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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

CHICAGO DRAINAGE CANAL COMPLICATIONS.

In response to the request of the shipping interests of Chicago, the Secretary of War has given an order that the flow in the Chicago Drainage Canal must be reduced to 200,000 cubic feet per minute, which is about a third less than the discharge for which the canal was designed. When the construction of the canal was authorized by the Legislature, it was distinctly laid down that, when the sewage of Chicago was turned into the canal, it should be diluted at the rate of 20,000 cubic feet per minute for each 100,000 population, and that the total flow must not fall below 300,000 cubic feet per minute. These stipulations were made in agreement with the laws, and in response to the urgent representations of the residents of the valleys through which the sewage-laden waters of the canal would be carried to the sea, and it would surely seem as though the provision for a flow of 300,000 cubic feet per minute is surely none too ample in view of the unsavory burden that the canal waters carry. Unfortunately, the discharge of this volume of water produces a current which, it is claimed by the shipowners, is dangerous to navigation in the Chicago River. Moreover, the authorities of the city of Chicago are disposed to make much trouble over the question of canal bridges. Thus this magnificent enterprise would seem to be just now placed "between the devil and the deep sea."

It is not likely that any of these opposing interests would seriously deny that the drainage canal is a necessity, and that its completion and execution is one of the greatest sanitary works of this or any other age. That a large city like Chicago should continue to pour its refuse into Lake Michigan, with the prospect of ultimately bringing it into the absolutely disgusting condition which obtains to-day in Havana Harbor, is a proposition that neither the inhabitants of the Illinois and Desplaines valleys, nor even the city of St. Louis, would justify for a moment. Since the canal is there, and there to stay, it is surely possible, in such a reasonable age as this, for the contending interests to meet and consider the matter in a practical and broad-minded spirit, and make a compromise which shall do justice to every interest affected.

LIQUID AIR AS A BLASTING AGENT.

The problem of the exact field of usefulness of liquid air has been simplified by the elimination, for the present at least, of one class of work for which it was claimed that the new liquid would prove highly efficient. We refer to its use as a blasting agent. A paper recently read before the British Institution of Mining Engineers by Mr. A. Larsen described some tests recently made in the Simplon tunnel with cartridges, which consisted of a wrapper filled with a carbonaceous material, and placed bodily in liquid air until it was completely saturated. The cartridges were kept in the liquid, at the working face of the rock, until they were required for use, when they were lifted out, quickly placed in the shot-holes and detonated with a small guncotton primer and detonator. It was found that, owing to the rapid evaporation, the useful life of the charges was very short. The cartridges, which were 3 inches in diameter by 8 inches in length, had to be fired within fifteen minutes after being taken out of the liquid air; otherwise there was danger of a misfire. It was chiefly on this account that the tests were discontinued. The disruptive effects, however, were said to be comparable to those of dynamite.

TRAIN BRAKE RESULTS OF HIGH SPEED.

In our issue of April 27 we gave a synopsis of Behr's description of his high-speed monorail system, which it is proposed to build between Manchester and Liverpool, and on which it is expected that speeds of over one hundred miles an hour will be realized. It was mentioned that the important question of braking was to be solved by the use both of an electric and Westinghouse brake, and that calculations were based upon an estimate that the Westinghouse brake alone would enable the speed of the train to be reduced at the rate of three miles per second. Sir F. Bramwell, in a communication to the Journal of the Society of Arts, corroborates Mr. Behr's figures, and gives the results of tests carried out by himself and the late Mr. Cowper on the Midland Railway, in which it was proved that the speed of a train could be reduced at exactly the rate named, a train running at a rate of thirty miles a hour being brought to rest during these experiments without shock in ten seconds. Bramwell further suggests that it might be possible to utilize in high-speed trains a method of braking which is not dependent upon the weight of the train, and suggests the use of the "clip" brake, which, as the name implies, grips the sides of the rails in the same manner as the safety clutches used on many of the modern elevators grip the vertical guide-rails. The suggestion is a good one, for it would certainly seem that some form of clip brake would be necessary, at these high speeds, to secure an absolutely reliable and certain braking effect, whose power could be multiplied to any extent desired.

