



ROUND THE WORLD BY RADIO-TELEPHONE

“You cannot talk to your friends in India. If you could, you would.”

So said John Ruskin, seventy years ago. And at that time, as there was no known way of conveying spoken words farther than a shout could carry, there would have been every reason to regard speech from England to India as inconceivable. The secret of the telephone was discovered less than sixty years ago, within the memory of men and women still living. It consists in the conveyance of the sounds of speech by means of an electric current.

After the first discovery, many improvements were made in the design of lines and apparatus. In 1891 the first international submarine telephone cable was laid between Dover and Calais. But for thirty years more the distance over which speech could be conveyed continued to be severely limited; and at the beginning of this century rapid communication with other countries was still dependent almost entirely upon the telegraph. Twenty-five years ago, France was still the only foreign country within speaking range of England.

Since the war, land and sea cables have connected in one international system the length and breadth of Europe; and, within a decade which is not yet completed, all the continents of the world have been united by the radio-telephone. That speech with India, which Ruskin found inconceivable in 1865, was made available to all parts of the United Kingdom in 1933.

In the international telephone service, physical wire connections are chiefly used over land and for short sea crossings. Telegraph cables

can be laid for many hundreds of miles under the sea ; but a telephone cable running for a great distance at a stretch would involve considerable cost. Wireless telephony is therefore used for conversations across the oceans and between the continents.

Thus, conversations between the United Kingdom and the countries of Europe are conducted by means of insulated wires in telephone cables across the land and under the sea. These cables cross from the coast of Kent to the coasts of France and Belgium, and from the Suffolk coast to Holland, and connecting lines radiate from these countries to all parts of Europe. Similar cables run from Northern Ireland to Scotland, the Isle of Man, and England ; from Dartmouth to the Channel Islands ; from the Nevin peninsula in North Wales to the Irish Free State ; and from the mainland to some of the islands of Scotland.

The long-distance wireless telephone links, which convey speech to continents other than Europe, have been established entirely within the past eight years. Before that time, radio-telephony—as the system of telephony by wireless, instead of by wires enclosed in a cable, is called—had been used occasionally and experimentally ; but the first regular public radio-telephone service in the world was opened in January, 1927, between London and New York, crossing 3,000 miles of ocean. This spanning of the Atlantic, the outcome of prolonged and patient research by engineers of the British Post Office and the American Telegraph and Telephone Company, was soon followed by the establishment of other links ; and within the four years 1930—1933 services were opened from Great Britain in rapid succession to Australia, South Africa, Canada, India, Egypt, the Argentine Republic and Brazil. A service with Japan was opened in March, 1935. These lines of wireless telephone communication are shown on the accompanying map, designed by Mr. MacDonald Gill. Similar links have been established by Continental powers : for example from Holland to the Dutch East Indies, from Belgium to the Congo, from France to Algeria, Tunis and Indo-China, from Germany to Siam. Direct services from this country to Kenya and Iceland are in prospect.

Nor is the work of the radio-telephone confined to the linking of

country with country. Nowadays great liners, as they plough their way across the Atlantic, and luxury cruisers under Mediterranean or Eastern skies, are within reach of the radio-telephone ; and the powerful apparatus, which will keep them in constant touch with wireless telephone stations on land, is being installed on more and more ships every year. To many of us, communication to and from ships at sea is among the most striking of all the achievements of the radio engineers. A man in his own home in London, Penzance or Inverness, Belfast, Norwich or Cardiff may lift his telephone and ask to speak to a traveller far out at sea on his way to New York, Montreal, or the Cape ; and soon, as clearly as if only a few miles separated the speakers, the voice of his friend will be brought to him.

A technical description of the wonderful apparatus by which voices are conveyed to and fro all over the world is given in an accompanying leaflet. At the heart of it all is the thermionic valve, familiar nowadays to most people as the amplifying valve in a loudspeaker wireless set. It is this invention which enables the electric speech-currents to be strengthened and renewed at intervals during their passage, and notably at wireless transmitting and receiving stations, and so destroys the effect of distance.

THE POST OFFICE RADIO-TELEPHONE STATIONS

The overseas radio-telephone services of the United Kingdom are conducted through three Post Office stations—at Rugby (for transmission), and at Cupar in Fifeshire and Baldock in Hertfordshire (for reception).

