Correspondence.

A Suspended Tunnel.

To the Editor of the SCIENTIFIC AMERICAN:

In the issue of the SCIENTIFIC AMERICAN of January 24 last, in an article on "New Methods of Tunneling," you describe three methods suggested for the support or foundations of the proposed North and East River tunnels of the Pennsylvania Railroad Company. In my opinion, there are serious objections to each of these plans.

The one proposed by Mr. Jacobs, the railroad company's engineer, is, if I understand it correctly, simply a girder bridge of several spans incased in a tunnel with foundations at each span reaching down to bedrock. The inclosing of these girders inside the tunnel makes it necessary to build the tunnel of very large outside diameter, which fact makes it very difficult of construction and *very costly*.

Mr. Sooysmith's plan of freezing the silt is, I believe, too much of an experimental nature, as yet, for tunneling to warrant its adoption in an undertaking of this magnitude. The adoption of Mr. Sooysmith's plan of driving piles throughout the whole length of the tunnel would certainly disturb the silt through which the tunnel would have to be pushed, to such an extent that in all probability it would be of the consistency of builder's mortar, and consequently very difficult to tunnel through.

As to Mr. Reno's plan of pushing the tunnel in the usual way by means of a shield, and the use of compressed air, I believe it to be the correct way; but as to his method of providing a foundation for the tunnel, I cannot approve, for the reason that the solidity of the concrete foundation would depend entirely upon the solidity of the silt or other material upon which the concrete rested. Consequently, it seems to me it would be quite unsafe to rely upon a foundation of this nature.

With your permission, Mr. Editor, I will suggest a plan for supporting these tunnels, entirely different from either of the above named. I would suggest that the tunnels be built in the usual way, as Mr. Reno suggests, by the use of a shield and compressed air, and that at each end of the tunnels, as close to the water's edge as possible, a substantial foundation be built upon the bedrock, and of sufficient height to reach about half way up the tunnels at each side. These foundations are for the purpose of supporting wire cables, which would be run through the inside of the tunnels, one at each side, and securely fastened thereto and anchored at each end, as in those of any large suspension bridge. From these two cables the car tracks would be suspended. This method of suspending the tunnels on wire cables would effect a very large saving, as the diameter of the tunnel could be much less than those containing bridge girders. It could also be built in much less time than either of the three plans above mentioned, as the tunnel and the cable foundations could be proceeded with simultaneously.

J. S. PARMENTER.

Woodstock, Ontario, Canada, February 2, 1903.

The Cause of Thunder Again.

To the Editor of the SCIENTIFIC AMERICAN:

I note with interest the theory of the cause of thunder advanced by Robert V. R. Reynolds on page 41 of your issue of January 17.

I fully agree with Mr. Reynolds as to the fallacy of the vacuum theory. Perhaps most fairly educated men will recall how unsatisfactory was the explanation of the learned (?) professor who first imparted to them the information that the noise of thunder is "due to the air rushing in to fill the vacuum caused by lightning passing through it;" when to their boyish minds every peal of thunder within their hearing had already firmly established the conviction that in each case "somethin's busted," "exploded," "blown up."

In later years, when called to mind at all, the conviction is still more firm with me that a deafening peal of thunder is the result of a violent explosion of gases of high efficiency, rather than the rushing together of walls of air at about normal atmospheric pressure.

The vacuum theory seems unreasonable and unsatisfactory in at least two particulars:

First: So far as I am aware, it has never yet been satisfactorily demonstrated that the mere discharge, or passage, by whatever technical term designated, of an electrical current, however powerful, through the atmosphere, produces any perceptible disturbance in that atmosphere or any portion of it, let alone displacing oceans of air, leaving a completely walled-in vacuum of thousands or millions of cubic feet.

Second: Granting the creation of the vacuum, the theory that a volume of air regaining its equilibrium under fifteen pounds pressure can produce the deafening roar of a peal of thunder seems absurd and preposterous.