WATERWAYS AND CANALS OF CANADA.

The rivers and lakes of Canada, to say nothing of the splendid systems of canals by which they have been linked together, form a continuous inland water route which is unmatched in any other quarter of the globe. From the mouth of the St. Lawrence to the most westerly Canadian port on Lake Superior, a vessel may steam continuously in Canadian waters for a distance of 2,260 statute miles; while from Belle Isle to Montreal the St. Lawrence River offers a channel, large enough for the accommodation of ocean steamers, for a distance of nearly a thousand miles. The difference in level between Lake Superior and tidewater on the St. Lawrence near Montreal is 600 feet, and a vessel, in ascending from Montreal to Port Arthur, has to be lifted through this great vertical distance. Of this total 551 feet is covered by means of locks, and 49 feet of it are overcome by steaming against the stream, which, in some stretches of the river, is so strong that the vessels have to be assisted by tugs. According to figures furnished by J. L. Bittinger, consul-general, there are between Montreal and Kingston seven canals, with a total length of 50¼ miles, and a total lift at the locks of 207½ feet. The width of these locks is 45 feet, and the depth of water on the sills 14 feet. Steamers on the run down from Kingston make no use of several of these canals, for the reason that the rapids may be run with safety. From Kingston the westward course is through Lake Ontario to Port Dalhousie, where the Welland Canal commences. This structure is 26¾ miles in length, and the total lift of 326¾ feet is effected by twenty-seven locks, each 270 feet by 45 feet, with a depth of 14 feet. From Port Colborne, at the Lake Erie end of the canal, there is deep water for a distance of 394 miles to the Sault Canal, which is 5,967 feet in length, and contains a lock 900 feet by 60 feet, with a depth of 20 feet 3 inches, the total lift being 18 feet. Once through the Sault Canal the last natural obstruction is passed, and there is deep water to Port Arthur.

In addition to this magnificent system, Canada has another watercourse, which runs from Montreal to Ottawa, and then down to Kingston, a total distance of 245 miles. On this route there are four canals and locks: Lachine, St. Anne's, Carillon and Grenville. In the distance from Ottawa to Kingston, 126¼ miles, there are thirty-five locks. In addition to these main-line canals, moreover, there are other canals on the line of the Richelieu River, in Ontario, and through the Peterborough district in Cape Breton; and there are a number of branches connecting with the Rideau and Welland systems. The total traffic through the several canals in the Dominion, in 1889, amounted to 6,225,924 tons. The total quantity of through freight passed through the Welland and St. Lawrence Canals from Lake Erie to Montreal was, in 1890, 231,746 tons eastward and only 13,951 tons westward. In 1899 354,933 tons were passed eastward and only 5,991 tons westward. The total expenditure for the fiscal year ending June 30, 1900, was $3,351,164, and the total net revenue was $322,642. Commenting on this, the consul-general says that if it is judged by the net revenue received, as compared to the outlay, the Canadian canal system would be found wanting; but that the Canadians do not take so narrow a view of the question, and recognize that waterways and roadways are essential to the commercial life of the country.

TRANSPORTATION OF TRAINS ON LAKE BAIKAL.

