THE CHROMO-CAMERA.

The chromo-camera is the name given to a new apparatus for the study of colors and colored lights. It consists of a cardboard box measuring 6 × 6 × 3½ inches and open at one end. The box or camera is covered with black cloth and the interior is lined with dead black paper. A cover, also black, closes the open end. On one side is an opening 3⅝ × 7⅞ inches, the lower edge of the opening being 1 inch from the bottom of the box. With the box are three "tinters," such as are used in color projection lanterns. These tinters are made by inclosing a film of colored gelatine between two lantern slide covers. A slide mat is placed over the film between the glass covers, and the whole is bound with paper on the edges. One of the tinters is a deep orange red, one is a yellowish green, and the other is light violet, these three tints in a color projection lantern giving a white light on the screen. There should also be with the camera a number of squares of colored papers, such as are sold in packages of assorted colors for use in kindergartens, some colored fabrics, ribbons, etc., natural or artificial flowers, and a sheet of stiff white cardboard 5½ × 6 inches.

The chromo-camera is the invention of Mr. Charles Barnard, of New York, and was first used by him in his school lectures on the study of sense impressions of color. The color camera is used to examine the colors of objects placed in a colored light and to enable the student to mingle diffused white light and a colored light in various proportions. The invention is here described for the first time, and is freely dedicated by the author to the use of students and teachers.

To use the color-camera, place a table close to a window having a north or sky light free from reflections from buildings or trees, and cover the table with black cloth or paper. Remove the cover from the box and place it on the table with the opening uppermost and with the open end away from the light. The side curtains should be drawn together to mask the light from the eyes, leaving only a space in the center a little wider than the box. Draw the shade down to about on the line of the eyes when seated behind the table. Two or three persons can sit at the table where they can see the interior of the box. The teacher or operator should stand at one side of the table behind the curtains. Here the tinters, colored papers, etc., are in easy reach.

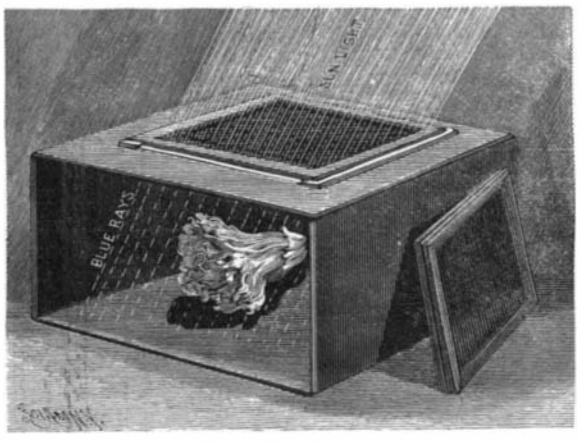
The box is now fully illuminated by the light that falls through the opening and by the reflected light that enters the open end. Place a sheet of red paper in the box. It is plainly visible. Now lay a book over the opening in the box. The red paper now appears to be almost black in the dark box.

Remove the book and paper, and place the red tinter on top of the camera near the back. Slide it slowly forward toward the light, and let the students watch the interior of the camera. When the glass fits the frame, and covers the opening, the interior of the camera appears to be of a very dark red, the color being faintly visible near the edge of the opening at the back, and fading away to dead black inside the camera. Place a sheet of white paper in the camera, and it appears a bright pink. The fingers are rosy, and a white flower is pale red. The effect will be improved by placing the cover of the box on edge just above the opening. Remove the red tinter, and the paper is again white. Place the green tinter over the opening, and the paper is a pale grass-green. Place the violet tinter on the box, and the paper is violet.

What has been accomplished? The light contains all colors. The tinters act as strainers. They shut off or strain out all colors except one. The paper capable of reflecting all colors (white) finds only one, and, therefore, reflects that one and no other. It would reflect it perfectly were it not for the fact that some white light is reflected into the back of the box and mingles with the colored light. It is this that causes the paper to appear pink under the red tinter.

Remove the white paper and put the red tinter in place. Put a red paper or red flower in the camera. It appears a deeper red. Now remove the cover from the top of the box, and let the operator hold the sheet of white cardboard upright on the edge of the box. Now gently tip it forward, and at the same time move it backward. It acts as a reflector and throws more white light into the box, and the red flower changes its shade of red, becoming lighter in shade as more white light mingles with the colored light.

