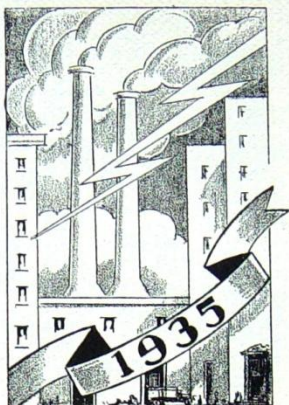




43 YEARS



LIGHTNING, as one of Nature's most spectacular phenomena, is beautiful; it is majestic—spectacular—**destructive**. For centuries it wrought fear and superstition in the mind of man. It was regarded with awe, as a visitation from the gods indicative of their wrath and displeasure towards mankind. With the mentality of superstition it was feared.

We fear that which we do not understand.

Science in its onward march towards truth and the understanding of Nature's phenomena has robbed lightning of much of its awesome characteristics; it has given us the mental equipment and understanding to witness it without fear, to admire its splendor and beauty and, as well, has it given us the means to rob it of much of its destructiveness. It has done this because through scientific research we have been enabled to understand the nature of lightning and most of the laws governing its action.

Lightning affects exposed electrical circuits; equipment, such as transformers, connected to such circuits is likewise affected and unless adequately and properly protected is subject to lightning damage. Understanding lightning phenomena, its nature, occurrence



and effects, we are enabled to protect against it and having done this we have little to fear.

**Your** particular interest in lightning undoubtedly centers largely in this highly specialized field of lightning protection for electrical equipment and it is in this field that the lightning arrester has played a most important part. Through its proper application you are now enabled to successfully operate through severe electrical storms with little or no damage to equipment—a condition quite unrealizable in the earlier days of electrical development.

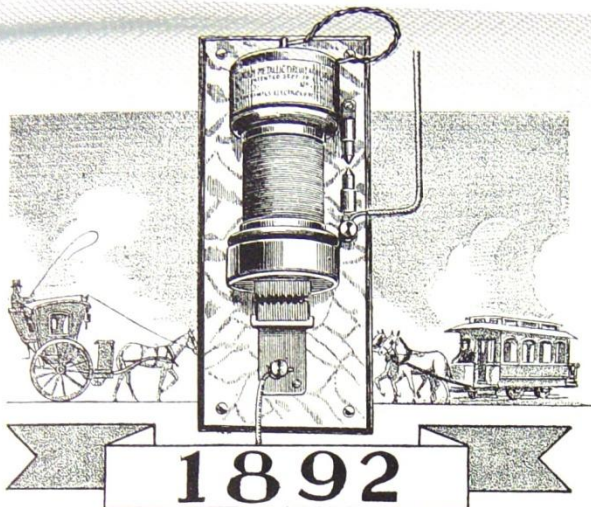
Our Company for more than forty years has played an important part in making possible the present day effectiveness of lightning protective installations, and behind the Crystal Valve there stands as a background the vast experience of these forty years—experience in research, in design, in manufacture, in service.

Facts like these you should know; you should know what is behind the lightning arresters you purchase and install to protect valuable electrical equipment.

To acquaint you with some of these facts and the self-evident conclusions which may be drawn therefrom is the mission of this little booklet.

We hope that its contents and our manner of presenting it may prove of interest to you.

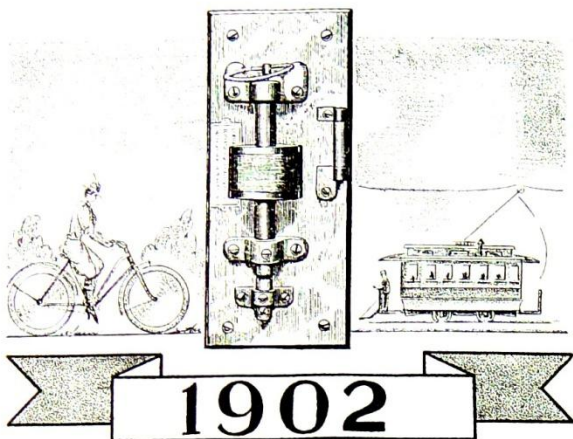




In 1892 we began the manufacture of lightning arresters for both direct and alternating current service, which two lines of manufacture we have of course continued to the present time. Our A. C. types (which only will be considered in this booklet) were in 1892 made for circuits "from 50 to 3500 volts and from  $2\frac{1}{2}$  to 2000 amperes."

The illustration above shows a typical A. C. arrester manufactured by us in 1892. Vastly different, of course, were these arresters from the highly perfected valve type units of 1935, yet certain fundamental principles common to both types are readily recognizable; these are spark gaps employed for isolating the arrester proper from the circuit under normal operating conditions, together with means for interrupting any flow of follow or dynamic current following the lightning discharge through the arrester to ground.

