

# The Power Age and Modern Civilization

**Although the moving powers of heat and electricity have raised man's physical existence to Olympian heights, they have not worked similar miracles in his spiritual life. Engineers and scientists are called upon to banish fear and hatred from the human heart by application of that greatest power of all—the power of love.**

By

**M. I. PUPIN**

Honorary Member A.I.E.E.

Columbia University  
New York, N. Y.

**F**ARADAY'S DISCOVERY of electromagnetic induction, a hundred years ago, is the closing event of a great epoch in the history of physical science and engineering. It is the epoch in which the power age was born.

Watt's invention of the steam engine marks the beginning of this epoch. It suggested to the genius of Carnot the immortal idea embodied in his well known law. This law defines what Carnot called the moving power of fire, that is of heat, a name which today is one of the greatest names in physical science.

Carnot's interpretation of the moving power of heat completed in 1824 the first great step in the evolution of the power age. The second great step was made when in 1820 Oersted discovered the magnetic force of moving electricity and a few years later Faraday discovered the electric force generated by moving magnetism. The law of action of these forces defined the moving power of electricity just as Carnot's law defined the moving power of heat. We know today that these two moving powers are the fundamental physical powers in the universe, and that their revelation was the greatest achievement ever recorded in the history of engineering sciences. It inaugurated, a hundred years ago, the power age. This age is the parent of our present civilization and the moving powers of heat and of electricity are the propelling powers in the physical evolution of this civilization.

Our civilization very often is called the machine civilization and what I call the power age often is called the age of machines. I don't like these names for the simple reason that machines are the creation of the hands of mortal man. They are transient, but the moving power of heat and the moving power of electricity are eternal;

these powers are the immortal elements in the physical structure of our civilization.

Advancement of science during the power age, that is during the last hundred years, revealed that the same fundamental powers which are at work in the evolution of our civilization were also at work in the evolution of organic life ever since life appeared on this terrestrial globe and that they are also the only propelling powers in the evolution of the luminous stars. Radiations from these stars tell us that the moving powers of heat and of electricity are of celestial origin; they were brought to earth on the wings of solar radiation and remained dormant until the genius of Watt, Carnot, Oersted, Faraday, and Henry called them to the service of man. This service is the service of our central star to this tiny terrestrial globe; its mission on this earth recalls the mission of the celestial flame which, according to an ancient legend, the Titan Prometheus snatched from the radiant chariot of the sun god Helios and brought down to earth. The ancients believed that the mission of that celestial flame was to make the life of man similar to the life of the Olympian gods.

We believe that the mission of the moving powers of heat and of electricity, our most precious gifts from our central star, is to raise the life of man to Olympian heights. But has our civilization, the offspring of the power age, lived up to the lofty aim of this mission?

Two pictures occur to me when I attempt to answer that question—two entirely different pictures. In one of the pictures I see the triumphant conquest of space by the automobile and the aeronautical art. I see the wonders of power distribution increasing a hundredfold the comforts and the creative power of man, and I am thrilled by the electric waves which gliding over wires or wandering through space convey on their wings speech and melody over continents and oceans to every nook and corner of this terrestrial globe. These are a few of the miracles of our power age by which the moving powers of heat and of electricity have displayed the magic of their celestial origin; they certainly have made the physical side of human life even more glorious than the life of the Olympian gods. This achievement of the power age is its greatest glory.

But the spiritual side of human life, exhibited by another picture, is far from edifying. In this second picture we see desolation on every side in the wake of the most deadly war which the world has ever seen. The world appears here standing on the verge of economic collapse, and yet vast armies and navies are devouring the meager remnants of the wealth of nations while millions of idle workers are starving. The most repulsive figures in this horrible picture are fear and hatred, which, like two ugly demons, are hovering on each side of the boundary lines between neighboring nations.

Banish these demons from the human heart and there will be no need of vast armies and navies to guard our security against hostile neighbors; there will be no hostile neighbors, and wars will become a dying memory only of former barbarous ages. But the celestial ser-

An address delivered by Doctor Pupin when the John Fritz Medal was presented to him at a special session of the A.I.E.E. winter convention on the evening of Jan. 27, 1932.

