SCIENCE

VOL. LVII FEBRUARY 23, 1923 No. 1469

SCIENCE: A Weekly Journal devoted to the Advancement of Science, publishing the official notices and proceedings of the American Association for the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

100 Liberty St., Utica, N. Y. Garrison, N. Y.

New York City: Grand Central Terminal

Annual Subscription, $6.00. Single Copies, 15 Cts.

Entered as second-class matter January 21, 1922, at the Post Office at Utica, N. Y., Under the Act of March 3, 1879.

IDEALS OF THE TELEPHONE SERVICE[1]

A TRIBUTE TO THE MEMORY OF ALEXANDER GRAHAM BELL

THIS is the ninth annual meeting of the Telephone Pioneers of America, although our association is now entering upon its twelfth year. On account of the war, during three years no annual meetings were held. The pioneers were then engaged in the great struggle to save civilization.

The membership of our association is made up not only from those who took part in the first development of the telephone, but also from those who have been in the telephone service for a period of twenty-one years. We have in the service tens of thousands of zealous men and women doing pioneer work now, but because they lack in years, though not in achievement, they have not been enrolled. We and they are looking forward to the day of their formal admission. To these our fellow-workers we extend our greetings and our appreciations. In their hands lies not only the future of our society but the future of our art.

Our first meeting took place eleven years ago, at Boston, the birthplace of the telephone. At that meeting, the inventor of the telephone, Alexander Graham Bell, was present and delivered to us an address which must always be memorable in the history of our society. To-day, we recall with peculiar sadness these words which he then spoke to us:

"This is a great day for me, the first meeting of the Telephone Pioneers of America and of the world. It gives me great pleasure to meet with you all to-day, and yet there is a feeling of sadness about it. I am the first telephone pioneer and my memory goes back to the very beginning, and I miss the faces I remember so well, the faces of the old pioneers who I wish were here to-day. . . . I feel it a little presumptuous on my part to try to speak of the telephone

[1] Presidential address delivered at the ninth annual meeting of the Telephone Pioneers of America, at Cleveland, Ohio, September 29, 1922.

to telephone men. You have all gone so far beyond me. Why, the little telephone system that I look back upon, what is it compared to the mighty system that goes through the whole extent of our country to-day? It is to you that this great telephone development is due, and I feel that it behooves me to speak very modestly of the little beginning that led to this great end. I can not tell you anything about the telephone. I can not speak to you about undulating current, intermittent current and pulsatory current. I belong to the past; you belong to the present."

Here stand revealed those lovable qualities of the great pioneer—generosity and modesty—which endeared him to us all. It is true, indeed, that he belongs to the past, though then he still belonged to the present. Now he belongs to the ages.

Alexander Graham Bell died on Wednesday, August 2, at the age of seventy-five, at his summer home in Nova Scotia, near Baddeck. He was buried on August 4, at sunset, on the summit of a mountain overlooking the Bras d'Or Lakes. As a tribute to his memory, telephone service was suspended for one minute throughout the United States and Canada during the simple ceremony.

The manifold activities of his life, devoted to the service of mankind, would require volumes to portray. The medals and other honors which he received from learned societies, his honorary degrees from universities at home and abroad, and special recognition by governments, all testify to the esteem in which he was held. His scientific researches in the field of heredity and eugenics, his experiments in aeronautics, his work in improving the phonograph and in teaching the dumb to talk, and his invention of the photophone, reveal the scope of his mind. This record alone is enough to insure his fame, but his discovery of the method of transmitting articulate speech by electricity, and his invention of the apparatus to do this, have placed his name among the immortals.

Dr. Bell was born on March 3, 1847, in Edinburgh, Scotland. He went to Canada in 1870, and the next year, at the age of twenty-four, he removed to Boston. After introducing into New England schools improved methods of teaching deaf mutes to speak, he was appointed professor of vocal physiology in Boston University.

In his spare time, he conducted experimental researches in electrical wave transmission. He was assisted financially in these experiments by two gentlemen of Boston, Thomas Sanders and Gardiner Greene Hubbard. By the summer of 1874, he had worked out his theory that the transmission of speech by electricity could be accomplished by producing "electrical undulations similar in form to the vibrations of the air" which accompany the original words or sounds. In spite of great difficulties and discouragements, he succeeded in reducing his theory to practical form, when, at Boston, in the summer of 1875, he invented a telephone which faintly transmitted parts of words and even entire words.

Mr. Thomas A. Watson, Bell's assistant, relates that it was on March 10, 1876, over a line extending between two rooms in a building at No. 5 Exeter Place, Boston, that the first complete sentence was ever spoken and heard through the electrical telephone. It was spoken by Bell and heard by Watson, who recorded it in his note book at the time. It consisted of these words: "Mr. Watson, come here; I want you." Thus the telephone was born.

