

# Surge Protection Hall of Fame



**John W. Kalb**

April 2009

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## John W. Kalb

Inventor of the Current Limiting Gap

Jack Kalb, as he is known to his friends, was an extraordinary arrester design engineer and surge protection pioneer. At 90+ years old, he is still active but not in arresters any longer. He just sold his candle making business after 25 years and resides on St. Simons Island, Georgia USA. He was kind enough to submit an excellent recollection of his arrester career. See "In Jack's Own Words"

When he retired from Ohio Brass in 1981 he had been involved in surge arrester design for over 40 years with more than 11 US patents on arresters in his name. Jack is recognized as the inventor of the surge arrester current-limiting gap. This invention moved the surge arrester protection capabilities to the next level in surge protection in the early 1960's. US patent 3,019,367 filed in Jan 1957 and granted in Jan 1962 was the first patent to describe the Arrester Current-Limiting Gap Concept. In August 1959 Jack's AIEE paper titled "New Current-Limiting Gap Extends Valve-Type Lightning-Arrester Performance", co-authored by AG Yost, also of Ohio Brass, introduced the world to the new concept of current limiting gaps. This new invention allowed for lower resistance valve blocks that translated in to improved protective levels on arresters. This invention replaced the magnetic field controlled arc gap design that had been used for the decade before the current-limiting gap was introduced. This invention is also credited with improving surge protection around the world.



Jack Kalb (1980)

Besides his current-limiting gap experience, Jack Designed an expulsion arrester in the 1940's and lead the Ohio Brass team with the introduction of its first MOV type arrester.

### Career, Awards and Honors

- 1940 – Graduate of Swarthmore College, Swarthmore Pa.
- 1940 - Started his Career at GE
- 1949 - Joined Ohio Brass,
- 1957 - Invented Current-limiting Gap for Arresters
- 1958 - Named Director of R&D, Ohio Brass
- 1959 - IEEE Fellow
- 1980 - Elected to the National Academy of Engineering of the US.
- 1981 - Retired from arrester business
- 4 - IEEE Prize Papers
- 11 - US patents 1949-1970

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## In Jack's Own Words

(An April 2009 letter)

I haven't kept any material from my work at OB or GE so it is just vague reminiscences' of a dwindling memory. I will not mention work done by the other engineers, because I would probably get the names mixed up. After a while at OB, I realized that several of the engineers were smarter and more diligent than I was. This didn't bother me and probably didn't bother them much either.

I started work at GE in 1940 and worked there for 9 years in lightning arrester research. Most of this work was on developing an expulsion type distribution arrester. In its simplest form, an expulsion arrester is like an expulsion fuse with the fuse link replaced by a gap of suitable spacing. Other manufacturers used this type, but GE made sort of a valve type arrester using lead peroxide pellets. It was large, heavy and was not as durable as the expulsion type so the R&D group had just started work on an expulsion arrester.

I developed sort of a fancy arrester using cellulose pellets in the arc chamber with a spring loaded reservoir of pellets. It went into production and I got to spend two great summers on a field study where a REA utility was equipped with many of these arresters. They seemed to work fine. I still remember a great experience from this study. I had just turned on a battery powered oscillograph at a transformer pole leading from one of the farms, and I was looking along a 7.2kV line as it crossed a valley. I saw lightning strike the line about ½ mile away and simultaneously, a cannon went off over my head; then 2-3 seconds later I heard the thunder. The new expulsion arrester had given audible

evidence of the lightning via the power line with no time delay.

There must have been a major defect in the arrester design that I missed, because I never saw any on distribution lines in later years.

At this point I got the offer from OB to help them start in surge arresters. Since I had no valve arrester experience at GE, OB sent me over to ASEA in Sweden for 3 months to study their operation. When we started manufacturing, the internal parts were almost exact copies of the ASEA design, but OB had the engineering for the porcelain housings and hardware. It was called an "Intermediate Class" arrester and I believe was limited to a top system voltage of 69 or 138kV. As I remember it, the sales department had no trouble selling them and about the only problem was, now and then, some failures in contaminated areas. The multi-gaps used ordinary linear resistors for grading and this was not adequate for the more severe contamination found in this country at that time. Non-linear grading resistors were our first departure from the ASEA design.

The big change was the current-limiting gap. At that time, all valve type arresters consisted of a non-linear silicon carbide valve element in series with a simple multi-gap element. The various valve elements were comparable, the active semi-conductor being silicon-carbide granules. They had to limit the power follow current after sparkover to about 100 amperes or the simple gaps could not interrupt it and the arrester would fail.

A current-limiting gap allowed use of lower resistance and more durable valve element while still limiting the power follow current. This stretching and cooling of the arc was no new

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principle: it was used in certain circuit breakers; it just hadn't been used in arrester gaps before. As long as we were the only ones using this design, it was easy to have the best product and our arrester line was extended to the station class arrester for EHV systems.



**The Kalb 1958 Current-limiting Gap**

As GE and the European companies started using current-limiting gaps, we kept gradually improving our gap design so that we at least thought we had the best product. I then went too far and for EHV systems designed an arrester with no valve element, just current-limiting gaps. I forgot the simple fact that surge impedance in these large EHV stations was so low that when sparkover occurred the follow current was instantaneously several amperes just from normal system voltage. The gaps could not lengthen arcs of this magnitude so at considerable expense we had to add a small amount of valve elements.

At about this time, some folks in Japan perfected some bulk solid-state diodes called metal-oxide varistors (MOV) as big as arrester valve blocks. Our SiC blocks had a voltage-current exponent of about 6 and the MOV exponent was about 20. This effectively eliminated the need for a gap in

arresters. So to stay in business we took out a license quickly to learn how to make good MOV's and kept on going.

Well so much for the short happy life of a current-limiting gap surge arrester. I retired in 1981 feeling that the research and development groups had contributed perhaps a leading part of the company's welfare.

Jack

## **Jacks Career from another Perspective**

Fellow arrester designer and mentee of Jack Kalb, Dennis Lenk of Hubbell Power Systems had this to say about Jack.

"Jack was, in my opinion, much too modest in his letter on his career. Through his diligent efforts with ASEA, he led Ohio Brass into the Modern Era of surge arrester design in the early 1950s with the multi-gap SiC arrester. His best work was to come as he guided the Ohio Brass research efforts which resulted in the introduction of Current-limiting gapped SiC arrester in 1957. From 1957 thru the late 1970s, still under his leadership as Director of R&D, five gapped arrester design improvements were integrated into the arrester product line. As you know, each gap improvement translated directly into better arrester protective levels and more favorable BIL levels. "

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