It always amazes a speaker by radio-telephone when he learns for the first time that his voice, as he speaks into the mouthpiece of his telephone, is being conveyed across the world through Rugby, whereas his friend's answer is being brought to the earpiece of the same instrument by a different route and through a different station perhaps hundreds of miles distant from Rugby.

When you are speaking, for example, to some friend at Delhi in India, it is astonishing to reflect that between the two telephones your voices are carried by two different paths. "How are you all at home?"

he may ask. The words are brought down the land-line to Bombay, across to Baldock by wireless, and so by wire to the London Exchange and on to your home. They reach your telephone less than a tenth of a second after they have been spoken. "We are all very well here," you reply; and your voice is heard in Delhi in the same fraction of time, having travelled by way of Rugby, instead of Baldock, and by way of Dhond, instead of Kirkee, at the Indian end. (Both these stations are within 50 miles of Poona). Separate stations have to be used for transmission and reception, in order to prevent any clash between outgoing and incoming speech; but there is nothing in your exchange of greetings with your friend in India to make either of you suspect that your voices are travelling by quite different routes.

The transatlantic service is by far the busiest service of its kind in the world. Here long-wave, as well as short-wave, radio transmission is used. Variation in atmospheric conditions makes now one system and now the other the more efficient. Engineers at both ends are therefore constantly watching the conditions and ensuring that the best channels are used. With both systems available, communication can be maintained throughout the twenty-four hours. Those, however, who put a call through to a far-off land cannot tell which system is being used. They only know that in some apparently miraculous way their remarks are carried to the farthest ends of the earth, and that without delay the reply sounds clear and crisp in their ears.

Rugby Radio Station, a scene in which Mr. John Cooper has depicted in one of the two posters which accompany this leaflet, is the most powerful in the world and contains a larger collection of radio equipment than any other single station. It covers a site of 900 acres, and, as one would expect, its huge aerials stand out on the countryside. There can be seen a long-wave telephone aerial three-quarters of a mile in length, a long-wave telegraph aerial, three miles in length, and a great variety of short-wave aerials, some used for the daily traffic of the station and others for experimental work.

The two long-wave aerials are supported on insulated steel masts 820 feet high. There are twelve of these masts, each weighing 200 tons. They are so constructed that they can withstand a horizontal pull of

10 tons at the top and a wind velocity of 140 miles per hour. They are built of slender steel work and are triangular in form, with sides of a width of 10 feet. They are pivoted 17 feet from the ground on porcelain insulators supported on granite blocks, and are held upright by five sets of three stays, attached at intervals of about 160 feet throughout their height. Each mast encloses a lift. If you travel to the top platform you must be prepared to find the mast at that height swaying six feet or more to this side and that under the pressure of the wind. The corresponding earth system, consisting of buried copper wire, follows the plan of the aerials and extends 800 feet on either side of the base of the masts.

The long-wave telephone transmitter has a power input of 230 kilowatts, and a wave-length of the order of 5,000 metres. By means of special generating machines, high-tension current can be supplied to its huge valves at a pressure as great as 18,000 volts. Every year this station consumes 5,000,000 units of electricity.

Rugby and other radio stations of the British Post Office do not deal with the traffic of this country alone. Britain is the centre of the radio-telephony system of the world, and London has been called the world's switch-board. If, for instance, a subscriber in Paris wishes to speak to San Francisco, his call passes through England and over the radio-telephone channels maintained by the British Post Office.

THE LONDON INTERNATIONAL TELEPHONE EXCHANGE

The centre of the system is between St. Paul's Cathedral and the Thames. Here, surrounded by a wealth of equipment, is the International Telephone Exchange, which Mr. Cooper has depicted in his second poster. Imagine that you are entering an L shaped room, about 150 feet long. Its ceiling is artificially silenced, so that the operators' voices meet you, when you open the door and go in, as a subdued murmur. In a line, facing outwards all round the room, some seventy girls are sitting. There may be, as in the poster, an engineer at one of the positions, testing a line. The girls are all wearing what are called breast-plate transmitters and headgear receivers, which leave both their hands free. In front of them is a long range of very

complicated looking switch-boards. These switch-boards are streaked with lines of black letters and numbers on white and yellow strips. They are dotted, too, with pin points of light, each little lamp indicating the first connection with a particular exchange that is free at any given moment. Above their heads the great cities of the modern world beyond the seas are named in golden letters—"Budapest"—"Prague"—"Oslo"—"Copenhagen"—"Stockholm"; or, further on, where the radio services come in and go out—"Buenos Aires"—"Cape Town"—"Montreal"—"Poona"—"Ships." You would be struck by the delightfully clear voices and good pronunciation of the operators. You would be struck, too, by the complete absence of fuss with which they do their work.

