electrical boxes, I look for rusted metal, melted plastic, exposed copper on the hot and neutral wires, and loose connections.

Look for failing wires

After I inspect the fuse box or breaker panel, I look at all the accessible wiring, usually in the attic and basement. I check for signs of deterioration or of improper modification. If I find bare wire where the insulation has fallen off, or brittle insulation that will fall off soon, I know there's a risk of shock, electrocution, and fire.

I inspect modifications to knob-and-tube wiring. Original splices should have a neat layer of friction tape and should be supported by knobs on both sides. Nonoriginal splices should be made in electrical boxes. Open splices can fail and arc. The National Electrical Code (NEC) does not allow knob-and-tube wiring to be buried in insulation, although some jurisdictions do, as long as it has been inspected by an electrician and there is a sign warning that the wiring is present. (Go to www.finehomebuilding.com for more on old wiring and code issues.)

I begin my evaluation of armored cable at places where it's exposed to moisture because rust is the most common cause of deterioration. I also make sure the fittings that connect the cable to electrical boxes are not rusted or loose. Rust and bad connections impair the grounding path. If I spot rusted cable, I test the quality of the grounding path with a special tester. (Go to www.finehomebuilding.com for more on these testers.)

With NM cable, I first check to see if the sheathing is deteriorating or has been chewed by rodents. Then I look in a few boxes to see how the grounding conductor is terminated. During the transition to grounded circuits, some electricians clipped off the ground wire or wrapped it back onto the sheath. If grounding outlets are installed in a system without a grounding wire, I replace the outlet with a nongrounded or GFCI (ground-fault circuit interrupter) receptacle.

Some NM cable installed in the 1960s had aluminum conductors. If I find branch circuits with aluminum wiring, I inspect all connections. Because aluminum expands and contracts, it can work itself loose. I make sure that all the switches and outlets are rated for aluminum wiring. I also look inside junction boxes and behind outlets and switches. Looking in these areas, I can tell if past electrical work was done properly.

Rewire or upgrade?

After I inspect an electrical system, I have to decide whether to recommend rewiring the house or just doing selective upgrades. If much of the cable sheathing or conductor insulation is in bad shape, if there are no fixture boxes, or if testing shows poor connections, I recommend a rewire. If only one or two areas have deteriorating insulation and it looks as if the original installation and any modifications were well done, and the results of voltage-drop testing are acceptable, then selective replacement or upgrading is an option.

Folks often worry about nongrounded circuits. If wiring is in good shape and grounded outlets aren't needed—for three-prong plugs or surge protectors—these circuits are fine.

Older wiring and the small outlet boxes that often were used with it can be difficult to rework. If you need or want to add GFCI outlets, for example, you may find it difficult to install the GFCI in a small

THREE MYTHS ABOUT OLD WIRING

The design, materials, and installation techniques of older wiring are very different from today's systems. As a result, there are many misconceptions about older wiring. Here are three of the most common myths:

Myth #1 Knob-and-tube wiring must be replaced

When the opportunity presents itself—during a remodeling project, for instance—I usually recommend replacing old wiring. Some insurance companies won't issue new policies or will charge higher premiums for houses with knob-and-tube wiring. However, if it is inspected, proves to be in good condition, and meets your needs, there is no reason to rewire your house.

Myth #2 Old nongrounding circuits are unsafe

Most new appliances, lamps, and tools have two-prong plugs that don't need a grounded outlet. These two-prong plugs are double-insulated, reducing the chance of shock or electrocution and the need for a grounded circuit. What is unsafe is using an adapter to make a three-prong plug work in a nongrounded outlet. If you need to plug in a surge protector or other grounded device, run a new circuit that has an equipment-grounding conductor.

Myth #3 GFCIs won't work with old wiring

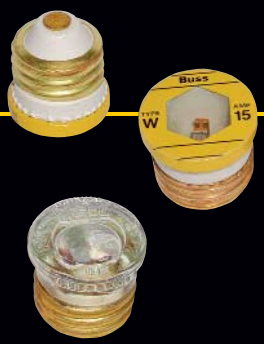
A GFCI receptacle will work fine in an old electrical system even if the circuits don't have a grounding conductor. The GFCI self-test button will work, too. Because there's no grounding conductor, though, a plug-in continuity tester won't trip the breaker.

