RECESSION OF NIAGARA FALLS.

BY ALTON D. ADAMS.

Horseshoe Fall has receded more than 260 feet within the memory of living men, and is now traveling toward Lake Erie at the rate of fully 500 feet a century.

At present the crest of this fall, as its name implies, has the general outline of a horseshoe, and its length is about 3,000 feet, but if the present rate of erosion continues the length of the crest may reach 8,000 feet or more within the next half millennium. Now the Canadian end of the Horseshoe Fall is a few rods upstream from the spot whence Table Rock has fallen into the Gorge, but the indications are that this end of the cataract will gradually retire toward the Dufferin Islands, leaving a bare cliff as the apex cuts its way upstream.

The forces that are operating to bring about these changes have cut the prophecy of their completion in the rock of the river bed. In the earliest known view of Niagara Falls, that of Father Hennepin, published in 1697, the crest of what is now the Canadian cataract, like that of the American, is a straight line. Draw such a line from the spot where the crest of the Horseshoe Fall touches Goat Island, and across the Gorge at right angles to the Canadian bank of the river, and you have the probable approximate location of the crest of the greatest of the three cataracts that Hennepin saw. During the more than three centuries since Hennepin and La Salle first looked on this "great and prodigious cadence of waters," what is now the American Fall seems to have changed but little. Meantime the relatively small cataract, that the picture made by Hennepin shows in front of and flowing at right angles to the Horseshoe Fall, has disappeared so long ago that no living man can remember it, and the latter fall has so changed that Hennepin himself would hardly recognize it if he came back.

The straight line across Niagara Gorge, mentioned above as the probable location of the Horseshoe Fall in the time of Hennepin, measures nearly 1,300 feet from cliff to cliff. From the main New York bank along the crest of the American Fall to Luna Island, a mass of rock that is separated from Goat Island by a slender stream of water, the distance is only 800 feet in a straight line. The picture given by Hennepin shows no break in the crest of the American Fall between the New York bank and Goat Island, and it seems most probable that Luna Island was then a part of the former. With 800 and 1,300 feet, respectively, for the widths of the two larger cataracts seen by Hennepin, his picture of the Falls is very nearly in accord. All this is some evidence that the crest of the Horseshoe Fall in the time of Hennepin was approximately a straight line from the down-stream end of Goat Island to the Canadian bank. From the center of such a line to the present apex of Horseshoe Falls the distance is about 1,300 feet, and so it appears that the fall has receded to this extent during something more than three centuries.

Conclusions based on the apparent size and form of the Falls in the picture of Father Hennepin are in the nature of the case uncertain, but later and more accurate information leads to similar results.

In 1842, the contour of the Horseshoe Fall was determined by the State Geologist of New York, and, in 1890, the contour was again determined by the New York State Engineer. During the forty-eight years between these dates the crest of the Horseshoe Fall at its apex receded some 260 feet upstream. In this recession the apex of the Fall moved not in a straight line, but on a curve, as it had apparently done before, and maintained a nearly constant distance from Goat Island, while receding from the Canadian bank. As located in 1890, the apex of the Fall was about 1,300 feet from the nearest point on the shore of Queen Victoria Niagara Falls Park, and some 700 feet from the bank of Goat Island. If the apex of the Fall continues to cut its way upstream during the next 500 years at the same rate it has gone since 1842, and follows about the same curve, the year 2400 will see it some 2,500 feet nearer Lake Erie, and between the Three Sisters and Little Brother Island on the one side, and the Dufferin Islands on the other. From Little Brother Island the apex of the Fall will then be distant probably 700 feet, or 1,400 feet from Goat Island, and some 2,100 feet from the Dufferin Islands. In order to understand the reasons for the past and probable future movements of the crest of Horseshoe Fall, it is necessary to consider the forces by which the strong hand of the waters is chiseling a narrow channel several hundred feet deep through the strata of rock that underlie the upper river.

