A report on…

ELECTRICAL CURRENT

MMG Insurance

CHALMERS INSURANCE GROUP

MMG INSURANCE
Protecting your piece of the world®

How often have you encountered the following logic? . . . "I know this appliance should be connected to a 15 amp fuse, but that's not convenient. So, I'll just feed it from this 30 amp fuse or circuit breaker. After all, a 30 amp fuse or circuit breaker is only twice the size of a 15-amp fuse or circuit breaker, and if a short occurs it will blow the 30 amp fuse or circuit breaker anyway! So, what harm can it do?"

Unfortunately quite a bit of harm can be done! Fuses and circuit breakers are installed to protect electrical circuit and apparatus from the damaging effects of over currents.

If for any reason the flow exceeds the designed capacity of a given size circuit wire, the fuse or circuit breaker should interrupt the flow unless the fuse is too large for the circuit wire (e.g., a 30-amp fuse on a number 14 wire) or the fuse or circuit breaker has been tampered with. In such an event, the excessive flow of electricity causes the wires to become hot and either ignite adjacent material or destroy insulation causing a short circuit or ground fault. This in turn further increases the flow of current and generates more heat, resulting in **FIRE.**

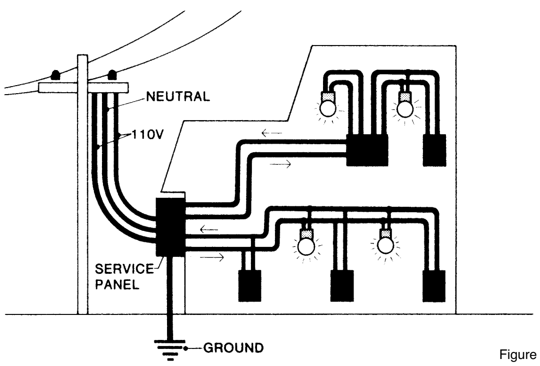

Figure 1

Electrical current is brought into a business or home from an exterior power source to a service entrance panel. From the service entrance panel, current is fed through individual circuits called branch circuits which service the building (Figure 1). In larger homes or buildings a feeder circuit might be needed. This is a circuit between the main service entrance panel and a smaller circuit breaker panel. Each branch circuit serves one of three purposes. It furnishes power to heavy duty appliances, to small appliances or for miscellaneous purposes such as lighting.

A circuit breaker is similar to a switch which flips to the "off" position, (Figure 2) stopping the flow of electricity to that circuit any time the rate of electrical flow (ampere) exceeds a prescribed limit. A fuse, on the other hand, contains a small metal strip which melts when the flow exceeds the prescribed limit.

ELECTRICAL BASICS

Perhaps the fundamentals of electrical circuitry are best explained by relating the subject to the flow of water.

Voltage is similar to water pressure.

Ampheres or "amps" are similar to the quantity of water flowing through a pipe.

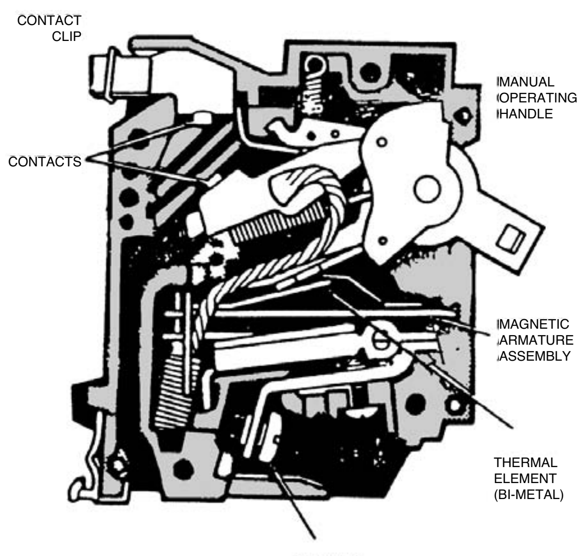

FIGURE 2

Watts are merely the product of volts times amps. (Therefore, watts divided by volts equals amps.) For example a 500-watt appliance on a 100-volt circuit will draw 4.5-amps.