Remove the flower, and place a sheet of pale yellow paper in the camera. It is now a deep golden orange, and by the aid of the reflector, the color can be made to change from yellow to orange. The same effect can be produced by sliding the tinter back to allow a thin sheet of light to enter the opening. Remove the yellow paper, and place a sheet of green paper in the camera. It appears neither red nor green, but yellow. The eye is now receiving two sensations, a sensation of red from the red light in the camera and a sensation of green from the green paper partly illuminated by white light that contains green. The compound sensation we call yellow. By sliding the tinter backward, or using the reflector, paper can be made to pass from green to yellow through many beautiful tints and shades.



THE CHROMO-CAMERA.

Place a white rose in the box, and we shall see a pink rose with yellow leaves. Place a blue flower or blue paper in the camera, and we shall see a purple flower or paper.

Put the green tinter on the camera. Now yellow paper is olive green, blue paper is Nile green, bright red paper is dark brown. A red rose is almost black-brown, while its leaves are a vivid green. Slide the tinter forward and back to observe the color change. Try the violet tinter, and under its violet light every color will suffer endless changes as the proportion of white light is allowed to mingle by means of the reflector with the colored light.

These experiments, novel and beautiful as they are, can be greatly improved by using the color camera in full sunshine. Place the table close to a sunny window in the full sunlight, the best time being between 12 and 3 o'clock. Draw the shade down till its shadow just touches the back of the camera. Now the shaders of the camera will fall on the black cover of the table, and upon it will be a square of sunlight from the opening in the box, this square of light being partly within the box, according to the position of the sun. By tilting the box up at the back it can be thrown inside the box, but if the curtains are closely drawn and the other windows are darkened, the effects can all be seen on the table outside the box.

Now all the experiments can be repeated with the most brilliant results. With the red tinter a sheet of blue paper appears a wonderful purple, green is a splendid gold color, and yellow a red orange. Every color, single or compound, will appear in marvelous brilliancy, and the students will be lost in wonder at the endless combinations of tint and shade of flowers, paper, and other materials under the magic of two lights, white light and a colored light.

Take a piece of cardboard and cut in it a small cross, star, or other figure. Lay this over the red tinter, and in the camera we shall see the figure in vivid red on a black ground. Place a green paper in the camera, and the figure seems to shine with an orange-yellow light. Try each tinter in the full sunlight, and a great variety of beautiful effects will be observed.

Next take the color camera to a good north light. Place a sheet of white paper on the bottom of the box, and upon this lay a penknife, rule, pencil or other small object. Put the object about an inch from the front of the box. The light that falls into the open box causes the object to cast a shadow on the white paper. Now place the violet tinter in top of the box, next to the front. Now let the operator move the tinter slowly backward till it covers the opening, while the students fix the attention upon the shadow in the box. When the opening begins to be closed by the tinter, the shadows deepens. A faint violet fringe appears on the edge. This grows deeper and deeper as the violet twilight in the box decreases. Suddenly, another color appears. The shadow suggests yellow, and just as the tinter closes the opening the gray shadow turns to a pale ghost-like yellow. By using the reflector the shadow can be made to turn from gray to yellow at will. With the red tinter the shadows are green, with the green tinter they are red; in each case the shadow is of the complementary color of the tinter.