Just above Goat Island the width of Niagara River is more than 4,000 feet; between the upper end of the island and the Canadian bank the width is about 3,300 feet; and across the Gorge on a line uniting the ends of the Horseshoe Fall the distance is 1,200 feet. Approximately nine-tenths of the 222,000 cubic feet of water discharged by Niagara River per second is thus crowded into a deep and narrow channel before it reaches the Horseshoe Fall. Along what was supposed to be the deepest part of this channel runs the boundary line between the United States and Canada, fixed by the treaty of Ghent at the close of the war of 1812. Curiously enough at first sight, but for a very good reason, this boundary line coincides nearly with the center of the boiling cañon between the two converging sides of the Horseshoe Fall, and passes 300 feet from its apex. Such is the nature of the bed of the upper Niagara River that the erosion along the crest of the fall increases very rapidly with the depth of the water. This is due to the fact that all of the more rapid erosion takes place not by the gradual wear of the silt and gravel carried by the water, but by the breaking of great chunks of rock from the river bed.

At the bottom of Niagara River, just above the Falls, there is a layer of hard limestone intersected by numerous seams, and below this are layers of shale and other soft rock to a depth of several hundred feet. The limestone crest wears away only slowly as the water rushes over it, but the shale underneath is rapidly disintegrated by the spray and back-wash, so that the face of the cliff behind the Falls is constantly concave. It is this formation that makes it possible to go behind both the American and the Horseshoe Fall. As the overhanging ledge of brittle limestone is thus constantly increasing in length, a point is frequently reached near the apex of the Horseshoe Fall where the great depth and weight of water overhead can no longer be supported, and a large block of the projecting rock breaks off. In this way is the Horseshoe Fall cutting a gorge upstream, and the overhanging limestone naturally breaks away faster and forms the apex of the Fall at the point where the water is deepest and its weight the greatest. Hence, the form of the Horseshoe Fall. At the crest of the American Fall the water is shallow, for it forms only about one-tenth of the entire discharge of the Niagara River, and the channel between Goat Island and the New York bank, about 1,800 feet above the Fall, has a minimum width of only 400 feet, while the clear crest of the Fall is about 1,000 feet long. These conditions, together with the approximately uniform depth of water along the crest of the American Fall, have kept it nearly a straight line, and made its recession very slow.

It now remains to determine some of the results that will probably follow as the apex of the Horseshoe Fall travels toward the first line of breakers some 3,000 feet above the present crest. Niagara River changes its direction by fully ninety degrees at the Horseshoe Fall, and the Gorge just below is gradually being cut to form the arc of a circle, much as that at the Whirlpool was many centuries ago.

When Father Hennepin, in 1679, first saw Niagara, the Horseshoe Fall was just about to begin to make this 90-degree turn; its crest line seems to have been nearly straight, and its probable length was about 1,300 feet, as indicated above. Now the recession of the Falls has more than doubled that length of crest line, by changing it into the horseshoe form, and as the process goes on a long gorge not more than 700 feet wide will be cut in that part of the river bed where the water is the deepest. Thus the edge of the cliff over which the water flows will constantly lengthen, and the average depth of water over the edge of that cliff will approach more nearly to the greatest depth in that part of the river between Goat Island and the Canadian bank. As the volume of water per second that will flow over the edge of the cliff depends on the length of that edge, and on the depth of water above it, and as the actual discharge of the river may be assumed to be constant for this purpose, it follows that the water level between Goat Island and Queen Victoria Niagara Falls Park will be much lowered within the next five centuries. Even the coming century, if the apex of the Horseshoe Fall recedes 500 feet meantime, will see the crest of this fall increased by 1,000 feet, or one-third of its present length, and the water level between Goat Island and Queen Victoria Park will probably be reduced by one to several feet. Before the apex of the Falls reaches a point between Little Brother Island and the Dufferin Islands, the water flowing in front of Queen Victoria Park will be so thin a sheet that it will make nothing but spray in going over the edge of the cliff.

When the Horseshoe Fall has a crest some 8,000 feet long into a gorge that measures 3,500 feet from the apex of the Fall to its lower ends, and not more than 700 feet across between the two facing wings of the cataract, it will present an even more interesting spectacle than it does to-day.

