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SCIENTIFIC AMERICAN SUPPLEMENT

No. 759.

For the Week Ending July 19, 1890.

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COST OF THE NEW AQUEDUCT.

The new Croton Water Works for New York City have so far cost a little over twenty-three and a half millions of dollars. It is expected the water will be let on within a few days. The total length of the new aqueduct is 33⅛ miles, of which 30¾ miles is in the form of a tunnel, mostly through solid rock, 18 feet diameter, lined with brick 16 to 18 inches thick, filling of concrete, interior diameter for the most part of 14 ft. The delivering capacity is three hundred and ten millions of gallons per day. The work of excavating the tunnel was begun March 7, 1885, and finished July 7, 1888. This may be regarded as excellent progress, and shows the practical advantages of using the best and most improved tools.

THE PANAMA CANAL BUBBLE.

It is now over eight years since work was first begun upon the Panama Canal, and about two years have elapsed since active operations were suspended. The total cost of the work up to the present time, including the indebtedness of the company, is estimated at seven hundred millions of dollars, and the canal is hardly half finished.

De Lesseps' estimate of the cost in 1881 was one hundred and twenty millions, and the time required to open the canal five years. The mismanagement of the enterprise has been conspicuous, and the swindling practiced upon the company fearful. Among the methods of deception the following system was at the time reported. When a ship arrived with a cargo of coal, a small portion would be landed and vouchers given for the whole cargo; the ship would then depart and return again in a short time, ostensibly with another cargo, for which new vouchers would be given; the same trick would then be performed again. Thus by the knavery of its agents, who were simply plunderers, the company paid for materials several times over. There were rumors of frauds in almost every department of the work. There seems to have been a woful lack of that rigid business organization, and close scrutiny of details, which should govern in such an undertaking, in order to secure economy and success. Much of this laxity was doubtless due to the deadly and enervating climate, which almost at the beginning of the work carried to the grave several of the ablest and most experienced chief officers and many of their valued assistants.

After the failure of the company to meet its obligations, a receiver, as we should term him, but in France he is called a liquidator, M. Brunet, was appointed to take charge of the work and the properties of the company. He named a commission, consisting of twelve independent, experienced, and prominent persons, among whom were engineers and professors, who were charged to visit Panama, examine the works and machinery, and report on the best way of completing the canal, the further costs, etc. Efforts were also to be made to obtain a renewal of the concession granted by the Colombian government, as the privilege will soon expire—having now only a little more than two years to run. The commissioners reached Panama in December last and investigated everything with much care. Their report has lately been made to the Chamber of Deputies, and is anything but encouraging.

The committee says that the construction of the canal at the calculated level would occupy twenty years and would cost 1,737,000,000 francs—$347,400,000. In the opinion of the committee the work could only be completed on the basis of an international agreement or a syndicate of the states interested.

The report further states that, taking into account the interest to be paid during so long a period without any receipts, and also the general financial charges, the capital necessary must be estimated at three milliards of francs, or say six hundred millions of dollars.

A further report deals with the defects and omissions of four plans proposed for the completion of the canal. According to the first of these plans, the canal is to be isolated, no use being made of the existing waterways. The second plan proposes to make use of such waterways. The third provides for a ship railway as a portion of the proposed interoceanic route, and the fourth for a ship tunnel through the high land at Culebra.

Meantime the unfortunate shareholders have petitioned the French Congress, asking that the liquidator shall prepare a statement showing precisely what has been done with the money received by M. De Lesseps and the directors. More than twice the sum they stated would be required has been subscribed, and the creditors now believe it was obtained upon false representations. They seek to have the directors made personally responsible for their losses, and hope in that way to recover back at least a portion of their vanished treasures.

The Plasticity of Ice.

Mr. Thomas Andrews, F.R.S., recently read a paper on this subject before the Royal Society. The experiments named in the paper form a continuation of a previous research by the author. The experiments were made to investigate the relative plasticity of pure ice at various temperatures, ranging down to —35 deg. Fah. The arrangements of apparatus used in determining the plasticity of pure ice, and also of pond ice, are illustrated in detail in the paper.