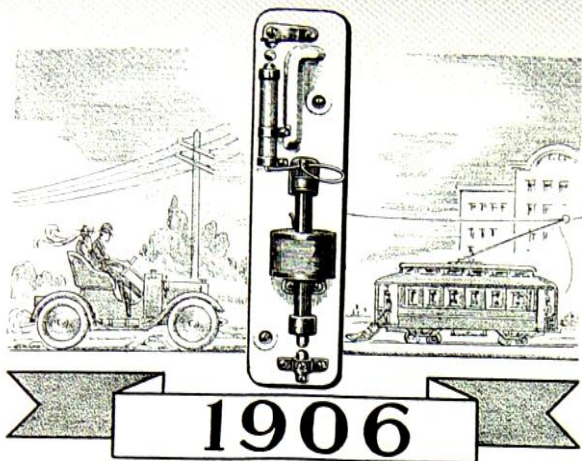
These arresters of 1892 were good arresters of their time and for the then existing conditions, gave excellent service, and their field operation planted the seeds of confidence in products of our manufacture which have since bloomed into world-wide recognition.



Now let's hurry through 10 years and look at 1902. The use of alternating current had increased, necessitating increased plant capacity, the building of more transmission and distribution circuits, the installation of additional capacity, more service connections. Expansion and improvement were the order of the day.

Our lightning arresters of 1902 likewise reflected these trends of the times and we find them incorporating basic improvements in design and construction; we find them better looking, more efficient, more widely used and representing decided advances in the art of designing and building equipment of this nature.

The illustration of one of our 2500 volt A. C. arresters as made in 1902 and appearing above will show some of these changes and improvements. The same fundamental principles of spark gaps and an interrupting means for follow current are still employed, their construction and electrical characteristics having however been vastly improved. Perhaps the most marked improvement was in the use of the shunt resistor by-passing the circuit-breaker coil for lightning discharges—an improvement very greatly increasing the discharge capacity and efficiency of the arrester.



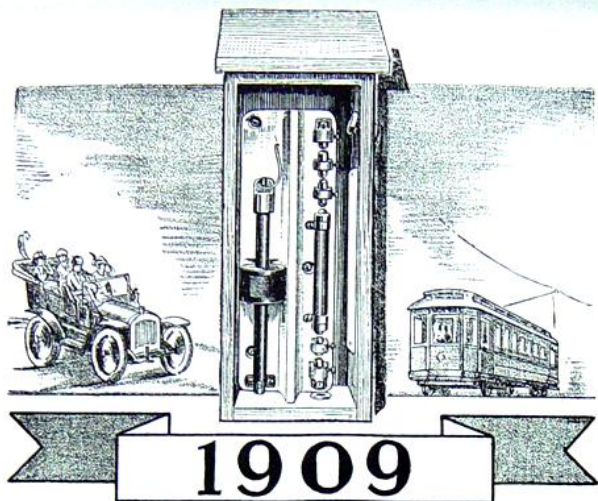
The year 1906 found alternating current transmission, distribution and utilization further expanded.

It likewise found our entire line of both D. C. and A. C. arresters radically changed over designs previously existing. These 1906 arresters embodied the straight line principle of arrester construction more fully than previous types; they embodied metallic discharge electrodes of non-arcing metal, more rigid construction, better insulation; in addition to retaining the shunt resistor by-passing the inductive circuit-breaker winding, they also incorporated in their make-up a series resistor for limiting the flow of follow current to ground following the lightning discharge. The use of this series resistor was a very marked improvement in arrester construction owing to the ever-increasing capacity of the circuits on which they were designed to be used.

Their discharge capacity was increased; better circuit breaker design plus the use of the limiting resistor increased their cut-off voltage; new types were developed to extend their range up to 20,000 volts.

Development, research, experience dictated these changes, bringing our arrester line strictly in accord with the then existing operating conditions.

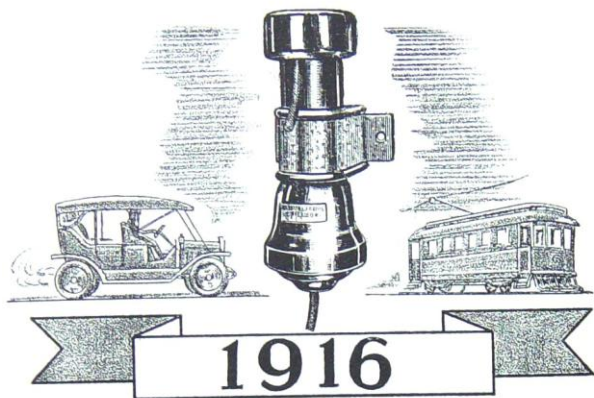




But research, development, progress in our lightning investigational work still continued and in 1909 we again find our entire line of A. C. lightning arresters redesigned and embodying our latest developments to make them still better adapted to the heavier and more exacting service which was constantly being impressed upon them.

