of such extreme delicacy as photographing the corona, and, lastly, to consider whether the proposed method of removing it to arrest the process of destruction, and restore to the scenery its natural character. In pursuance of this commission, the commissioners instructed Mr. James T. Gardiner, director of the state survey, to appoint an examiner, and prepare for their consideration a project. He was assisted in this work by Mr. Howard Potter of New York being president, and Hon. J. Hampden Robb, chairman of the committee.

Through the efforts of this Niagara Falls association, an act was passed, in 1883, providing for the protection of the falls. The commissioners of the state reservation at Niagara, and giving them power to proceed through the courts to condemn the lands needed.

The examination showed that the destruction of the natural scenery which forms the framework of the falls was rapidly progressing; unsightly structures and mills were taking the place of the beautiful woods that once overhung the rapids; the fine piece of primeval forest remaining on Goat Island was in jeopardy from projects looking to making a show-ground of the island; and every point from which the falls could be seen on the American side was fenced in, and a fee charged for admission. It was found, that, owing to the topography of the main share, it was practicable to restore its natural aspect by clearing away the buildings from a narrow strip of land 100 to 800 feet broad and planting it with trees which would screen out from view the buildings of the village. When these trees should be grown, and the mills removed from Bath Island, and trees planted there, the falls and rapids would be again seen in the setting of natural foliage which formed so important an element in their original beauty. Every point from which the falls could be seen would also become free of access by the plan proposed. A map was made showing just what lands should be taken to carry out these objects. It was adopted by a law which adopted the plan of Mr. Gardiner and Mr. Olmsted, and recommended to the legislature of 1888 the passage of a bill for acquiring title to the necessary lands by the exercise of the right of eminent domain, leaving it to a future legislature to consummate the purchase by appropriating the amount for the payment of the awards, if the sum should seem a reasonable price for the property. Such an act passed the assembly, but was defeated in the senate, although the movement was supported by petitions signed by the most distinguished men of this and other countries. The report of the state survey, with its complete descriptions, illustrations, and maps, then became the basis of a systematic effort on the part of a few men to hold the legislature to educate and arouse public opinion to save the scenery of Niagara. Early in 1883 this movement ripened into the organization of an association to promote legislation for preserving the falls of Niagara. Mr. Howard Potter of New York being president, and Hon. J. Hampden Robb, chairman of the committee.

The recession of the falls of Niagara will be understood by reference to the accompanying figure. The strata, as will be seen, dip gently (twenty-five feet to the mile) toward the south. The upper stratum (No. 1) consists of compact Niagaran limestone about eighty feet in thickness. Underneath it (No. 2) is the comparatively soft Niagara shale of about the same thickness. Nos. 3 and 5 are strata of hard rock, with a softer rock underlying. The river formerly plunged over the escarpment at Queenston, about seven miles below the present cataract, and where the perpendicular fall must have been upwards of three hundred feet. From that point to the present cataract, the river now occupies a narrow gorge from five hundred to twelve hundred feet in width, and from two hundred and fifty to three hundred and fifty feet in depth. The manner of the recession is easily understood from a glance at the diagram. The softer rocks (Nos. 2 and 4) rapidly wear away, thus under­ mining the harder rocks above, and leaving them, pole by pole, to crumble into huge fragments, and fall to the bottom, where they would lie to obstruct the channel. The river cut not for the great momentum of water constantly pouring upon them, and causing them to grind together until they were pulverized and carried away piecemeal. The continuity of the underlying soft strata insures the continuance of a projecting stratum at the top, and perpetual slugging of the base of the state in order that the waters may suddenly be thrown over it.

Double interest attaches itself to the Niagara gorge, when we consider the evidence of its post-glacial origin, and thus are permitted to regard it as a chronometer of the glacial age.

That the Niagara River can have occupied its present channel only since the glacial period, was shown by Professor Newberry when he proved that the Cayahoga River, emptying into Lake Erie at Cleveland, occupied in preglacial times a channel about two hundred feet below its present bed, bournings in the bed of the Cuyahoga extending that distance in glacial days before reaching the lake. To receive a tributary at that depth, the level of Lake Erie must, of course, have been correspondingly represented; and it is estimated that in more than two hundred feet in depth, we may confidently say, that, before the glacial period, such a body as Lake Erie did not exist, but
Instead a wide valley through which a great stream, corresponding to the present Niagara, found its way to the head of Lake Ontario, through a deep and continuous gorge. Professor Spencer, indeed, thinks he can trace the course of this preglacial gorge from near the mouth of Grand River in Canada, northward to Lake Erie.

We might also infer the relatively late origin of the present channel of the Niagara from the small stream on which the river has done its present channel. The Allegany and Ohio rivers, which lie outside the limit of glaciation, illustrate in a striking degree the extent of preglacial erosion. For a distance of more than a thousand miles, these streams occupy a continuous eroded trough, averaging about a mile in width and from three hundred to five hundred feet in depth; whereas the gorge in the Niagara River below the falls is only about seven miles in length.