Watts and amps are related just as water pressure and flowage are related.

Connect a small diameter tube to the water spigot on the side of a house and open the valve all the way. A small stream of water shoots out of the tube a good distance. Obviously, the water pressure in the tube is considerable but the quantity of water flowing through the tube is limited.

Now, fasten a large hose (e.g., a fire hose) to the same spigot and open the faucet. The water now merely spills out of the end of the hose. In this instance, there is little or no pressure in the hose but a considerable amount of flowage -- all that the spigot can produce.

But crimp or otherwise partially obstruct the end of the large hose. This decreases the quantity of water flowing through the hose but increases the pressure. It is apparent then, that pressure can be exchanged for flowage and flowage for pressure.

The same is true in electrical circuitry. Electrical pressure (volts) and flowage (amps) are interchangeable. "High tension" power lines contain tens of thousands of volts but few amperes. A transformer will reduce the volts to 110/120 but increase the amps for example, to 150.

Electrical wiring of various sizes, like water hoses of different sizes, is designed to accommodate different rates of flowage. Unfortunately, the numbering system for electrical wiring is opposite to what might be expected. That is, the larger the wire number, the smaller its size (Figure 3). A number 14 copper wire for example, is designed for a 15-amp circuit. Such a circuit should only accommodate normal household lighting and perhaps some small appliances. A number 12 copper wire is designed for a 20-amp circuit which can handle a few more lights or appliances. A 30-amp circuit requires a number 10 copper wire and is used for larger appliances.

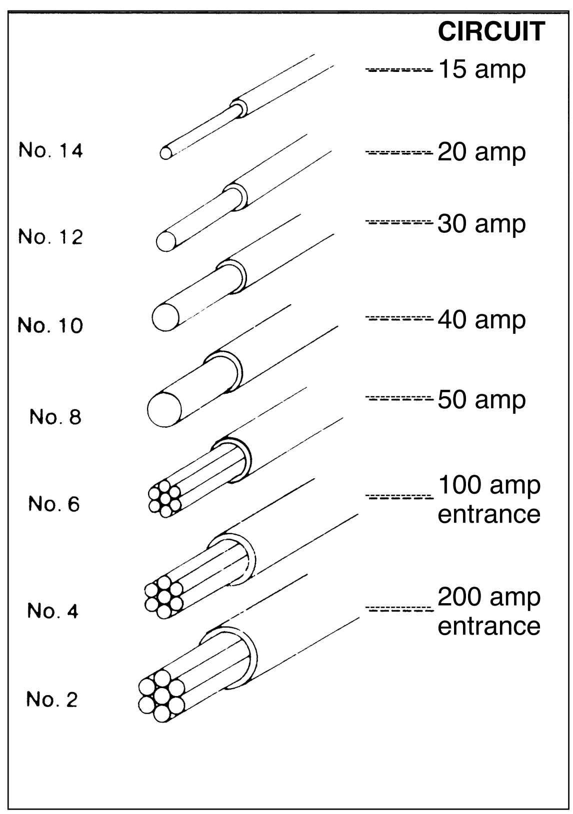

Figure 3

Residential appliances requiring 220-volts (e.g., electric ranges, clothes dryers, electrical heat, water heaters, and central air conditioners) are generally served by two 110-volt lines to produce the required 220 volts.

An electrical "circuit" is just that -- a circular route. Electricity is carried to outlets, fixtures, appliances or other electrical apparatus by a "hot" wire. After passing through the light, appliance or device, the excess electricity is returned via a neutral service wire. In cords, the two wires, the "hot" and the "neutral", are typically bound together but insulated from one another. Hence, the two prongs in the plug at the end of a lamp cord connect the hot wire which carries electricity to the lamp and a neutral wire for the return. If either wire is broken, the circuit is incomplete and the lamp or other device will not operate. However, other things might happen:

SHORT CIRCUIT

When for any reason the hot wire and the neutral wire come in direct contact with each other, a "short circuit" results (Figure 4). This causes a rush of current through the shorted circuit. If properly fused, the flow would be stopped before enough heat is generated to cause a fire.

