The trouble with aluminum wiring

It could be a fire hazard in 1½ million homes

At 3:25 A.M. on April 28, 1974, a fire broke out on the second floor of John Hersh's house in Hampton Bays, N.Y. Hersh and his daughter died in the blaze; his wife, Rosalind, survived. Four years later, she told a Congressional oversight subcommittee what happened that night. An electrical outlet that had apparently been smoldering for a long time burst into flame, she said, "causing the entire room to become quickly engulfed and spreading through the upper floor." The receptacle had been connected to aluminum wiring, which had been used throughout the house.

Investigators found that other outlets in the Hersh's home, including one only about a year old, were charred and damaged—but not from the fire. According to the investigators, heat building up where the wiring was attached to the outlets had caused the deterioration.

"I guess we had a right to assume that something that had been around as long as electricity would be supplied to us safely," Rosalind Hersh testified.

When the Hersh's house was built, in 1967, aluminum house wiring was generally assumed to be safe. Over the years, however, fires and other problems associated with the wiring have convinced Government agencies and many local fire inspectors that the aluminum wiring used in the late 1960's is a hazard.

Almost from the day the U.S. Consumer Product Safety Commission (CPSC) opened for business in 1973, the agency has been trying—with only limited success—to do something about aluminum house wiring. It has filed suit in U.S. District Court to have aluminum wiring declared an "imminently hazardous" consumer product. The CPSC has also been promoting a special tool that electricians can use to make aluminum house wiring safer. But there is little hope of solving the problems associated with aluminum wiring quickly or inexpensively

The era of 'old technology'

Aluminum, like copper, is a good conductor of electricity Most of the high-voltage transmission lines in the U.S. are made of aluminum or aluminum reinforced with steel. Aluminum wire is also commonly used as the "service entrance" wire that connects a house to the power line in the street. But, until about 1965, aluminum was not widely used for the branch-circuit wiring that runs throughout the house. (Such circuits are designed for 15- or 20-ampere loads.) In the mid-1960's, a copper shortage drove up the price of copper wire, so builders and electricians turned to aluminum wire.

Electricians used what the CPSC has termed "old technology" wiring systems—aluminum wire in conjunction with switches, wall outlets, lighting fixtures, and the like designed for copper wire. That, according to the CPSC, is how the trouble began.

Electricians had little practical experience with aluminum wire. Only a small amount of it had been used before 1965, and little research had been done to assess the suitability of aluminum wiring systems for homes.

Indeed, the two organizations that play the greatest role in promoting electrical safety had said that aluminum wire was just as suitable as copper for household wiring, if properly installed. Underwriters Laboratories (UL) first "listed" aluminum wire in 1946, and maintained until the late 1960's that switches and outlets designed for copper wire could also be used with aluminum wire. The National Electrical Code, published by the National Fire Protection Association, has allowed the use of aluminum wire since 1901.

But aluminum wire doesn't behave the way copper wire does. When aluminum is exposed to air, a film of aluminum oxide forms on the metal's surface. The oxide is an insulator, not a conductor of electricity. If the wire is not firmly attached to an electrical receptacle in the first place, the aluminum oxide can build up readily. Even properly made connections can present problems.

While aluminum, like other metals, expands when it gets warm and contracts when it cools, it expands and contracts more than copper or steel do. When an electrical current flows through an aluminum wire, the wire resists the flow and gets warm. If the wire is held in place with a steel screw (as it would be in an old-technology wiring system), the screw forces the wire to expand sideways, out from under the screw When the current stops, the wire contracts. Although the movement is microscopic, the continual expansion and contraction can work the wire loose. Vibrations and temperature changes around the wire can also lead to loose connections.

Testifying before the Congressional subcommittee that heard Rosalind Hersh, Jacob Rabinow, an electrical engineer who was then with the National Bureau of Standards, explained what could happen: "Because it's loose, air gets in between the wire and the head of the screw." That can add to the build-up of oxide. "The next time you plug something into this outlet it gets hotter because the connection is worse. The worse the connection, the more heat you generate," he said. "Finally, you have a situation where you may have a fire."