March 1932

vants of our civilization, the moving powers of heat and of electricity, have not banished them.

Science admits that the magic of these two primordial powers cannot unaided purge the soul of man and eliminate the poisons which corrupt its spiritual life. Another moving power is sorely needed which can penetrate more deeply than the moving power of even the infinitely minute electrons into the depths of the human heart. This need was recognized nearly 2,000 years ago when our Saviour revealed the moving power in the spiritual world and commanded us to love the Lord our God, and to love our neighbors as ourselves.

This was a message of the approaching power age in

the spiritual world. But this age has not yet arrived; mankind has not yet yielded to the greatest moving power in the spiritual world, and without its aid the moving powers of heat and of electricity cannot contribute their full share to the evolution of the spiritual life of man.

Love of the eternal truth and of their work to reveal this truth for the good of mankind has guided the scientists and engineers to the great triumphs of science. These triumphs of love will persuade the reluctant world that the victorious triumph of the moving power of love which Christ discovered will be the greatest triumph of the power age.

# A High Speed Relay for Short Lines

A new high speed distance relay with composite impedance-reactance characteristic has been developed. This modification combines the mechanical simplicity of the impedance type relay having inherent possibilities for high speed of operation so desirable where stability is a factor, with, on the shorter lines, the greater independence of the reactance type relay from the effects of fault resistance.

By  
**S. L. GOLDSBOROUGH** Westinghouse Elec. & Mfg. Co., Newark, N. J.  
Associate A.I.E.E.

**W. A. LEWIS** Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.  
Associate A.I.E.E.

**T**RANSMISSION of power over longer distances and the concentration of greater amounts of power over a single circuit have rendered the presence of a short circuit on the system a more serious matter, and a considerable effort therefore has been made to reduce the duration of the short circuits. The result has been the development of circuit breakers and relays operating to clear the disturbance in a very short time. The conventional type of induction overcurrent relaying, depending upon successively increasing time inter-

vals to obtain proper selectivity between circuit breakers, is no longer suitable where the maximum speed is desired; and so a new form of relaying, known as distance relaying, has been developed for the general protection of transmission and distribution lines. Relays operating on the distance principle make use of the characteristic impedance or reactance of the circuit, as determined by comparing the voltage and current at the relaying point, to determine the distance from the relay to the fault. Hence, selectivity between circuit breakers can be obtained without the use of increasing time intervals in the time settings of relays as the generating station is approached.

The tripping-time characteristic employed with the new types of distance relays is shown in Fig. 1. When a fault occurs between station A and the point *m* the relay trips instantaneously. When a fault occurs between the point *m* and the point *n*, a time delay  $t_1$  purposely is introduced in the relay at A. If the fault is between station B and the point *n*, the time delay introduced in the relay at A will allow the relays at B to trip the circuit breaker at B first, so the relay at A resets and does not trip its breaker. If, on the other hand, the fault is between *m* and B the breaker at A will be tripped after a time delay  $t_1$ . It is customary also to provide a third range of protection which will trip the circuit breaker at A after a time interval  $t_2$ , for a fault at any location between station A and the point *p*, if it is not cleared earlier by the action of other relay elements.

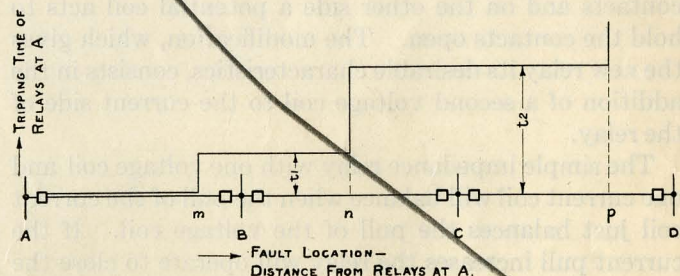


Fig. 1. Distance-time characteristic of "balance point" distance relays

Based upon "A New High Speed Distance Relay" (No. 32M1) presented at the A.I.E.E. winter convention, New York, N.Y., Jan. 25-29, 1932.