CHAPTER V

Wireless Achievement and Anticipation

THE two things which the human race can effectively attend to, and achieve with some success, are *Locomotion* and *Communication,* both developed enormously and in an almost revolutionary manner during the nineteenth century; and this development has continued during the early years of the twentieth century. Very few people still living can remember the introduction of railways into Britain. Some can remember the introduction of electric telegraphy; many more, the beginnings of signalling by means of cables; while electric means of transit, and wireless telegraphy are developments of our own time.

All electrical applications—from electric bells to the telephone, from the transmission of power by the dynamo to the latest messages across the Atlantic—represent the harnessing of the ether in the service of man. Whether a cable is used for the transmission is a mere detail. It is like using a speaking-tube instead of shouting across the street: air conveys the sound in both cases, but in one case it is guided, or so

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to speak focused, on a definite receiver ; in the other case it is broadcast. Electricity and magnetism and light are affairs of the ether primarily, though they are controlled, initiated, and directed by material appliances. But so far as mere transmission is concerned, matter is of no assistance, except that it can act as a guide like the walls of a speaking-tube. Electric force, magnetism, and light can go on equally well in a vacuum. To ether waves, matter is mainly an obstruction. Fortunately however, the air, in its normal state, has very little effect. It is essential to the conveyance of sound, but it takes not the slightest part in the conveyance of ether waves.

It is possible, however, to ionize the air, that is, to split it up into electrified particles—the positive and negative ingredients of which atoms are composed. Air thus acquires electrical properties, and is able to react upon the ether ; it becomes a conductor, though a poor one. Such air, like any other electric conductor, is partially opaque to ether waves, and, like other opaque materials, it can either obstruct those waves, absorbing them and turning them first into electrical currents and then into heat, or it can reflect them, somewhat as a mirror reflects lights.

Many causes are capable of ionizing air.

Radioactive substances do it, though they themselves are a recent discovery. But the sun is a radioactive substance on a large scale, and undoubtedly some ionization of the atmosphere is due to solar radiation. There are other causes, such as the splashing and spraying of water and the breaking of water-drops, which by some eminent physicists are considered to be capable of accounting for most of the electrification of clouds, and the consequent occurrence of thunder-storms.

Electric discharges in the atmosphere on a small scale are very frequent; and they are known in radiotelegraphy as "atmospherics." They are of no assistance, and are a nuisance which ought to be eliminated. One of the problems to be solved is how best to eliminate their disturbing effect on the reception of messages. Moreover, when ionized air exists extensively between a sending and a receiving station, it acts as a partial screen and renders communication difficult, in the same sort of way that a light fog or mist causes indistinct visibility.

Ionization is not wholly obstructive. An ionized layer of air might assist transmission by its refracting power. It might, for instance, cause the rays to move in a curved instead of a straight path. Such a helping layer is believed to exist in the upper regions of the atmosphere, for it is those upper regions which receive and consume much of the specially active rays from the sun. Waves generated at a sending station are, therefore, liable to be curved round the earth by this ionized layer, when it is placid and not too corrugated, somewhat like a mirage, or roughly as a whispering gallery acts in the case of sound.

Water also is a conductor, which can still more efficiently reflect the waves, and thus we live between two layers—a " floor " of water or damp soil, and a " ceiling " of ionized air—so that ether waves cannot easily get out and travel across empty space, which they are so well qualified to do. They are enclosed, as it were, in a space of two dimensions—a most fortunate circumstance, without which wireless telegraphy at a great distance would be impossible. Rays travelling in straight lines, like lighthouse beams, could not possibly travel, say, from London to New York, whatever their intensity. They would go far over the top of a receiving station, even at a distance of only a few hundred miles.

Summarizing what I have said in a previous chapter :—The discovery of electric waves was made in the latter half of the last century by that tremendous mathematical genius Clerk

Maxwell, on the purely theoretical side. After twenty years, Hertz showed how to produce them practically, and what was more, how to detect them at a distance, in an elementary and purely laboratory fashion. Further improvements in detecting appliances were soon devised by many people, and in due time they were made amenable to practical and commercial uses by the energy and enterprise of Senatore Marconi and his co-workers.