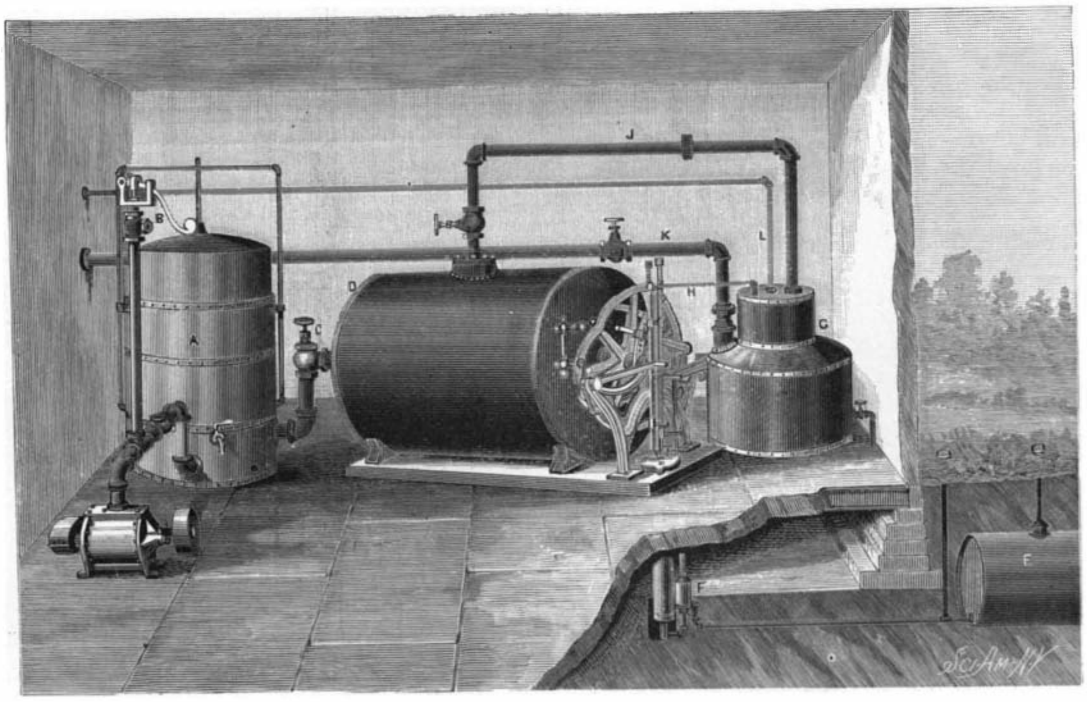
Students and teachers will find the chromo-camera both useful and entertaining in the study of color. Such experiments tend to train the eye to a finer appreciation of the distinctions of color, hue and shade, and such training cannot fail to add to our enjoyment of nature and art.

A NEW GAS-GENERATING MACHINE.

In the ordinary method of generating hydrocarbon illuminating gas, a large quantity of naphtha is exposed to the evaporating action of air and is absorbed. The degree of absorption depends upon the amount of naphtha thus exposed, upon the intensity of the heat applied, and upon the quality of the naphtha. This method has its defects, chief among which may be mentioned the lack of any means for producing an absolutely uniform quality of gas, as at times the air is supersaturated and carries an excess of hydrocarbon vapor, which condenses in the pipes, and at other times the air is but partially charged, the amount of saturation varying between these points. The most volatile portion of the naphtha is evaporated, and the portion of lesser degree of volatility often remains in the apparatus, necessitating removal as a waste. The difficulties which have been encountered in filling this want of an absolutely uniform quality of gas from naphtha without waste or condensation seem to have been overcome in the gas apparatus illustrated herewith and made by the C. M. Kemp Manufacturing Company, of Baltimore, Md.

The apparatus consists essentially of a naphtha-tank, *E*, an air supply regulator, *A*, a meter-wheel, *D*, and a converter, *G*.

The regulator, *A*, is provided with a gasometer-bell, the rising and falling of which operates the blow-off valve, *B*, of a pipe communicating with a blower serving the purpose of pumping air into the regulator, *A*. The air thus applied to the regulator, *A*, passes through the valved pipe, *C*, into the meter, *D*, by which it is automatically measured into volumes proportionate to the amount of naphtha-vapor with which it is to be mixed. As the air is being measured, the meter-wheel shaft is rotated by the passing current of air, the power thus obtained being made to operate a mechanism on the front of the meter-wheel, whereby the requisite quantity of naphtha is pumped from a well-pipe connected with the tank, *E*, and provided with a float cut-off, *F*. By reason of this arrangement the quantity of naphtha fed depends upon the quantity of air passing through the meter-wheel, *D*. The air which has been measured by the meter-wheel and the naphtha are respectively conducted to the converter by the pipes, *L* and *H*.



THE KEMP GAS-GENERATING APPARATUS.

Within the converter, *G*, a steam cylinder is mounted, to which steam is supplied by the pipe, *J*. The air conveyed by the pipe, *L*, and the naphtha fed by the pipe, *H*, are volatilized by the steam heat, are intimately mingled in the converter; and the inflammable mixture thus produced is distributed to the various burners in the building by the service pipe, *K*.

One chief point of merit of this apparatus resides in the automaticity of its operation. If the demand for gas be great, the gasometer-bell of the regulator, *A*, falls, thereby closing the blow-out valve, *B*, and causing a larger quantity of air to pass to the meter-wheel, *D*. If there be but few burners in use, the gasometer-bell of the regulator will rise, thus opening the blow-off valve, *B*, and permitting the surplus air to escape. When the various burners are shut off, the machine stops, but renews its operation automatically whenever gas is desired.

In the illustration the various parts of the apparatus have been disposed in a single room; but in practice they can be so distributed and arranged as to meet the conditions of the building in which they are placed.