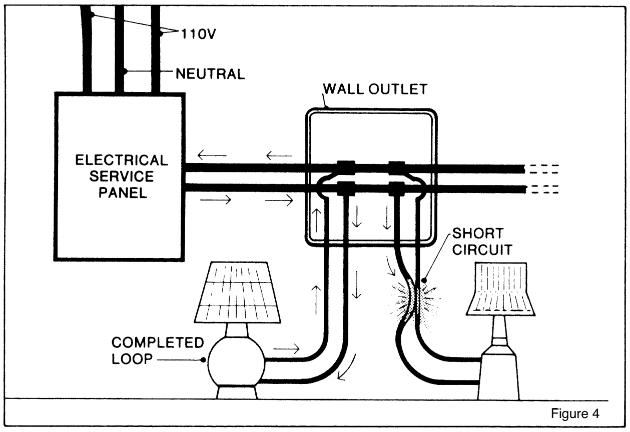

Figure 4

A short circuit occurs when the insulation around the wiring is worn or defective and the two wires are allowed to touch. Pinched wires can also cause short circuiting. During a fire, the insulation can be burned away causing wires to make contact after the fire has started.

Electrical fires from wiring are usually the result of two malfunctions. If you suspect a short circuit, investigate why the insulation between the hot and neutral wires failed allowing the wires to make contact with each other and why the safety device (i.e., fuse or circuit breaker) failed to operate.

GROUND FAULT

The entire electrical system should be thoroughly "grounded." This is, if an energized wire touches the metal conduit housing the wire or metal parts of the appliance or device, the electricity should be quickly and harmlessly carried into the ground (Figure 5). This is accomplished through a ground circuit. The ground circuit is connected to a metal object or conductor which is in the ground. Water pipes are commonly used for this purpose. All metal conduit and connecting junction metal boxes, outlet boxes, etc. should be connected to this ground. Metal encased wire (e.g., BX) and plastic coated wire have a special wire which connects the junction box etc. to ground (Figure 6). Fixtures, appliances and other devices should be grounded or otherwise solidly linked to the ground system. This assures that not only accidental "leakage" of electricity can be drained harmlessly away (rather than through a person who happens to come in contact with the metal) but assures that the "leakage" can surge to ground causing sufficient flowage to blow the fuse or trip the circuit breaker. If poorly or inadequately grounded, the electricity continues to "trickle" generating considerable heat.

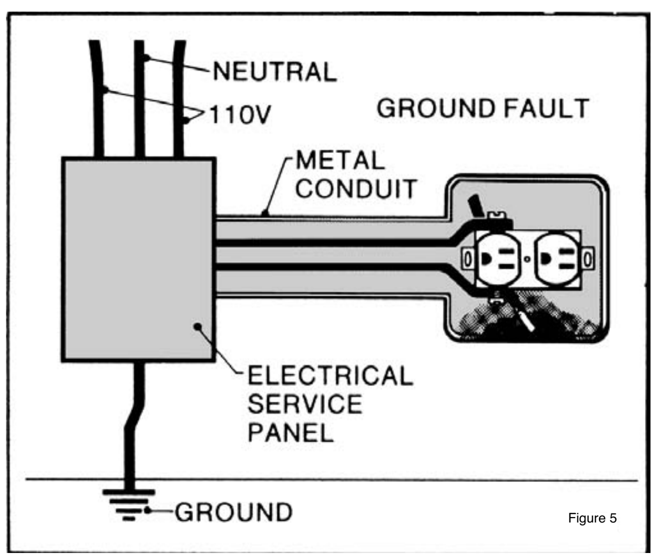

Figure 5

The amount of heat generated depends on the resistance of the conductor. Most metals are excellent conductors permitting the surge and resulting circuit interruption. However, some conductors are highly resistant or poorly grounded preventing an adequate surge of current to blow the fuse. This causes intense heating which can become an ignition source.

In the event of a ground fault, two malfunctions are also typically required. A properly installed electrical distribution system should not permit contact of the power wire with anything other than the power source and the appliance or device which it services. If it does, the continuity of the grounding system should be such that the resulting electrical surge will cause the safety device to operate.