After completing his fundamental invention, Bell in a remarkable document predicted with amazing foresight the telephone system of the future. He also invented the photophone, which was the first method of transmitting speech by electricity without wires, and the induction balance and the telephone probe for which he was awarded the honorary degree of doctor of medicine by the University of Heidelberg. To his successors in the laboratories in which he was the original worker, he left the further conduct of telephone research and development.

Turning to other departments of science, he displayed his remarkable intellectual gifts by the fruitful researches which he conducted. In his work on behalf of the deaf, which he continued to the end, is revealed a dominant motive in his life.

To Bell was accorded a privilege so often denied to those who have advanced the world by their discoveries—he lived to see the triumph of his great idea. When the first sentence was transmitted, the public regarded the telephone as a scientific toy. Then, the telephone plant of the entire world could be carried

in the arms of a child. To-day, vast telephone systems of intercommunication have been developed, extending the spoken word among the peoples of the nations.

The advances of the telephone art made by the successors of Bell were always a source of great satisfaction to him. Some of these, epoch-making in their nature, gave him special gratification.

On January 25, 1915, the transcontinental line, spanning Bell's adopted country from ocean to ocean, was in the presence of dignitaries of state and nation dedicated to the public service. This was a day of triumph for Bell, for, using a reproduction of the original instrument, he once again spoke the memorable words, "Mr. Watson, come here; I want you." But this time Bell was at New York, and Watson, who heard him with perfect ease, was three thousand miles away in San Francisco.

Another advance attained the greatest distance over which the transmission of speech had ever been achieved. Early in the morning of September 30, 1915, words were spoken through a radio telephone at Arlington, Virginia, to the Hawaiian Islands, where they were plainly heard. But, as if to proclaim the telephonic conquest of time as well as space, the words reached these distant islands of the Pacific when it was there still the evening of September 29.

There yet remained to be realized that prophetic dream of the telephone pioneers—the bridging of the Atlantic by the human voice. But the day of its fulfilment was not far off, for on October 21, 1915, during the dark days of the war, speech was for the first time in history successfully transmitted across the Atlantic Ocean. This was accomplished by the radio telephone, which carried the words spoken at Arlington to the Eiffel Tower at Paris.

The last memorable telephone development destined to occur in the life of Bell will always be associated with a great historic occasion. At the burial of the Unknown Soldier at Arlington, on November 11, 1921, the voice of President Harding, by means of the new loud speaking amplifiers, was easily heard by the great concourse of a hundred thousand people about him, even by those in the most distant parts of the vast cemetery. Corresponding multitudes numbered by tens of thousands, at New York and San Francisco, heard over the wires every word spoken by their chief magistrate, as clearly as though in his actual presence. These distant multitudes heard also the invocation of the chaplain, the music and the hymns and the words of the commitment service used by the bishop at the grave. They joined with each other and with those at the cemetery in the singing of the hymns, and they united with the President in reciting the Lord's Prayer with which he closed his address. They heard in amazement the salvos of artillery fired at the grave, and even those on the shores of the Pacific caught the loud reverberations thrown back by the Virginia hills. At the end, in profound silence and with heads bowed in sorrow, they listened to the plaintive notes of the trumpet sounding the soldiers' last farewell.

On that day, the achievements of science imparted a mystical power to the most solemn national ceremony in the history of America. This ceremony, its deep significance so enriched by the art of Bell, we can now believe contained an exalted sanction of the greatest of all the achievements of his life.

These are but some of the advances which have been made in the first half century of the telephone art, which is now drawing to a close. They belong to the golden age of communications which has achieved the extension of the spoken word throughout both space and time.

But this golden age has not yet ended, and when we contemplate the possibilities of the future we discover that it has only just begun. It is to the future that we must now turn our minds and direct our endeavors. It is true that we pioneers belong to the past, but it is equally true that we belong to the present. As individuals, we must all pass away, as did the first pioneer; but our association, the Telephone Pioneers of America, will continue to live. The greatest work which our society can do is to exemplify the ideals of our service, and to transmit to its future members the splendid traditions of our art. It should be our purpose to encourage and to sustain among the men and women of the telephone system their ever-increasing zeal for the public service.

While it is beyond my power to put into words these ideals of our service, they already

exist within your hearts and mine, where we all can feel, though I can not express, their potency. These feelings, which form the mainspring of our actions, do not arise from mere wishful thinking, nor do they spring from an idealism which is disconnected from reality. They rest upon a solid basis of achievement, and represent the practical purpose of that great telephone system of intercommunication which bears the name of our first pioneer.

