

This drawing by Alexander Graham Bell illustrated a letter to his family in May, 1875, describing an experiment which was one of the starting points in his experiments with electrically generated sound.

THE BELL TELEPHONE. The Deposition of Alexander Graham Bell in the suit brought by the United States to annul the Bell Patents (1887-1896). Printed by the Bell Telephone Company, Boston, 1908.

SALEM, MASS., JULY 1st, 1875.

DEAR MR. HUBBARD:

The experiment to which I alluded when I saw you last promises to be a grand success. On singing this afternoon in front of a stretched membrane attached to the armature of an electro-magnet, the varying pitch of the voice was plainly perceptible at the other end of the line, no battery nor permanent magnet being employed. When the vibrations are received upon another stretched membrane in place of a steel spring, it is possible, nay, it is probable, that the "timbre" of the sound will be perceived. I hope to try the experiment tomorrow afternoon. . .

With kind regards,

Yours respectfully,

A. GRAHAM BELL.

Int. 82. Will you describe the instruments with which such experiment was tried, beginning with the one of earlier construction, and ending with that of later construction?

Ans. I have here some drawings, one showing the first instrument in perspective, and the other showing it in cross-section, by the aid of which I will make my description.

In this earlier arrangement, a membrane *M* is attached to a straining ring *R*, carrying three metallic projections, through which screws *S* pass into a board *F*. By the operation of screws *S* the membrane *M* can be stretched tightly across the end of a tube *T*. Attached to the board *F* are side-pieces *U, U*, carrying a cross-bar *B*, which is retained in position in the

The Telephone

—A Classic Invention

Electricity

The dramatic fact that Bell's patent application on the speaking telephone was filed two hours before Gray's caveat on a musical telegraph has been much discussed. The correspondence between the rival inventors, if occasionally emphatic, is dignified and courteous. Some of their friends became more controversial, as when the *Chicago Tribune*, championing Gray, declared: "Talking by telegraph and other sport of that description Mr. Gray has not paid much attention to as yet, because there is no present indication in it of anything more than sport."

Using the description and diagrams below, you can reconstruct Bell's first speaking telephone and enjoy the sport of telephony, 1875 style.

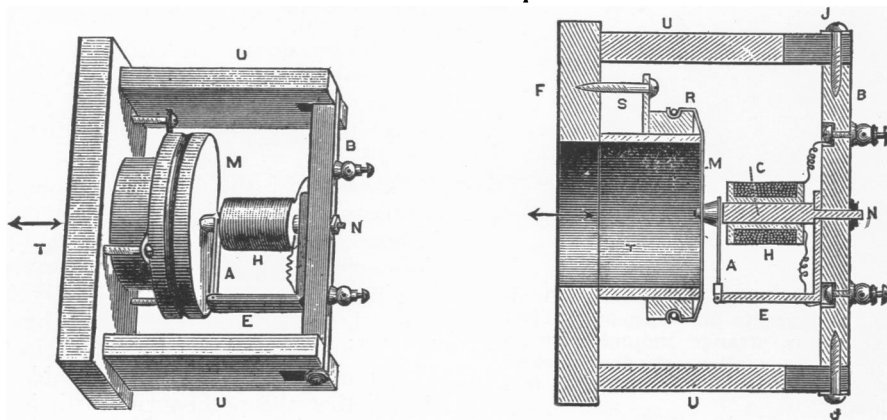
slotted ends of the side-pieces by screws *J, J*. The cross-bar *B* supports an electro-magnet *H, E*, which is attached to the cross-bar by a screw and nut at *N*. The leg *C* of the electro-magnet is covered with a coil *H* of insulated copper wire, and to the uncovered leg *E* of the electro-magnet is pivoted one end of the steel armature *A*, the other end being attached to the center of the strained membrane *M*. I am not sure at the present moment, how the attachment of the membrane was made, but I think the drawing shows a piece of cork between the center of the membrane and the end of the armature or reed. On the other side of the membrane is a metallic washer, through which passes a screw, clamping the membrane between the washer and the cork. I think this is the arrangement shown in the diagram. At all events, we used such an arrangement in some of our experiments in June or July, 1875. If I remember rightly, we did not at first adjust the electro-magnet, in the earlier instrument, by changing the position of the cross-bar; but we did so by means of the screw and nut shown at *N*. By unscrewing the nut a little, we could cause the electro-