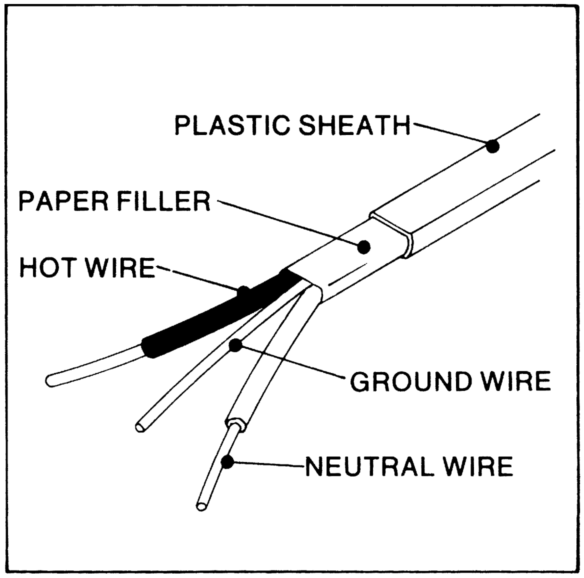

Figure 6

OVERLOAD

A third cause of electrical fires from wiring is circuit overload. This results from equipment, appliance(s) or device(s) drawing more electrical current than the capacity of the wire in that circuit. The “overload” causes the wire to heat. The heat breaks down the wire’s insulation and produces a short circuit (i.e., contact between the power and neutral wires) or ground fault (i.e., contact between the power wire and the metal conduit, junction box, ground wire or other grounded object). But again, if the circuit is properly fused, that is, if the size of the fuse is proper for the size of the circuit wiring, the fuse or circuit breaker should operate before the insulation breaks down and certainly after the short circuit or ground fault. Overfusing or fuse tampering can be a cause of fire.

Circuit overloading is not uncommon. This is especially true in older buildings constructed when electrical codes were not as rigid as in more recent years. Older buildings have fewer circuits enhancing the potential for excessive draw on them. When overloading occurs, heat builds up quickly. If the fuses or circuit breakers are working properly, the electrical supply should cease. Any 60-amp entrance box should limit the fuse size to a 15-amp fuse by the installation of a 15-amp fustat or adaptor within each fuse receptical of the 60-amp entrance box (Figure 7).

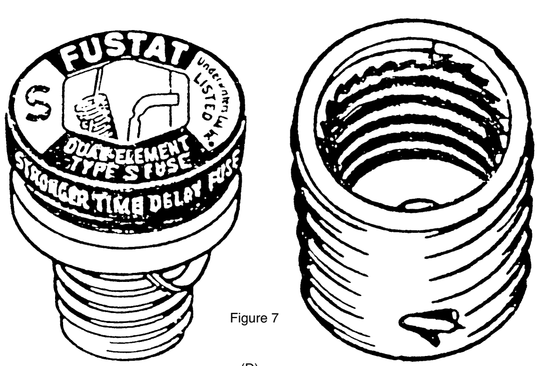

Figure 7

(D)

–Dual-element Type S fuse.

–Adaptor.

APPLIANCES AND DEVICES

The sheer number and spectrum of designs of electrical appliances and devices prevents any thorough discussion of fires from this source. But perhaps a few guidelines can assist your inquiry.

1. Heat generating appliances

(e.g. toasters, coffee makers, irons, electric griddles and hot plates) draw a good deal more current than other household items.

2. Large appliances such as electric ranges, clothes dryers, central air conditioners, and electric heat usually use 220-volts. That is, two 110-volt lines are connected to the appliance. Typically, these devices are on separate circuits. In addition, many of these appliances include one or more internal safety devices to prevent overload and electrical fires.

3. Other major appliances and most modern fixtures that are wired directly to the circuit are carefully grounded. Observe the “bare” wire connecting some appliances (e.g., clothes washer to a water pipe) or the short wire (usually green) connecting the housing of a light fixture to the metal junction box (Figure 8).

