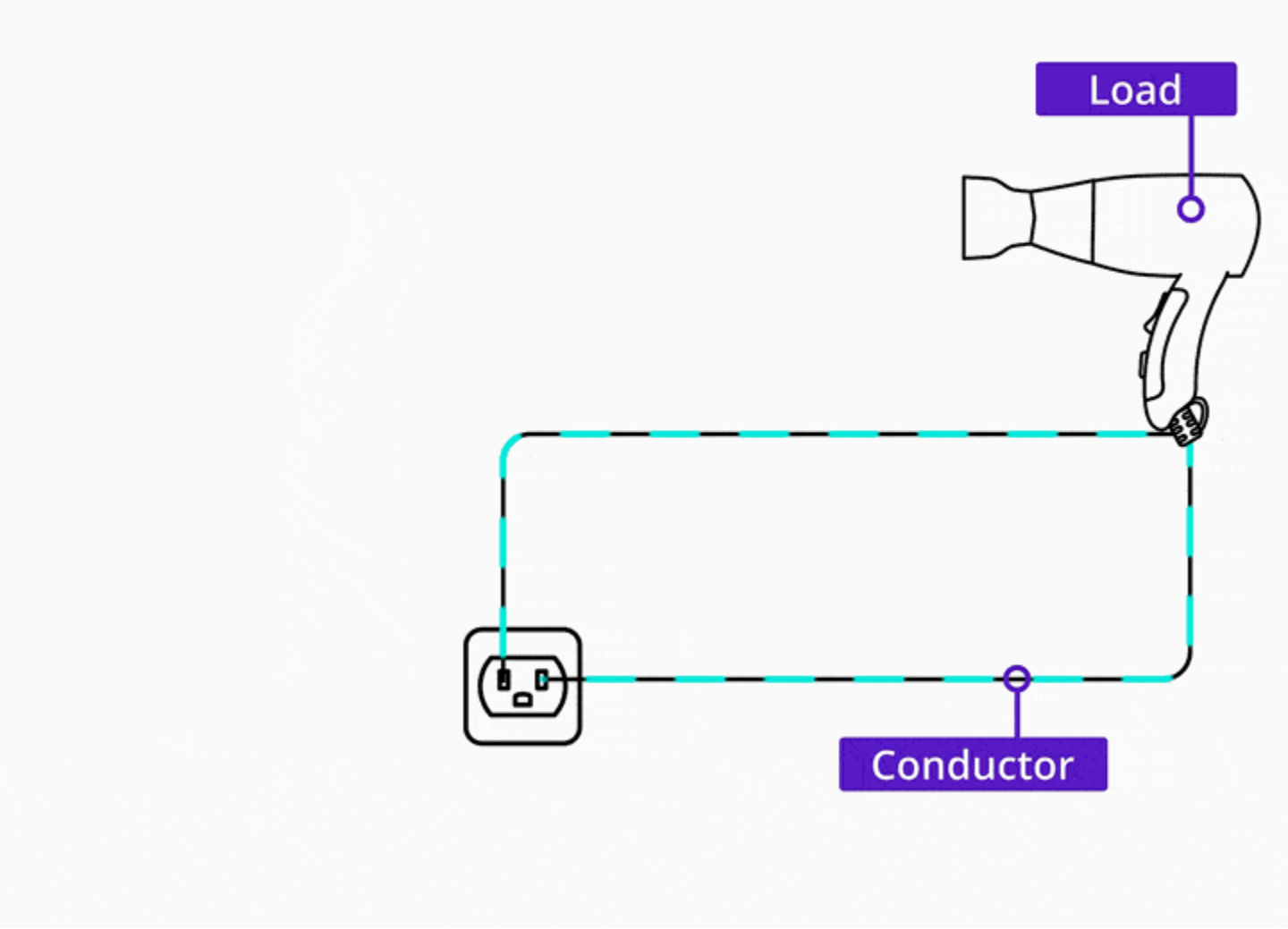
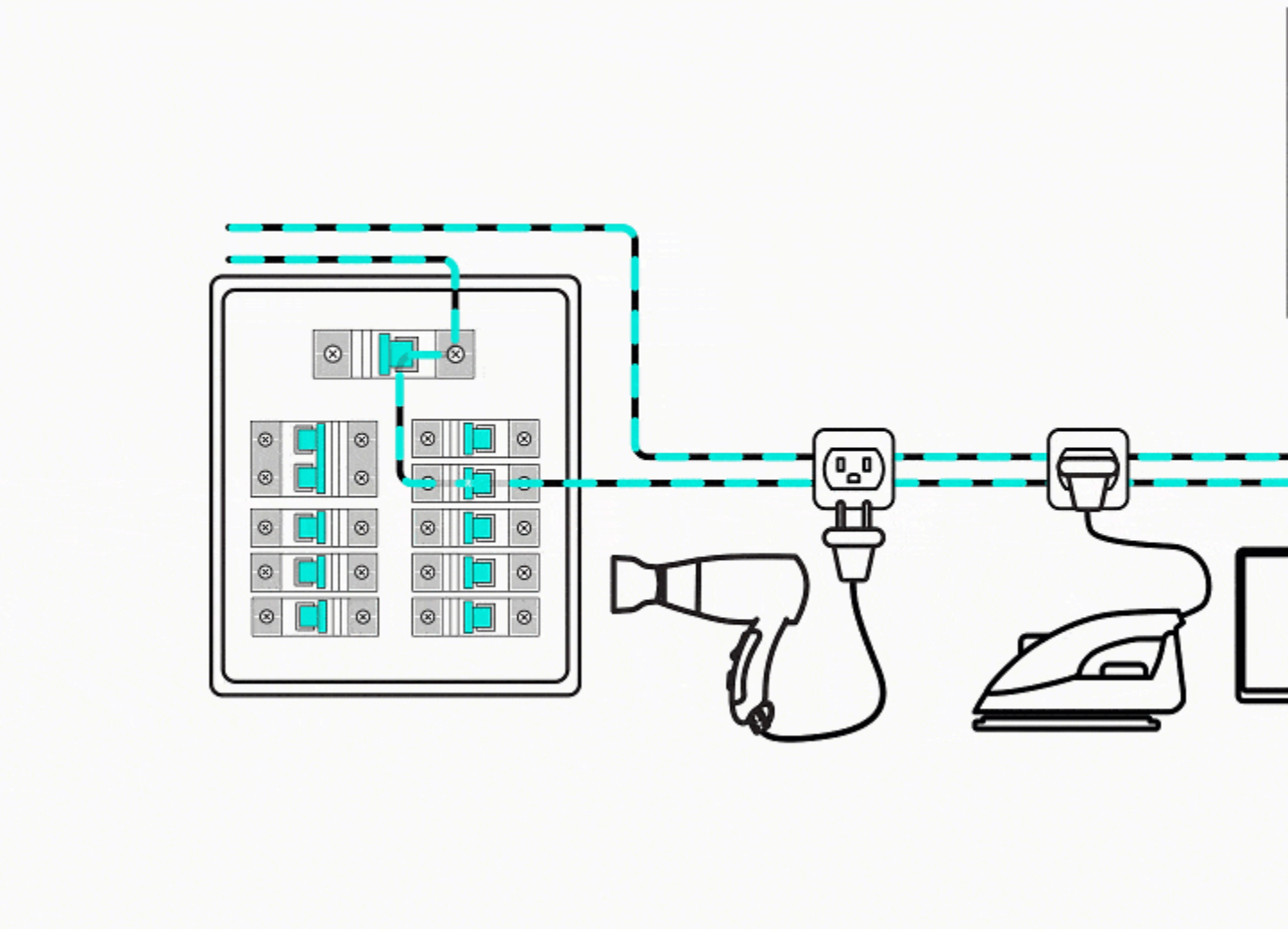
Electric circuit basic

