

A Pioneer of Long-Distance Telephony

The Collected Papers of George Ashley Campbell, Research Engineer of the American Telephone and Telegraph Company

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DR. G. A. Campbell, who has recently retired from active service with the American Telephone and Telegraph Company, is well known to telephone engineers for his many contributions to the theory and practice of telephony. One of his best-known inventions is the 'wave filter' which bears his name, by means of which the harmonics in the electromotive waves produced by a generator are effectively suppressed by means of a multiple system of condensers and inductances. To commemorate his retirement, the American Telephone and Telegraph Company has issued this handsome volume of his collected papers. The representative of this company in Great Britain has written stating that requests for copies of the book will be entertained so long as the somewhat limited number of volumes printed lasts. Requests should be addressed to Dr. L. F. Morehouse, American Telephone and Telegraph Company, Bush House, London, W.C.2.

A few years after the invention of the telephone by Bell, the present plan of organizing the Bell System had been evolved. The unusual requirements of the telephone industry were met by an organization having licensee-telephone units and a manufacturing unit grouped around a parent company. In 1897 the American Bell Company, the functions of which as the parent company were taken over later by the American Telegraph and Telephone Company, had by gradual steps built up a research organization of physicists, chemists and engineers. It was then located in Boston under the direction of Dr. Hammond V. Hayes. In 1937, this department appears a small group, but so late as 1897 organized industrial research was scarcely known outside the Bell System. In those days the Bell System had 325,000 stations; compare this with the 14 million stations of to-day.

Forty years ago, long-distance telephony had begun to come to the front, but line costs were high and a practically commercial range did not exceed a thousand miles. Hence the two main objectives were to secure better and more economical circuits and to explore the possibilities of reaching greater distances. The rapidly expanding telephone business about large cities soon made it necessary

to place telephone circuits in cables. The study of these circuits presented many problems to the engineer and called for considerable mathematical knowledge. Dr. Hayes was faced with the problem of adding to his staff one who had a good working knowledge of advanced electrical theory—work recently developed by Kelvin, Maxwell, Weber, Heaviside and others of the great mathematical physicists of the nineteenth century. He appointed Dr. George A. Campbell, a graduate of the Massachusetts Institute of Technology, who had also had five years study at Harvard, Paris, Vienna and Göttingen. This appointment was fortunate and timely for the communication industry.

In an introductory chapter, Mr. Colpitts says that soon after Campbell's appointment he was engaged in developing cable circuits. At the same time and independently, Prof. M. I. Pupin was engaged on the same problem, and his patent slightly anticipated Campbell's. The Associated Companies immediately acquired Pupin's patents. Campbell's analysis was more thorough and led him to formulæ more convenient than his rival's. The latter alone were employed for the building of loaded lines in the United States. When engaged in this work, he invented his famous wave filter.

It was found that all the questions relative to loading coil design depended on the quality of the iron used in the core. The best results were obtained using iron of normal permeability and very high resistivity. In 1900 a successful experiment was carried out between Bedford, N.Y., and Brushton, Pa., a distance of 670 miles over a loaded cable. Campbell was the inventor of the single-transformer anti-sidetone circuit which is now almost universally used.

Perhaps Campbell's best known paper is that "On Loaded Lines in Telephonic Transmission" published in the *Phil. Mag.* in 1903. Even at that early date he had begun to consider the problem of the high-pass and the low-pass wave filters. As an early investigator of antenna arrays to secure directional transmission, Campbell did excellent work and holds certain fundamental patents in this field. He is at present taking a leading part in the struggle to get the adoption of a rational system of physical units.

Although the volume extends to nearly 550 pages, all Campbell's researches are not included in it. We hope that he will continue his researches for a long time to come.

A. R.