howitworks

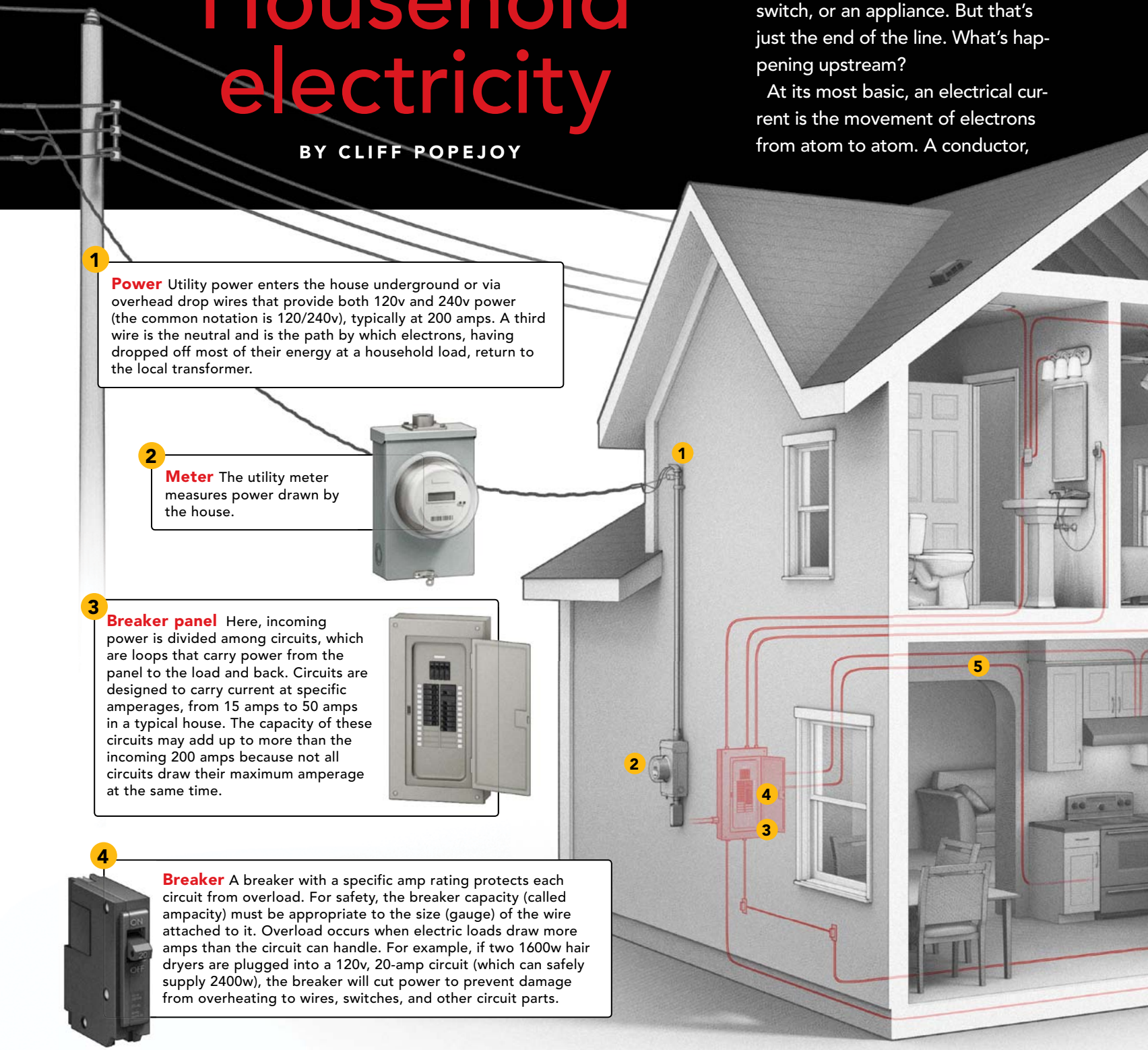
THE MECHANICS OF HOME BUILDING

Household electricity

BY CLIFF POPEJOY

Electricity is a form of energy we use every day, from opening a garage door, to lighting a desk lamp, to running a clothes washer. If you're not a trained electrician, you likely interact with household electricity at its point of use—an outlet, a light switch, or an appliance. But that's just the end of the line. What's happening upstream?