Electric devices, machines, and appliances are all around us. One thing they all have in common is that they need electric power to operate. In a very simplified manner, an electric circuit can be diagrammed as such: the electric current travels from the power source, through conductive wires, to the object that needs load, such as the motor of your blow dryer, and back into the power source.



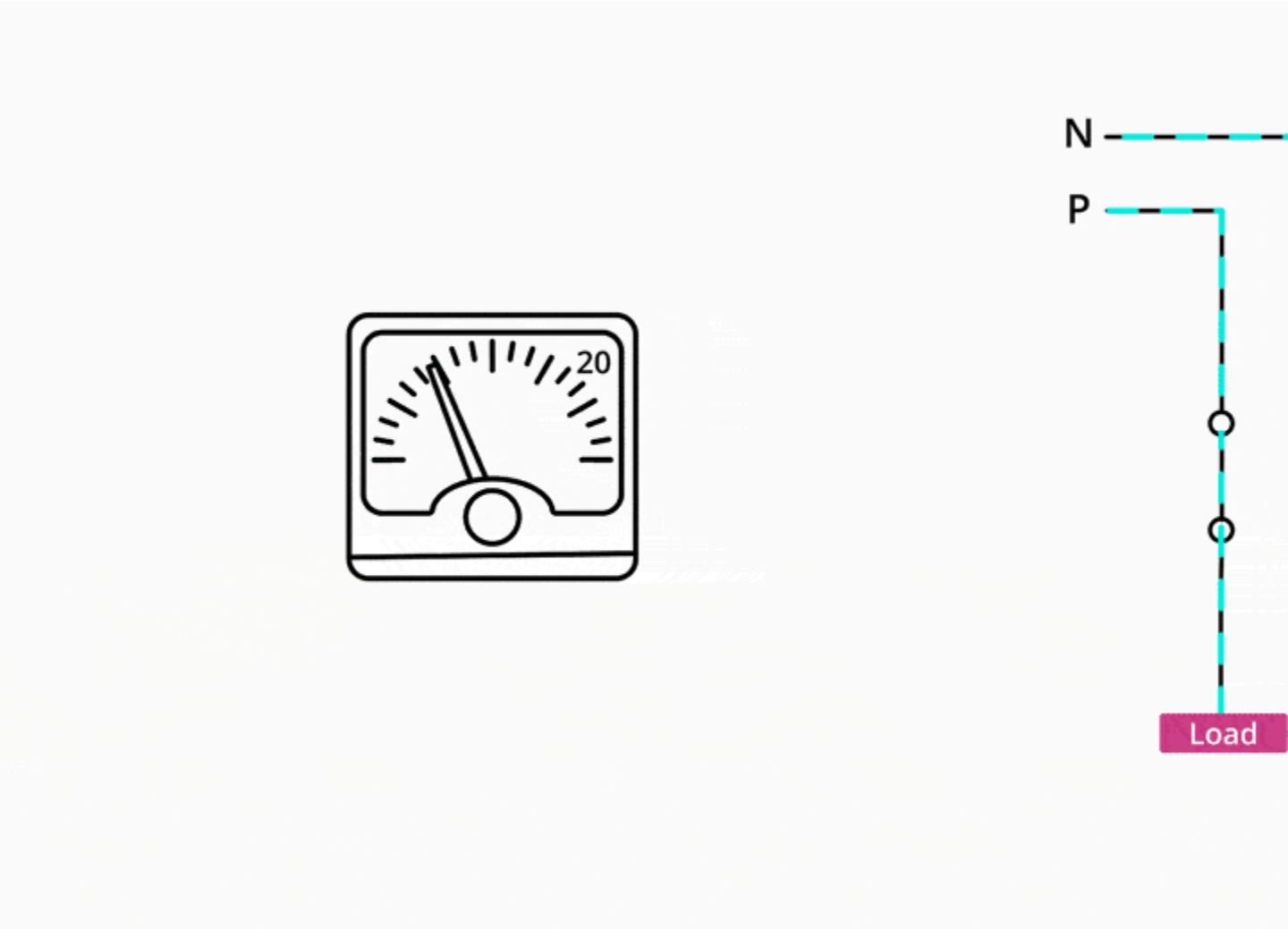
Circuit breaker basic

The circuit breaker is an electromechanical device whose function is to **protect** electrical installations, being used in electrical distribution boards.