If this "air rushing in to fill a vacuum" theory is still being advanced by the salaried professors of science throughout the country, as Mr. Reynolds' article seems to indicate, then certainly some suggestions from laymen may not be amiss. Following this example, and also "at the risk of advancing a theory which may have been already presented by meteorologists," I will suggest a theory somewhat at variance with that of Mr. Reynolds.

Some years since, a friend—Prof. H. A. Lewis, superintendent of our schools—and myself, whiled away a leisure afternoon in experimenting with some new apparatus just received for the high school laboratory. Among other experiments we decomposed a small quantity of water by electrolysis, using for the purpose a small cell battery. The apparatus is very inexpensive, and the experiment may be tried by any novice, with a little instruction from some high school student familiar with the experiment.

Two glass tubes, closed at one end, were filled with water and then inverted in a dish of water, in the usual manner, for the reception of the hydrogen and oxygen gases respectively.

These two apparently harmless gases, as is generally understood, become highly explosive when brought in contact with each other in proper proportions and a flame applied. Accordingly, when the hydrogen tube was two-thirds filled, the battery was disconnected, and the balance of the hydrogen tube was carefully filled with oxygen from the other tube. The wires were then properly arranged to pass a spark through the gases, the battery again connected, and the expected happened—a violent miniature explosion, shattering the glass tube into fragments, while the gases, following a natural law, as the result of the explosion fell to the table in the form of the water from which they had been decomposed.

Briefly, a slight electrical current, with the aid of a little sulphuric acid, decomposes a dish of ordinary water into two gases, hydrogen and oxygen. These two gases are collected, and brought together in proper proportions. A spark from the same current that generated the gases converts them into the same water from which they were generated, or decomposed; the water falls into the dish from which it started. Here, then, seemed to us the logical solution of the cause of thunder.

Now, as to the application: The heavy, moisture-laden clouds represent a huge dish of water. The electricity of the atmosphere furnishes a current equal to that of perhaps millions or billions of our experimental cell battery. This current, with resources of a magnitude beyond comprehension, rapidly decomposes the water of the heavily saturated atmosphere or clouds, into the two gases in vast volumes.

These gases rise in strata possibly miles and miles in length—limited only by the extent of the field, or water cloud, upon which the current is operating. In rising they rapidly commingle or permeate each other, until there is an explosive mixture of tremendous volume. When the conditions are right—when the proportions are correct to form a high explosive—a flash from the same current that has been generating the elements of this mixture explodes the charge, and we have thunder as the result of a violent explosion—either as a short sharp crash due to the explosion of a limited volume of the gas directly overhead or in the immediate vicinity of the hearer or the long, reverberating roll, due to the difference in time required for the sound waves to travel to the ear from the nearest to the farthest point of an explosion of a long stratum of the gas, returning possibly for miles along the crest of some heavy cloud.

Is not this a more rational, logical theory as to the cause of thunder than that it is caused by a volume of air at fifteen pounds pressure rushing in to fill a vacuum that has never been demonstrated to exist?

If this theory or solution of the cause of thunder is not perfectly logical in every sense, will the SCIENTIFIC AMERICAN kindly explain, editorially, why it is not?

One further point: The wise professor who explained the vacuum theory of thunder, also explained that the heavy precipitation of rain immediately following a heavy peal of thunder, was due to the concussion—the vibration from the concussion jarring the moisture together into drops and shaking the drops down, as a boy shakes apples from a tree. While it is true that there may be some basis for the theory that detonation, such as that of heavy cannonading, etc., will precipitate moisture, it is still open to question; and how much more simple and logical is the explanation that the heavy precipitation immediately following a peal of thunder, amounting in some instances to a cloudburst, or the dropping of almost a solid body of water, is only a natural consequence.

The same explosion which causes the sound of thunder also converts a large volume of gases into pure water—the water simply falls from force of gravity in greater or less quantities in proportion to the volume of gases exploded and converted into water.