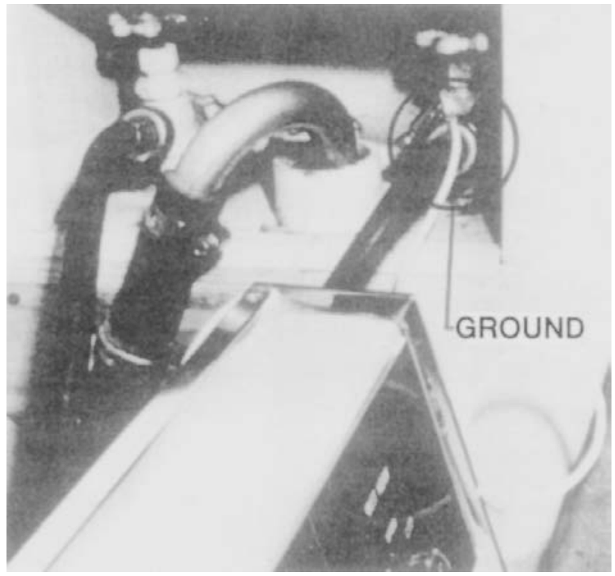

Figure 8

IMPROPER INSTALLATION OR MAINTENANCE OF ELECTRICAL SYSTEMS

Poor terminal connections can cause arcing. Poor or loose connections resist the flow of electricity (like crimping a hose) creating heat and at times, sparks. This can occur at switches, outlets and fixture terminals.

If the electrical system is the suspected cause of the fire, you must first determine what combustible kindling was ignited at the point of electrical disturbance. Even though arcing or overheating has occurred, fuel must be present to begin the combustion process.

Other appliances might have an external ground (e.g., a three-prong plug) or an internal ground system that carries any electric fault back through the circuit’s grounding system.

The more common fire hazards come from appliances with heating elements such as electric cooking ranges, portable heaters, toasters and hair dryers. Appliances with heating elements typically draw more current than other domestic appliances. Therefore, an electrical fault within the appliance or a short circuit of its wiring will generally create more heat. Other common sources of ignition are the heating elements. Any readily ignitable combustible that is in close proximity to the element creates a hazard. Finally, overheating of the appliance itself can cause fire. Note, however, that most such devices from hair dryers to clothes dryers, have a safety device which should prevent this.

All electrical appliances have the possibility of becoming instruments of ignition because of their power source -- electricity. Appliances that have frayed or damaged power cords are subject to electrical arcing. In appliances such as clothes dryers or power tools, if overheating occurs and the units have not been kept clean, the collection of sawdust, lint or other materials is subject to ignition.

ELECTRICAL MOTORS

There are numerous types of motors used depending upon the type and size of appliance or equipment involved. However, the common hazards with electrical motors are:

1. Immobilization. This can be caused by the locking or obstruction of the object (e.g., compressor, blower fan, pump or other mechanical device) being powered by the motor. If the motor drives the object with a drive belt, the belt might be loose enough to allow the motor pulley to slip. This situation usually causes a load noise, heat and smoke. If near combustibles, the heat might be adequate to cause fire. If the pulley cannot slip inside the belt or if the connection with the object otherwise prevents the motor from turning, the motor will overheat and may burst into flames.

2. Unlubricated or otherwise “frozen” motor bearings will produce the same results.

3. Motors vibrate. The vibration of motors can loosen wires or other connections causing a short or ground fault.

CONCLUSION

We have tried to demonstrate how dangerous overfusing can be. Many people believe that doubling the size of a circuit protective device only doubles the amount of energy that can be transmitted during a fault. In reality the relationship between fuse size and “let-through” energy is not a straight line. Doubling the size of a fuse (or circuit breaker) can provide a fault with 30 to 40 times more energy than would normally be expected and dramatically increase the potential for a resulting fire.

Whenever a suspected electrical fire is investigated, an attempt should be made to trace the suspect circuit back to the electric panel. Listing “electrical” or “electrical short” as the cause of loss is an inadequate explanation. You should also determine or arrange to determine:

Why the short, fault or overload occurred and,

Why the safety device failed to break the circuit before fire started.

It is your responsibility to probe these areas and determine the answers either through your own skills or with the assistance of experts. Subrogation should always be considered.

REFERENCE:
Property Loss Research Bureau