

Oscar Kjellberg – Inventor and Visionary

By
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ESAB's early years are inextricably linked with its founder, Oscar Kjellberg. The inventions, the formation of Elektriska Svetsningsaktiebolaget (ESAB), establishing the ESAB brand overseas were the life's work of this extraordinary individual. Since 1904, various authors have written histories of ESAB. But Kjellberg, the man, has always been overshadowed by his achievements. So, who was he? And what drove and motivated him?

Oscar Kjellberg was born into a time of unprecedented technological progress. The latter half of the 19th century saw a sustained innovation in every technical and scientific discipline from medicine to manufacturing, laying the foundations of the world as we now know it. Across Europe and North America, industrial revolutions transformed national economies from largely agricultural into manufacturing based, aided by the development of mechanized transport. A new breed of engineer-entrepreneur, exemplified by Robert Stephenson, Isambard Kingdom Brunel, Thomas Edison, Karl Benz, Samuel Colt and the Wright Brothers, drove this along.

Sweden similarly fostered industrial pioneers who exhibited the ability to innovate and then go on to establish companies which have survived and

prospered. Gustaf de Laval (the inventor of the first useable steam turbine), Gustaf Dalén (inventor of lighthouse equipment and MD of AGA) and C. E. Johansson (the first gauge blocks) belong to this pioneering club. As does Oscar Kjellberg, born in 1870 in the little village of Mötterud.

He was the eldest of five children born to Johannes and Karolina Kjellberg. Johannes, a railway construction worker, emigrated to Canada in the early 1880's, hoping to find work to support the family. Unfortunately, shortly after his arrival, he died during railway construction work, under circumstances that have remained unclear. Oscar Kjellberg was then 12 years old and it must have been a very difficult time for the family. Nevertheless he was able to continue his education and at 16 he enrolled as an apprentice at Kristinehamns Mekaniska Verkstad.

It is said that he was a quiet and very hardworking pupil, who was not content with the lessons he received in the daytime, but who borrowed specialist literature on mechanical engineering, which he studied long into the evenings.

There is an anecdote from his time in Kristinehamn. One evening, Kjellberg was sitting on a bench in the port and entered into a conversation with an older gentle-

man. This was Axel Broström, who had already started to build the shipping empire that would later become the Broström group. Axel Broström is said to have remarked that somebody should invent a process so that the plates forming the hull of a boat could be welded together instead of riveting them. Kjellberg, a 17 year old at the time, is reputed to have responded: "Surely, that ought not to be impossible!"

Perhaps he remembered the young man because in 1888 when Oscar Kjellberg applied to work for Axel Broström, he was immediately employed as an engine-room apprentice. He worked for four years on different ships belonging to the Broström fleet and also attended night school. At 22, he came ashore to become an engineer fitter at Kockums Mekaniska Verkstad in Malmö, whilst continuing with his studies. Four years later, he completed his engineer exams and was able to take up the post of engine room officer. He served for the next two years on various ships, whilst continuing with the theoretical side of his education, and he passed the chief engineers' exam in 1898.

Now, he was presented with the opportunity to work and continue his studies in Germany. At the age of 32, he passed the German ship's engineer exam. The following year he was able to add electrical

engineering to his list of qualifications.

By 1903, Oscar Kjellberg had an impressive theoretical education, very good qualifications and 15 years of practical experience, mainly gained from work onboard steamships. He now had the opportunity to work as a technical officer on one of the biggest ships of that time, an easy choice for most.

Not for Oscar Kjellberg, however. All that studying, while he worked for his upkeep, all the experience which he had accumulated, appears to have been preparation for fulfilling the vision sparked by that evening in Kristinehamn and that brief conversation in the harbour. "Surely, that ought not to be impossible!"

THE INVENTOR

Instead of installing himself as the chief technical officer on one of the world's biggest steamships, Oscar Kjellberg rented a small workshop near to the Masthuggskajen quay in Gothenburg, where he began his welding experiments. He was aware of previous attempts at electrical welding, and had encountered craftsmen who could solder and weld using contemporary methods.

Importantly he was fully aware of the two major failings of existing welding processes. Firstly, the welded joint was not of the same quality as the parent metal, instead it was normally more brittle and porous. Secondly not all welding positions could be tackled successfully; overhead welding, for instance, was virtually impossible. For welding to become the universal method of repair which he aspired to he needed to solve these critical problems.