It works by interrupting the electric current when it exceeds its design limitations, therefore preventing the supply of energy to the loads, and damage to the circuit.
In other words, if the electric current supplied from the power source to your blow dryer is higher than a predetermined number sized for your circuit breaker, the device will trip, interrupting any more current to flow



Circuit breaker working principles

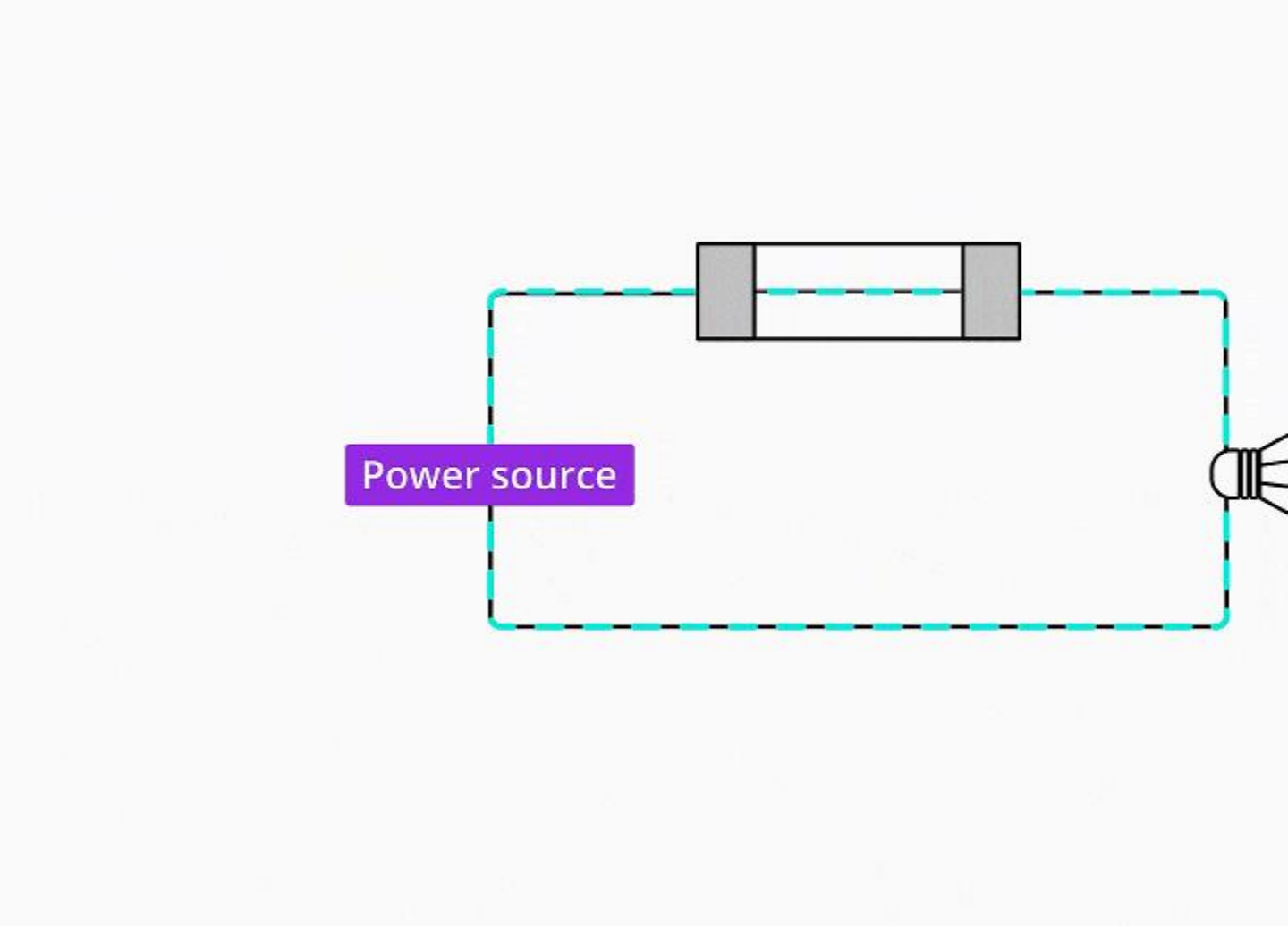
Simply put, the circuit breaker basically works like an automatic switch, which has a base current value, switching off the circuit where it was installed whenever this value is exceeded!



