

were requested to communicate to me by letter a description of the experiments witnessed, and were requested to post these letters without envelopes, so that the post-mark might prove an additional proof of the date of the experiments. The letters written by these witnesses are herewith enclosed.

Experiments made Saturday 31st Feb'y / 80.

On Saturday 31st Feb'y 1880. still more satisfactory results were obtained, by placing the Photophone in the direct rays of the sun and by using a battery of 31. Leclanché's elements.

Experiment I. Mr Charles Bell operated the Photophone in the workshop, while I listened to the telephone in the back basement. I heard the words *Hay, Hay, off,* in different tones, the vowels being well marked. Then came a sentence in different pitches of voice, which I could not make out. The tones of the voice were plainly audible, but articulation not intelligible. Then came a song "God save the Queen", the words in this case were perfectly plain. Sentences like "Do you hear me", "Do you understand what I say", were easily recognized. I then came up stairs, and asked Mr. C. Bell to talk some sentences that were not familiar. Upon listening, again I heard Mr. Charles Bell's voice but could not make out the words. I came up stairs and imitated the sounds I heard, and Mr. Charles Bell said that

The Photophone.

An instrument for the production of sound
through the agency of light.

The model accompanying this paper and
illustrated in the diagrams enclosed (Fig 1 & 2)
was successfully used on the 19th July 1880, at
my laboratory No 1335 G. St. Washington D. C.
by Mr. Sumner Tainter & myself, for the purpose
of reproducing the articulation of a speaker through
the agency of a beam of sunlight. The light
was passed through two plates A & B. (Fig 1 & 2)
and allowed to fall on some crystalline Selenium
contained in the cell C, which was connected
in circuit with the two telephones D & E, and
with a battery F consisting of nine cells of
Sulphate of Copper battery. The glass plates
A & B were coated with metallic silver and
a number of parallel fine lines scratched upon
the silver films. The plate A was attached
to a piece of cork G which was fastened to
the center of the metallic diaphragm H, which
could be set in vibration by the voice of a
speaker directed through the mouth-piece I. The
plate A was attached rigidly to the plate B.
In the normal position of the instrument

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receded portion of the plate A. partially covered
the spaces or fine lines upon the plate B., thus
partially obstructing the passage of light through
it. A very slight motion of the diaphragm H. caused
the plate A. to slide forward, so that
the fine lines drawn upon A. came opposite the
corresponding lines on the plate B., in which position
the light could pass freely through the gratings A & B.

Operation of the Instrument.

When a person speaks through the mouth-piece I,
while a bright light is passed through the gratings
A & B, the amount of light transmitted varies
with every motion of the diaphragm H., and an
undulatory beam of light is produced, which
falls upon the Selenium in the cell C. Every
variation in the amount of light transmitted
occasions a corresponding variation in the electrical
resistance of the Selenium. This occasions a change
in the strength of the current passed through the
Selenium, and a corresponding change in the
magnetic force of the telephones D & E. Thus the
motion of the diaphragm A. varying light passed
through the gratings A & B, causes the diaphragms
of each telephone D & E, to be attracted with a
varying force, and a sound is produced similar

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in quality to that which originally caused the
vibration of the diaphragm &c.

Experiments made Feb'y 19th 80.

On Feb'y 19th, 1880, experiments were made by Mr.
Sumner Tainter & myself, with the model accompanying
this paper, in the presence of Mr. Charles Bell. The
photophone was placed near the window in the workroom
of my Laboratory No 1535 L. St. Washington D. C.
and the telephones D & E in the back basement of
the same building. Mr. Charles Bell reflected sunlight
on to the gratings A & B. by means of a mirror. Mr.
Sumner Tainter spoke into the mouthpiece I. of
the photophone, and I listened at the telephones D & E,
while Miss Mary A. Stone stood ready to short-circuit
the telephones by touching together the points L & M.
I heard the words "Hoi, Hoi" very faintly but
distinctly, followed by a verse of "Auld Lang Syne".
I recognized the air, and could also distinguish
the words. During the course of the experiments
Miss Stone short-circuited the telephones, a number of
times, by touching together the wires L & M, and
at such times no sound was audible from the telephones.
I then went up stairs to the workroom to ask Mr.
Tainter to repeat some sentences that were not
familiar, as I thought that the recognition of
the air of "Auld Lang Syne" had assisted me in

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distinguishing the words. Upon again listening to telephone D - E, I could hear Mr. Jaunter's voice but could not understand what he said. Mr. Charles Bell then spoke into the photophone, and his voice was reproduced much more broadly than Mr. Jaunter's, but I could not understand what he said. I heard him sing "God save the Queen" and recognized the words a number of sentences which he uttered into the tube were heard by me, but I failed to understand them. During the course of the experiments I observed an occasional diminution in the loudness of the sounds produced by the photophone, it seems to have been due to the passage of a cloud in front of the sun. Mr. Jaunter & Mr. Charles Bell took turns in listening to the telephone, while I spoke to the photophone. Their observations agreed with my own. The varying pitch of the voice was plainly perceptible and the articulation seemed distinct, when familiar sentences occurred, but were not intelligible otherwise. Miss Sumner & Miss Rice were called to witness the experiments. Miss Sumner heard the air of "Culd Song Sign", but could not distinguish the words. Miss Rice heard the air of "Yankee Doodle" and perceived the words "Yankee Doodle come" as clearly and distinctly as if they had been uttered in a low voice by some person in her presence.