The amount of steam used is trifling, as there is no large body of air or naphtha to be heated, but a very small amount of naphtha at any one time requires to be volatilized in the converter.

The inventors of this apparatus claim that the gas produced is of absolutely unvarying quality, and is supplied in accordance with the amount required by the burners. The demand may be very large or very small; the service may be constant or intermittent; but the apparatus will always conform with the requirements of the consumer.

They also claim that this apparatus does as well on the last gill of naphtha as when there is a full tank supply, and that the combination of air and naphtha is such as to insure against condensation. They claim further that the naphtha is kept underground with no pressure upon it whatever and is withdrawn and conveyed to the converter through a very small pipe. The apparatus has been favorably passed upon by the insurance authorities, and is allowed to be installed in city premises even having no yard space.

The inventors state that the fuel gas made by the apparatus produces an intense and extremely cheap illumination with incandescent burners, and is designed for lighting small towns, hotels, institutions, etc., and for fuel purposes for factories, etc.

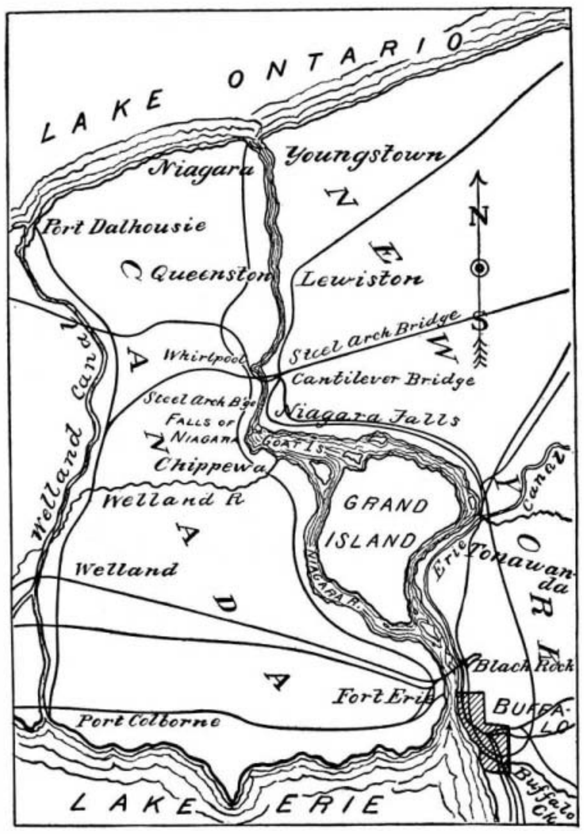
The manufacturers have other modifications of the apparatus adapting it to be operated by water service.

NIAGARA AS AN INDUSTRIAL CENTER.

At the foot of the main thoroughfare in the town of Niagara, at a point on the edge of the gorge about midway between the American Falls and the new steel bridge, is shown the spot where the first white man (so says tradition) obtained a view of the majestic falls of Niagara. That was more than two centuries ago, and Father Hennepin was so impressed with what he saw that in his book "Louisiana," published in 1683, he gave the height of the falls as being over three times as great as it actually is, putting it down as 500 feet. In 1697 he wrote his quaint work, "New Discovery," in which he gives the following oft-quoted description: "Betwixt the Lakes Ontario and Erie, there is a vast and prodigious cadence of water, which falls down after a surprising and astonishing manner, insomuch that the universe does not afford its parallel." So profound is the impression of magnitude upon the mind of the worthy father, that in a later description he adds yet another 100 feet to his former estimate, making the total height of the falls 600 feet! Its actual height is 167 feet. Father Hennepin was the first of a host of word-painters who have attempted to portray this surpassing sight—and failed. Niagara must be seen and heard; moreover, its appeal to the spectators will be as infinitely diverse as there are diverse temperaments in the multitudes of pilgrims that gather yearly at its banks from the four corners of the earth.

The present series of articles will be devoted to a description of the topographical and engineering features which are included in and suggested by the term Niagara: the river, the fall, the gorge with its overarching bridges, and the scenic railways which line its crest and follow the shore line at its base, and above all the unprecedented hydraulic and electric works by which the outflowing drainage of our great inland seas is being subjected to the service of a growing industrial city.

