

"As to the first question I can't answer, but here is a part of what I suppose to be my first invention," replied Mr. Bell, as he took down from a book a kind of a cross between a rat trap and a human jaw made in the shape of a mouth of what appeared to be shoemaker's wax and rubber, or soft leather. It had rubber lips, which opened and shut, and the jaws were hinged like those of a man. "This," continued Mr. Bell, "is my first attempt at a speaking machine. When I was a little boy my father took myself and brothers to see an automaton which uttered some words, and when we came back he offered a prize to the one of us who could invent a machine that could speak. I made the instrument of which this is a part, and I succeeded in making it say some words. We were living in Edinburgh at the time, in one of those Scotch flats in which each family has a floor, with a common hall. When I had completed the machine we took it out into the ball one day and made it cry 'Mamma.' It made a noise much like that of a baby, and the other families in the flat ran out and asked where the baby was that was crying. I remember this delighted us very much."

"Your attention was turned very early to matters connected with speech and speech transmission, was it not?"

"Yes; my father was noted as having considerable knowledge of matters connected with elocution. He knew all about the physiological production of sound, and I was brought up, as it were, in an atmosphere of sound-investigation. I was educated at the High school in Edinburgh, and spent a year at the university there, but my attention was early attracted to elocutionary studies, and I earned my first money as a teacher. I went out to teach when I was in my teens, and I received at first £10, or \$50, a year and my board. Later on I got £70, or \$350, a year as teacher of elocution and music. This was before I was twenty, and at that time I devoted a great deal of attention to music. I used to compose, and one of my early dreams was that I might become one of the great composers of the world."

"How about your musical compositions, Mr. Bell? Were they of real value?"

"I don't know about that," was the reply, with a laugh. "I suppose not, but they seemed of great value to me at that time."

"I suppose your work in music helped you toward the invention of the telephone?"

"It may have done so," was the reply, "as I worked for a long time attempting to transmit musical sounds. When I was about sixteen I discovered what was to me a wonderful physiological fact, and that was that each of the vowel sounds has a different pitch, which is formed by the change in the size of the cavity in the mouth in making them, and not by what are popularly known as the vocal organs. I found that I could produce a similar pitch in the taps upon a pencil laid against my lips and tapped while changing the cavity of my mouth, as you do when making the vowels. You can, in fact, play a tune in this way. You can do the same with a pencil laid upon your throat, but here the sounds are reversed. I was much excited by this discovery, and I wrote the facts regarding it to Sir Alex-

ander Ellis, a celebrated English authority on phonetics and mathematics, and received a request to call upon him when I came to London. I did so, and when I met him he told me that my discovery had been made only a short time before by Helmholtz, the famous German scientist, who died last year, and that he had written a book on the subject. This was in German, which I could not well read. Sir Alexander Ellis told me about it, however, and gave me to understand that by means of vibrating metal, a tuning fork perhaps and electricity, Helmholtz had reproduced sounds I understood from him that he had been able to transmit these sounds by electricity. In this I was mistaken, and it may have been from my misconception that I was thus early made ready for the idea of the telephone. I had accustomed my mind to the fact that vowel sounds had been transmitted, and if vowel sounds, why not the consonants? It was while endeavoring to transmit musical sounds by electricity many years afterwards, you know, that I arrived at the discovery."

"Had you devoted much time to electricity before this?"

"No," replied Mr. Bell. "I knew absolutely nothing about electricity, and it was to carry out my investigations of this question that I began to study it. I commenced with telegraphy and learned to telegraph. I had a friend at school who was interested in electricity, and we worked together. Later on, while teaching school near London, I had among my pupils one young man whom I was trying to cure of stammering. He gave him one of the instruments and practiced my telegraphy on him. All this time I was studying and teaching the physiology of the voice. I had this knowledge of the different pitch of the vowels, and as I carried on my experiments with the telegraph the idea came to me of multiplex telephony. I thought that signals of different pitch might be used in telegraphing, and in these the sounds in one pitch could be arranged so that they would not conflict with those on another pitch, and thus a number of messages could be sent over the same wire at the same time. I worked upon this for years, and the telephone was the outgrowth of this idea, and of my studies in connection with the deal and the effort to produce some kind of an instrument by which speech could be made intelligible to them. It was while I was teaching in Boston that I succeeded. I had discovered that I could transmit musical sounds by wire, and from that it was only a step to the conception of the telephone or the transmission of speech. The discovery came slowly, and I had all sorts of difficulties, both imaginary and real, to contend with. I had first a number of reeds as sounding instruments at each end of a wire, with permanent magnets attached to them, these reeds being of different pitches. I then found I could produce the same result with a battery and one steel rod. I worked for months, after I had the idea that speech could be transmitted, under the impression that the power of the voice would be so lost in its transmission that though I knew all the sounds could be transmitted, I did not believe they would be loud enough to be audible to the human ear."

"I made all sorts of experiments at this time in testing such matters, and in my investigations I wanted a diaphragm

as near like the human ear as possible. One day, in talking about this to Dr. Terrence Blake of Boston, he remarked, 'Why not use the ear itself?' I said that that would suit me exactly, but asked him where I could get a man who would give me his ear and how I could possibly keep it in good condition after I had gotten it. He replied that he would get me one, and shortly after that I received from him a human ear cut from a dead subject, and so treated that I was able to study it and use it in my experiments. This was of great value to me."

"Have there been many improvements in the telephone since your original invention?"

"No," replied Mr. Bell. "There have not. The principle of the telephone is unchanged. There have been many improvements, but they have been in the line of transmitters and receivers, and things connected with the telephone. As to the machine itself and its fundamental principles, it is about the same as when it was first made."

"Will we ever be able to telephone without wires?"

"Yes," replied Mr. Bell; "I think so though the distance may be limited. I remember some experiments that I made one day in a field near New Haven, Conn. We had about fifty feet of wire stretched between two poles, which we had driven into the ground and had attached a battery to them. I put the receiver to my ear, when I heard the sound of a clock ticking. There was neither clock nor watch at the other end of the wire, and by listening to the ticking, I recognized that it was the ticking of the University electric clock at least half a mile off. By this clock a number of the clocks of the city were regulated, and the sound had evidently traveled from these wires to the batteries connected with our poles, and that for a long distance without actual wire connection. I think that our great steamers, by means of the heavy dynamos, which they carry, could telephone each other on the sea when miles apart, and I have no doubt that we will in the future be able to telephone for limited distances without wires."

"How about telephonic cables? Will we ever be able to talk across the ocean?"

"It may be, but there are difficulties there which have yet to be overcome. These will have to be mastered by some one who has the cables at hand to experiment with. I have never made much investigation along these lines."

"How about long-distance telephones? How far apart are they practicable?"

"As far as land telephony is concerned," replied Mr. Bell, "distance is practically eliminated. We can now talk between Boston and Chicago, and we talked in Boston to one another through wires which went to Chicago and back, a distance, I judge, of about 2,000 miles. I expect to see the long-distance wires rapidly increase, and the day is coming when the telegraph will only be used for business requiring written messages."

"How about cheap telephones? Would not putting down the rates so increase the business as to make it pay far better than it does now?"

"The telephone business," replied Mr. Bell, "is like no other that I know of. In ordinary business the result would be as you suppose. But with the telephone, the increase in the number of