**Falls of Niagara**

That the Niagara gorge is post-glacial, was also shown as early as 1841, by Professor James Hall of the New-York survey, who wrote to Sir Charles Lyell: "The probable course of a preglacial channel, now filled with gravel, extends from the whirlpool to St. David's, where the level of Lake Ontario is reached. A glance at the accompanying cut will explain the situation. From the falls to Queenston, the perpendicular bank of the gorge, from two hundred and fifty to three hundred feet in height, is continuous on the east side; but upon the west side, about a hundred feet down, there occurs a remarkable indentation known as the 'whirlpool.' Following this bank down, the small streams in the rocks on both sides before descending to the whirlpool, and the rocky bank re-appears at e. But between e and no rock appears, although the stream d has worn a channel from fifty to a hundred feet deep. The sides and the bed of d consist of the familiar gravel deposit, the 'bowlder clay.' The distance from e to f is about five hundred feet. Following up the channel of d, one comes, at the distance of a half-mile, to the general level of the banks of the river above the cataract, and of the escarpment of Niagara limestone, from which the river emerges at Queenston. The opening of the supposed pre-glacial channel to the northwest is, as is shown in the plate, much wider than its entrance at the whirlpool, and the descent of three hundred feet to St. David's is rapid. The broad opening toward St. David's is also filled with gravel rather than with till; and this gravel extends southward over the higher level towards the falls...somewhat like the familiar 'lake-ridges' of Ohio. It will be seen that the existence of a pre-glacial channel from the whirlpool to St. David's—a distance of about three miles—is somewhat hypothetical, since for a space of two miles the original features of the country are wholly disguised by the glacial deposit, and no wells have been sunk to a sufficient depth to test the question properly. The idea to which Sir Charles Lyell referred was probably about the head of the stream c, which is really in the gravel outside the escarpment. Still there is little doubt that before the glacial period there was a narrow gorge, about two hundred and fifty feet deep, extending from the whirlpool, and perhaps a little above it, to the Ontario level at St. David's. But it is equally clear that the river which wore this gorge was not the Niagara, since a stream of that size must, during the long preglacial period (measured by the eroded channel of the Ohio and Allegany), have worn a gorge far longer than that between the whirlpool and the present falls. The preglacial channel from the whirlpool to St. David's was probably, therefore, as Dr. Paley suggests, a work of a comparatively small stream, with a drainage basin occupying not more than two or three counties in western New York.

**The First Suggestion of the Possibility of Niagara Falls as a Source of Electrical Energy.**

The first suggestion of the possible employment of Niagara Falls as a source of electrical energy, and the distribution of this energy in the shape of light and power, is due to C. W. Siemens. It was a large suggestion; and it took root speedily in what may be termed 'cosmical minds.' The way, however, to its fulfillment, has not been made plain to business enterprise. The most noteworthy remarks upon the subject were made by Sir William Thomson in 1851, at the York meeting of the British association. His remarks and calculations were in substance as follows: With the idea of bringing the energy of Niagara Falls to Montreal, Boston, New York, and Philadelphia, a total electromotive force produced by the dynamos-machines at the falls was taken at 80,000 volts. This was between a good electrical connection at the falls, and one end of a solid copper wire of half an inch in diameter, and three hundred statute miles in length. The resistance of the circuit was so arranged that there should be an electromotive force of 64,000 volts at the remote end, between the wire and the earth connection. The calculations showed that a current of 240 webers taking that as the dividend, if we can determine the annual rate at which the falls recede, and take that for the divisor, our quotient will represent what current would have been expelled since the period of the glacial period. The accompanying map gives a more definite idea of that divisor than we have heretofore. The lower dotted line represents the margin of the horse-shoe fall as mapped by the New-York geological survey, in the report of Professor James Hall. The upper line is that made in 1875 for the U.S. geologic survey. By comparing the two, a pretty correct calculation may be made as to the amount of recession of the horse-shoe fall in the interval of thirty-four years. This cannot vary much from a hundred feet upon the whole line, being, as the commissioners calculate, two hundred and seventy feet at certain points. Until this last survey, the attempts to estimate the time required for the cataract to recede from Queenston to its present position have been based upon very insufficient data. Mr. Bakewell, an eminent English geologist, gave personal attention to the problem as early as 1850, and, from every thing he could learn at that time, estimated that the falls had receded about a hundred and twenty feet in the forty years preceding. He recurred to the problem again in 1846, 1851, 1856 (American Journal of Science, January, 1857, pp. 87, 93), and was each time confirmed in the belief that the apex of the horse-shoe fall was receding at the average rate of a foot a year. On the other hand, Sir Charles Lyell, upon his first visit, in 1841, 'conceived' upon what basis he does not tell, the rate could not be more than one foot a year, which would give us thirty-five thousand years as the time required for its recession. As it appears, the result of the recent survey is to confirm the estimate of Mr. Bakewell, thus bringing the period down to about seven thousand years.