It is important to note that for circuit breakers to work correctly, error-free sizing of the circuit and the components that compose it, is essential!

Fuse invention

The first mention of a device that interrupted the current because of some problem is more than 100 years old and was made in a patent by **Thomas Edison**, inventor of the incandescent light bulb.
At that time, Edison needed a way to protect the lighting system he sold to big cities. For this, he proposed a device that would protect the network against possible short circuits and overloads and called it a fuse!
A fuse is a safety device used to protect against overcurrent, short circuit, and overload. It consists of a tube with a metal alloy inside, usually leads, which when overloaded heats up and breaks, preventing short circuits!



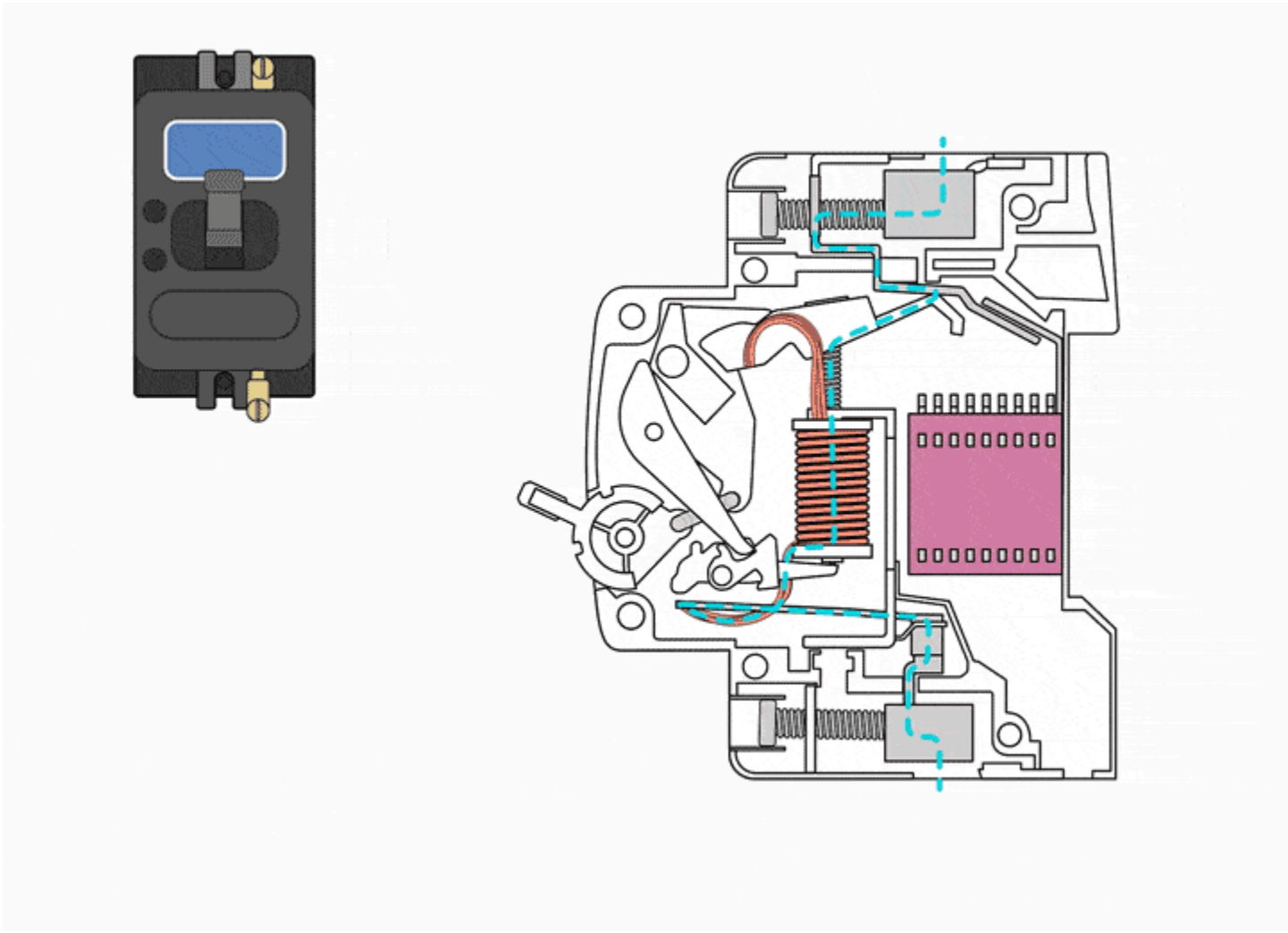
When this heating occurs, the metal alloy inside the fuse melts, causing the power supply to the circuit to be interrupted. To work again, the fuse must be replaced, generating unnecessary labor, costs, and interruptions!