We again find heavier circuit breaker construction resulting in still higher cut-off voltages, heavier discharge capacities due to larger series resistors of lower ohmic value, higher values of insulation, straight line discharge path for lightning and many other minor improvements.

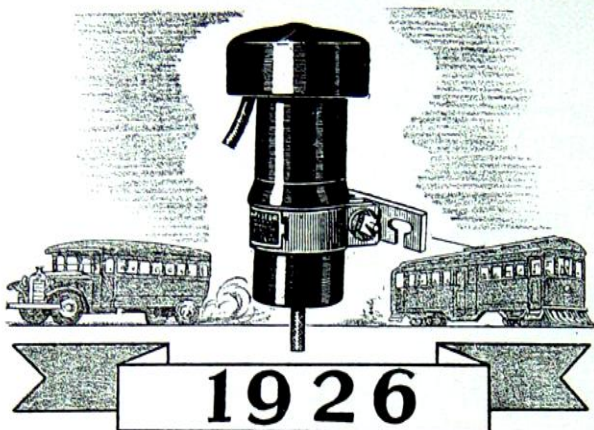
One of the most outstanding developments incorporated into these arresters was the use of the circuit-breaker and its associated operating coil entirely in shunt with a portion of the lightning discharge path. This improvement disassociated these two arrester elements and our discovery and utilization of this principle was responsible for the deserved popularity which these arresters enjoyed for many years.



Now let's again hurry through the years and see what 1916 can show in the way of further improvements in our lightning protective equipment. Studies prior to 1916 showed conclusively the desirability of protecting every transformer with lightning arresters mounted directly on the transformer pole; this practice called for the use of small, self-contained arresters; arresters that were relatively inexpensive in first cost, easy and cheap to install and requiring little or no inspection.

These conditions were met in a highly satisfactory manner by another new line of arresters created by our organization and known as the Keystone Expulsion Type Arrester, illustration of a typical unit being shown herewith. These arresters were constructed on the multigap principle and consisted essentially of a low resistor in series with spark gaps. By an ingenious principle an expulsive blast of air through an opening in the lower end of the body assisted the air gaps in cutting-off system current following the lightning discharge to ground and resulted in a small self-contained arrester having very excellent protective and operating characteristics.



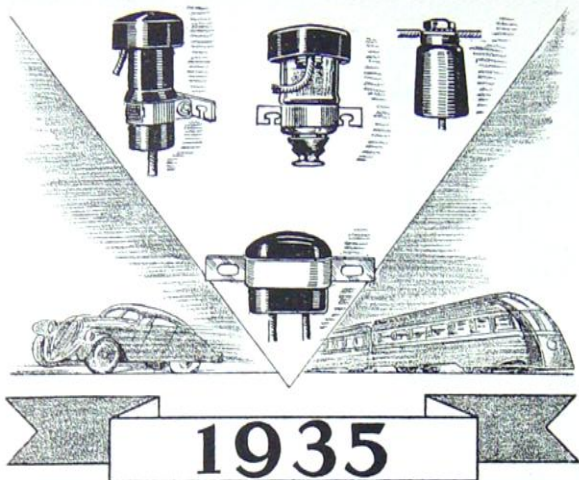


But still our search for better lightning arresters continued and in 1925 our Engineers conceived still other ideas, the principles of which they felt could be utilized in the construction of another type of lightning arrester—an arrester fundamentally new, an arrester of exceptionally high efficiency and one that would be far in advance of any type then available.

In 1926 these ideas had become realities and in that year was born this new arrester, an arrester whose principles of operation depended primarily on the electrical valve action of certain highly refractory conductive crystals of the carbide group; quite appropriately this arrester was given the name "Crystal Valve."

In 1935 the fruits of these earlier ideas have become known throughout the civilized world and Crystal Valve lightning arresters are found wherever electricity is available for the services of mankind; they are known and used wherever lightning hurls its mighty forces of destruction.