The Bulletin of the Société des Ingenieurs Civils contains an account by M. Platon Yankowsky of the method of transporting the trains of the Trans-Siberian Railroad across Lake Baikal. The railroad is now in operation from Tcheliabinsk on the eastern frontier of Siberia, to Stretiensk, on the river Chilka, an affluent of the Amour, on the frontier of Manchuria, making a total distance of 2,650 miles. The route is interrupted over a length of 40 miles by Lake Baikal, and the trains are ferried across the lake, in order to avoid going around it, which would increase the distance by 82 miles. It is expected that the route will ultimately follow the shore of the lake, but its exact position has not yet been decided. The piers for the ferry system have been built at a considerable distance from shore to assure a sufficient depth of water; the piers are united to the bank by causeways which have 1,800 and 1,100 feet length respectively. These piers are formed of wood caissons filled with stone, and each has the form of a fork, whose branches are of unequal dimensions, that next the lake measuring 486 feet long by 32 feet wide, and that next the shore 220 feet by 20 and 25 feet. The ice-breaking ferryboat "Baikal," used to transport the trains, enters the free space between the two branches, where it is protected from the waves. Upon the deck is let down a gang-plank which establishes communication between the rails of the piers and those of the boat, and the train passes upon the latter. The "Baikal," whose shell is of soft steel, measures 285 feet long by 56 feet maximum width, and the height from keel to the center of the main deck is 12 feet. When fully loaded, it has a draught of 19 feet forward and 17 feet aft; its displacement is 4,200 tons, including 580 tons water ballast and 250 tons of coal. It is driven by three screws, of which two are in the rear and one forward; the latter serves at the same time to disperse the ice which has been broken. These screws have four blades, the forward screw being of phosphor-bronze and the rear pair of steel. The former has a diameter of 12 feet and the latter 10 feet. The three triple-expansion engines give a total of 3,750 indicated horse power, and the steam is furnished by fifteen cylindrical boilers. With its three engines, the "Baikal" passes easily through compact ice two feet thick and more at a constant speed of about three knots an hour. Upon the deck are three tracks, which can receive 25 freight cars of a gross weight of 500 tons. Above the deck have been constructed cabins of three classes, which permit the transport of 200 passengers. Another ice-breaking boat, the "Angara," is used as an auxiliary for the transfer of passengers and for freight unloaded from the cars; she is also built of soft steel, and measures 197 by 34 feet, with 24 feet height at the center. Its draught at full load is 14 feet, and its displacement 1,200 tons. This boat, which has a capacity of 150 passengers, is driven by a single rear screw, and has a triple-expansion engine of 1,250 horse power. In smooth water each of these boats makes a speed of about 12.5 knots an hour. It is estimated that the total cost of the Lake Baikal transportation system reaches more than $3,400,000.

THORIUM COMPOUNDS.

In a paper lately read before the Académie des Sciences, Messrs. Matignon and Delépine give an account of a series of experiments which they have made upon two imperfectly known bodies, the hydride and the nitride of thorium. The nitride appears to have been discovered by Chydenius in 1863; he formed it by reacting upon the chloride with ammonia. M. Moissan obtained the same compound by the action of ammonia upon the carbonate. It has since been found that the metal will combine directly with nitrogen. As to the hydride of thorium, its existence has been demonstrated by Winkler. The experimenters purpose to make a further study of these two compounds, and to form them from the metal. To obtain thorium from its chloride by the method of Chydenius, the chloride was prepared by two methods; first by the action of well-dried oxide of carbon and chlorine upon the oxide of the metal heated in a porcelain tube, and second by the action of tetrachloride of carbon upon the oxide heated to redness in a glass tube. The first process gives a very pure product, but its action is slow, and the second is preferred, as it gives large quantities of the chloride, which, however, are less pure, and contain thoria in the form of oxychloride. The metal is prepared from the latter chloride by acting upon it with sodium; it contains a large proportion of thoria, being only 74 per cent pure. To form the hydride of thorium, the metal is heated to low redness, when it combines with hydrogen with incandescence, and forms a compound which is not decomposed by water. Hydrochloric acid attacks it, giving off hydrogen, which has double the volume of that given by the metal. By determining the proportion of hydrogen the formula for the hydride of thorium was found to be ThH_4. This body is easily decomposed; when heated in a small tube, in presence of air, an explosion takes place, due to the liberation of hydrogen, this being followed by the combustion of the metal. The second compound, the nitride of thorium, is formed by heating the metal to redness in an atmosphere of nitrogen; it corresponds to the formula Th_3N_4. Unlike the former body, it is not decomposed by heating in the air. Water decomposes it slowly when cold, but more rapidly warm, giving the reaction

$$Th_3N_4 + 6H_2O = 3TH_2 + 4NH_3.$$

These two compounds will burn in oxygen, but without giving the brilliant incandescence of the metal itself.