By reference to the accompanying map, it will be seen that the Niagara Falls are situated on the river of that name and about midway between Lake Erie and Lake Ontario. The river, which is 33 miles in length, flows in a general northerly direction, and in that distance it has a total fall of 326 feet, almost the whole of which occurs in the last 17 miles of its course. It forms the channel by which the whole of the drainage of the four great lakes, Superior, Michigan, Huron and Erie, flows into Lake Ontario; and as the total drainage area is 90,000 square miles and the total flow 275,000 cubic feet per second, it can be understood that Niagara is a truly imposing river. The interruption to navigation presented by the falls and rapids has been overcome by two notable canals. On the Canadian side, the Welland Canal has been cut in a northerly direction from Port Colborne on Lake Erie to Port Dalhousie on Lake Ontario (see map), and communication with tide water on the American side is maintained by the Erie Canal, which extends from Buffalo, at the entrance to the Niagara River, to Cohoes, on the Hudson River.

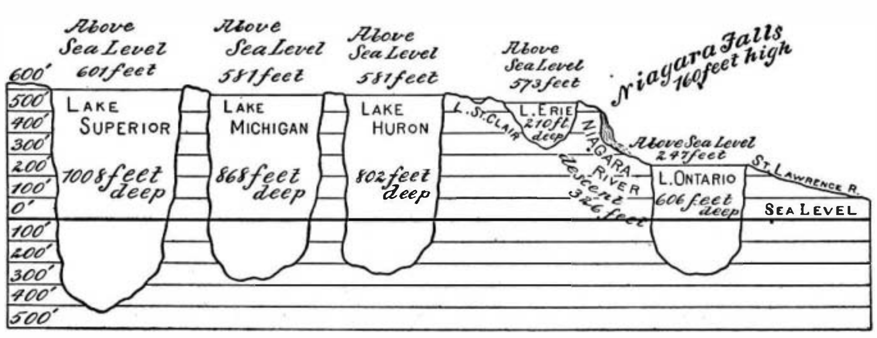


MAP SHOWING THE COURSE OF THE NIAGARA RIVER.

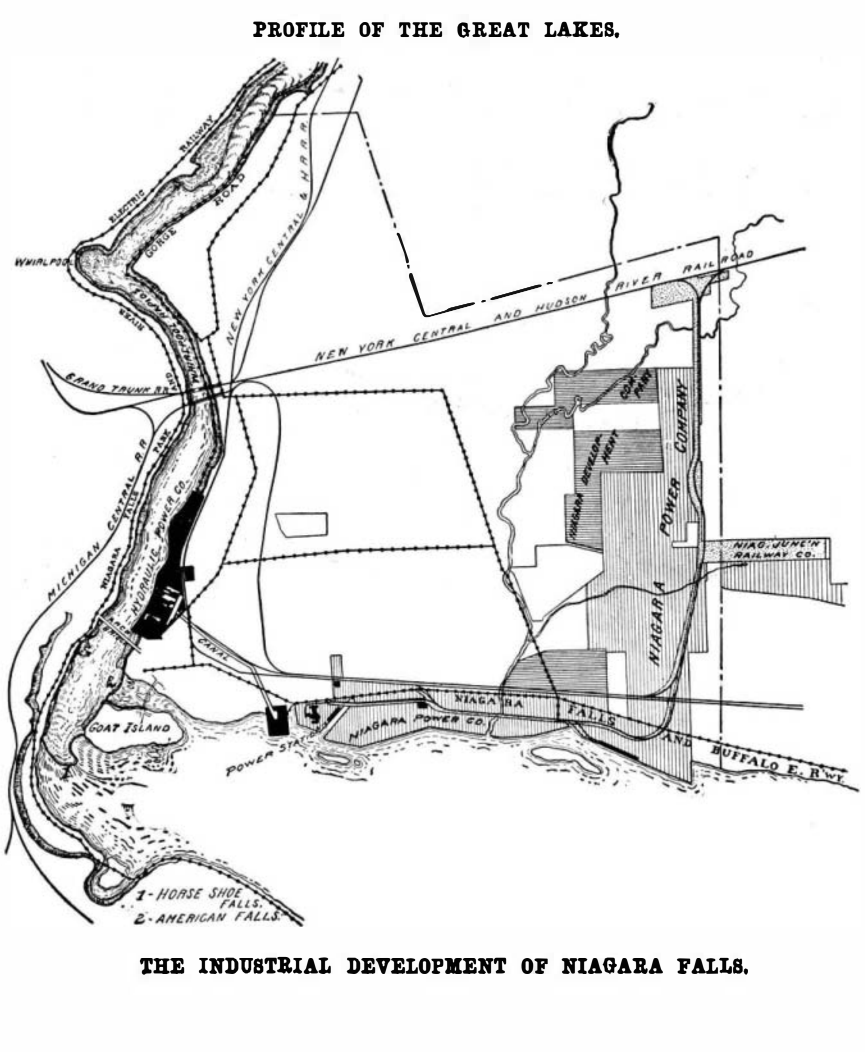
After leaving Lake Erie, the river flows somewhat swiftly for the first two miles, and then, with a slackening and widening current, divides to pass on either side of Grand Island (see map), below which it widens to its fullest breadth of 2½ to 3 miles, and flows sluggishly among numerous low-lying islands that make it look more like a lake than a river. Here the general course of the river is westerly, and it gradually narrows as it approaches the upper rapids, which extend about a mile above the falls. At this point the river enters the field of the bird's eye view embraced in our first page engraving. The total fall of the rapids is 52 feet, and, as the extreme width of the river is here 4,750 feet, the swift rush of the expanse of troubled water over its rocky bed forms a fitting introduction to the majestic falls below. About half a mile from the brink of the gorge the river is divided by Goat Island into two unequal streams, the one on the American side comparatively shallow and narrow, discharging over the precipice in what is known as the American Falls, while the major portion of the river swings around to the north and discharges over a crest of a general horseshoe form, from which it takes its name.

