RADIO ROUND THE WORLD

CHAPTER I

PRELUDE

THE why and the wherefore of wireless are in real danger of being lost in the flurry of achievement. The possessor of a good, but in no way unusual, receiving set can expect to be able to "tune in" during the quiet hours of the night to half a dozen or more American stations. The B.B.C. broadcasts regularly to the farthest corners of the Empire, and if reception is not perfect the voice of criticism is raised. It is as easy to talk to New York or Calcutta by radio-telephone as to one's next-door neighbour. Each year fresh triumphs are placed on record, and each year fresh catchwords are added to the jargon of radio—until, if pride did not prevent us, many of us would like to ask, quite simply, what is this wireless?

"Wireless", the expert replies, "consists of electro-magnetic vibrations in the ether, or (if you prefer it) in space-time." And we are left little wiser than before.

What, then, are electro-magnetic vibrations? How do they get into the ether? Why do our wireless sets give us, as a rule, only one out of the hundreds of stations which are broadcasting? Why do these vibrations in the ether (or space-time) sometimes fade out without warning as if they had never been? What are "atmospherics", and why are they so difficult to keep out?

The truth is that the waves of wireless—vibrations,

the expert called them—are just as genuinely waves as the rollers which beat in from the Atlantic upon the north coast of Cornwall or the ripples which a stone makes when it is dropped into a pond.

Even the longest rollers have a beginning somewhere, a centre of high wind, perhaps a thousand or more miles away. Where the ripples start from in a pond there is no doubt. These are the "transmitters" of water's more familiar waves. In each case energy is being put into the waves at the source—by the wind which is blowing harder out at sea, or by the person who lifts up the stone to drop it. In each case the waves follow one another at intervals which depend on their source.

So it is with wireless. The transmitter needs power, and the sort of waves which are produced depend on the way in which the power is applied. The power is supplied in the form of an electric current, and at whatever rate the engineer makes that current vibrate in his aerial, at that rate will successive waves follow one another out into space.

Then reception. We do not in the ordinary course have to bother about receiving water waves at all. We see them, or are knocked over by them. No outside aid is necessary. But a blind man sitting beside the Round Pond in Kensington Gardens could have his "receiver" if he wanted, "watching" on the bank to feel the ripples coming in. He could tie a piece of cotton to a cork, bobbing at the edge of the pond; and, with perhaps a little exercise of the imagination, feel the pull of the water as it sank between one wavelet and another.

That is the part of the wireless receiver—to move as

the wireless waves move, to vibrate in harmony as the string of a violin will "sing" when a second instrument sounds the note to which it is tuned.

Not all waves, it is true, behave in the same way. Already we have mentioned water waves, and light waves, and sound waves, as well as our original wireless waves. We would not know them by different names if they did not in many ways behave differently. But from these very differences we can learn much of what we want to know.

Ripples are sea rollers on a different scale, and the relation of wireless waves to light waves is the same. That will provide one line of attack. It will help us to understand why wireless goes round the world, and light does not; why even a mountain is not sufficient entirely to block out a wireless wave; and why wireless will penetrate, little diminished, the brick and mortar of our houses.

It is the purpose of this book to tell something of the story and to make clear—so far as it can be seen—what chapters may yet be written. The quest will take us as far as a hundred miles into the earth's atmosphere, as far north as the Arctic, and as far out into space as the sun itself. Wireless knows nothing of the limits of commerce. Like light it can pass through empty space. Its realm is the universe.

And, at the end, we shall see that radio is finding unexpected applications in medicine and as a means of weather forecasting. Nor have its powers been yet fully exploited either in warfare or in the promotion of safety at sea. If the past and the present of radio are full of interest, its future suggests tantalising possibilities.

CHAPTER II

FROM PROPHECY TO PROOF

I HAVE only one objection to wireless as a subject. Its story begins with a mathematician—a mathematician, it is true, who was at least half a scientist, and a mathematician, also, who was capable of being the life and soul of that mysterious body, the Red Lions, the unofficial dining club of the British Association, which takes its name from the Red Lion Inn at Birmingham and whose members are supposed to roar like lions when they rise to speak.

Certainly James Clerk Maxwell (1831–79), the first professor of the newly built Cavendish Laboratory at Cambridge, was a lion among mathematicians. His was the almost unbelievable triumph of proving that wireless must exist, more than twenty years before the first wireless signal was detected; of showing that this wireless must consist of waves; and of "measuring" the speed at which these waves must move—all, as I have said, before wireless as such was discovered.

It is the sort of success which a mathematician may achieve perhaps once in a century. Newton watched an apple falling, watched the moon's motion in the sky, and saw that both could be explained by a common force, gravitation. Einstein built up a more complicated and difficult theory and predicted, amongst other things, that the course of light would be bent when it passed near a star.