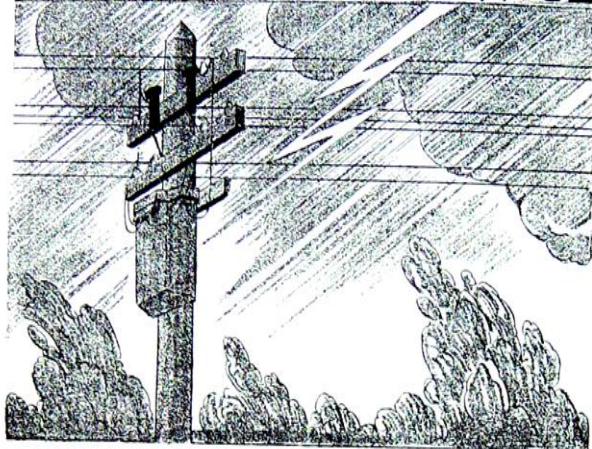
Thus have Time and Service bestowed their honors on the Crystal Valve.



The name "Crystal Valve" in its narrow sense refers to lightning arresters and lightning protective equipment—inanimate things composed of procelain and copper, crystallite and brass. In its broader sense it has come to signify and to mean a living, vital thing—a **service to the electrical industry**. It is a service of research in lightning protection, a service of design, of manufacture, of consultation and of recommendation; it is a service that grows and expands with the industry, keeping always in the forefront with development to meet the ever-changing requirements of modern electrical operations. It is a combination of the vast experience of the past, the knowledge and tools of the present, ever looking forward into the future and towards future trends and requirements.

Many of you use the Crystal Valve Arrester; to you these words convey the spirit of our appreciation; you have been a part in the development and growth of this device, for, having seen its underlying merit, you have purchased and installed the Crystal Valve on your properties throughout the world; the efficient lightning protection they have afforded your transformers and

# CRYSTAL VALVE SERVICE

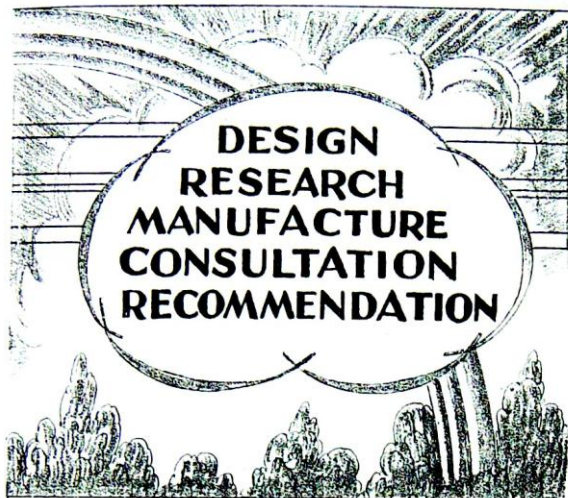


other electrical equipment, their freedom from troubles, their dependability and reliability—all these and many other features have amply vindicated your judgment in their selection and rewarded you for their use.

And why should not a lightning arrester bearing the name "Crystal Valve"—or why should not any other piece of lightning protective equipment so named, typify equipment of exceptional merit? The development of successful and satisfactory protective equipment is fundamentally the result of two essentials—long experience in the field combined with the most modern facilities for research and development in this difficult art. No one can doubt the importance of this statement of fact. A new lightning arrester, such as the Crystal Valve, developed in the light of past experience by an organization fully equipped with research facilities for this work may be expected, and rightfully so, to represent a decided advance in the art of lightning protection.

To you who use the Crystal Valve these words need little





argument, for the fact that you **do** use them is proof positive that you understand and appreciate these vital considerations; the selection and use of equipment whose functions are as vital as those of a lightning arrester is a duty that cannot lightly be passed upon.

To you who use Crystal Valve lightning arresters, as well as to you who do not, this booklet is addressed.

It is one of a series dealing with certain features of the Crystal Valve as well as with some of the new and broader aspects of lightning protection in general.

You will find them interesting and well worth your careful study. Future issues will tell you how the Crystal Valve is constructed, how it operates and how and why it will give you exceptionally efficient and reliable lightning protection. Through them we will discuss with you many of the latest developments in the field of lightning protection—Interconnection and Balanced Protection; will show you our developments in protective and co-ordinating gaps designed especially for

and used in connection with these lightning protective developments; will discuss the various means by which you may secure the high degree of protection that their proper use and application will insure.

As we have stated before, the Crystal Valve arrester is the result of more than forty years experience in the design and manufacture of lightning arresters and lightning protective equipment; of the vast background of specialized experience gained in the manufacture of several million lightning arresters; of splendid laboratories containing the most modern equipment which science affords for the study of lightning phenomena; of highly skilled personnel for this work.

**With all of this back of it, would it not be strange if the Crystal Valve were not an arrester of outstanding merit?**

If you now use them, you know all this and the time is ripe to place additional orders for this present lightning season. If you do not as yet use them why not profit as so many others have done by getting and installing them on your circuits, thereby enjoying the **proven** quality of lightning protection that Crystal Valve arresters will give?

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