SOME FIGURES OF THE FIRST COST AND OPERATION OF SOUTHERN COTTON MILLS.

To make the assertion that cotton mills in the Southern States have increased from 10,000 to 5,000,000 spindles working in 485 mills in seventy years invites criticism from those who are unfamiliar with the development of the industry in this section of the United States. Yet, according to the most accurate calculations, mills containing the number referred to were either in operation or practically completed at the beginning of the new century. It should not be imagined that they are located in all parts of the South, for Florida has no mills whatever, but a half dozen are in the State of Texas, extensive as is its area, and Kentucky and Virginia have but a few, scattered here and there.

The principal activity in construction of cotton mills has been confined to the South Atlantic and Gulf States, beginning in the north in North Carolina and ending at the Mississippi River, although a beginning has been made in Arkansas, as well as Oklahoma and Indian Territories. An idea of the rapidity of construction can be gained when it is stated that the number of mills built in the South during 1900 was about 100, compared with 75 during the previous year. In 1895, according to best estimates, the number of mills was 325, representing 2,400,000 spindles. In 1897 the number had increased to 390, representing about 3,500,000 spindles. Here is shown a gain in five years alone of over 100 per cent. During the present year the number of plants projected is estimated to be somewhat less than in 1900, but the tendency in the South has been to increase the number of spindles and looms installed in a single mill, so that the total amount of machinery would practically be more than that erected during 1900.

The figures showing the cost of mill construction, etc., are significant. Those which follow are based upon actual estimates made of plants which have been constructed. The sum of $75,000 will build and equip a plant ready for operation containing from 3,000 to 4,500 spindles, according to the size of the yarn it is to produce. The sum of $100,000 is sufficient for a mill ranging from 4,000 to 6,000 spindles, while $175,000 will complete a 13,000-spindle plant. This price includes a brick and stone building, with heavy framework, containing fire protection, electric lights, steam heating, a water supply, also tenements for the necessary number of operatives, and warehouses for storing cotton. The $75,000 plant will consume between 50 and 60 bales of cotton a week, working on No. 8 yarn, or from 25 to 30, working on a finer product, No. 30, for example. In calculating these figures, an estimate of 15 per cent is allowed for waste of material by soiling, the amount taken out in going through the various processes, and the shrinkage. To operate such a mill with 6,000 spindles, 40 operatives are required for spinning alone. The labor is calculated to represent 15 per cent of the total cost of the product when coarse goods are made, the raw material 65 per cent, and the depreciation of the plant and other expenses the balance. The organization of a company operating a mill of 10,000 spindles and 320 looms generally consists of a president, who is also the treasurer, a secretary and a superintendent. These three form the executive heads of the various departments, the secretary acting as bookkeeper. No large salaries are paid, that of the president sometimes being as low as $2,500, while the superintendent receives from $1,500 to $2,000, and the secretary $1,200 to $1,600. The salaries, of course, increase in proportion to the size of the mill; the president of a plant of from 75,000 to 100,000 spindles may receive from $12,000 to $15,000 annually, the secretary $2,500, and the superintendent, who may have an assistant, $5,000. The cost for power, of course, varies, but upon averages secured from a number of mills in various portions of the South, operated under different conditions, steam costs per horse power per year from $12.50 to $17.50. Water power varies from $7.50 to $15 where the power is applied directly to the machinery and not used for electrical generation. It is calculated that between six and eight tons of coal per day are sufficient to operate a 400 horse power engine during eleven hours of continuous service. About one and one-half cords of pine wood are equal to one ton of coal.