One of his strengths was his own practical experience of the problems with which a chief engineer on a steamship had to grapple. Marine

boilers were riveted and, without exception, they began to leak after a time. This was a serious problem, as pressure could not be maintained, which resulted in reduced power from the engine. Therefore, leaks had to be sealed as quickly as possible. Normal practice was to force a wedge-shaped nail, followed by flax and hemp, into the leaking joint. This was a very difficult task under the worst conditions imaginable. The boiler had to be cooled down so that workers could endure working on it. Also leaks would sometimes occur on the underside of the boiler, making access difficult.

As a ship's engineer Oscar Kjellberg had experience of repairing these types of leak and was motivated to develop a better and more permanent method of repair. The principle of electrical welding was well known, and explained in over 300 patents. However existing methodology was not capable of providing a workable solution for boiler repair. In this respect Kjellberg's strength was his perception that the solution nevertheless lay within the scope of electrical welding, if the method and the equipment were improved.

Working in his experimental workshop, he set himself the task of developing a complete solution comprising both the method and the equipment that was needed. Oscar Kjellberg himself put the matter into words in a posthumous text.

"Electrical welding came about at a time of total abject poverty. It was not a beaten path that was being trod. However, difficulties are often there to be overcome and I decided to investigate whether the engineers of the 1880's had left the subject unresolved. After detailed studies of what they had done and achieved, it thus became apparent that this

was indeed the case. I managed to see my predecessors' mistakes and I learnt from them."

When we know this, it is unsurprising that welding as a method or a process interested Kjellberg. His first patent, dated 14 July 1905, is consequently a process description. He was able to obtain the patent based on the existing well-documented process, whereby an electric arc between an iron electrode and the base material makes the metal heat up until it is liquid.

However, he added two important modifications. First, only a very short piece was to be welded, strictly speaking only enough so that there appears a clear melt. Then, the electrode is taken away, and the still hot weld is fashioned (puddled) with a hammer.

In a working description, which Oscar Kjellberg wrote around the same time as he received his first patent, there are very detailed instructions on how to hold the electrode in the left hand in order to be able to hold the hammer in the right hand. These instructions, titled "Working method for electrical welding, including material and how it is handled", dated 1 October 1904, are preserved in the original. The 8-pages of instructions are handwritten; there is not one spelling mistake, not one correction – typical of his methodical approach and attention to detail.

At this point it should be mentioned that, by 1904, Oscar Kjellberg had already developed the theoretical basis for what became his major contribution to electrical welding – the coated or covered electrode. In the minutes of a board meeting that took place that year, it is stated that he had deposited a confidential report in a bank safe. We now know

that in this secret report there is an account of the first experiments with coated electrodes.

It was quite natural that in a large maritime city such as Gothenburg, it became known that Kjellberg was in the process of revolutionising welding. Although in many circles there was well founded cynicism regarding the effectiveness of welding as a method of repair, Oscar Kjellberg was soon given the opportunity to demonstrate his improved methods.

In the early part of 1904, he repaired some parts of a Swedish warship that were frozen and broken. The result was so good that both shipping companies and industrial concerns took an interest. This probably helped to finance continued development of welding through formation of a company.

Its mandate was "to machine and weld metals, and to manage a business that promotes these activities". A professor from Chalmers University of Technology and a chief engineer from Lindholmens Mekaniska Verkstad in Gothenburg were included on the company's board of directors. Oscar Kjellberg was appointed as the company's managing director.

The statutory meeting was held on 12 September 1904. The name of the new company was Elektriska Svetsnings Aktiebolaget. However, the abbreviation ESAB was used in everyday speech right from the beginning.

As was apparent from the name of the company and also from its articles of association, it was the welding method that was the business concept; the equipment required was of secondary importance. During the early part of the company's existence, execution

different welding assignments was its most important product and source of income. Solving practical repair problems was thus the basis of the early ESAB.

In parallel with being MD for the company and actively participating in all areas of its work, Kjellberg continued to develop the welding process. His second patent came in 1906 and describes an "electric switching device". Its function was to limit the output for a direct current generator.