The ice for the pure ice experiments was frozen from distilled water; the coldest freezing mixture used, consisting of three parts by weight of crystallized calcium chloride and two parts by weight of snow, yielded a constant temperature of —35 deg. Fah. Other freezing mixtures were used for the temperatures above this. The cylinders of pure ice employed were 2 feet 1½ inches long and 2 feet 1½ inches diameter, and weighing 470 pounds. The plasticity was ascertained by measuring the relative penetration during equal periods of time of the polished steel rods into the ice, care being taken to avoid errors from conductivity. A large number of experiments were also made on the plasticity of natural, lake, or pond ice. The influence of the composition of water on the plasticity of the ice frozen therefrom was investigated, and a number of experiments were made to ascertain the proportion of the saline constituents of the lake water taken up into the ice during crystallization.

Roughly speaking, it was found that the proportion of inorganic matter in the melted ice was about 10 per cent of the total inorganic salts contained in the lake water from which it was frozen. The general summary of results of the experiments on the plasticity of pure ice at the various temperatures employed are plotted out in four curves, and the results of the experiments on the plasticity of pond ice were shown in detail. In the majority of instances it was found that if the plasticity of the ice at —35 deg. Fah. be called one, at 0 deg. Fah. it would be about twice as much, and at 28 deg. Fah. the plasticity would be about four times as great as at 0 deg. Fah., or eight times as much as at —35 deg. Fah. The comparatively great contractibility in ice observed at considerably reduced temperatures—see the author's former paper "On Observations on Pure Ice and Snow," Royal Society "Proceedings," No. 245, page 544—may probably account for the great reduction in its plastic properties at low temperatures.

This is in accord with the practical cessation of motion in glaciers during the cold of winter. It was also noticed in course of the research that the plasticity of the naturally frozen pond ice was manifestly greater than that of the prepared pure ice. The comparative difference in the behavior of the pond ice was doubtless owing to a portion of the saline constituents of the water interspersing during congelation between the faces of the individual crystals of ice, thereby tending to reduce the cohesion of the mass as a whole, and increasing its plasticity.

Latent Heat.

The phenomena of latent heat were first investigated by Dr. Black, of Edinburgh, nearly 130 years ago. He was first attracted to the subject by noting that it was impossible to raise the temperature of ice until it was all melted. For instance, if a pound of ice is put over a spirit lamp, a large quantity of heat passes into the ice, but the mixture of ice and water shows no tendency to rise in temperature until all the ice has disappeared. The question then was what became of the heat. It was proved that the heat was used to melt the ice, but where did it all go to? It had disappeared and was unaccounted for.

Another experiment was tried in which a pound weight of water at 100° C. and a pound of water of 0° C. were mixed, and the result was two pounds of water at 50° C. In the mixture the pound of boiling water gave up 50°, reducing its temperature one-half, and the cold water receiving it is raised to 50°. But if instead a pound of water at 100° C. and a pound of ice at 0° be mixed, we have two pounds at the same temperature, but the mixture, when the ice is melted, would show but about 10° C. instead of 50°. Thus it would appear that 80 units of heat had disappeared and were unaccounted for. The experiment was then tried, from which it was found that this 80 units of heat reappeared when water was converted back again to ice, and this heat was manifest and given to the surrounding bodies. The question was: Where does this heat go to and where does it come from when it reappears? Dr. Black answered that heat was a kind of matter, a subtile and elastic fluid, and water had a great capacity for holding this fluid. Between the molecules of the water, it was said, there are minute spaces into which the heat finds its way, and there lies hidden as long as the water remains in the liquid state. In this condition the heat produces no sensible effect on the thermometer. But no sooner does the water begin to pass back into the solid form of ice than this heat is forced to come out from its lurking place and to make itself sensible once again. This was the doctrine that prevailed down to the close of the last century. The same action is seen in making steam, for if heat be applied to water, the temperature will rise until the boiling point is reached, and if the steam formed is allowed to escape, the water will show no higher temperature, though heat is being constantly added. This heat, it was said, was concealed between the particles of the vapor, and was squeezed