very much increase the rate of discharge, and, as nearly as I could tell by this rough experiment, about double the rate.

"In regard to the general action of the machine, I can say that I have never seen any machines of the Holtz or Toepler-Holtz pattern that worked so uniformly well in all weathers. One of these machines has been standing on the table here in the office for several days, and I have tried it almost every day, and have never had it fail to generate. During some of the time it has been here, the weather has been very damp and rainy, — sometimes so damp that I did not expect the machine to work at all, — but I have never found it fail to build up quickly, and give a spark two inches long. [This was one of the smallest-sized machines.] This shows that you have succeeded in finding some very good glass, and also that the insulation of the various parts is of the very best. The addition of the round disk, with the insulator in front of it, as one of the electrodes, is also a very interesting one, as it permits of one of the best experiments that I have ever seen for showing the difference in the discharge when the polarity is reversed. The difference in the character of the discharge from the knob is very marked when the knob changes from positive to negative. I may say, therefore, that I consider all the special features of the machine as distinct and important improvements."

Another great improvement that is made in this machine is the form of the electrode which is used. This is made of a metallic disk two inches or more in diameter, and hollow, so as to have very gradually rounded edges, thus preventing any leakage at the edges. Over this disk, separated from it by about an eighth of an inch, and nearer the other electrode, is fastened a thin disk of vulcanized rubber about half an inch less in diameter. This rubber disk plays the part of the rubber sheet sometimes held between the electrodes, and compels a much higher potential to be established between the two electrodes before a spark can pass. It can be used upon either one or both electrodes, as desired.

These new machines are being sold by Messrs. Queen & Co. at the same price as the ordinary form heretofore used, and are gotten up in the finest possible manner. It may be mentioned, also, that the plates used in Messrs. Queen & Co.'s machines are manufactured and prepared by Voss himself, the inventor of what is usually known as the Toepler Holtz machine, and are guaranteed to give much finer and more reliable results than any plates made in the American market. There are certain little tricks of the manufacture and application of the insulating shellac which Americans have not yet mastered, pursued by the Germans to perfection, and which add greatly to the efficiency of the machine.

It may not be generally known that Messrs. Queen & Co. were the first to introduce the Toepler-Holtz machine into this country. In 1880 the manager of their physical department, Joseph J. Walton, while on a business trip abroad, accidentally learned of the existence of this machine, examined it, and was so favorably impressed by it that he purchased a number for introduction into this country. This was the first appearance of the now well-known Toepler-Holtz machine in the United States. It was exhibited soon afterwards by the before-mentioned gentleman at the meeting of the American Association for the Advancement of Science, and attracted much attention. It immediately became popular, and had such a large sale that it was straightway copied by various American makers, and patents secured upon modified forms.

WYNNE'S ELECTRIC TRAMWAY SYSTEM.

THE system of electric tramways invented by Mr. Frank Wynne of 5 Westminster Chambers, London, aims at connecting a moving tramcar with an electric conductor buried beneath the roadway, without the use of an open slot. To effect this there is laid in the centre of the track a crenellated contact-plate or rail, in short sections, of the form shown in the annexed engraving. It is half an inch wide on the surface, and about four inches and a half deep, the form being such as to follow the junction line of the sets. It will be seen that the contact-plate will be quite different in its effect upon vehicles from the tramway rail; wheels will cross it without difficulty at any angle, since they cannot slide along it for more than a few inches; horses will also find a good foothold upon it. The plate is laid in short sections entirely disconnected from each other, and each piece is coupled by a wire to the electric conductor beneath. In this wire is an automatic switch which makes circuit between the section and the conductor as the car comes over it, and breaks the connection when the car has passed. Only three sections are ever connected to the conductor at a time, and generally there are only two. A strong wire brush on the car rubs along the sections, and conveys the current from them to the electric motor, whence it flows to the rails and to earth. The automatic switch is exceedingly simple: it consists merely of an electro-magnet, an armature, and two contact-pieces. Supposing the car-brush is in contact with No. 1 section, the current will flow from the main conductor across one contact to the armature, through the armature to a second contact, thence through the magnet-coils to the section and the motor. A fine wire connects the armature

to the magnet of the next section, but, as no current flows through it, the armature of that magnet is not attracted. But immediately the car-brush touches that section, the current flows, the armature is attracted, and the section is connected directly to the main conductor. At the same time, the armature of the section over which the car has just passed drops, and breaks the circuit. Thus, as the car proceeds, it successively takes sections into circuit and drops them out. The details of the system have been very carefully worked out with the view of meeting every contingency that may arise in working, and it is estimated that the system can be applied to an existing tramway for an expenditure of $11,000 per mile of single line; that is, for about the cost of horses and horse-cars. *Engineering* says, "This seems one of the most promising schemes for electric tramways which has been yet brought out in this country [England], and it is well worth a trial. The astonishing success of electric trams in America will be repeated here as soon as a system has been developed suited to English tastes and ideas."