To a public ignorant of the work of Clerk Maxwell and Hertz, this application came as a great surprise, and seemed very novel and mysterious. To physicists it did not seem so: it was a natural application of what was known. But when Senatore Marconi found experimentally that the waves would actually curve around the earth and reach the American continent, physicists were surprised. It was an important discovery; and a mathematician, Mr. Oliver Heaviside, began to show how an ionized layer of air in the upper regions must be operative, and could explain it.

Tuning and selective telegraphy were realized by the proper use of self-induction, as set forth in the fundamental Lodge patent of May, 1897.

Then came a method of detection far superior to any that had previously been used, namely the vacuum valves of Prof. Fleming,

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improved, as they soon were, into their present form by Dr. Lee de Forest of America. In these valves the actual electrical particles, the electrons, were employed as the detecting agency, and proved themselves far more perfect than any material mechanism could be. They responded instantaneously to every fluctuation, so that it became possible to transmit, not Morse signals only, but microphonic or telephonic speech.

For some time it seemed as if speech could only be transmitted over moderate distances. But now, through the energy and enthusiasm and inventive genius of a great number of workers in all parts of the world, but especially in England and America, it has been found possible to hear the human voice across the Atlantic. Not that the voice travels any farther than it did before, any more than it travels along a telephone wire: the voice generates electric waves, with all its peculiarities accurately represented in those waves, and when those waves are collected by a distant aerial, the electrons in the receiving valve respond with precision to all the fluctuations, and enable a telephone to reproduce the speech and the tones of voice of the distant speaker. The achievement of speech across the Atlantic in this indirect way is certainly a marvellous one, which excites the admiration and to some extent the astonishment even of physicists. Nor is this likely to be the limit. The waves that have begun to curl round the earth can go on even to the Antipodes, and in a short time it is likely that the human voice in this way can reach Australia and New Zealand.

Thus humanity will be welded together in a manner more intimate than ever before, and the beauty and simplicity of the arrangements, the comparative ease with which the result is effected, is very surprising.

It used to be thought by the early experimenters that to get waves to travel effectively over enormous distances, the apparatus used must be large and powerful and the waves very long. Long waves can usually get through obstacles which would stop short ones. Why? Because in going through a slightly opaque medium a certain percentage of energy is wiped out at every swing. The crest of each wave will be slightly weaker than its predecessor. Therefore, if in a given distance, say 100 miles, there were twenty crests—which would mean that the waves were 5 miles long—there would be a chance of a sufficient portion getting through, even though each wave were 1 per cent. weaker than the one behind it. But if the waves were only a quarter mile long, there would be 400 such crests in the 100-mile distance, and the proportion of energy which got through would be very slight. If the waves were each only 100 yards long, the oscillations in the given distance would be so numerous that no trace could be detected, unless the opacity were insignificant. Hence, it appeared that long waves had the advantage.

To the physicist it always seemed that short waves ought to do better, if space were as reasonably transparent as one might expect it to be; that is, when the air is hardly ionized at all, which is a condition to be expected in the absence of light. Short-wave radiation is far more intense than long; a much greater conversion of energy into radiation takes place. An engineering alternator hardly radiates at all; its waves are far too long. A simple dumb-bell set oscillating may have but little energy, but whatever it has it radiates completely. There must, therefore, be a compromise for powerful signalling by waves. It is now found that, at any rate during the night, short waves are quite efficient, and the great size of sending and receiving stations will probably, in due time, be found unnecessary. A short-wave or small station is just as energetic as a big one, within limits. It possesses less energy, but it radiates a larger proportion. For the true wave

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starts not at the actual radiator, but about a quarter wave-length distant from it. Hence, the shorter the wave, the nearer, and therefore the more energetic, is the place from which it starts. A radiator no bigger than a dumb-bell can emit waves of 100 horse-power. This I published as long ago as 1890. A very large radiator under the same conditions is no more intense, though it is true the emission would last longer. That would depend on its capacity. And what is true of the emitter is also true of the receiver. Hence, recent experiments have redirected attention to the advantages of short-wave transmission.