By about 1969, reports of trouble with aluminum house wiring began to appear. The problems included flickering lights, static in radio and TV sets, odors and smoke around outlets—and fire.

UL has characterized the reported incidents as "nuisance problems," and says the reports it received "did not result in fires in buildings." UL, like the National Fire Protection Association, blames the problems on poor installation.

Still, largely as a result of the reported problems, UL revised its requirements for aluminum wire in April 1971. UL also began what it termed "extensive testing of conductors and wiring devices," as a way of "reducing the possibility of poor workmanship." Then, in July 1972, UL approved a new type of receptacle and switch—the so-called CO/ALR device, which can be used with either copper or aluminum wiring. CO/ALR switches and receptacles have brass screws, with wide heads, to hold the wire.

With the advent of these devices and a new UL standard for aluminum wire, the era of "new technology" wiring began. The CPSC considers CO/ALR devices to be "a great improvement" over the old-technology hardware.

Problems persist

Before the new-technology wiring was developed, however, an estimated 1.5-million houses had been wired with old-technology systems. The CPSC believes that the wiring in those homes represents a fire hazard.

Five years ago, the CPSC considered setting a safety standard for aluminum wiring. Instead, the agency settled on a more drastic course of action. In October 1977, it filed suit against 26 companies in U.S. District Court for the District of Columbia, charging that the aluminum wire and old-technology switches and outlets sold by the companies were "imminently hazardous" products. The CPSC asked the court to order the companies to repair or replace the wiring in the affected homes. Estimates of the size of the repair bill range from about $400-million to more than $1-billion. The suit is pending.

In the beginning, the CPSC's case against aluminum wiring was based

mainly on fire reports, calls to a CPSC hot line, and the like. Much of that data was inconclusive. In 1974, when the National Bureau of Standards studied the reports of aluminum-wire problems available at that time, the agency concluded that the data didn't prove anything one way or the other. Over the years, the CPSC has collected hundreds of affidavits from homeowners who have had problems with aluminum wiring.

William King, an electrical engineer at the CPSC, maintains that individual reports of problems can be important even if not statistically significant. "If you're sitting here as a commission and you get 500 reports about a problem, you can suspect something's wrong," he said.

The CPSC did produce a telling piece of evidence against aluminum wiring in 1979. A $1-million study, conducted for the CPSC by the Franklin Research Center, compared the safety of copper- and aluminum-wired outlets in more than 400 houses in four parts of the country. The test involved 1590 aluminum-wired receptacles (all old technology) and 2025 copper-wired receptacles. Half of the aluminum-wired houses were found to have at least one overheated receptacle, while only 5 percent of the copper-wired houses had that problem. The Franklin report said that the risk of a "fire hazard condition"—sparks, arcing, or a 300°F temperature at the outlet cover plate—was 55 times greater in homes with aluminum wiring. In addition, 107 aluminum and two copper receptacles that had reached a "fire hazard condition" were tested further in a lab. Twenty-four of the aluminum-wired receptacles caught fire, while one copper-wired receptacle ignited.

According to a UL official, industry disagrees with the way those tests were conducted and with the results.

Fixing the problem

Clearly, old-technology aluminum wiring is more trouble-prone than copper. The problems may result from improper installation, as the industry suggests, or they may be caused by flaws inherent in the wire and the outlets used with it, as the CPSC says. Whatever the reason, the homeowner is the one who must suffer the consequences and—for now—pay for the repairs.

Problems can also take some time to make themselves known. "Even if you have lived in your house for several years and have had no trouble with your wiring, a fire hazard may later arise," the CPSC says.

How can you fix the wiring if problems do occur? The aluminum industry's trade association, UL, and other groups recommend either of two repairs: replacing existing switches and outlets with CO/ALR receptacles, or "pigtailing"—attaching short lengths of copper wire onto the existing aluminum wire. (The copper "pigtails" are then connected to the receptacle.)