James Clerk Maxwell

Newton, Maxwell, Einstein—all three were true adventurers. They wanted to see things that no man had ever seen before. But whereas the new things that Einstein saw are far removed from the world as we know it, the abstruse calculations of Newton and Maxwell proved intensely practical. And alone of all the world's mathematicians Maxwell can claim to have founded a great industry.

Picture him in his study in London, still a young man as the world reckons to-day, keen, alert, with a reputation as much for wit as for learning, interested as mathematicians are in trying to find connections between things which to ordinary men seem unconnected. Always in a mathematician's work there is this idea of unification. It is his business to reduce everything to formulas, and, if only for his own convenience, it is obviously easiest to have as few formulas as possible. It is the mathematician who is the link, for example, between the "bite" of a skate on ice and the impossibility of boiling an egg on a mountain top. The "bite" of a skate depends on the momentary melting of the ice beneath the pressure of the skater's weight, although the temperature may be still several degrees below the ordinary freezing point; and whether an egg will, or will not, be cooked in boiling water depends on the temperature at which the water is boiling, which is in turn affected by the lower pressure of the rarefied air of the mountain top. So, dissimilar as these two effects may seem, they have at least this much in common. Each depends on a change of physical state, in one case that from solid to liquid, and in the other from liquid to vapour; and it

so happens that both these sorts of change are affected by the surrounding pressure.

The connection which Maxwell sought was more ambitious. He wanted to weld all the known facts about light and electricity into a single coherent whole. It was to be the greatest unification which man had yet achieved, as great even as that represented by Newton's discovery of the law of gravitation.

Here again there was one definite similarity from which Maxwell could start. He knew that both light and the forces of electricity could reach out across space. We do not need telling that the headlamps of a car will light up the road ahead, or that it is the light from our distant sun which illumines both the earth and planets. And the very simplest experiment in electricity shows that electrical forces have the same sort of power. Most people must at some time or other have rubbed a stick of sealing-wax on their coat sleeve, so that it is electrically charged, and noticed that it will then pick up small pieces of paper just as a magnet will attract iron filings or a steel pin. In the same way the movement of an electric current in a wire will deflect a compass needle, and it will do this even if the needle is suspended in a vacuum. It is true that the scale is very different, but to this extent the effects are of the same kind. Both light and the forces of electricity can reach out across empty space, and Maxwell thought that they ought to reach out in the same sort of way.

It is difficult to-day to realise how miraculous the idea of "action at a distance" really is. It should be just as much a shock to a sunbather to find his skin

tanned by rays which have travelled more than ninety million miles through empty space as it would be to an aborigine to be knocked out by a white man's gun at a mere half mile. The aborigine's problem would be solved, if he was still interested, by the discovery that a bullet had been fired from a rifle; and that a bullet, presumably the same one, had lodged in his leg. He would no longer believe that the injury was magical, but would very properly conclude that the bullet had somehow passed from the rifle to where he was standing and was nothing more wonderful than a glorified edition of the arrows or slung stones which he himself used to kill game. But it is the bullet, and only the bullet, that removes the element of magic from the hurt which he has suffered.

So too, as science dislikes magic even more than does an aborigine, something had to be found to carry both light and the forces of electrical attraction through apparently empty space. The something was the ether, an intangible all-pervasive material which had been solely invented in the first instance to provide the vehicle for light's journeys about the universe. But exactly the same difficulty arose in the case of electrical forces, and Maxwell's essential idea was to make the same ether perform both jobs. To do this he had somehow to find a common factor in the light of the stars and the effect of a current-carrying wire on our compass needle. So he set to work with his equations to see what resemblances he could find. It may well have seemed a hopeless task. But in accomplishing it he proved that wireless, as yet undiscovered, was the necessary missing link between light and electricity.

The reason why there had to be wireless is not far to seek. Light was already known to consist of waves, so that if light and electricity were to appear at all alike there had to be electrical waves as well. The only difficulty is that most of us have no very definite ideas as to what is meant by any kind of waves except those of the sea. So before we can see what an enormous amount Maxwell was able to prove, merely on paper, about waves which no one had yet detected, we must make a short digression to find out what waves really are. As everything which wireless can do depends on its wave nature we shall not be wasting our time.

The simplest definition of a wave is that it is something which moves through space in a form which is regularly repeated. This is the characteristic, a little idealised, of the familiar invasion of sea rollers from the Atlantic. Occasionally we may see the ideal almost perfectly realised, each wave arriving at a regular interval after the last, each wave the same size, and each advancing at the same speed towards the beach. We may also notice that it is only the waves, and not the water itself, which are moving inshore. If the water were really, as it seems, moving towards us we should find that the tide on a rough day was always rising, and we ourselves would very soon be swept off the beach.

Without leaving our seat on the shore we can also, with the aid of a stop-watch and a little imagination, measure both the "wave-length" and the "frequency" of sea rollers—and can see how these two quantities are related. We might, for example, notice that the crests of successive waves were always about 400 feet