Another incident of this change will be its effect on the great power plants between Dufferin Islands and the present crest of the Fall, along the shore of Queen Victoria Park. Directly in front of and only 700 to 1,000 feet distant from these plants will then be the crest of the Fall, and a great reduction of the water level at their intakes must result. The present stockholders and bondholders in these plants need not be alarmed, however, for long before the changes mentioned can be completed much of the equipment of these plants will have sunk in rust, after having earned, it is hoped, at least a fair return.

Electrical Notes.

The German Atlantic Telegraph Company is just laying out a new telegraph cable between Constantinople and Constanga, on the Black Sea. This cable is to be connected in Constantinople with the existing aerial telegraph lines between Bucarest and Berlin, so that a new direct telegraphic connection is forthcoming between Berlin and Constantinople. In addition to the German-Turkish telegraphic traffic, this new line is to be used for communication between the states of western Europe on the one hand, and Turkey, Asia Minor, and Greece on the other. The new line is supposed to assume a high importance for the economical interests of Germany in Turkey and Asia Minor, while greatly accelerating the transmission of telegrams between Berlin and Constantinople.

In order to prevent wireless messages interfering with one another, endeavors have been made to send electrical waves only in one direction, as luminous signals are given off from a concave mirror. Prof. Braun has been engaged in experiments of this kind, and in a lecture held on July 11 before the Strassburg University Association of Electricians and Naturalists he announced that these experiments had come to successful conclusion. Prof. Braun's methods are based on the fact that three antennæ arranged in the angles of a regular triangle are excited by waves of the same periodicity, but of different phases. The inventor states that one of the three antennæ begins vibrating by 1-250,000 second earlier or later than the two others, this difference in time being kept up, according to experiments, with an accuracy of about one second in three years. This will result in different radiation according to the difference of the space, and by simply inverting a crank the direction of maximum effects can be shifted by 60 or 120 degrees.

A new system of electrically lighting trains is being adopted on certain British railroads. This is the Leitner-Lucas system. It differs from the general Stone type, wherein the electrical energy is generated by an axle-driven dynamo and stored in accumulators, inasmuch that instead of compensating the variable speed of the axle by a slipping belt, there is an automatic decrease of the lines of force cut by the armature windings, by reducing the dynamo field in approximate proportion to the speed of revolution. To attain this end, subsidiary armature windings are mounted on the same shaft as the primary armature, and revolve under small separate fields, thereby becoming a small subsidiary dynamo. This arrangement is carried out in such a manner that the flow of current through the main field is counteracted or choked back by an opposing electromotive force from the small subsidiary armature, which opposing voltage rises proportionately to the speed at which the whole machine is driven. Various methods of winding have been adopted in this system for regulating against sudden rise of current or voltage in the circuit feeding the accumulators and lamps due to variations. The output of the dynamo is kept reasonably constant independent of the train speed.

Among miners, where the underground workings are lighted by electric incandescent lamps, there is often a tendency to be careless in the handling of the lamps. As the light is not naked, it is considered that the lamps may be laid down anywhere without fear or danger. Some experiments that have been carried out in England, however, prove the fallacy of this contention, and show that an incandescent electric lamp is equally as dangerous if not properly handled as a naked light. The investigations of Mr. H. Hall, one of the British government inspectors of coal mines, showed that when a sixteen-candle-power lamp was covered with coal dust, the generation of heat was so rapid that within four minutes a temperature of 450 deg. F. was attained, and the bulb burst. His investigations also showed that when the heat had risen to a certain point evidences of spontaneous combustion developed, and although the lamp was then removed from the coal, heat generation still continued, and finally the coal burst into flame. In another case the investigator imbedded a 100-volt 16-candle-power lamp in a heap of coal dust. Within three minutes smoke was emitted from the dust, and in another case where the lamp was simply laid down upon the heap, flame burst out in the course of twenty-five minutes. Colliery managers should therefore impress upon the miners the great danger, when stopping work for a few minutes, attending the laying down of the lamp upon the ground. It should always be suspended, with the bulb free from contact on all sides. Every care should also be displayed in handling the globes so as to avoid breakage, as the instantaneous exposure of the incandescent filament when the bulb bursts is sufficient to create a violent explosion should any firedamp be present. A short time back a terrible explosion occurred in a French coal mine, by means of which sixteen men lost their lives, owing to the ignition of the firedamp by the bursting of an incandescent bulb.