Circuit Breakers: Then and Now

The circuit breaker is arguably one of the most useful devices in the electrical industry due to its ability to protect electrical circuits from damage in the event of a short circuit or current overload.

Before the invention of the circuit breaker, fuses were the primary means of circuit protection. The main advantage of circuit breakers versus most fuses is that circuit breakers can be reset after a protective operation.

One of the earliest records of a circuit breaker is from the late 19th century, in a patent application by Thomas Edison, even though his own commercial power systems used fuses. While Edison submitted this patent application in 1879, it was a few decades later before the concept gained traction.

The company Brown, Boveri & Cie (BBC), now known as ABB, patented the miniature circuit breaker in 1927. Designed by Heinrich Schachtner, this version found rapid use in the rising electrification of homes and businesses and was truly the forerunner of the modern thermal-magnetic breaker commonly used today.

"My invention relates to automatic electric circuit breakers of the kind in which two contact pieces normally pressed together by springs are separated by the interposition of an insulating slide," Schachtner wrote at the time, according to the U.S. Patent Office document. He continued, "When the overload in the apparatus ceases, switching-on can be effected by the mere pressure of the finger without the necessity of unscrewing the apparatus from its socket."

This was a significant technological improvement from the use of fuses in many common applications.

The evolution of circuit breakers

Based on this initial innovative idea, breakers continued to evolve into many variations, each designed with unique features and characteristics to suit specific electrical applications. Thermal circuit breakers are widely used in residential and commercial applications, while magnetic circuit breakers are commonly employed in industrial and commercial settings where higher currents are typically involved.

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Thermal circuit breakers operate on the principle of thermal expansion and use a bimetallic strip that bends when exposed to excessive heat, which trips the circuit. Magnetic circuit breakers rely on an electromagnet that responds to the magnetic field produced by excessive current, which causes the circuit breaker to trip and interrupt the flow of electricity. Other examples are oil circuit breakers, air circuit breakers, and SF6 (gas) circuit breakers. These, along with other unmentioned examples, all have unique characteristics that are well-suited for specific applications.

Over the years, circuit breaker designs have evolved significantly, driven by the need for higher performance, improved safety, and increased efficiency. One of the more recent improvements that covers several circuit breaker types is the innovation of electronic trip units.

Electronic trip units use electronic sensors and controls to monitor current more accurately and typically respond quicker to circuit abnormalities. This provides more precision and sensitivity in detecting faults, which reduces the risk of damage to electrical equipment and prevents unnecessary power interruptions.

This addition of electronics to breakers paved the way for more advances like the introduction of intelligent trip units. These devices incorporate features such as adjustable trip settings, communication capabilities, and built-in monitoring systems. They provide real-time data on various electrical parameters, which improve the visibility and control of electrical systems.

Innovation in digital circuit breakers

As breakers continue to evolve, digital technologies have further transformed circuit breaker designs. Digital circuit breakers integrate advanced sensors, microprocessors, and communication capabilities, allowing for additional enhanced monitoring and control. They not only enable remote operation but also incorporate intelligent load management and predictive maintenance capabilities, which revolutionize the way electrical systems are managed.

Evolving from electromechanical mechanisms to intelligent digital systems, circuit breakers have become more sophisticated, versatile, and reliable, meeting the ever-increasing demands of modern electrical systems. It seems that the sky is the limit when it comes to how circuit breakers can continue to improve how power can be distributed to the end user for reliable and sustainable applications.

When we consider that electrical circuit protection began with fuses as the predominant technology, it is fascinating to consider where we are as an industry. Today, we have companies like ABB that are using technology such as the EPiC mobile app to streamline the way electrical workers can configure, install, and interact with their breakers. We went from choosing the correct fuse size to selecting the correct breaker size to manually configuring adjustable breaker trip settings. Now, we can connect to a breaker via Bluetooth technology to download breaker settings remotely.

Thankfully, the industry has continued to put more of an emphasis on safety every day. This Bluetooth technology also allows electrical workers to connect to breakers while outside of the arc flash boundary. It also enables the user to download information from breakers to understand why a breaker has tripped and aid in the quick and safe decision for how to respond to an unexpected outage. This digital connectivity of breakers allows for augmented reality features during installation, commissioning, and maintenance scenarios to aid in more efficient and safe decision-making.

Breakers were an impressive innovation a century ago, and the technology that is being applied to them today continues to improve efficiency, safety, and sustainability options when applied to new or upgraded systems. It is exciting to see how this old technology continues to evolve to meet the needs of today's priorities. The advantages of these versatile devices continue to prove their usefulness while evolving priorities continue to drive significant advances in the tried and true application of the intriguing device called circuit breaker. What will come next?

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