1950s

Grounding conductor is included in some cable. Grounding receptacles (three-hole outlets) appear, but it'll be 20 years before their use is universal.

1960s

Plastic insulation is used on conductors in loomex. Fuses still are widely used for 15-amp and 20-amp branch-circuit overcurrent protection.



1970s

NM cable with plastic sheath and full-size grounding wire is introduced. GFCI protection is required for residential bathroom and garage receptacles. Circuit breakers become common.

box without damaging the old wires. In this case, I install a junction box at a point where the original wiring is in good shape, and splice and run new cable to the outlet. If the outlet box is still too small, I remove the old electrical box and install an old-work box.

If a house's wiring is in good condition but is overloaded, adding a few new circuits is the best solution. Installing new circuits to serve the kitchen-counter and bathroom outlets, computers, dishwashers, and garbage disposals takes a significant load off existing circuits and costs much less than rewiring the house.

If I'm adding new circuits, I have to decide if the fuse box or breaker panel has enough capacity and breaker spaces to handle new circuits. If the service is an original 120v, 30- or 60-amp fuse box or breaker panel, or if I need to add branch circuits to a fuse box, I recommend upgrading to a modern panel and 200-amp service. It is also time to upgrade the service when the load calculations show a demand larger than the existing service or when no space is available for new circuits. Finally, if the panel is rusted or if the hot buses are badly pitted, it's time to upgrade. If all you need is one or two additional 20-amp circuits, and the panel has capacity and breaker space, there's no reason to replace a panel just because it is old.

Looking at the condition of wires, and their supports and connections, is a big part of inspecting an old electrical system. If you inspect the wiring in your house and still have concerns, call an electrician who has expertise in old wiring and has the special equipment to test the safety and reliability of the circuits and overcurrent protection. □

Clifford A. Popejoy is an electrical contractor in Sacramento, Calif. Photos by Brian Pontolilo, except where noted.

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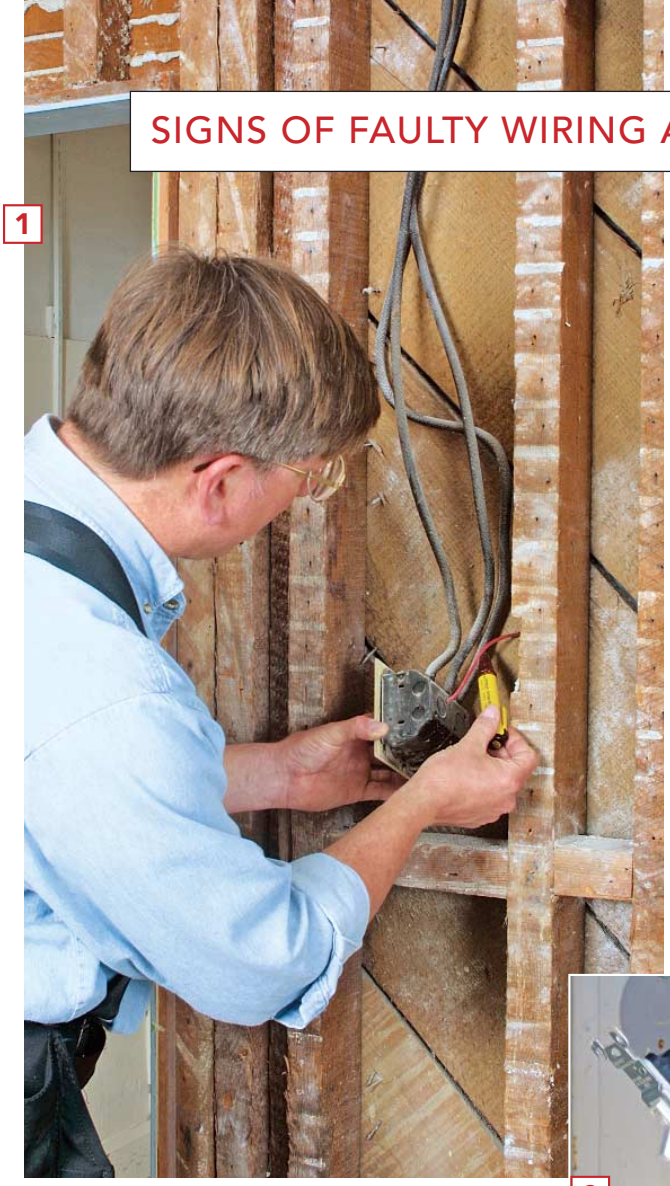
SIGNS OF FAULTY WIRING AND BAD UPGRADES