But CPSC engineers and some fire inspectors CU spoke with consider those repairs only halfway measures. Replacing switches and outlets would leave other parts of a circuit, such as lighting fixtures and junction boxes, open to deterioration. The CPSC recommends "pigtailing" with the use of a special tool that crimps the copper pigtail firmly onto the aluminum. "We've satisfied ourselves that this is a permanent repair," says the CPSC's William King. In ongoing tests, the crimp connections have held up where other kinds of connections have not, according to King.

Repairs made with a crimp connector, although not complicated, must be made by an electrician. Once a switch or an outlet has been removed and the aluminum wire exposed, the electrician fits the aluminum wire and a short length of copper wire into a special metal collar. The collar is then placed in the jaws of the crimping tool. Compressed air clamps the jaws around the collar with several thousand pounds of pressure, crushing the collar around the wires. The electrician then slips a piece of plastic insulation around the collar and shrinks it in place with a hot-air gun.

According to the CPSC officials and the contractors CU has spoken with, it takes 15 to 20 minutes to redo a light switch or a wall outlet with crimp connections. But redoing a typical suburban house could take two workers two days, because all the junctions and other connections hidden in attics and crawl spaces have to be crimped.

So far, interest in the crimping tool has far outstripped its availability. According to a representative with the tool's manufacturer, AMP Special Industries, only 36 electricians are now using it. "It's not a new tool for us, just a new marketplace," the representative said. "We're used to building 13 tools a year, and we have 300 on order."

Repairing aluminum wiring with crimp connections is about twice as expensive as simply replacing existing receptacles, judging from the estimates we've seen. For example, to redo a three-bedroom, one-story house with crimp connections would cost $600 to $700. Installing CO/ALR receptacles in the same house might cost $300 to $400. By contrast, rewiring the whole house with copper could cost more than $1000.

What to do

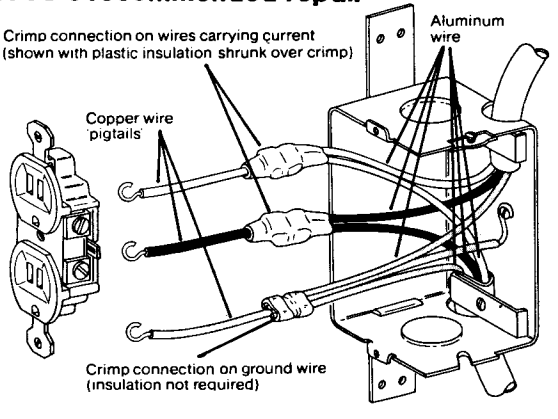
Old-technology aluminum wiring was widely used only between 1965 and 1973. If your house was built or rewired during those years, you can tell if you have aluminum wiring by looking for exposed runs of wire in the basement, attic, or garage. The letters "AL" or the word "aluminum" will be stamped on the insulation covering the wire. If you can't find any exposed wiring, have an electrician examine the wiring, or call the contractor who built your house.

The trouble signs to look for are:

- Cover plates on switches or outlets that are warm to the touch.
- Smoke, sparks, or arcing at switches or outlets.
- Strange odors, such as the smell of burning plastic, near switches or outlets.
- Lights that flicker periodically.
- Receptacles or entire circuits that don't work.

If you find no trouble signs—and your house has old-technology aluminum wiring—keep the list in mind for the future. As the CPSC indicates, problems may occur later. If you do find problems with your wiring—or if you simply want the wiring inspected to put your mind at ease—call in an electrician. Repairing aluminum wiring is a job for a licensed electrician, not for do-it-yourselfers. Repairs should be made with the AMP crimp connector. Unfortunately, that tool is in short supply, so you may not be able to find a nearby contractor who is trained in the use of the tool. For help in locating a contractor, contact AMP Special Industries, Valley Forge, Pa. 19482.

CPSC's recommended repair



Copper wire, crimped onto aluminum wire and connected to receptacle, overcomes problems posed by aluminum house wiring.