BIRTH AND GROWTH OF WIRELESS

Earliest Discoveries

WORK OF FARADAY, MAXWELL AND HERTZ

No. 1.

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DURING the past decade wireless has made astounding advances. Professor Kerr Grant has specially written for "The Advertiser" a series of articles on the history of wireless, of which this is the first. They will appear from day to day.

RADIO telegraphy or telephony—briefly termed "wireless"—the distant communication of signals or speech by means of electric waves in the intervening space, has its scientific basis in the ordinary conceptions and laws of electricity.

The earliest recorded observation of an electrical effect, the attraction of light bodies by a piece of rubbed amber (elektron) goes back to Thales of Miletus in Asia Minor, 600 years B.C. History records no important addition to this isolated fact in the ensuing 2,000 [illegible]. Then, in the reign of good Queen Bess, William Gilbert, of Colchester, showed that electrification by friction was a general property of a certain class of substances, which he termed "electrics." The discovery of the existence of two mutually complementary kinds of electricity, as also its property of flowing through metals and other substances, soon followed.

The distinction between "electrics" and "non-electrics" was found to depend entirely upon the difference in the conducting power of the two classes of substances. Electrification by contact or rubbing with a different substance has subsequently been established as a universal property of all materials. Towards the end of the eighteenth century the Italian professor Volta of Pavia, following up the observations of his fellow-countryman, Galvani, on the twitching of a frog's legs when touched with a pair of dissimilar metal wires, made the highly important invention of the voltaic cell, which led to the discovery of the electric current, flowing in a wire connecting two metal plates. Not less important was the observation of Oersted, of Copenhagen (how cosmopolitan is the march of scientific discovery!), in 1929, of the effect of such a current on a magnetic needle. Oersted's discovery, with the developments that rapidly followed it, was elaborated into a complete system of electrodynamics by the labors and genius of Ampere in France, Ohm, Gauss, and Weber in Germany, and many other workers in the fields of electrical experiment and theory.

First Great Advance

Then began a new epoch in electrical history with the advent of Michael Faraday, greatest of experimenters, great also in his theoretical intuitions. And among these brilliant intuitions there was one in which lay latent the germ from which was later to develop the whole body of "wireless" theory and practice, the idea, namely, of space or, as Faraday would have said, of an "ether" filling space, as the vehicle or medium by which electrical and magnetic action was communicated from body to body.

Faraday was the fore-runner of the greatest theoretical physicist—Newton alone excepted—that Britain has yet produced, James Clerk Maxwell.

Maxwell brought to bear on Faraday's somewhat undeveloped conceptions of electric and magnetic fields pervading space, all the powers of his natural and highly-trained mathematical genius. He was thus able to formulate a mathematical theory of the inter-relations of electricity and magnetism, which comprehended all existing knowledge. But to make this theory entirely self-consistent he found himself compelled to introduce the novel, and at first sight repellent, conception of a new kind of electric current which could exist, not only in matter devoid of electrical conductivity, i.e., in dielectrics, but even in the most perfect vacuum. Maxwell likened electricity to an immaterial fluid pervading all space, and pictured the charging of a body with electricity as effecting a displacement of this fluid, outwards or inwards, according to sign of the charge, in the space surrounding the body, in much the same way as an expansion or contraction in bulk of a body immersed in an ocean of material fluid would result in an outward or inward movement of this fluid.

Conceived in 1865

With such "displacement currents" in air or empty space there would be associated magnetic effects identical with those occurring in the case of a current flowing in a conducting wire. This relation of a changing electric field to a magnetic one is reciprocal to the creation of electric forces by a changing magnetic field discovered by Faraday, a principle on which depends to-day the operation of the world's vast systems of electric power supply. On the basis of these two relations Maxwell deduced the possibility of electric waves in space travelling outwards in all directions from any electrical or magnetic disturbance. He was able to calculate the rate of travel of these waves. This rate turned out to be identical with the measured velocity of light, and from this remarkable coincidence, supported by other deductions from his theory, Maxwell drew the conclusion that light consisted in electric, or more properly, "electro-magnetic," waves, a conclusion be it said, which has since been confirmed in a thousand other ways. The electro-magnetic theory of light remains to-day one of the most firmly established truths of physical science.

Light waves were, even then, known to be of an exceedingly short wave length, about 50,000 to the inch, but the artificial production of longer waves, although exceedingly obvious to the modern physicist, does not appear to have been attempted or even contemplated either by Maxwell himself or by any of his contemporaries or his immediate followers. Nevertheless, the theoretical possibility of creating such waves and their essential characteristics were quite conclusively established by Maxwell, and the conception, if not the actual birth, of "wireless" must certainly be dated from the year (1865) in which his great theory was given to the world. The full experimental proof of the existence of Maxwell's mathematically demonstrated waves did not come for over twenty years, though in the interim more than one experimenter came within a hair's breadth of the great discovery.

First Wireless Transmission Not Recognised

Professor D. E. Hughes, of London, famous as the inventor of the microphone, which still forms an essential part of the ordinary telephone, made in 1879 and the following year many experiments on the transmission of signals by means of an electric wave which he generated by means of an electric spark and detected by means of his microphone in combination with a telephone. He actually detected such signals at distances up to 500 yards, but his suggestion that the effect observed might be due to electric waves traversing free space was scouted by an eminent physicist of the day. Hughes was so discouraged by this verdict that he refused to publish any account of his work, and thus lost the credit of having made the first discovery.

It was Heinrich Hertz, the most brilliant pupil of the great von Helmholtz, who in the year 1888 made experiments which proved beyond all possibility of doubt the reality of Maxwell's waves and the entire agreement in their characteristics with his predictions. Hertz's apparatus and methods had the simplicity that ever characterises experimental genius of the highest order. An induction coil was used to charge two metal plates. Metal rods were attached to these, and the ends of the rods separated by a short space in air. When a spark leapt across this gap electric oscillations of immense rapidity took place in the plates and rods, and these set up electrical waves in the surrounding space. Hertz detected these waves by means of a piece of stout wire bent almost to a circle but with a minute gap between the ends. Across this gap tiny sparks would pass whenever the electric waves fell upon the loop of wire.

Birth of Wireless

Hertz proved that these electric disturbances had all the properties characteristic of waves in which the vibrations took place in a direction transverse to the direction of travel, that they could be reflected by sheets of metal, but not by sheets of glass or other dielectric, that the train of reflected waves, when thrown back upon the train of incident waves produced standing or stationary waves. He measured the distance from nodal point to nodal point in this stationary train, and thus showed the wave-length to be of the calculated order of magnitude of a few metres. The waves could be polarised by a grid of metal wires or refracted by the passage through a prism of paraffin or sulphur exactly as light waves can be polarised or refracted.

In short, there was entire concordance between the experimentally ascertained attributes of these Hertzian waves and the characteristics predicted for electric waves by Maxwell.

Although the distance between transmitter and receiver in these experiments did not exceed a few yards, we must unquestionably admit that they constituted a genuine transmission of signals by electrical impulses unguided by wires. It was the birth of "wireless!"

In the second article, which will appear on Monday, Professor Kerr Grant gives an interesting commentary on the apportionment of credit for the discovery and development of wireless.