Knob and tube wiring

Knob and tube wiring (sometimes abbreviated **K&T**) was an early standardized method of electrical wiring in buildings, in common use in North America from about 1880 to the 1930s. It consisted of single insulated copper conductors run within wall or ceiling cavities, passing through joist and stud drill-holes via protective porcelain insulating *tubes*, and supported along their length on nailed-down porcelain *knob* insulators. Where conductors entered a wiring device such as a lamp or switch, they were protected by flexible cloth insulating sleeving. The first insulation was asphalt-saturated cotton cloth, then rubber became common. Wire splices in such installations were twisted for good mechanical strength, then soldered and wrapped with friction tape (asphalt saturated cloth), or made inside metal junction boxes.

Knob and tube wiring was displaced from interior wiring systems because of the high cost of installation compared with use of power cables, which combined both power conductors of a circuit in one run (and which later included grounding conductors).

New knob and tube installation is permitted in the US only in a few very specific situations listed in the National Electrical Code.

Elements

The ceramic knobs were cylindrical and generally nailed directly into the wall studs or floor joists. Most had a circular groove running around their circumference, although some were constructed in two pieces with "pass-through" grooves on each side of the nail in the middle.

By wrapping electrical wires around the knob, and securing them with tie wires, the knob securely and permanently anchored the wire. The knobs separated the wire from potentially combustible framework, facilitated changes in direction, and ensured that wires were not subject to excessive tension. Because the wires were suspended in air, they could dissipate heat well.

Ceramic tubes were inserted into holes bored in wall studs or floor joists, and the wires were directed through them. This kept the wires from coming into contact with the wood framing members and from being compressed by the wood as the house settled.

Ceramic cleats, which were block-shaped pieces, served a purpose similar to that of the knobs.

Other ceramic pieces would typically be used as a junction point between the wiring system proper and the more flexible cloth-clad wiring found in light fixtures or other permanent, hard-wired devices. When a generic power outlet was desired, the wiring could run directly into the junction box through an insulating sleeve called loom.

Wiring devices such as light switches, receptacle outlets, and lamp sockets were surface-mounted or flush-mounted within walls, using metal boxes to enclose the device.

Advantages

When originally installed in the early 1900s, K&T wiring was less expensive than other wiring methods. For a long time, electricians could choose between using K&T wiring on one hand and conduit, armorflex, and metal junction boxes on the other. The conduit methods were known to be of better quality, but their cost was significantly higher than that of K&T.

Modern wiring methods assume two or more load-carrying conductors will lie against each other, as for instance in standard NM-2 cable. Since the load-carrying wires are in close proximity, when they heat up the heating is shared across the wires, limiting the overall current load they can support. Since the load-carrying wires in K&T wiring are widely spaced, the wires are capable of carrying higher loads without risk of fire.

K&T wiring was commonly insulated with cotton cloth and soft rubber, in addition to the porcelain standoffs. Although the actual wire covering may have degraded over the decades, the porcelain standoffs have a nearly unlimited lifespan and will keep any bare wires safely insulated. Porcelain standoffs are commonly used with bare wire electric fencing for livestock, and such porcelain standoffs carry far higher voltage surges without risk of shorting to ground.

Disadvantages

Grounding, switching, and junction differences

Historically, wiring installation standards were less stringent in the age of knob-and-tube wiring than today. Compared to modern electrical wiring standards, the main shortcomings of knob-and-tube wiring are: knob-and-tube wiring never included a safety grounding conductor; did not confine switching to the hot conductor (the so-called *Carter System* places loads *across* the common terminals of a three-way switch pair); and it permitted the use of in-line splices in walls without a junction box (and thus exposing a potential fire hazard of an uncontained spark caused by arcing following mechanical failure of the splice). Compared to modern thermoplastic wiring insulation, the K&T wiring was less resistant to damage, but had a higher temperature rating.

Capacity insufficient for today's usage patterns

Knob and tube wiring can be made with great ampacity. However, most existing residential knob and tube installations, dating to before 1940, lack the ampacity that is desired today because of the paucity of circuits and the fineness of the wire gauge. Although these installations were adequate for the electrical loads at the time of installation, modern households use a range and intensity of electrical equipment unforeseen at the time. Homebuyers often find that existing K&T systems lack the ampacity needed for today's levels of power use. As household power use increased following the Second World War (because more appliances per household were being plugged in), first-generation wiring systems became susceptible to abuse by homeowners who would avoid repeatedly blowing fuses by overfusing the circuits, thus subjecting the wiring to heat damage due to higher levels of current.

Deterioration or abuse may have rendered it unsafe

Knob-and-tube wiring may also have been damaged by building renovations. Its rubber insulation will be dried-out, thus brittle when handled, or it may have been damaged by rodents or carelessness (for example, hanging objects off wiring running in accessible areas like basements).

Covering K&T with thermal insulation is unsafe and prohibited

Currently the United States NEC forbids use of loose, blown-in, or expanding foam insulation over K&T wiring. This is because K&T is designed to let heat dissipate to the surrounding air. As a result, energy efficiency upgrades that involve insulating previously uninsulated walls usually also require replacement of the wiring in affected homes.

Homeowners insurance underwriters may refuse to cover it

As existing K&T wiring gets ever older, insurance companies may deny coverage due to increased risk. Several companies will not write new homeowners policies at all unless all K&T wiring is replaced or an electrician has certified that the wiring is in good condition.