This impasse was only resolved more than 40 years later, by an inventor named **Hugo Stotz**.

Circuit breaker invention

In 1923, Stotz launched the first compact device that combined the functions of thermal and magnetic protection on the market, produced in Mannheim, Germany. That was the first commercial circuit breaker!

He and his team, looking for an idea to replace the fuse, developed a brilliant invention: a device that had a component that, if heated, would contract and trigger a disconnecting mechanism, but, when cooled, could be turned on again.
There, the circuit breaker was born!



Since then, companies have continually developed this technology, and today, there are several models of circuit breakers, such as the **single-pole**, **two-pole**, **three-pole**, and even the **four-pole** circuit breaker!
They are used in many types and sizes for use in different applications, from residential to large industrial systems.

Circuit breaker design

Now, to understand how a circuit breaker works, let's first take a look at a cross-section of the device that shows the basic parts and design of a circuit breaker.

The basic circuit breaker consists of:

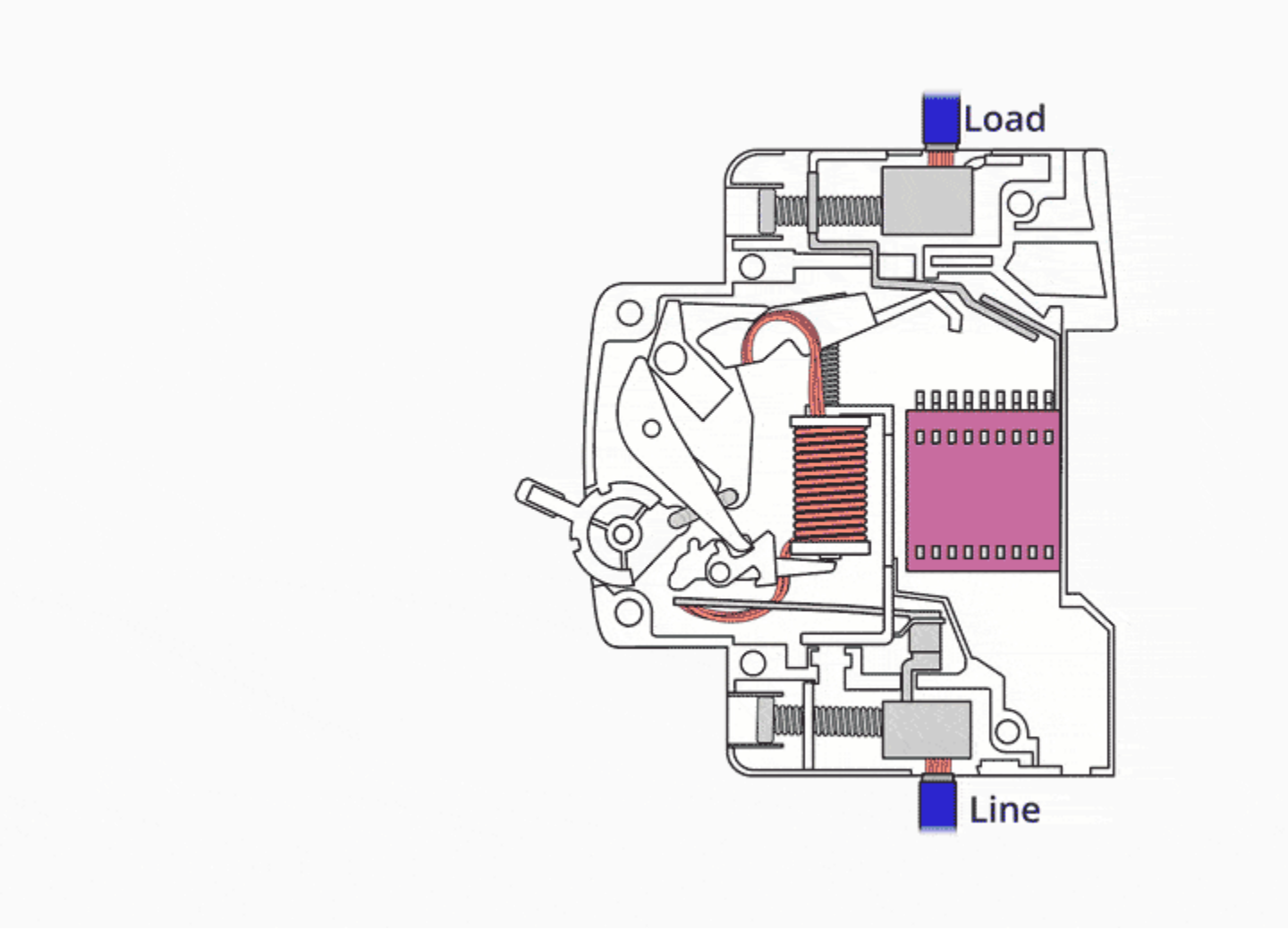
1) a terminal
2) a stationary contact
3) a catch
4) a simple switch
5) an electromagnet (copper coil)
6) (and/or) a bimetallic strip
7) another terminal