The use of electricity generated by water or steam power is becoming more and more popular with Southern mill owners. Calculations have been made showing that the installation of motors in various departments, so that one section of the machinery can be operated independently of another, is much more economical than when power is communicated by shafting and belting, which requires possibly half or all of the mill equipment to be run in order to operate a certain portion. The Columbia Manufacturing Company, at Columbia, S. C., recently constructed an extensive plant for the manufacture of heavy duck. A set of turbines located on the Columbia Power Canal supply the sources of power from a series of large dynamos, and the current is conveyed to motors in each department. In turn, the machinery in the departments is divided into sections, each connected with its individual motor. Thus a section of looms can be placed in operation, while the rest of the plant is idle, if desired. The Pelzer mill, at Pelzer, S. C., containing the largest number of spindles under one roof of any plant in the world, is also operated by electricity, distributed upon the same plan. It has been argued that even where steam is depended upon solely, electric transmission is from 20 to 30 per cent cheaper in the long run.

Houses for the operatives are usually constructed of wood, and in the larger mill villages have from six to ten rooms each. If the company installs gas or electric lights and water works, they are furnished with these conveniences, also baths. A six-room house costs, on an average, $600, or $100 a room. The same is true of the larger houses. A six-room house will rent at from $10 to $12 a month, or 25 per cent of its total cost. Estimating interest on investment, "wear and tear" and taxes at 10 per cent of the rental, a profit to the company is left of 15 per cent yearly. The scale of wages naturally varies according to the character of the goods produced. An estimate taken from the daily pay roll of a North Carolina mill gives $13.50 for fifty-four hands. They include one spinner at $1.50, six boys in various capacities from 75 cents to 40 cents, and twelve girls at 26 cents each. This group includes every department of the mill, from picking the cotton to the spinning. Yet at this scale of wages, little difficulty has thus far been encountered to obtain enough labor, as the operatives, on the average, live much better and suffer less hardships than when earning a livelihood in the mountains.

The above are some of the reasons why cotton manufacturing in the South has so rapidly revived on account of the profits which have accrued to the manufacturers. The combination of advantages which they have enjoyed has enabled not a few of the companies to earn enough to declare, if they desired, an average dividend of from 10 to 15 per cent annually, after allowing from 8 to 10 per cent for depreciation of machinery and buildings. Few such dividends are announced, however, as it has been the general policy of late years to add to the surplus, making it a fund for enlargements and betterments. This is why quite a number of the Carolina mills have doubled their capacity within the last ten years, paying entirely for the enlargements out of the profits of the original plant. A number of illustrations might be cited of this kind. One mill located at Gaffney, S. C., earned 22 per cent yearly for the first three years it was in operation, and its machinery was operated 22 hours out of the 24 during the first two years. It manufactured a certain grade of sheeting, and during the period mentioned actually controlled the price of the American market. Instances are also known of mills which have cleared as high as 30 per cent in a year upon their capital stock, or enough to give stockholders a dividend of 20 per cent, after allowing for wear and tear and new machinery. These figures include income from all sources, including the rental of property owned by the company.

The inducements to construct mills have resulted in possibly a score of small plants being built on the installment plan. In the vicinity of Gastonia, N. C., are several of this character, in which the operatives are also stockholders. For instance, a $100,000 company would be organized, divided into 1,000 shares of $100 each, each shareholder being allowed to pay at the rate of fifty cents to $2 per week per share, the idea being to have the stock fully paid up at the end of two or three years. As soon as $25,000, or enough had been accumulated to start work, contracts would be let for a certain portion of the mill building. Possibly it would be finished off and a small amount of machinery installed and started, the balance of the machinery being added as subscriptions were made to the capital stock. Thus employes were actually helping to pay for the plant out of the proceeds of the wages received from the company. The plan followed is quite similar to that pursued by building and loan associations.