magnet to approach its armature more closely and retain this position by means of washers or thin pieces of metal placed between the cross-bar and the heel-piece of the electro-magnet. This was the first method, I think, of adjusting the position of the electro-magnet; and then came the plan of fixing it firmly to the cross-bar, and adjusting the position of the cross-bar by the screws *J, J*. It may be perfectly possible that the cross-bar means of adjustment existed in the apparatus before the experiment was made, described in the letter of July 1. I cannot be sure now at this date.

I will now describe the second instrument, and will do so by the aid of the following drawings:

Comparing these drawings with the drawings of the earlier instrument given above, like parts are indicated by the same letters. I will simply point out the differences. In the second instrument, the straining ring *R* carried a circular flange, through which three screws passed, adjusting its distance from the board *F*. The tube *T* was much shorter than in the earlier instrument, so that the flange of the straining ring *R* came much closer to

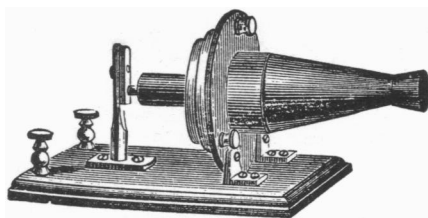
The first membrane telephone.



the board F. The electro-magnet H, E was attached firmly to the cross-bar B by a screw passing through a washer at O, and the distance of the pole of the electro-magnet from its armature A was regulated by adjusting the position of the cross-bar B by means of the screws J, J. The steel-spring armature A was attached to the uncovered pole E of the electro-magnet by means of a leather hinge, and the end of the pole itself was filed to an edge which was intended to be in contact with the end of the armature A. The other end of the armature A carried a metallic pin, and a screw passing through the center of the membrane into the metallic pin clamped the membrane firmly between two metallic washers.

Int. 84. Please, now, describe the trial which you made of these two instruments which you have described in your answer to Interrogatory 82, and state the results which you obtained from such trial, early in July, 1875.

Ans. One of these instruments was placed in a room in the upper part of Mr. Williams's building, 109 Court Street, Boston, and the other in one of the work-rooms below. The two instruments were connected together in metallic circuit, but I do not remember at the present moment whether a battery was used in the first experiment, or not. I spoke and shouted and sang—with my mouth as close to the membrane as possible—into the instrument upstairs, while Mr. Watson listened to the instrument downstairs. I remember that while I was talking or singing to the instrument upstairs, I was interrupted by the sudden appearance of Mr. Watson, who had rushed upstairs in great excitement, to tell me what he had observed below. I remember that he told me he could hear my voice quite plain-



Bell's Speaking Telephone shown at the Centennial Exposition, Philadelphia, 1876.

ly, and could almost make out what I said. I then asked Mr. Watson to do the speaking, but was myself unable to verify his assertion. We made a number of experiments at the time, changing places so that one should be upstairs and the other down. I do not remember the details of these experiments, nor exactly the results obtained, excepting that speech sounds were unmistakably produced from the receiver, and were almost intelligible, and that Mr. Watson appeared to hear a good deal more than I was able to do. While I am free to say that the character of the articulation produced was rather disappointing, the fact that any sound at all was audible, under the circumstances of the experiment, convinced me that the supposed difficulty which had been in my mind since the summer of 1874—namely, that magneto-electric impulses generated by the action of the voice would be too feeble to produce distinctly audible effects—was a mistake, and the results encouraged me to believe that the apparatus, if carefully constructed, and tried in a quiet place, would transmit speech intelligibly, and prove to be a practically operative speaking telephone.