At its most basic, an electrical current is the movement of electrons from atom to atom. A conductor,



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Power Utility power enters the house underground or via overhead drop wires that provide both 120v and 240v power (the common notation is 120/240v), typically at 200 amps. A third wire is the neutral and is the path by which electrons, having dropped off most of their energy at a household load, return to the local transformer.

2

Meter The utility meter measures power drawn by the house.

3

Breaker panel Here, incoming power is divided among circuits, which are loops that carry power from the panel to the load and back. Circuits are designed to carry current at specific amperages, from 15 amps to 50 amps in a typical house. The capacity of these circuits may add up to more than the incoming 200 amps because not all circuits draw their maximum amperage at the same time.

4

Breaker A breaker with a specific amp rating protects each circuit from overload. For safety, the breaker capacity (called ampacity) must be appropriate to the size (gauge) of the wire attached to it. Overload occurs when electric loads draw more amps than the circuit can handle. For example, if two 1600w hair dryers are plugged into a 120v, 20-amp circuit (which can safely supply 2400w), the breaker will cut power to prevent damage from overheating to wires, switches, and other circuit parts.

Drawings: Christopher Mills

such as copper wire, allows easy movement of those electrons from one point to another. An insulator (the plastic coating on a conductor) prohibits this movement, containing the current.

Current is defined as the number of electrons passing a given point during a given time and is measured in amperes, which is often shortened to *amps*. Voltage is the pressure that drives the flow of electrons. The relationship between voltage and amperage is sometimes compared to the flow of water through a pipe, with voltage being the water pressure and amperage being the amount of water. This analogy illustrates another point regarding amperage and voltage: If one is increased and the other is decreased proportionally, the amount of work performed stays the same—just as a low-volume, high-pressure stream through a hose delivers as much water as a high-volume, low-pressure stream.

Multiply the volts and amps in a circuit, and you get watts, the unit used to measure the power needed to support an electrical demand, or load. As you can see in this illustrated overview, the relationship between voltage, amperage, and watts has practical applications in the wiring of a home for the safe and effective delivery of electricity.

Here's how it works.

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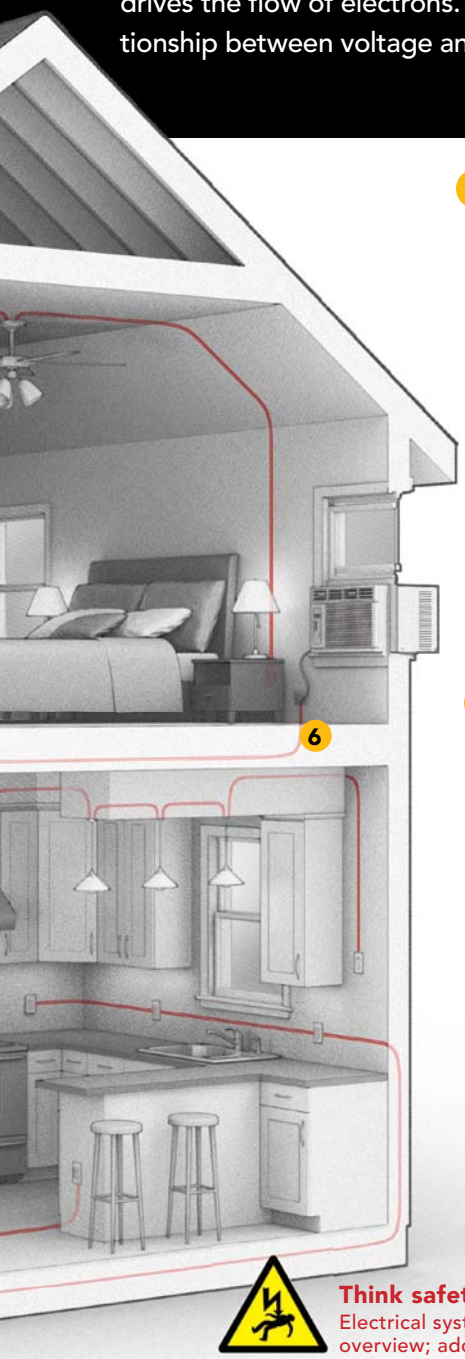