WATER-SPOUTS.[1]

HAVING sailed from New York the 16th of October in the United States steamship "Pensacola," we had first a few days of westerly winds and moderate sea, and then fell upon a region of easterly winds, generally south-easterly, and with every indication that we were in the easterly portion of a cyclonic region, the storm-centre being three hundred to five hundred miles to the westward. From such observations as we were able to make on shipboard, it was concluded that the storm-centre, which on the 20th of October was south-westerly, was slowly moving to the north-eastward, and would overtake us and pass beyond. This it apparently did, and disappeared from our observation on Friday the 25th. Meanwhile we experienced warm south-easterly winds, with numerous showers of rain and occasional squalls of wind.

On the morning of Tuesday the 22d we were favored with a remarkably fine development of water-spouts. About 9 A.M., occasional whirls of spray were seen on the surface of the sea, at points bearing between south-south-west and west-south-west. These whirls, and the subsequent water-spouts in that region, were all on the north-easterly side of a region of cloud and rain, the interior of which constituted a veritable rain-squall. The north-easterly side of this region, as seen from the vessel looking south-westward, was bordered by rolls of low scud upon which the sun shone; but beyond and below this the clouds, being mostly in the shade, had the dark-blue tint that belongs to the rain-cloud and the rain. The water-spouts apparently originated in the scud-clouds, which, as I have just said, formed the north-easterly border of the squall proper. These scud-clouds were

[1] From Bulletin No. 6, by Cleveland Abbe (Nov. 7, 1889), of the United States Scientific Expedition to West Africa, 1889 (David P. Todd, director).

moving towards the north-west, and therefore nearly perpendicularly to our line of sight. By 10 A.M. the conditions for the formation of the water-spouts, namely, the long axis extending down from the clouds, had become very favorable; so that from 9.30 until 10.15 there was a continued succession of such spouts, forming and disappearing in this portion of the horizon. At one time as many as five and seven were visible simultaneously; and the total number that formed and disappeared was estimated at about thirty by some, but at about twenty by myself. The first ones formed were at a distance from us estimated at about four miles; the last ones, at a distance of two or three miles. As the squall grew in dimensions and approached us, it was hoped that spouts would be formed much nearer; and in fact one was observed endeavoring to form in a mass of rain, at a distance of scarcely a quarter of a mile on our starboard bow. A number of drawings of these phenomena were made, and some photographs were taken. The latter, however, are not considered very successful, owing to the insufficient contrast. Among the features noted in these water-spouts, which will, I think, deserve to be ranked as general phenomena for all such spouts, are the following:—

1. The whirling motion of all the spouts took place in the same direction, so far as could be judged, and was that ordinarily called "counter clock-wise."

2. The general motion of the water-spouts as a whole was from left to right, or from the south-east toward the north-west, and therefore counter clock-wise, considered as a partial rotation round the centre of the rain-squall.