Int. 86. Did you subsequently make trial of just such instruments as your two membrane telephones which you have described in answer to Interrogatory 82, in a more quiet place,

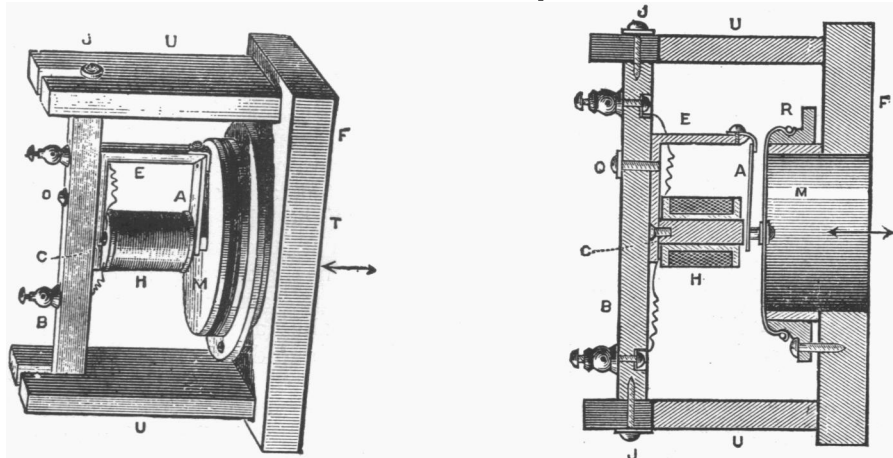
and compare the results obtained, with their trial in the same situation as when the originals were first tried; and if so, when, and what did you find their capacity to be?

Ans. Yes. I made experiments with membrane telephones that were substantially reproductions of the instruments used in the summer of 1875. I am not sure about the date, but think it may have been about 1879. The instruments were tried in Mr. Williams's establishment in about the same places occupied by the original instruments in 1875. I think it was Mr. Watson who made the experiments with me, but cannot be quite sure. I remember that, under such circumstances, I could hear the sound of the voice, but could not make out the articulation. The instruments were then carried off to some quiet place—and here again my memory fails me. I am inclined to think that they were taken either to some office on State Street, or some place on Milk Street; but at all events, I remember that it was some place of a quiet character, where there was no noisy machinery at work to distract the attention. The instruments were set up just as they had been immediately before at Mr. Williams's establishments, and I was able to carry on a conversation with the person at the other end—at least, that is my recollection. I am perfectly sure of so much—that I heard and understood speech through the instruments in this quiet place, where I could not understand anything in the noisy shop of Mr. Williams. I remember, also—during the course of the experiments in the quiet place, a fire-alarm struck, or some noise occurred outside, in which there was ringing of bells, etc., and that while the noise lasted I could not make out what was said by the telephone, but when the noise ceased, I was able to understand again.

Int. 87. In what position were the membrane telephone instruments, described in your answer in Interrogatory 82 intended to be held when used; and how did you, in fact, hold them and their duplicates, when subsequently tried, when experimenting with them?

Ans. The position in which the membrane telephones were held was not material. In the experiments referred to I took the telephone up in my hand, and simply tried to get my mouth or ear, as the case might be, as close to the membrane as possible. In doing this I (*Turn to page 58*)

The second membrane telephone.



Ancient Myth Had Basis in Fact

Archaeology

Tomb of "Dwellers Behind North Winds" Found

THE ancient Greeks were not dealing entirely in myths when they talked about the Land of the Hyperboreans, the dwellers behind the north winds. The latest discoveries by Prof. Peter Kozlov, famous Russian explorer, reveal that the Greeks were right in accepting rumors of a cultured race far to the north of their little world.

Prof. Kozlov, who has been excavating at an ancient burying ground in the mountain passes of northern Mongolia, has just sent back word to civilization that he has entered the tomb of an Asiatic person of rank who lived in eastern luxury more than 2,000 years ago. The expedition has placed special hopes on the mound containing this tomb, because the conditions of getting into it were so discouraging that it must have been thief-proof through the centuries.