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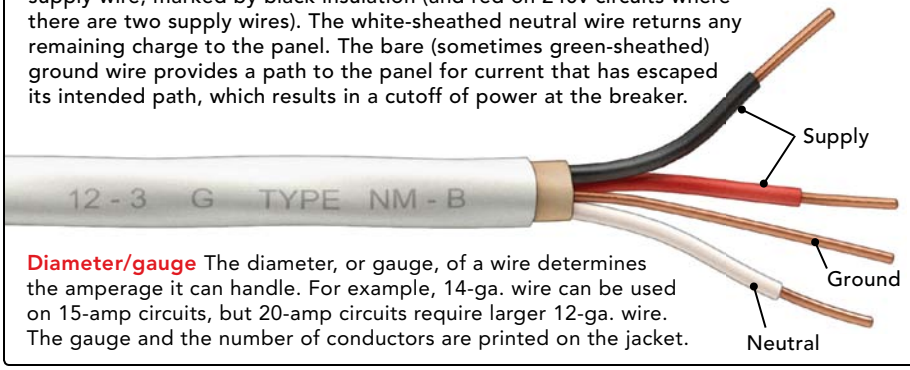
Wiring Modern branch-circuit wiring consists of nonmetallic-sheathed cable that holds a bare grounding wire along with two or three copper conductors encased in insulation. Electricity flows to the load on the supply wire, marked by black insulation (and red on 240v circuits where there are two supply wires). The white-sheathed neutral wire returns any remaining charge to the panel. The bare (sometimes green-sheathed) ground wire provides a path to the panel for current that has escaped its intended path, which results in a cutoff of power at the breaker.



Diameter/gauge The diameter, or gauge, of a wire determines the amperage it can handle. For example, 14-ga. wire can be used on 15-amp circuits, but 20-amp circuits require larger 12-ga. wire. The gauge and the number of conductors are printed on the jacket.

Respect the neutral! When correctly wired, the neutral conductor is energized when power is passing through a load—that is, when a circuit is complete. This current can cause electrocution or shock, despite its name.

6

Branch circuit These circuits transport electricity to loads and back to the service panel. Here are some common branch circuits.

- **General-purpose (lighting) circuits** are 15-amp or 20-amp circuits that carry 120v power to multiple lights and receptacles.
- **Dedicated branch circuits** deliver power to a single load, such as a large appliance, or to a group of loads as specified under the National Electric Code to prevent overload. These include 120v, 20-amp kitchen-appliance circuits and bathroom-receptacle circuits. (It's good practice to provide a dedicated 20-amp circuit to each bathroom receptacle to support the amperage drawn by hair dryers.)
- **240v circuits** are dedicated circuits that provide extra power to air-conditioning compressors, electric water heaters, and other heavy-duty appliances that draw a lot of amps. Doubling the voltage means the amperage can be reduced by half, allowing the use of smaller-gauge wire that is less costly and easier to install.
- **120/240v (multiwire) circuits** service loads that require both 120v and 240v, such as electric clothes dryers and ranges. The 120v runs lights, motors, and controls, while the 240v supplies the heating elements. Amperage is typically 30 amps to 50 amps.

Is it 110v or 120v? 220v or 240v?

The nominal voltage for homes in the United States is 120/240v. Before a national power grid was created and voltages were standardized, some local generators delivered electricity at 110/220v. Today, those values are outdated and incorrect.

Think safety

Electrical systems are inherently dangerous and complex, even when wired correctly—and many are not. Shown here is a broad overview; additional knowledge of electrical theory and technique is a must before you can safely work on wiring.