However, the big breakthrough came with the invention that was granted a patent on 29 June 1907. The patent is called "Procedure for electric welding including the electrode intended for this purpose." Its revolutionary property was that Kjellberg had coated the welding electrode with non-conductive material, which gave many advantages. Firstly, the coating generated a protective gas (CO_2) when it melted. This gas prevented the formation of iron oxides in the hot melt and it became possible to weld longer pieces, up to a whole electrode length, without needing to interrupt the welding. Welding could therefore be more continuous. Moreover the patent described how to build up a weld with several beads.

Secondly, we remember that Oscar Kjellberg sought a solution to the problems associated with difficult welding positions, particularly overhead welding.

When he formulated a 'recipe' for the coating that melted at exactly the same rate as the welding metal rod, he found that a crater was formed at the tip of the weld electrode. This crater directed the flow of molten metal and after many experiments with different coating compositions he was able to find one that enabled

overhead welding.

The genius of the patent is that it neglected to describe the composition of the coating, and the patent became a principal patent on the coated electrode. We have to be grateful for the fact that Oscar Kjellberg had had the practical experience of repairing leaky boilers, and that the leaks appeared on the underside. Otherwise, he may have been content with just his first patent.

Mastering difficult welding positions was the challenge that led to this third patent, which is the basis for allmodern welding with coated electrodes.

THE COMPANY MANAGER

Oscar Kjellberg has been described primarily as a gifted researcher and inventor. From 1907 until his death there was, however, another side of his character that assumed an ever-increasing role. It is possible that fellow directors understood how the Kjellberg inventions could be exploited, but it is beyond doubt that Oscar Kjellberg himself made a very active contribution to this work.

Early activities were concentrated in Gothenburg, where ESAB offered repair facilities from a barge in the port. During this time, he participated in all types of work. However the training of welders was a task that he willingly took upon himself to lead. Without skilful welders, welding wouldn't be able to win ground from other repair methods.

Kjellberg had ambitions that ESAB should establish workshops in large ports all over the world. However he soon realised that the company lacked the financial resources for such a massive expansion. Therefore, both Swedish and foreign companies were offered licences to use the Kjellberg method. To start

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with, the going was tough; ESAB had to accept a number of unprofitable agreements, where in some cases a company gained the exclusive right to use the Kjellberg patent within an entire country. However by 1911, the company had sufficient capital to set up its first wholly owned foreign subsidiary.

Great Britain was the foremost industrial and maritime nation of this time. ESAB already had some licence holders in England, and it took a year before the Anglo-Swedish Electric Welding Co., - as the subsidiary was called - could be formed. Based in London, it offered similar practical welding services to its parent company. In fact the British subsidiary was also the last to discontinue such activities. Two years later a second foreign subsidiary was established in Belgium. At the same time, a very extensive contract was signed with Mitsubishi Zosen Kaisha in Japan.

It might have been thought that the Kjellberg method would win fast acceptance in engineering circles. This was not the case, and Oscar Kjellberg had to devote a lot of his time to arguing the case in favour of MMA welding, both in Sweden and abroad. He was a skilful presenter and always well prepared. At the core of his argument was the cost benefit for customers of welding compared with other repair methods. He was able to draw on examples where repairs with welding had been performed at a cost that was only about 2% of the cost to repair in another way or to replace with something new.

Proving the quality and durability of welded repairs was also important. He followed up all jobs undertaken by the company for several years after their completion and could show a very low complaints ratio by the standards of the time at about

0.5 to 1.0%.

Oscar Kjellberg thus became a tireless promoter and developer of the electric arc welding process, continuously improving the capabilities of the equipment, consumables and techniques and aiming to convince people by demonstrating actual results. He dealt with setbacks by increasing his already large workload. He participated in the practical work both in Gothenburg and at the subsidiaries and agents. He was without doubt the greatest expert on welding of his time.

Companies and colleagues turned to him if they needed advice on how to manage especially difficult jobs. It has also been said that he had an incredible memory. Everything from contracts to welding method descriptions were remembered word for word, and he never needed to refer to his notes. As well as being an inventor/innovator/industrialist and one-man publicity machine, Kjellberg was also financially astute. If ESAB's most important task was to perform practical welding work, its second most important task was to remain independent of banks and other financial institutions. He wanted his company to be self-financing to the greatest possible extent. This would prove itself to be a very good principle during and after the First World War 1914 - 1918.