The tumulus, or mound, was dub-

bed by the excavators the "wet tumulus" because of the water in it. Starting last summer, the expedition set four pumps working day and night to pump it dry. When this attack failed, they waited until winter brought heavy frost, and now scientific persistence has won. Out of the tomb the workers brought jade, tapestry, a carpet adorned with hieroglyphs, little carved figurines of dragons, lynxes, and spotted deer, and other beautiful things.

"It is astonishing to find articles of wood, leather stuff, not to mention carpets and human hair, in good preservation deep underground for a period of two thousand and more years," Prof. Kozlov stated. "The explanation is to be found in the even, low temperature from zero to one degree, which at a depth of a few sazhen has not changed for centuries, thus preserving even fine fabrics."

The explorer explained that his chief interest in the Mongolian sepulchres is to use them to shed light on the remote history of the region. Some of the buried objects show that Greek ideas spread to this distant heart of Asia. In the course of this relayed spreading of Greek objects and Greek styles in art, doubtless came the return wave of rumors as to the strange land beyond the north winds. Other objects from the Mongolian tombs show that the fine old culture of China influenced the lives of the people of this tribe.

Prof. Kozlov explains that according to Chinese scholars, the European Huns of the fourth century B. C. were in touch with the Hun-Hu people, who were wanderers living to the north of the Chinese. These Hun-Hu wanderers began to play politics about 200 B. C. when the chieftain was slain by his son, and the son united other nomad tribes and formed the first wandering empire. The Chinese soon discouraged this ambitious project, and tradition says that the Hun-Hu were assimilated by marriages between Hun-Hu princes and Chinese princesses.

"Objects found by us in the sepulchres between Urga and Kiachta confirm these varied influences," Prof. Koslov reported. "Objects bearing the impress of local art lie side by side with those reflecting the time of dynasties two centuries before the dawning of our era."

The ancient burying grounds where the expedition has been working are in the passes of the mountains, among birch and scattered pine trees. About 150 mounds marking graves have been adopted by the expedition, and ten mounds have been excavated. Thieves long ago plundered some of these tombs, but one grave of a woman of high rank had escaped this fate, and still contained rings adorned with rubies, earrings subtly worked in profile of a bull's head, a portrait on a slab of jade, bits of Chinese mirror, and vessels of black Chinese lacquer ornamented in gold.

All articles from the tombs are sent to Leningrad to be cleaned and restored. Many of the articles used 2,000 years ago are so well preserved that they look almost new when restored, Prof. Koslov stated.

The Telephone—Continued

do not think I held the instrument in any uniform position, for I feel sure that I spoke with my mouth sometimes on one side of the membrane, and sometimes on the other, and listened in the same way. At all events, the position was immaterial.

SALEM, MASS., AUG. 14th, 1875.

DEAR MR. HUBBARD:

On glancing back over the line of electrical experiments, I recognize that the discovery of the magneto-electric current generated by the vibration of the armature of an electro-magnet in front of one of the poles is the most important point yet reached. I believe that it is the key to still greater things.

The effects produced, though slight in themselves, appear to me so great in proportion to their cause that I feel sure that the future will discover means of utilizing currents obtained in this way on actual telegraph lines.

So important does it seem to me to protect the idea that I think some steps should be taken immediately towards obtaining a Caveat or Patent for the use of a Magneto-Electric Current, whether obtained in the way stated above (by the vibration of permanent magnets in front of electro-

magnets), or in any other way. I should wish to protect it specially as a means of transmitting simultaneously musical notes differing in *intensity* as well as in pitch.

I can see clearly that the magneto-electric current will not only permit of the actual copying of *spoken utterance*, but of the simultaneous transmission of *any number of musical notes* (hence messages) without confusion.

The more I think of it the more I see that the method of making and breaking contact so many times per second is only the *first stage* in the development of the idea.

When we can create a pulsatory action of the current which is the *exact equivalent* of the aerial impulses, we shall certainly obtain exactly similar results. *Any number of sounds* can travel through the air without confusion, and any number should pass along the same wire.

It should even be possible for a number of spoken messages to traverse the same circuit simultaneously, for an attentive ear can distinguish one voice from another, although a number are speaking together.

Yours respectfully,

A. GRAHAM BELL.

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