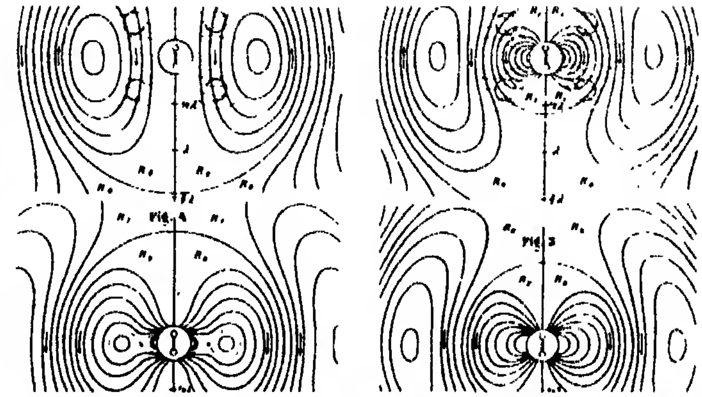
MEET SOME PIONEERS OF RADIO

The story of radio is a long one with many landmarks. It is also, like that of most scientific discoveries, an international one with scientists from many countries each making their contribution towards this wonderful technique which today has so many applications and to which we owe so much. This article highlights the contributions of just a few pioneers of radio; there were others who might also have been mentioned but space does not allow us to describe their contributions here.

The story began perhaps with Joseph Henry (1797 - 1878), an American physicist, who discovered in 1842 that electrical discharges were oscillating. A gigantic step forward was that due to James Clerk Maxwell (1831 - 1879), a Scottish physicist and one of the great mathematical geniuses of the 19th century. His treatise on "Electricity and Magnetism" was first read as a paper to the Royal Society in 1864, and published in fully developed form in 1873. It has been called "one of the most splendid monuments ever raised by the genius of a single individual." By purely mathematical reasoning. Maxwell showed that all electrical and magnetic phenomena could be reduced to stresses and motions in a medium, which he called the ether. Today we know that this "imponderable electrical medium" does not exist in reality, any more than the equator of the geographer or the average man of the statistician. Yet the concept of an ether helped greatly, and allowed Maxwell to put forward his theory that the velocity of electric waves in air should be equal to that of the velocity of light waves, both being the same kind of waves, merely differing in wavelength. This we know today to be an elemental truth, yet to Maxwell must go the honour of having first shown it to us in pure mathematical form.

In 1857 Feddersen demonstrated that if an electrical condenser is discharged into a conductor, oscillations are set up which give rise to intermittent spark phenomena. Twenty - one years later, in 1878, David Edward Hughes (1831 - 1900), an Anglo - American physicist, made another important discovery in the pre - history of radio and its essential components; he found that a loose contact in a circuit containing a battery and a telephone receiver (invented by Bell in 1876) would give rise to sounds in the receiver which corresponded to those that had impinged upon the diaphragm of the mouthpiece. Hughes "microphone" consisted of a carbon rod resting in grooves of two carbon blocks; from it developed many of the early carbon microphones of both telephone and radio. In 1883, George Francis Fitzgerald (1851 - 1901), an Irish physicist, suggested a method by which electromagnetic waves might be produced by the discharge of a condenser.

Next we must turn to Heinrich Rudolph Hertz (1857 - 1894), famous German physicist, who was the first to create, detect and measure electromagnetic waves, and thereby experimentally confirmed Maxwell's theory of "ether" waves. In his experiments he showed that these waves were capable of reflection, refraction, polarisation, diffraction and interference. They corresponded precisely in their behaviour to waves of light. Hertz produced his waves, soon to be called by others "Hertzian waves" from the sparks of an induction coil, and in order to study some of their properties he employed a zinc mirror. He described one of his experiments, in 1888 - 1889, as follows:



Pictures of the lines of flux around an oscillating dipole from the original paper of Heinrich Hertz. He was the first to create, detect and measure electromagnetic waves, and in 1887 Hertz experimentally confirmed J.C. Maxwell's theory of "ether" waves. His predictions and Heinrich Hertz's experiments created the basis of modern radiocommunications. (Illustration: Deutsche Bundespost).

"The height of the (parabolic) mirror was thus 2 metres, the width of its aperture 1.2 metres and its depth 0.7 metre. The primary oscillator was fixed in the middle of the focal line. The wires which conducted the discharge were led through the mirror; the induction coil and the cells were accordingly placed behind the mirror so as to be out of the way. If we now investigate the neighbourhood of the oscillator with our conductors, we find that there is no action behind the mirror or at either side of it; but in the direction of the optical axis of the mirror the sparks can be perceived up to a distance of 5-6 metres." The half wave length of this experiment was about 30 cm.