During the war, things went well for the company, and when the difficult years arrived after the war, ESAB could survive on the money it had saved. During, and directly after the war, wider acceptance of the process saw companies starting to use welding not only for repair work, but also for new construction work. This opened up completely new opportunities for ESAB.

However, initially the classification societies did not accept welding as a replacement for riveting when building new ships.

During and after the First World War, however, there was considerable need to replace and repair both naval and mercantile tonnage. Here the economic argument was strong as welding instead of riveting could reduce the sheet metal weight by up to 10%.

Lloyds Register in London was the first classification company to investigate the possibilities of all-and part welded ships. Trials were carried out at ESAB's premises in London and the results were highly positive. Consequently, in 1920, Lloyds approved all-welding as a production method for all types of ship.

Shipowners remained skeptical so Oscar Kjellberg commissioned a small floating workshop to be built. ESAB IV was launched on 29 December 1920. It became the world's first all-welded ship to be classified by Lloyds, and it contributed to dispelling the prejudice of shipowners and shipyards against welded ships. ESAB IV still exists today and forms part of Gothenburg's Maritime Museum.

The next challenge for ESAB was a double challenge; to establish a subsidiary in Germany and to commence manufacture of welding power sources. In 1921, the German company was formed and after a slow start it became the largest subsidiary within the group. The factory in Finsterwalde was equipped to manufacture rotary converters, which ESAB started to sell in Sweden in 1923.

It was typical of Oscar Kjellberg that he chose to start manufacturing

power sources rather than turning to an already established electrical equipment company. It was the demand for very special functional characteristics that determined the decision to start manufacturing rotary converters within ESAB, as the compromises that an external supplier might have demanded were unthinkable.

Gradually, production at Finsterwalde came to comprise a number of different welding machines and electric motors, and much more besides. At its peak in 1939, 5000 employees were kept busy, 1500 of them with welding equipment.

The minutes from board meetings and other records from Elektriska Svetsnings-Aktiebolaget's first 25 years reveal that Oscar Kjellberg didn't leave anything that concerned his company outside his personal control. The records sometimes state approximately, "that director Kjellberg informed the board that he had...." In other words, the issue was already resolved. It could be a matter of agreements concerning the right to make use of the company's patent, or large or small purchases or setting up abroad.

Like many successful industrialists Kjellberg probably perceived himself and the company to be indivisible. It is testified that he didn't have many interests other than the company and its development. He was its MD, and its technical director at the same time. He managed the foreign contacts, he was engaged in practical welder training, and he was an indefatigable lecturer on everything to do with welding.

Within his field he was the fount of all knowledge. By the time of his death at the early age of 61, Oscar Kjellberg had received several

awards in recognition of his efforts, including, in 1927, the Royal Swedish Academy of Engineering Sciences (IVA) gold medal.

Dedication to his work ultimately undermined his health, but he ignored medical advice to reduce his workload. He was working right up until the very end and died on 5 July 1931, sitting at his desk. He was mourned by his wife and four children, of whom the youngest, Björn, would follow in his father's footsteps. By 1931, he had fulfilled the vision that had driven him all those years. Electric arc welding was a generally recognised method, not just for repair work, but also for new production and construction. ESAB was a well-established, respected company with a range of foreign subsidiaries and interests.

Even so, by 1931 ESAB was facing new challenges. The original business concept, to carry out welding on contract, was no longer sustainable and the world was in recession. It was a time of change requiring new ideas and a new set of business goals.

Had Oscar Kjellberg lived longer he would doubtless have responded with the same optimism, enthusiasm and tenacity that recommended him to Axel Broström that evening in Kristinehamn over forty years before: "Surely, that ought not to be impossible!" In the event it was left to his successors to demonstrate that to be the case.

The information in this article has been collected by Bo Sörensson from several sources, including the following works:

- Gösta Ferneborg: Oscar Kjellberg
- Bertil Lundberg: Maskinhistorik
- Memorial publication:

Elektriska Svetsnings-Aktiebolaget
1904 -1929

• Sixten Wiberg: En vandring genom åren, ESAB 50 år

As well as through articles and other historical material that have been collected by Eva Persson, responsible for the historical archives at ESAB in Gothenburg.

ANNOUNCEMENT

Indian Institute of Welding (Kolkata Branch) periodically conducts the following short term courses either at IIW office or at the customers premises

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