It is interesting to note that the biologists were the first to appreciate the peculiar importance of electrical communications in the social organism, and to Herbert Spencer, writing more than fifty years ago, we are indebted for some analogies which have not yet been sufficiently studied either by the biologist or the engineer. In tracing the analogy between the telegraph system of his day and the nervous system of the animal organism, Spencer expressed the view that probably when the then rudimentary telegraph systems were more fully developed, other analogies would be traceable. This development has already been provided by the telephone art, and national telephone networks have now become a vital part of the social organism. I believe that the study of these networks from the standpoint of biology is destined to yield important results, and, indeed, that an investigation of the remarkable developments of the automatic machinery used in modern telephone switchboards might even throw light on the mechanism of the mind itself.

Scientists have long been studying the theory that man has advanced to his present high estate by upward progress in the biological scale from a microscopic speck of protoplasm forming the biological cell or unit of life. They have pictured him as composed of countless millions of these living creatures forming an organic entity marvelously designed, each cell performing its allotted part in that exquisite division of labor which characterizes this biological state.

We commonly compare a nation to a complex living organism. "We speak of the body politic, of the functions of its several parts, of its growth and of its diseases, as though it were a creature. But we usually employ these expressions as metaphors, little suspecting," as Spencer says, "how close is the analogy, and how far it will bear carrying out. So completely, however, is a society organized upon the same system as an individual being, that we may almost say that there is something more than analogy between them."

Each cell has its allotted and specialized work to do. Each cell must be fed, and live, and grow. Sustenance must be obtained, prepared and assimilated, and the waste removed. The physiological mechanisms for doing these things and many other things besides have their striking counterparts in the structure of organized society, and furnish instructive material for the philosophic student. But to us of the telephone art, the most marvelous thing of all is the nervous system, that inconceivably complex communication network, by which the activities of both individual and society are regulated and without which paralysis and death would result.

We are told that the cells which compose the nervous system are the latest to appear in the upward march of the organism, and that the degree of their complexity and the extent of their differentiation furnish a criterion for determining the stage of progress which has been attained. Because of the high function, almost spiritual in its nature, performed by these nerve cells, they have been called the noble cells. I have long felt and often expressed the feeling that because of this the workers in the telephone art are engaged in a high calling, building up the noble cells which constitute the nervous system of the nation.

As in the animal body these cells were the latest to appear, so in the structure of organized society the highest form of electrical communication, the telephone, is the latest to appear—it comes only at the stage of higher development. And again as in the animal body, the stage of development of the nervous system is an index of its place in the evolutionary series, so I believe it will be found in any social organism that the degree of development reached by its telephone system will be an important indication of the progress which it has made in attaining coordination and solidarity.

The use of the spoken word to convey ideas distinguishes man from all other created things. The extension of the spoken word by means of electrical systems of intercommunication serves

to connect the nervous system of each unit of society with all of the others, thus providing *an indispensable element* in the structure of that inconceivably great and powerful organism which many biologists feel is to be the ultimate outcome of the stupendous evolution which society is undergoing.

That such an organism, thus so magnificently conceived, would be the outcome of the higher evolution of man, I have long believed; but its form and the nature of its functioning, I could not imagine. But the great work of Trotter, who has studied the gregarious instinct in the lower animals and in man, permits us to contemplate this evolutionary entity from a new point of view. He has pointed out that nature, having failed in her giant organisms, in which so many individual cells were crowded into such animals as her giant lizards and the mammoth and the mastodon, was to try a new method which was to dispense with gross physical aggregations of cells combined into one body. He points out that the flock, the herd, the pack, the swarm—new organizations—were to be devised by nature, and to flourish and range throughout the world, and that in one of these new organizations, human society, the individual man is still to be regarded as the unit, but not constrained as is the cell in the animal body, but free to move about, the mind alone being incorporated into the new unit by the marvelous power of intercommunication. He shows that the power of these organisms depends on the capacity for intercommunication among their members, and that this power expands until the limits of this intercommunication are reached.

How fundamental electrical communication systems are, in the tremendous evolution of the human race which is now being manifested in the organization of society, and how vital to the welfare of mankind is the daily work of telephone men and women everywhere, is being made more and more apparent by the discoveries of the new school of biologists.

Speaking always of communication in its broadest meaning,[2] but emphasizing the importance of speech, Trotter says: "The capacity for free intercommunication between individuals of the species has meant so much in the evolution of man, and will certainly come in the future to mean so incalculably more, that it can not be regarded as anything less than a master element in the shaping of his destiny."

And again, in speaking of human society as a gregarious unit, he says: "The ultimate and singular source of *inexhaustible* moral power in a gregarious unit is the perfection of communion amongst its individual members."