Two elements of uncertainty, however, tending to lengthen the estimate, should be noticed. In the first place, the recession may have been somewhat slower while the hard stratum, No. 3, was exposed. In the second place, the deposits of gravel running southward from St. David's, and corresponding to the lake-ridges, indicate that subsequent to the glacial period this whole region was slightly submerged beneath a shallow body of water; in which case, the recession of the gorge would have begun only a short time after the close of the period. And we have no means of telling how long an interval may have elapsed between the withdrawal of the ice and the withdrawal of the water.
would be produced in the wire, which would take energy from the Niagara end at the rate of 26,000 horse power, and only 3,500 horse power would be necessary to superintend and dissipate the heat through the conductors; and this is the case of water-power, where the energy is already multiplied at the head of the water-course. According to Sir William Thomson's calculation, it will be seen that eighty per cent of the energy will be thus transmitted; and it is also supposed that the solid copper wire was supported, like the ordinary telegraph-wire, upon poles, and found that an electric spark would not be produced between wires electrified to the difference of potential of 10,000 volts, unless they were within three-quarters of an inch apart; there could not be, therefore, great difficulty in the insulation. The cost of the conductor was reckoned at $185,000, and the interest upon this at five per cent is $9,500 a year.

At the time these experiments were made, great hopes had been excited by the invention of the Faure storage-battery; and Sir William Thomson closed his address by a glowing picture of the possibility of keeping a Faure battery of 40,000 cells constantly charged, we will say in New York, and applying a methodical system of removing sets of 50, and placing them upon local supply-circuits, while sets of 50 are re-placed upon the main conductor.

The electromotive force of a Faure cell is in the neighborhood of 2 volts; and 50 cells would be sufficient to supply seven arc-lights, and 80 cells to supply several arc-lights. Thus the electromotive force of 80,000 volts could be obtained, and the cost must be something, since the Faure battery is not permanent, or even fairly so. It can be said, with no unmeasured, that its working-life is less than a year, and during the time of its best estate it cannot be depended upon.

Many minds have been made to perfection by the Faure cell, and other forms of electrical accumulators; but no form of storage-battery can be so successful as this present writing. It is not, however, beyond the power of invention to devise a system which will be called 'storage-battery'; but the great difference of potential of 80,000 volts can be subdivided and utilized on different circuits. A number of small dynamos, or dynamos which could be connected with the great copper conductor leading to Niagara Falls in such a manner that the energy transmitted by this conductor could be distributed over a large extent of territory, either in the shape of light or power.

The distribution of light from a great central station has already been accomplished. The system of village-lighting devised by Edison can now be studied by those who are interested in the employment of the energy of Niagara Falls for a similar purpose. The limitations of distance apply to the present central electric-lighting stations, but only in regard to the great plan of utilizing Niagara Falls as a source of energy for a strong current of electricity to be distributed over a distance. It is true that abundance of water-power takes the place of coal; but the cost of the long conductors, the maintenance of the insulation, and the interest on the cost of any method of subdivision, must also be considered, and may be found to offset the cheapness of the source of the energy. We imagine, moreover, that few towns or cities would be willing to depend for their light on a sea of energy so remote as even fifty miles, to say nothing of three hundred. An accident to the copper conductor, due to the falling of a tree, or to some mischievous action, could plunge a city into darkness. If the conductor were placed underground, defective insulation would enter, and produce the same result. Even if the system of utilizing Niagara Falls as a source of electrical energy should be adopted, a supplementary system of lighting would have to be unlimited.

It is not safe to assume that, if this large scheme of utilizing Niagara Falls could be made successful, the water-power would already have moved in this direction; for capital, it is well known, is extremely conservative. The true reason that large sources of water-power have not been utilized for electric lighting on a large scale, is due to the fact that the small details, and what are called the small items, assume great proportions, and bid fair to consume all profits which come from a saving of coal. Thus the city of Buffalo could have been lighted by the utilization of the water-power, but the calculations have been unsound, and show that the power will not pay. It is not correct to believe that the failure to do so has been due either to the opposition of the gas companies, or to the lack of interest on the part of capitalists. In short, the facility with which energy in the shape of coal can be transported from place to place is one of the chief authorities of the energy of Niagara Falls. Authorities of the energy of Niagara Falls.

The reason for the utilization of the energy of Niagara Falls as a source of light apply also to the question of the electrical transmission of power, with this exception, that the electrical transmission of power has not reached even the perfection which systems of electrical lighting have attained.