E. L. BATES.

Pentwater, Mich., January 21, 1903.

[The commonly accepted mode of accounting for thunder may be stated in a few words as follows: "The lightning heats the air in its path, causing sudden expansion and compression all round, followed by a sudden rush of air into the partial vacuum thus produced." (Quoted from Silvanus Thompson's "Elementary Lessons in Electricity and Magnetism.")

We presume that this is the theory with which Mr. Reynolds and Mr. Bates are dissatisfied.

We would venture to suggest that they have attached too little importance to the first part of the statement of this theory as given in Prof. Thompson's book.

When hydrogen and oxygen unite to form water vapor it is the heat produced, and it only, which causes the explosion, for at the same temperature the hydrogen and oxygen together occupy more space than the water vapor formed (supposing it to remain vapor and not to condense to water).

$$H_2 + O = H_2O.$$
$$2 \text{ vols.} + 1 \text{ vol.} = 2 \text{ vols.}$$

So whether there is any electrolysis of the water or not it is equally true that the noise of thunder is produced by the sudden heating of the substances in the path of the lightning as stated above. The expansion causes a compression of the surrounding air which rushes in to fill the partial vacuum. This in turn forms a second partial vacuum and thus the alternate condensation and rarefaction of the air produces sound waves. Judging by the pitch of the sound produced these waves are very long, which shows that the disturbance also must have a great length. To introduce any hypothesis of an electrolytic dissociation only complicates matters and moreover brings in an element of doubt, where none is needed, and by which nothing is gained.

It is very doubtful if the presence of any ordinary quantity of moisture in the air appreciably affects the nature of the noise of thunder. From the conditions of the case (i. e., the extremely high temperature and the suddenness of the lightning), it seems extremely improbable. It is no small matter for a large volume of air to be heated to several thousands of degrees centigrade in a vanishingly small part of a second, and the presence or absence of a small percentage of water is not likely to tell in view of the magnitude of the effect attributable to the heating of the air alone.—ED.]

The Langley Aerodrome's Accidental Flight.

Prof. Langley's aerodrome took a rather unexpected flight on January 31. The machine was moored to a houseboat in the Potomac. During a heavy gale it rose from its usual recumbent position and tried to soar. It was fastened to the houseboat, but is said to have snapped the mooring lines of the boat and to have taken that along with it. According to the watermen along the river, the houseboat was dragged along for a while, while the machine maneuvered strangely in the air. After a number of peculiar twists and turns the aerodrome and the boat ran into a steamer. Twenty feet of the steamer's guard rail were torn away. The aerodrome was caught in a flagpole.

On October 21 Prof. Cunningham delivered the Huxley lecture discussing the subject of right-handedness and left-brainedness. So far as evidence goes it seems probable that right-handedness was a characteristic of man at a very early period. It is an inherited quality in the same sense that the potential quality of articulate speech in man and of song in birds are inherited possessions. Investigation shows that right-handedness is due to a transmitted functional pre-eminence of the left brain, and this factor prevents an oscillation of the condition from one side to the other in those curious cases in which the right and left sides of the body are reversed and the thoracic and abdominal viscera transposed. The greater part, if not the whole, of the motor incitations which lead to articulate speech go out from the speech center in the left cerebral hemisphere. Left-handed people speak from the right brain.

Mr. J. N. Maskelyne, of London, has been experimenting for some time past with a wireless telegraphic apparatus of his own design, which is being installed upon a number of cable vessels. Maskelyne has attracted no little attention by his attempt at tapping Marconi's messages. He has installed a station at Portheurnow in Cornwall, 18 miles from Marconi's Poldhu station, and has been able to receive some of the messages that Marconi has dispatched to or from Poldhu. Maskelyne even received and deciphered the messages transmitted by Marconi from Nova Scotia. Marconi claims that Maskelyne received only imperfectly attuned messages.