Moreover, short waves are much more amenable to discipline. They can be projected by parabolic mirrors of reasonable size, as Hertz showed long ago, in 1888; that is, they can be directed, as light waves are directed from a lighthouse, so as to economize them and concentrate them in any required direction. There can be little doubt that this power of focusing and directing waves will be applied more and more, so that except for broadcasting purposes it will not be necessary to send out waves in every direction, at random. Senatore Marconi is beginning to apply this on a large scale.

Another improvement which is to be ex-

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pected is the attainment of greater power of control over distant things like aeroplanes and steamers, or other self-propelled floating bodies. The rudders of such machines can be actuated by people on them, but they may also be actuated wirelessly by people at a distance, so that an operator at a sending station, manipulating his keys, may guide a distant floating body to any desired destination, so long as he can see what it is doing and adapt his control accordingly. An aeroplane is not so easy to adapt as a floating body, because it has another degree of freedom. It can move up and down, as well as right and left. To control it perfectly is, therefore, not so easy. But none of these things is easy. Difficulties are things to overcome, and the ingenuity of those who are working at the subject is more than competent to deal with a difficulty such as this. It is interesting to find, moreover, that the old-fashioned coherer, employed as a detector, seems especially useful in these distant-control experiments, as has been demonstrated recently by Major Phillips.

What other developments are to be expected? Unfortunately, a certain amount of energy in the present state of civilization is directed to the opportunities for doing damage; that is, directing things for deleterious pur-

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poses. If people wish to do those things, no doubt they will always be able to find ways and means for so doing. It has been surmised that aeroplanes can be stopped in mid-air. Well, as Hertz found long ago—and before him both Joseph Henry and Elihu Thomson—ether waves are powerful enough to generate little sparks in metal conductors; and as the explosions of oil vapour in a motor are regulated by little sparks, it seems quite likely that such sparks can be generated at wrong times by the action of waves generated at a distance. If so, the engine may be brought to a standstill by the generation of unexplainable engine trouble. Such disturbances can be guarded against, when foreseen, by the proper use of a metallic screen or enclosure, because metals are opaque to the waves, and will ward off or reflect them harmlessly. A screen to be efficient must be complete, in the sense that it must have no bad joints or unclosed chinks. Round apertures do not let waves in, but elongated chinks do. A bird-cage complete with metallic floor is an efficient screen, but any insulated conductor penetrating its meshes would guide waves in. Electric leads and gas-pipes are liable to turn an otherwise protected enclosure inside out.

Contrivances for doing damage are danger-

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ous until the antidote is found. There always is an antidote, but meanwhile much damage may be done. It is lamentable that the ingenuity of man is thus capable of being misdirected. Other things can be suggested of a damaging character, though it is hateful to dwell upon them, and it is not a subject on which I am any authority.

However great have been our improvements in locomotion and communication during the past hundred years, that is but a small period; and who can say what will be accomplished in the next hundred years? Material progress, however, is not everything. And if there were any signs of our getting to the end of our tether in this respect—which there are not at present—there would be no reason to lament.

Locomotion is purely a physical thing, but communication, whether by speech, writing or telegraphy, is not solely a physical thing. It is a psychical thing, too. There were those in the sixties and seventies of last century who lamented that many of the messages sent through the recently achieved Atlantic cable were either deleterious or rubbishy. It is no use enlarging our powers of communication if we have nothing worth while to say. The moral and spiritual development of mankind ought to keep pace with its material achieve-

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ments. And if they do not, it is possible to regard even those achievements with gloom and apprehension. That, however, would show a lack of faith. The real progress of humanity is necessarily slow, while material achievements may be rapid: it rests with ourselves whether or not one can keep pace with the other. There should be no feeling of supine self-satisfaction in what has been done, but a girding up of our energies to see that the progress is not too lop-sided and unbalanced, and to contrive that the reign of good shall keep pace with the reign of power.

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