Miss Sumner, Miss Rice & Mr. Charles Bell

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even requested to communicate to me by letter a description of the experiments witnessed, and were requested to post these letters without envelopes, so that the post-mark might prove an additional proof of the date of the experiments. The letters written by these witnesses are herewith enclosed.

Experiments made Saturday 31st July / 80.

On Saturday 31st July 1880. Still more satisfactory results were obtained, by placing the Photophone in the direct rays of the sun and by using a battery of 31. Leclanché elements.

Experiment I. Mr Charles Bell operated the Photophone in the cookroom, whilst I listened to the telephone in the back basement. I heard the words *stay, stay, stay*, in different tones, the vowels being well marked. Then came a sentence in different pitches of voice, which I could not make out. The tones of the voice were plainly audible, but articulation not intelligible. Then came a song "God save the Queen", the words in this case seemed perfectly plain. Sentences like "Do you hear me", "Do you understand what I say", were easily recognized. I then came up stairs, and asked Mr C. Bell to take some sentences that were not familiar. Upon listening again I heard Mr Charles Bell's voice but could not make out the sense. I came up stairs and imitated the sounds I heard, and Mr Charles Bell said that

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The sentence was "No extra charge for named seats" - It was found that the vowels in the syllables I uttered were approximately the same as those in the sentence given. The vowels in the words "No named seats" were exactly correct. Another attempt was then made and upon listening I heard distinctly the words, "Alee, Alee, Alee," followed by the sentence "Good piece of bread" - Good piece of bread" - Upon coming up stairs however, I found that what Mr. Charles Bell had said was "Alee, Alee, Alee, Put me to bed, Put me to bed" - In this case also the vowels had been clearly recognized.

12/ Mr. Charles Bell listened at the telephone in the back basement while I spoke into the Phonophone. I repeated the following sentences a number of times "We must note our results and give them to Prof. Baird of the Smithsonian in a sealed package". Mr. Charles Bell soon came up stairs & said that he could hear the vowels very plainly, and could almost make out the articulation. He recognized the words "Professor Baird of the Smithsonian", but could not understand the remainder of the sentence. His own name "Charles - Charles - Charles" he understood perfectly, & could distinguish laughing & coughing perfectly plainly.

13/ Mr. Sainster listened while I operated the Phonophone. I commenced with "Hoy, Hoy, Hoy", in different keys then coughed and laughed into the instrument & sang a verse of "Auld Lang Syne" and recited a portion

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of Hamlet's soliloquy upon death. "To be or not to be" and finished up with "Mr. Saint, Mr. Saint. If you understand what I say come upstairs" In response to this summons he came. He stated that he had heard "Hoy, Hoy Hoy" very plainly. Had distinguished the coughing and laughing and the song of "Auld Lang Syne" He then heard some recitation which he did not understand, with the exception of the words "Slings & arrows" ^{and} "outrageous fortune". He then heard his own name, followed by the quite intelligible and distinct sentence "If you understand what I say come upstairs" —

Adams & Bornstein have shown (See Proc Roy Soc. 1896 & Phils Mag. June supplement 1897) that an electro-motive force is produced by the action of Selenium, Tellurium and the oxides, and Mr. Sumner Saint and I believe that with a more sensitive pair of Selenium all the effects noted above may be produced without the aid of a battery — we have made preliminary experiments to test the point, but have not as yet succeeded in hearing any sound, without the aid of a battery, although we have produced the results noted by Adams in the Proc. of Roy. Soc. Vol. ~~xxv~~ Page 113.

The success obtained in producing the Selenium results for the experiments referred to above is chiefly due to information derived from the lecture of Dr. G. Williams Siemens, "On the action of light on Selenium" read before the Royal Soc. of

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Just Betian on 18th Feb/76 (See Proc. R. Soc. Feb VIII p 68)

Alexander Graham Bell

1325 L St - Washington D.C.

February 26th 1880.

The above description of the Photophone and
the experiments made with it is correct.

Sumner Tainter

1325 L St. Washington, D.C.

February 26th 1880.

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Volts
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