The American Falls are 1,060 feet in width, with an estimated maximum depth at the crest of 8 feet, and a vertical fall of 167 feet. The Horseshoe or Canadian Falls have a total width of 3,010 feet, a maximum estimated depth of 20 feet, and the vertical height is 158 feet. It is a singular fact that the amount of water which passes over the falls is practically constant, and what variations there are, are not caused by rainfall, snow, or changes of temperature, but are dependent upon the prevailing winds, which, if they blow strongly and alternately from certain opposite quarters, back up and then release the waters of Lake Erie and greatly increase the depth of the water at the falls for the time being. The normal flow, according to the gagings of the United States engineers, is 275,000 cubic feet per second, or about half a million tons per minute. The total fall available for power purposes from the commencement of the upper rapids, where the power companies have their intakes, to the river immediately below the falls is 216 feet, and this shows the theoretical horse power of the falls to be about 6,750,000. If we include the additional fall of 100 feet from the foot of the falls to Lewiston, 8 miles below, we find that the theoretical possibilities of Niagara must be put down at 10,000,000 horse power.

There is no great depth of water underneath the American Falls, indications being that its bed is full of massive and broken rock; but the enormous mass of water (estimated at from four-fifths to nine-tenths of the whole) that thunders over the Horseshoe Falls with a depth at the center of 20 feet, has excavated a basin and channel that is fully as deep as the falls themselves. The river maintains this depth, from shore to shore, for a mile and a half or more below the falls, shallowing gradually as it approaches the cantilever bridge of the Michigan Central Railroad. The enlarged cross section of the channel has the result of slackening the stream, so that it flows very sluggishly through this part of its course, so much so that small row-boats do not hesitate to cross from shore to shore. At the new steel arch railway bridge the river begins to fall with great rapidity over an extremely rocky and uneven bed, the fall extending for about a mile. As the gorge at this point narrows considerably, the confined waters rush down tumultuously at an estimated speed of 30 miles an hour, and the effect, as one stands at the bottom of the gorge and close to the edge of the mighty torrent, is even more inspiring than that of the falls themselves. The 10,000,000 horse power, the 30,000,000 tons per hour, and other figures of Niagara seem very conservative when one is standing on the edge of the Whirlpool Rapids.



PROFILE OF THE GREAT LAKES.



THE INDUSTRIAL DEVELOPMENT OF NIAGARA FALLS.

At the foot of the rapids is the Whirlpool, where the river takes a sudden turn of about 90 degrees to the right. The onslaught of the river against the opposing cliffs, assisted by a natural depression, has worn out a vast circular basin into which the waters of the rapids rush, and form the celebrated Whirlpool. From the Whirlpool the river flows through a broadening and less precipitous channel, until it passes between the picturesque towns of Lewiston and Queenston, to broaden into a wide channel for the rest of its journey to Lake Ontario. The fall in this last seven miles of the river is about half a foot to the mile.

By studying our front page view of Niagara, our readers will see that the river appears to have cut its way back from Lewiston through an elevated and generally level country, and this impression is confirmed by a study of the actual locality. Coming up the river from Lake Ontario, one notices that the surrounding country is low and fairly level, but at Lewiston there is a lofty and somewhat precipitous escarpment or bluff, the ground rising to a height of 374 feet above