It is difficult for a visitor to believe that these girls really are speaking across the world. Yet that is what they are doing. They are talking in German and English to Berlin, in English to Holland and Scandinavia, in French to most of the rest of Europe; coaxing calls out of distant and bewildered villages, smoothing out passing difficulties with a few words of Spanish, it may be, or perhaps Italian. They talk with the operators in other exchanges, just as if they were chatting with friends in the same room. They are indeed friends, for by frequent conversation they get to know one another, and sometimes they correspond by post. But so far from being in the same room, they are separated by thousands of miles.

It is not very difficult, in favourable conditions, to intercept the messages which Rugby and the other radio-telephone stations send out, but an unauthorised listener would hear only an unintelligible jumble of sounds. For, by ingenious devices, the signals are distorted out of all recognition, and only complicated apparatus at the receiving end can translate them into intelligible speech.

By special arrangements in the International Exchange, a telephone subscriber can actually be connected up with other subscribers in a number of different countries at the same time. Business conferences have been arranged for firms with branches in Australia, India, South Africa, France and the United States of America, and a representative

of each branch has contributed his part to the discussion just as if the participants were seated round the table in a room.

A CALL FROM ROME TO WASHINGTON

The organisation behind an international call is startling in its intricacy. The simplest way to realise what is involved in a talk, for example, from Rome to Washington, is to follow the electric current as it carries the speech. The circuit from Rome to London consists of two pairs of wires, of which one pair carries the speech current in one direction, and the other pair in the reverse direction. The circuit is about 1,300 miles long and consists of some 47 tons of copper wire, insulated with wrappings of paper and enclosed in a lead sheath. At every 2,000 yards along the route a device, enclosed in a cast iron case and known as the loading coil, is jointed into the circuit. In addition, at intervals of every 50 miles, there is a repeater station, where thermionic valves amplify the sounds transmitted. Without such amplifiers the volume would be so reduced as to make speech inaudible. On the London—Rome circuit are twenty-seven repeater stations—ten in Italy, five in Switzerland, ten in France, and two in England. Each repeater station must have a skilled engineering staff for purposes of maintenance.

The speech current is conveyed from Rome by underground cables through Italy, Switzerland and France to Sangatte (near Calais) on the French coast. From Sangatte a cable laid on the bed of the sea carries the current to St. Margaret's Bay (near Dover); from there, it goes by way of a repeater station at Canterbury to the International Exchange, whence another underground cable carries it on to Rugby. From Rugby the speech-current, multiplied 250,000,000,000 times, is projected on its wireless course across the Atlantic. At Houlton, in the State of Maine, a faint remnant of the current is picked up, amplified to normal strength and taken by underground cable, through the International Exchange in New York, to the capital of the United States. A local connection at the Washington Exchange completes the call. The sound so transmitted travels at the speed of light, which means that the voice of the speaker in Rome is heard in Washington—nearly

5,000 miles away—in about one tenth of a second. The return speech follows a similar path but with an entirely separate wireless link.

The most spectacular and, to most people, the most familiar use of the international telephone service is its use for broadcasting. An opera performance, for example, in the Scala Theatre at Milan is transmitted by telephone to England and is then transmitted by a British Broadcasting Corporation station in such a way that every home equipped with wireless can listen in to it. Last summer a commentary on the test matches was sent by radio-telephone to Australia, and there broadcast to Australian listeners. Everyone knows of the King's broadcast to the Empire on Christmas Day. How that most famous of all broadcast talks is made possible is described in a separate leaflet.

The building, in which the London International Telephone Exchange is housed, was well named "Faraday Building" in honour of the great English scientist whose research and experiments were the starting point of modern electrical knowledge. Its assembly of delicate, complicated and beautiful equipment, however, is not a memorial to Faraday alone. It commemorates a great company of men—their names to-day often unknown—whose bygone research and labour made it possible for "nation to speak peace unto nation." It bears witness also to the devotion of many living men and women—of scientists and engineers working to maintain and improve the service, of linemen on the roads and seamen in cable ships, by whose vigilance the lines are kept in working order, and of girls deftly linking up at the switch-board the long-distance international telephone calls of the world of 1935.