Circuit breaker tripping principles

This circuit breaker contains two different tripping principles to protect the circuit:
– a **thermal protection** design, that will lead to circuit interruption in case of overheating (such as the one used by Thomas Edison!)
– a protection design via an **electromagnet** principle, due to a short circuit.

Let's take a look at how they work:

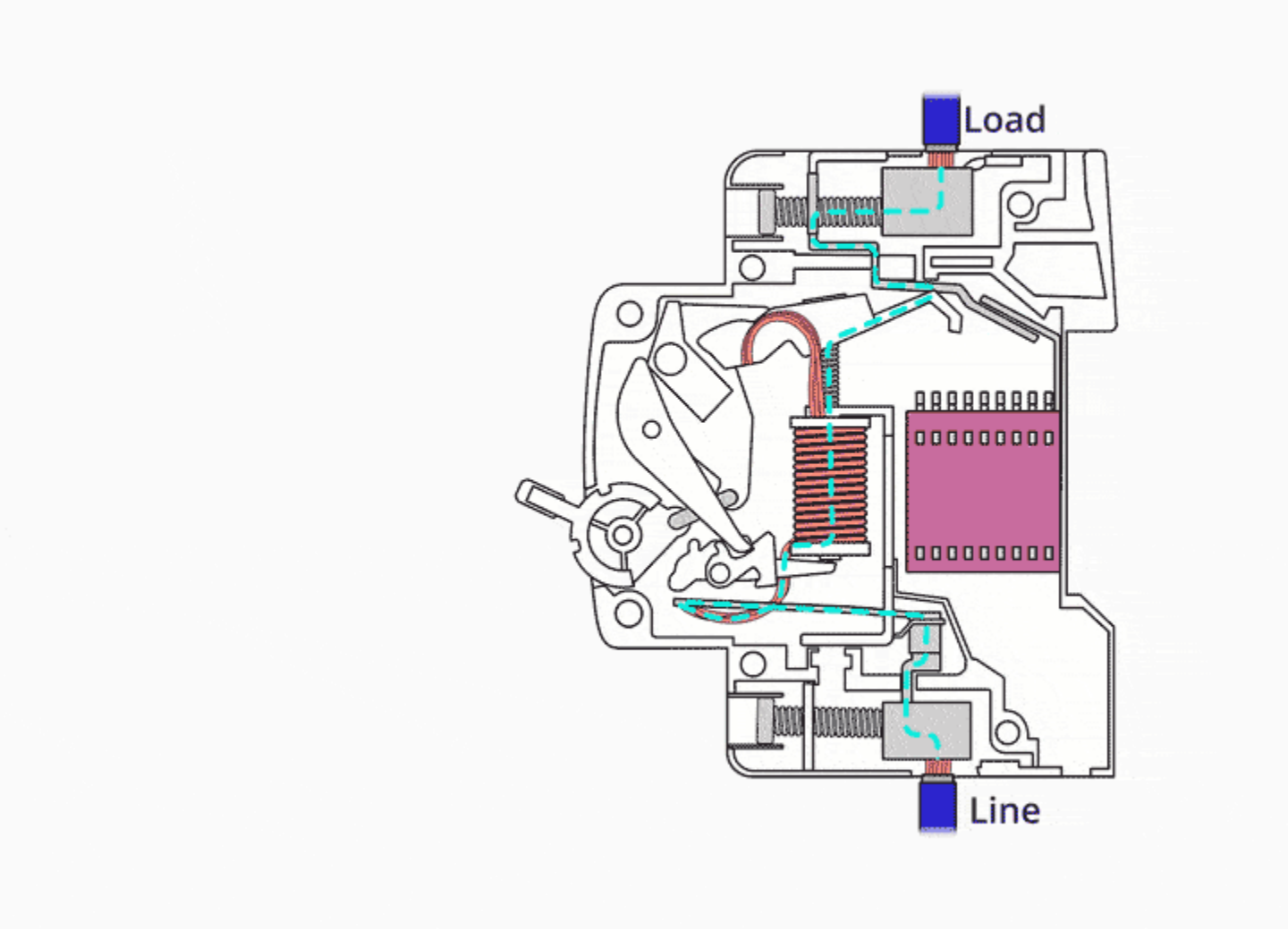
When the circuit breaker is in its on position, current can flow from the lower terminal throughout the **bi metallic strip**, to the **electromagnet coil**, to the **moving contact**, across the **stationary contact**, and out to the upper terminal.