1 *Poor additions.* *Other than knob-and-tube, wires should be in a cable or conduit. Loose current-carrying wires are vulnerable to damage.*

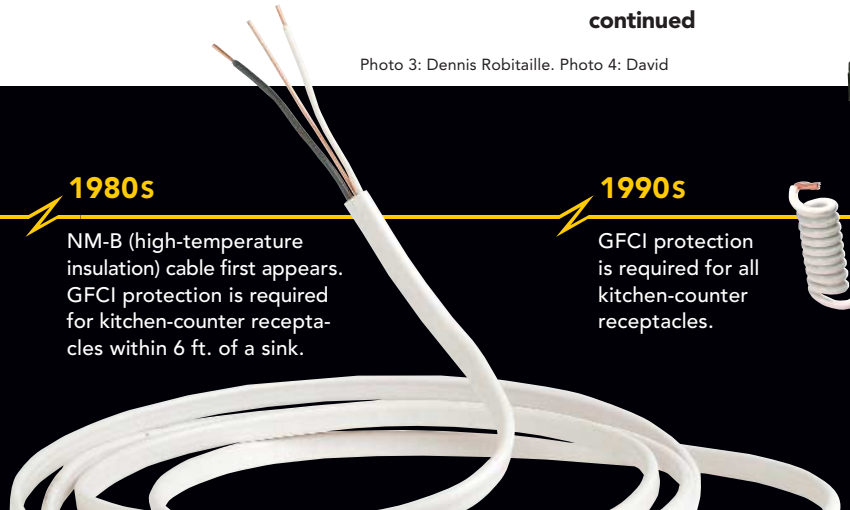
2 *Missing electrical box.* *Switches, outlets, and splices should be installed with electrical boxes.*

3 *Chewed cable.* *Rodents can be a problem with nonmetallic cable. Chewed cable should be repaired or replaced.*

4 *Bad connections.* *During an inspection, all connections should be checked. Because the armor on this BX cable acts as the grounding conductor, a bad connection means poor or no ground.*

5 *Deteriorating sheathing.* *The insulation on old wiring can be brittle. Brittle insulation crumbles, exposing wires and creating a hazard. Small areas of deteriorating cable can be fixed; lots of deteriorating cable should be replaced.*

Photo 3: Dennis Robitaille. Photo 4: David



1980s

NM-B (high-temperature insulation) cable first appears. GFCI protection is required for kitchen-counter receptacles within 6 ft. of a sink.

1990s

GFCI protection is required for all kitchen-counter receptacles.

2000s

AFCI protection is required for all bedroom circuits.

Ungrounded GFCIs must be labeled

In the February/ March issue, Clifford A. Popejoy's article "Is Your Old Wiring Safe?" (*FHB* #169, pp. 74-77) omits an important detail regarding retrofitting GFCIs to ungrounded circuits. Per the NEC, you also need to apply the "No Equipment Ground" stickers, usually supplied with the GFCI. The same applies for any three-prong outlets hooked to the "load" side of the GFCI, if applicable.

—CHRIS PATSTONE
via email

Clifford A. Popejoy replies: You're right. A GFCI-receptacle outlet that is not connected to an equipment ground should be labeled. This requirement is found in section 406.3(D)(3) of the 2005 National Electrical Code (NEC). Because the article's focus was not installation of GFCIs and because a GFCI receptacle comes with installation instructions (and most come with the required labels), I figured I didn't need to make the point. But it's a good one.