At present the mills in the South are manufacturing 17 per cent of the cotton produced in the United States, which represents nearly 70 per cent of the world's production. The home consumption of Southern cotton is rapidly increasing, as might be imagined from the activity in mill building, and calculations have been made that at the present rate of progress fully 5,000,000 bales will be converted into yarn and cloth in 1901 by the plants in the section referred to or three times the present amount.

SCIENCE NOTES.

Prince Luigi of the Abruzzi has been presented with the citizenship of Rome.

Capt. Bernier, whose scheme to organize an expedition for the discovery of the North Pole is now before the Canadian government, has received a letter from Lord Minto, the Governor-General, stating that he has much pleasure in publicly becoming a patron of the Arctic exploration scheme.

A strange phenomenon was recently witnessed in Southern Italy and Sicily. This was a heavy red cloud which extended over this territory, and the rain resembled drops of coagulated blood. This phenomenon, which is called "bloody rain," is attributed to dust from the African deserts transported by heavy south winds.

Germany proposes to forbid the employment of saccharine and other sweetening matter, except when it is recommended for therapeutic purposes. The sale of the substance will be permitted only by chemists and other specially authorized persons. Even in these instances it will be subjected to a consumption tax of $20 per kilogramme. This new law will go into effect in April, 1902.

The great dinosaur, the restoration of which has been the work of the Geological Department of Yale University for more than a year, has been placed in position in the Peabody Museum at Yale. It was discovered by Prof. J. B. Hatcher in the summer of 1891 while exploring for the late Prof. O. C. Marsh of Yale in Wyoming. The specimen was in excellent condition with all its parts intact, and it was also an entirely new variety. There is but one other specimen in the world, and this is in Brussels; its length is 29 feet 3 inches. The height of the head above the base is 13 feet 2 inches.

The indigo industry of Bengal is suffering severely from the competition of the manufactured German dye, huge quantities of which are being exported to India and the other markets hitherto controlled by the Indian industry. The German synthetic indigo is considered to be superior and is much cheaper. It is also stated that if the native indigo manufacturers were to conduct their work upon a more scientific basis, and were to extract the maximum quantity of dye from each plant, they would be in a position to meet the German competition. With a view to encouraging the industry, the government of Bengal has voted $22,500 for research work, with a view to facilitating and improving the existent process of manufacture.

Samarium oxide, according to Mr. Henri Moissan, at the temperature of the electric furnace, and in presence of carbon, forms a crystallized carbide of formula $Sa\ C_2$. The composition of this carbide is comparable with that of the carbide of cerium, lanthanum, neodymium, and praseodymium. It decomposes cold water in the same way as the carbide of the alkaline earths, giving a complex mixture of hydrocarbons, very rich in acetylene. It has a density of 5.86, a yellow color, and when examined under the microscope has a crystalline appearance—the particles having a hexagonal shape. This substance burns brilliantly at 400 deg. in a current of oxygen. The decomposition of water by the carbide brings the metal samarium near to the yttrium group, and removes it farther from the rare earths belonging to the cerium group.

A Parisian professor suggests a certain treatment of silk for enhancing its hygienic value. The process consists in combining gun cotton with silk or wool by impregnating either of them with a solution of collodion or a solution of celluloid. The dissolvent used may be either (preferably Hoffmann's) amyl acetate, acetone, or methylic alcohol. A solution is made consisting of one part of gun cotton (octonitric cellulose) or of celluloid in 100 parts of Hoffmann's ether (a mixture of alcohol and sulphuric ether), or any other suitable solvent. Or one part of tetracetate of cellulose may be dissolved in 100 parts of nitrobenzene. (The proportions are by weight.) Either of the above solutions forms the required "dressing" to be applied to the material. The material to be treated is made into a roll either of a loose fibrous material or as a fabric, according to the purpose for which it is designed. This roll is immersed in a cylinder filled with the solution. The roll is turned round several times in this bath, and the cylinder is then emptied by means of a tap provided for that pur pose. The material is taken out, unrolled and left to dry.