1) Thermal protection

On this thermal-magnetic circuit breaker, both thermal and electromagnetic protection happens in parallel on a similar principle to move the switching linkage.

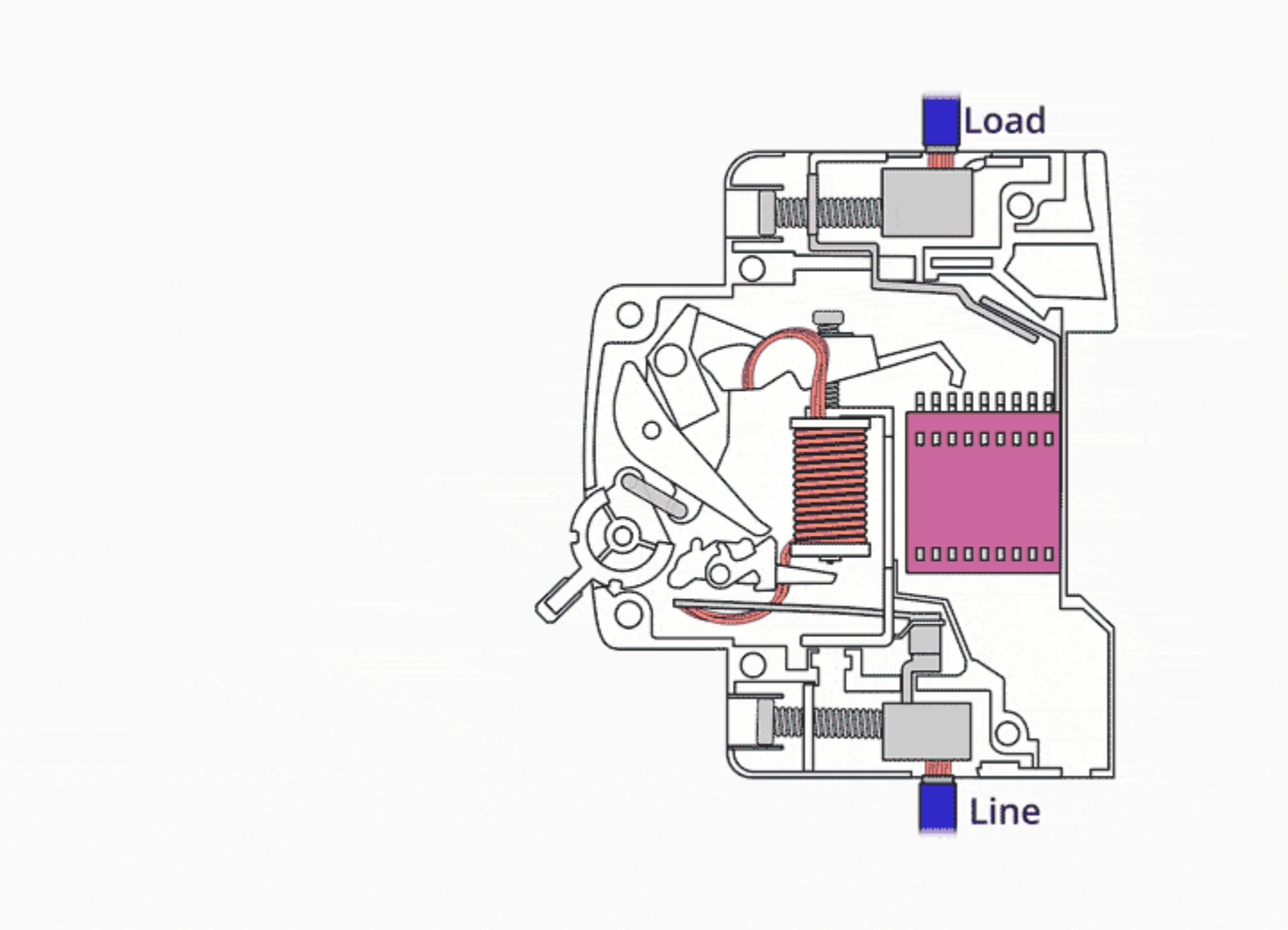
Looking at thermal protection: the bimetallic strip heats up with the current.
If the circuit's current rises over a certain level, the strip will bend, moving the switch linkage, and consequently the moving contact, breaking its connection to the stationary contact, causing the circuit to break.