As long as intercommunication was limited, he tells us, the full possibilities of nature's new experiment were concealed. But at length appeared man, a creature endowed with speech, in whom this capacity for intercommunication could develop indefinitely. "At once a power of a new magnitude was manifest. Puny as were his individuals, man's capacity for communication soon made him master of the world. . . . In his very flesh and bones is the impulse towards closer and closer union in larger and larger fellowships. To-day he is fighting his way towards that goal, fighting for the perfect unit which nature has so long foreshadowed, in which there shall be a complete communion of its members, unobstructed by egoism or hatred, by harshness or arrogance or the wolfish lust for blood. That perfect unit will be a new creature, recognizable as a single entity; to its million-minded power and knowledge no barrier will be insurmountable, no gulf impassable, no task too great."[3]

Here we have portrayed the forward march of humanity toiling ever onward to attain its goal. The realization that their wonderful art is destined to play such an important part in this final attainment, opens up a never-ending source of power and inspiration for telephone men and women everywhere. It adds new dignity to their calling. Already, as we have seen, the human voice has been carried with the speed of light across the Atlantic Ocean, and across our continent, and far out into the Pacific; but still greater things are to come.

It is the mission of the pioneers and their successors, and their associates among all the nations, to build up a telephone system extending to every part of the world, connecting

[2] In this should be included all methods of communication based upon speech, such as newspapers, books and letters, depending upon mechanical transportation; and telegrams, depending upon electrical transmission.

[3] W. Trotter: "Instincts of the Herd in Peace and War."

together all the peoples of the earth. I believe that the art which was founded by Alexander Graham Bell, our first pioneer, will provide the means for transmitting throughout the earth a great voice proclaiming the dawn of a new era in which will be realized that grandest of all our earthly aspirations—the brotherhood of man.

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THE AGGLUTINATION OF BACTERIA[1]

ONE of the characteristic properties of suspensions of finely divided matter in general and of bacteria in particular is the fact that under certain conditions the particles remain discrete, whereas, under other conditions, they collect into larger aggregates, *i. e.*, they agglutinate. This aggregation or agglutination is caused by certain concentrations of salts or acids and in the case of suspensions of bacteria by proteins and especially by the homologous immune serum. It is evident, therefore, that there must be a force which tends to keep the individual particles apart from each other, and another force which tends to hold them in contact. It has long been known that such particles carry an electric charge with reference to the surrounding liquid and it was early suggested that it was the repulsion due to the charge carried by the organisms which prevented them from coming into contact; the attractive force has usually been assumed to be surface tension. Many experiments have been performed to test this relation of the charge on the particles to the stability of the suspension, but nearly all have failed to show any definite relationship between the two phenomena. An exception is the work of Powis[2] on the coagulation of oil emulsions. Powis found that coagulation occurred whenever the potential between the drops and the surrounding liquid was reduced below a critical value of about 30 millivolts. The stability of these oil emulsions therefore is determined solely by the potential of the droplets. In the case of bacteria, however, it has been found repeatedly that agglutination, especially by immune serum, may occur without any change in the potential. Some qualitative relation has been found between the acid agglutination point and the potential inasmuch as the potential passes through a minimum and changes its sign at the acid agglutination point.

It will be evident from the result of the experiments reported here that the difficulty with the bacteria suspensions is due to the fact that electrolytes affect not only the potential and hence the repellent force but also the cohesive or attractive force. In order to account for the observations it is therefore necessary to measure *both*.

The experiments performed by the writers were carried out with thoroughly washed suspensions of *B. typhosus* and the bacillus of rabbit septicemia. The potential was calculated from the rate of migration of the organisms in an electric field.

AGGLUTINATION BY SALTS OR ACIDS

It was found that the experiments could be divided at once into two groups; first, those in which agglutination was caused by very low concentrations (less than 0.01 N), and second, those in which high concentrations of electrolytes were needed. In the first group it was found that agglutination occurred whenever the potential between the organisms and the solution was reduced below about 13 millivolts (either positive or negative). In this case apparently the stability is determined solely by the potential. In the second group, however, there was no critical potential and agglutination with many salts did not occur even though the potential was reduced to a value too small to measure. This distinction between the two groups is not due to a specific effect of the salt, since the presence of a high concentration of sodium chloride for instance, which does not cause agglutination in any concentration, completely prevents agglutination by acids.[3]

[1] A detailed account of the work described in this paper has been published in the *J. Gen. Physiol.*, July and November, 1922. References to other work will also be found in these papers and have been omitted from the present summary.

[2] Powis, F.: *Z. physik. Chem.*, 1914-15, lxxxix, 186.

[3] It follows from this experiment that in determining the acid agglutination point of bacteria