But Hertz's experiments were half a century in advance of his time, and belong to the field we now call microwave optics. Many repeated them and extended them, typical amongst them being Edouard Sarasin (1843 - 1917) and Lucine de la Rive (1834 - 1924) at Geneva, Antonio Giorgio Garbasso (1871 - 1933) and Emil Aschkinass (1873 - 1909) at Berlin, Jagadis Chunder Bose (1858 - 1937) at Calcutta and Augusto Righi (1850 - 1920) at Bologna. We shall see in a moment that only Righi had an indirect influence on the technology of radio, as a young Italian by the name of Guglielmo Marconi (1874 - 1937) was stimulated by his books and lectures.

The next most important event was a lecture given to the Royal Institution in London by Oliver Joseph Lodge (1851 - 1940) on 1 June 1894; it was called "The Work of Hertz and Some of his Successors," it was widely reported at the time, and was to have far - reaching consequences. Lodge, Professor of Physics at the new University of Liverpool, had himself worked extensively in the field of electromagnetic waves and was the first to comment on the phenomena of resonance or tuning. In 1898 he took out a patent on an adjustable inductance coil in the antenna circuit of a wireless transmitter or receiver, or in both, in order to tune one with the other. This patent won him a high place in the history of wireless. His sharply tuned resonance circuits were a substantial advance over Hertz's relatively primitive arrangements, but Lodge himself, like Hertz with heavy academic commitments, had not the time to develop his ideas on wireless telegraphy and never made an attempt to transmit any intelligent signals with electromagnetic waves.

Guglielmo Marconi's first transmitting apparatus, with a copper sheet aerial. An impression by the artist Steven Suprrler of Guglielmo Marconi's demonstration on Salisbury Plain, England, in 1896 to officials of the Post Office and the Armed Services (Illustration. Marconi Company)

Alexander Stepanovitch Popoff (1859 - 1906) was one of the many who read Lodge's lecture and was inspired by it. Popoff was in 1895 lecturer in physics at the Russian Imperial Navy's Torpedo School at Kronstadt near St. Petersburg. He experimented with Branly coherers, set up a receiver with a protruding wire in 1895, and read a paper about it, "On the Relation of Metallic Powders to Electric Oscillations," at the meeting of the Russian Physico - Chemical Society on 25 April (May 7, New Calendar) 1895. By means of this equipment, Popoff could register electrical disturbances, including atmospheric ones; and in July of the same year a similar instrument with an ink recorder was installed at the Meteorological Observatory of the Institute of Forestry at St. Petersburg.

Marconi, at the age of twenty in 1894, was well acquainted with the work of Hertz, Branly, Lodge and Righi. He began experimenting in the spring of 1895 on his father's estate at the Villa Grifone, near Pontecchio, Bologna. The idea had occurred to him that Hertzian waves might be the basis for a means of communication, signalling with them the dots and dashes of the Morse alphabet. Once he had convinced his father of the practical nature of his ambition, he received from him all the financial support he needed.

In his first experiments, he used an ordinary spark induction coil and home - made coherers of the Branly type. To turn the discharge on and off, he placed a telegraph key in the primary circuit of the induction coil, and thus produced short or long trains of sparks. He could soon detect these dots and dashes all across the room, and in the summer of 1895 he moved out into the garden. In order to increase the performance and range of his transmitter, he followed previous experiments by others: he attached on one end of his transmitter circuit an elevated metallic object, the antenna, and to the other end a metal plate buried in the ground. He could now signal across the whole garden, and he soon found that there was a direct relationship between the height of the antenna and the distance of transmission.

Marconi made important improvements in the components of his system, particularly in the design of his coherers. He also put a relay in series with it, which actuated the tapper of his coherers, and worked a telegraphic printing instrument to record the received signals. And here is perhaps the best place in our story to pay tribute to Edouard Branly (1844 - 1940) a great French physicist, officially described in France as "Inventeur de la Telegraphie Electrique sans Fil." His great contribution was the discovery of the coherer, that small fragile glass tube, looking like a thermometer, but filled with metal powder.

Branly found that electromagnetic waves, produced as much as 25 metres away from it, caused the individual metal particles in his coherer, first iron and later nickel and silver, to cohere and thus allow the passage of a current through them. A galvanometer was the instrument he used to show this effect; Marconi improved this greatly by using a telegraph printer. But the metal particles had to be separated again, and therefore an electric tapper, a tiny hammer precisely like that used in any electrical bell was added to the coherer. When it struck the glass tube it decohered the particles again, and thus stopped the current from the batteries.

Each successive impulse reaching Marconi's antenna produced the same phenomena in the coherer, first the coherence of the particles, then their decherence, and hence the recording of the dots and dashes. Marconi used tightly fitting silver plugs in his glass tube, which he evacuated and sealed and thus the coherer became the first of many sensitive devices to receive wireless telegraphy. Before Marconi left Italy, to continue his work in England, he had reached a transmission distance of the order of 1 kilometer. □