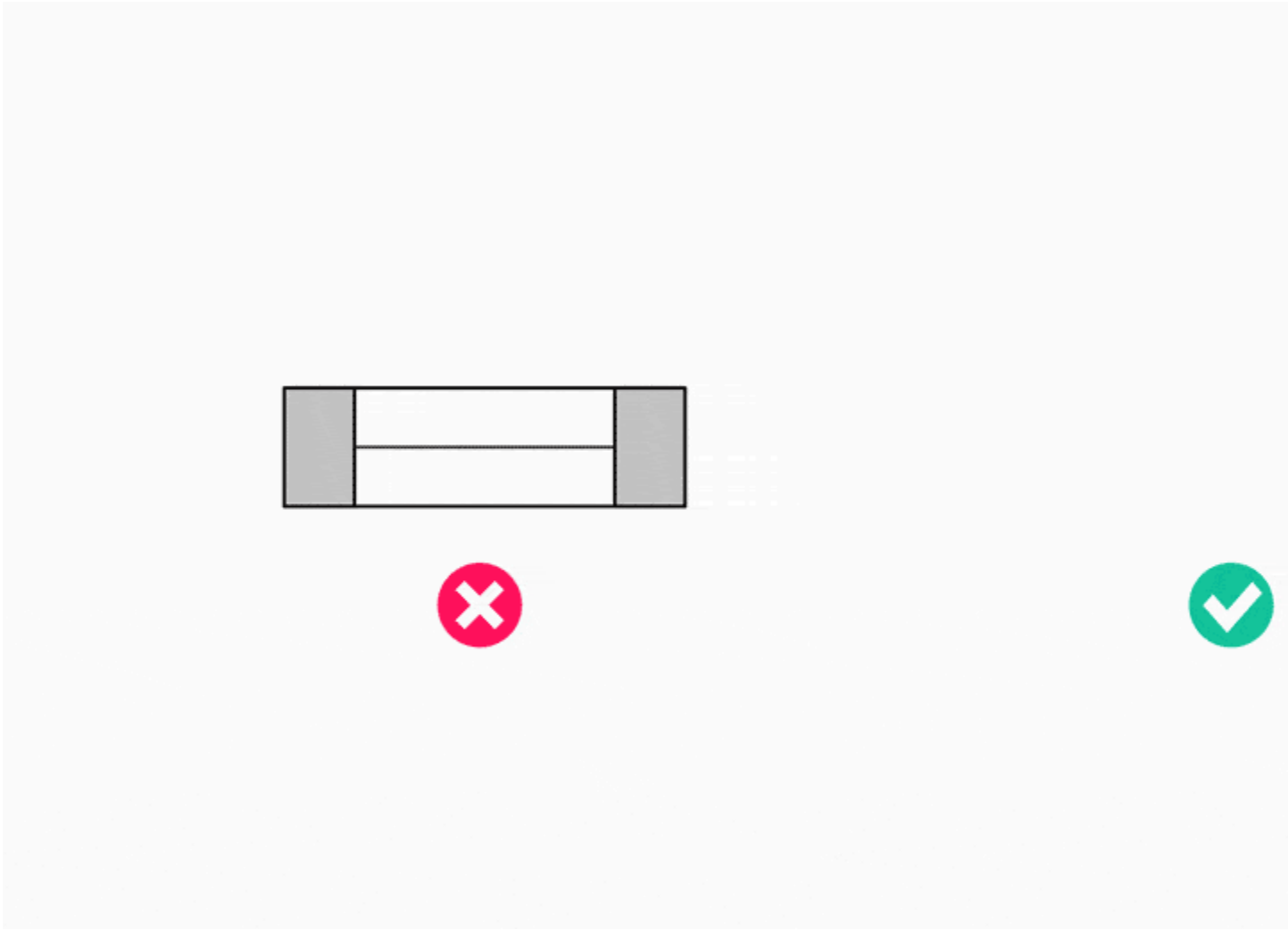
2) Short circuit protection

In parallel, electromagnetic protection comes from the copper coil. The electromagnet is magnetized when electricity flows through the terminals. The larger the current, the larger the electromagnetic force.

When a current reaches unsafe levels while traveling through this coil, the electromagnet becomes strong enough to move a small spool inside it, which will also move the switch linkage, the moving contact, therefore breaking the circuit.



Differently from fuses, once the issues that caused the circuit breaker to trip have been addressed, you can switch it back to the on position, and your circuit is once again protected.



Numerous advanced circuit breakers are available on the market. Those can be much more precise and can trip at much faster speeds, however, they are also much more expensive!

Summary

Summing up what we have learned today:
– A circuit breaker is a protection device. Its primary function is to interrupt current during fault conditions or overload situations preventing extensive damage.

– Circuit breakers used in power systems come in numerous types and sizes for use in a variety of applications, from residential to large utility and industrial systems.
The miniature circuit breaker contains thermal protection that will lead to circuit interruption in case of overheating and electromagnet protection due to a short circuit.
– Circuit breakers are essential devices in the modern world, and a crucial safety feature for your home and numerous other utility and industrial applications!