THE GROWTH OF ELECTRIC SYSTEMS*

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DURING the past few years data has been accumulating in the census reports and from many other sources, indicating the increasing use of electric energy. This increasing use is represented by an increased number of kilowatt hours used per capita during the year. The reasons for this increased use are of fundamental importance, and relate to the increasing wealth of the country.

Each man and woman in the United States actually utilizes a greater number of kilowatt hours each year, not only by travelling more times on electric trains, and by using more electric energy in the form of light, but also by other and more indirect means. The fact that the average wealth per capita has been increasing at a rapid rate, is reflected in more food, more clothing, more luxuries such as automobiles, player-pianos and all kinds of things which are produced either directly or indirectly by the use of electrical energy.

Million Men Employed

The result of this growth has been the development within recent years of an enormous industry, including not only the electrical generating and distributing systems, but also those manufacturing companies which are manufacturing apparatus used in the extension of these systems. The number of men employed in this whole industry exceeds 1,000,000; the gross annual income involved exceeds $2,000,000,000; and the astonishing thing is that practically the whole of this development has taken place since 1880.

It is interesting to note the evolution which has occurred in this industry. Certain schemes originated and were developed gradually until the limitation of these schemes was reached. Parallel with these schemes were others which did not have this limitation, and gradually these later and more important systems displaced the former ones. This evolution has taken place constantly, and is going on to-day.

The present systems have their limitations, but before reaching these, we may, however, look forward to a great development along present lines, and particularly to a much greater standardization of these systems as they exist to-day. The present systems are capable of supplying the demand as it exists at present, and the development must go forward for a long way before any radical changes are required.

As regards the development of the generating and distributing systems, a brief description of their early history is of interest. I will also touch upon the evolution which has taken place.

The first stations were then known as the Edison Stations, and it is generally conceded that one of the New York Edison Stations, if not actually the first, was within a few days of being the first central station in the United States. From this small beginning, thirty-seven years ago, there has developed an industry which directly or indirectly affects the lives and happiness of everyone in the United States.

Began About 1882

Beginning about 1882 with small direct current systems, the various Edison Electric Companies started distributing electric light at several points in the United States. These plants were originally steam operated. In the very earliest development, belt-driven, high-speed machines were adopted, the size of these machines gradually increasing from about fifty kilowatts in the early eighties to about 750 kilowatts in 1893, this being the size of a machine which was built for the World's Fair by the General Electric Co.

It soon became evident to engineers and the managers of these small enterprises that, while direct current distribution by the Edison three-wire system was suitable for use in thickly-settled communities, for lighting purposes in general other systems must be adopted.

There was very little discussion of power distribution in these early days, but a few men appreciated the fact that if a system of distribution of electric power could be developed, that the whole industry would be revolutionized.

"Too Dangerous and Too Expensive"

At that time the principal use of electric current was for lighting the streets in municipalities, using as a medium the so-called open arc light.

These early days were long before the amalgamation took place between the gas and electric systems, and one of my early recollections deals with the statement made by the gas companies that electricity would never be substituted for gas for residential lighting purposes, as it was too dangerous and too expensive.

The fight between gas and electricity for lighting continued for a number of years, but soon electric lighting began to drive out gas lighting by virtue of the inherent advantages of the electric lighting. There soon became developed quite extensive systems using direct current Edison three-wire schemes.

The expense of the heavy copper mains involved in transmitting electricity any considerable distance from the power station became pronounced, and numbers of stations were developed in the larger cities each to supply the zone in its own neighborhood.

About this time,—that is, in the early eighties,—alternating current systems were first discussed. Then came the invention of the transformer, which was apparently thought of simultaneously by several men, an American, Mr. Stanley, having apparently worked the scheme out to a successful conclusion a little earlier than anyone else. With the transformer was completed a scheme which, with the exception of the number of phases involved, is the basic idea of the present time—that is, the generator to develop power at low voltage, a transformer increasing the voltage, the transmission line transmitting the power for a distance, a second transformer unit reducing the voltage for further sub-division.

Poly-Phase System in 1887

In 1887-1888, the poly-phase system of generating power was proposed. This system is of the greatest importance because successful motors of large size have not been developed for operation on single-phase systems. Thus was developed, in 1890, all of the fundamental elements involved in the present system.

It must, of course, be understood that this development did not consist at first of a complete scheme, with the exception of Edison's own distribution system. This invention of Mr. Edison's was so remarkable that it has lasted practically intact up to the present time, and is in use, not only in direct current distribution where it started, but in alternating current distribution to-day.

The first poly-phase motors of the Tesla design, induction motors, were designed and built, I think, by the Westinghouse Company in the United States about 1892. During the early nineties there was a slow growth in this industry. Alternating current voltages rose to about 10,000 volts in 1895, and distribution by transmission line had been extended up to about twenty-five miles before 1900. The one great step forward in the industry occurred about 1895, when the development at Niagara Falls took place.

The Niagara Falls Power Co. was organized to construct a water-power station at Niagara Falls, and in connection with this work a great technical commission was formed, including engineers from the United States and abroad. This commission spent a good deal of time and thought on the various phases of the problem, and endeavored to foresee the possible future development in the use of electric energy.

Most of the decisions of this commission and of the engineers of the companies manufacturing the apparatus were

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