3. As this rain-squall was essentially a part of the formation of a cumulus-cloud out of a mass of what would otherwise have been called low scud, and as no water-spouts, or any tendency to the formation of such, were seen on the other side of the cloud after it had overtaken us, as it did at 10.30, I conclude that the formation of the water-spout requires a special upward ascending current due to a special buoyancy in one portion of the cloud; and, other circumstances being the same, such buoyancy must generally be found, as in this case, on the sunny side of the cloud, and is due largely to the action of the sun's heat on the surface of the cloud, combined of course with the buoyancy of the ascending cloud masses. As regards the individual tornadoes or water-spouts, it is very evident that a less rapid whirl was required to form the little saucer-shaped mass of spray at the ocean's surface than was required to form the axial cloud that reached down from above. There were, I think, more cases in which the spray appeared first, before the cloudy axis was visible, than the reverse cases; but there was nothing to show that the ascending movement started at the ocean's surface, and carried the sea-water upward into the cloud. On the contrary, all the details of the phenomena showed that the spray carried up from the surface of the sea attained only a height of perhaps a hundred feet, and was then thrown out, and descended from the rim of the saucer. In some cases the axial cloud apparently descended into, and was lost sight of in, the lower spray, but its appearance was such that it was always possible to distinguish it from the spray. The axial cloud invariably began its formation at the lower surface of the general cloud, and stretched downward by spasmodic efforts, gradually increasing its length until it perhaps reached the spray, and then began retreating, forming and re-forming several times, until finally either a permanently steady, tubular cloud was formed, which would continue in sight, bending and swirling about for several minutes, or, as in many cases, after several efforts the whirl broke up, and no permanent tube was formed. When the cloud was about to shoot down to a considerably lower level than it had hitherto attained, the shooting was generally preceded by the appearance of an exceedingly fine axial line; and when the tubular cloud shot down, as seen by the distant observer, I should say that this apparent descent was merely the sudden expansion to a visible diameter of the fine line that had just preceded it. The appearance of this fine line was very similar to that of the sting of a bee protruding from its sheath; and frequently I saw this line shoot down and disappear a number of times before the rapid whirl was finally able to produce an axial cloud of permanent size. In many cases the axial cloud itself showed a fine line down its centre, the cloud itself being whitish; while the central line was either dark or bright, depending upon the background against which it was seen. This agrees perfectly with the accepted theory of the formation of the spouts, according to which the long narrow cloud is not a solid mass of cloudy material, but rather a hollow cylinder; so that when one looks through it the central portion is much more transparent than the edges.

At numerous points, from the general cloud under which the water-spouts were formed, there were descending showers of rain; and scud, from which rain descended, afterwards formed between us and the tornadoes, and finally again off the port side of the vessel; so that by 10.20 we were enveloped in a heavy rain, with the wind from the south-east or starboard side. This continued ten or fifteen minutes, after which it slackened up. In hopes that we might get near enough to the whirl that surrounds the spout, and experience an appreciable depression of the barometer, I carried an aneroid in my hand; but in no case was I able to see that it was affected by any or all of the spouts. The barometer at 9 A.M. had read 30.12; at 9.35 it read 30.08; at 10.20, after the rain-squall had struck us, the pressure rose to 30.20, and at 1 P.M. had sunk again to 30.18. These fluctuations are those that attend ordinary rain-squalls, and have, I suppose, no connection with the water-spouts as such. It was not to be expected that the barometer would fall except within the whirling wind, and possibly within a hundred feet of the axes of the water-spouts.

It has frequently been supposed that the discharge of a cannon will break up a water-spout. On the present occasion, it so happened that a six-pounder was ordered to be discharged in order to clean it out; and this took place in the midst of the display of water-spouts, which were then three or four miles distant. The discharge of the cannon was followed within a few seconds by the breaking-up of one of the spouts; but others remained, and several others were formed a few minutes afterward, so that the breaking-up of the one can only be considered an accidental coincidence; nor is there to my mind any conceivable reason why the discharge of a cannon, at a long distance from a spout, or even the firing of a cannon-ball through the spout, should be considered likely to have any appreciable influence on the great mass of revolving air.

The general discussion of the mechanism of a water-spout has been so well given by Ferrel in his newest work, "A Popular Treatise on the Winds" (New York, 1889), that I need only say that every thing observed by us on the 22d of October fully confirmed the views therein set forth by him.

On the next day, the 23d, about 8.30 A.M., the clouds looked favorable for a repetition of the water-spout phenomena, and beautiful mammiform clouds were indeed seen developing into the axial clouds of water-spouts. One of these lasted over twenty minutes, but did not reach any considerable distance down toward the sea; nor was any whirl of ocean spray to be seen beneath it.

Of all the spouts seen on the 22d, the largest appeared to have a horizontal diameter of about one-tenth its vertical height. This one also lasted the longest, and, after breaking up, was apparently followed by rain to a greater extent than in the other spouts. The narrowest of these spouts had an apparent diameter of about one hundredth part of its height. The general height of the tops of the spouts was pretty uniform, like that of the scud to which they belonged, and was, I should estimate, about twelve hundred feet.

AMENDED ORTHOGRAPHY.[1]

THE alphabetic representation of language has long occupied much of my attention, although my efforts hitherto have been directed to means of facilitating the use of orthography as it is, and not to the advocacy of any changes in spelling. The funda-

[1] From a letter addressed to the House Committee on Printing and to members of Congress and of the Senate, by Alexander Melville Bell, on the scheme of amended orthography recommended by the commission of the Legislature of Pennsylvania.