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Chapter I

BACKGROUND FOR RESISTANCE WELDING

Any discussion of resistance welding would be incomplete without mention of its inventor, Professor Elihu Thomson. He was brought to the United States in 1858, when he was but five years of age. The family settled in Philadelphia, and there he received his early education. In the year 1877, when but twenty-four years of age, he was lecturing regularly at the Franklin Institute, and it was during one of these lectures that a fortunate accident occurred which resulted in the discovery of resistance welding as it is known and practiced today.

How Discovered

For one of his experiments Professor Thomson used a simple spark coil to step up battery current to a high-tension discharge for the purpose of charging condensers, or Leyden jars. It occurred to him that it wonld be of interest not only to his audience but also to himself to learn what would happen if the process were reversed, *i.e.*, to pass the charge from the jars through the "spark-coil" after charging them with a power-driven static machine. Current was passed through the "secondary winding," which was made of fine wire, while the "primary winding," made of heavier wire, had the terminals held together in rather light contact. The result was that this discharge of current through the fine wire of the secondary securely fused or "welded" the terminals of the primary circuit. Thus was resistance welding born and its basic principle has never been changed.

At the time Professor Thomson was almost wholly engaged in an exhaustive series of experiments in connection with apparatus for generating current for the arc lamp. This work required so much of his time that experiments in resistance welding were put aside for nearly nine years.

Early Development

In the early part of 1886, continuing his experimentation, he perfected the process and applied for patents covering his invention: one a process patent and the other a welding-clamp patent. The original process patent application covered butt welding only and simply involved the joining of two pieces of metal of equal area.

Experimental work continued in butt welding, and then in the year 1898 there probably occurred the first authentic use of spot welding, after which the development of resistance welding steadily advanced and its application became more widely diversified.

The largest users of spot welding during these first years of its life were the kitchen-utensil manufacturers who used it for welding handles to pans instead of using the former method of riveting. The wagon-manufacturing industry also quickly adopted it when it was shown that production costs could be greatly reduced.

One of the things which undoubtedly retarded the development of the resistance-welding industry was that in the early days no welding apparatus was disposed of as an outright sale. Each welding unit was built for a specific operation and was installed only on

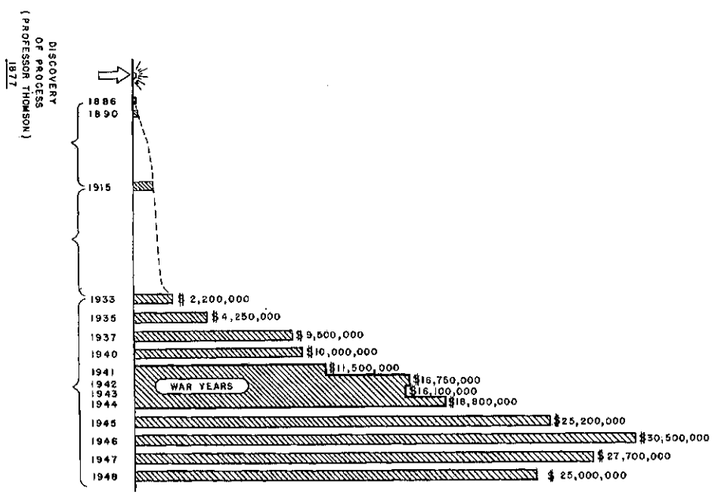

Fig. 1. Growth of Resistance Welding

Discovered in 1877, resistance welding saw little progress before 1890 owing to lack of knowledge of process and to closely held patents.

In the period from 1890 to 1915, industry came to recognize its value in fabrication but was restricted by poor quality of weld production.

Nineteen hundred and fifteen saw the construction of the first all-steel automobile, and slow steady growth ensued until 1933, at which time use was double that of 1915 because of better understanding of use values.

Nineteen hundred and thirty-three saw the beginning of maturity for the industry and a rapid year-by-year rise occurred through the years of the Second World War. But the spectacular rise in use value has occurred since 1944, until in 1948 there is in excess of $300,000,000 worth of resistance-welding equipment and an estimated auxiliary tooling of another $100,000,000.

a royalty basis. The user paid for the unit and thereafter paid a specified amount for each weld made on the apparatus. This arrangement continued for a considerable length of time and was considered fair and equitable to both parties, because the new method of welding was far superior to any of the old methods of joining and was so much faster that it proved very profitable to all concerned.

In addition to this royalty arrangement the growth of the resistance-welding industry was also retarded by the fact that all manufacture of this type of equipment was controlled by one company. However, as the process became more extensively used, other companies entered into the manufacture of equipment, which in turn led to patent suits and countersuits, argued through the courts until 1916 when five companies were licensed to build spot-welding equipment. All these patent claims and licensing arguments eventually wore themselves out and today, with but few exceptions, resistance-welding manufacturers sell equipment on an outright basis and without royalties.

When spot welding came into general use, the natural reaction was to look for a process by which more than one spot weld could be made on a single piece of equipment. This led to the discovery that by attaching electrodes to the opposite sides of the secondary of the transformer—placing them against two thicknesses of light-gauge material and backing it up with a copper conductor—*two* welds could be made simultaneously. This became known as *series* welding.

Then with the introduction of the all-steel body in the automotive industry, a *multiple* method of spot welding became a necessity and this led to the development of the hydromatic principle of welding. Later the ultraspeed method of welding was developed, and by 1939 experiments were being conducted to utilize a number of small welding transformers arranged in groups, making two to four welds from each transformer.

The Second World War interrupted these experiments, and little was done in the development of this type of welding until the latter part of 1945. However, by early 1946 these experiments became a reality and now the welding industry recognizes the multiple-transformer system as the most efficient known method of producing multiple spot welds. Great strides have also been taken in the development of welding aluminum and aluminum alloys as well as in the use of stored-energy types of welding equipment.

Thus it will be seen that though discovery of resistance welding occurred in 1877, no really substantial progress took place much before 1930, and the most ambitious strides have been made since the ending of the Second World War.

The future holds promise of great advancement for the industry and in the national economy, through increasing realization that, working as a composite team, designing, manufacturing, tooling, and welding engineers can substantially lower production costs of many, many metal-made products.

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