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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.

DELAY IN BUILDING THE AMBROSE CHANNEL.

The failure of the company that has taken the contract for dredging out the Ambrose Channel at the entrance to New York harbor to live up to its contract is assigned by Lieut.-Col. Marshall of the United States Engineer Corps as the reason for the backward state of this work. It seems that the government has endeavored to be lenient and has made several modifications in the contract in order to encourage the contractors in pushing the work through to completion. The original appropriation for the digging of the channel was $4,000,000, and up to the present time the dredging company has been paid $1,200,000 of this amount. In order to assist in the prosecution of the work the government has expended $700,000 in the construction of two dredges of its own, of which one was put upon the work in the autumn of 1904, and the other in the spring of 1905. The contract is for a 40-foot channel, and Lieut.-Col. Marshall states that he hopes to have a 35-foot channel ready by the beginning of 1906.

As showing that the government has been lenient, it is stated that the first modification was to grant an extension of time. It was followed by an easing-up on the question of the amount that was to be dredged in a given time, the quantity being cut down from 1,200,000 to 400,000 yards per month. This last concession was accompanied by an agreement that the government should put its own plant to work and that all the work which it accomplished should be deducted from the dredging company's contract at the contract price of 9 cents per yard. Even under the last-named conditions the work does not seem to have progressed any better; if anything, indeed, it has moved more slowly. It appears that from the experience gained with the government type of dredge, the material can be taken out for from 3 to 5 cents per yard instead of the contract price of 9 cents. In view of the above facts we heartily agree with the engineer in his conviction that the best plan under the circumstances would be for the government to cancel the contract and hire the necessary dredges to finish up this important work.

AN OLD PROBLEM IN A NEW FORM.

The publication of our recent article on the leap-frog railway has awakened an active discussion of the question of the speed at which the two cars pass each other. Some of our correspondents claim that if each car has a speed of eight miles an hour when they meet, they must pass each other at a relative speed of sixteen miles an hour. Others again claim that when the over-riding car passes on to the rails carried by the lower car, its wheels continue to revolve at a rate corresponding to a speed of eight miles an hour, and the two cars therefore pass each other at that speed. One correspondent clinches his argument by quoting the supposedly analogous case of a person who is walking, at a speed of four miles an hour, to the rear of a passenger car which is running at a speed of sixty miles an hour. In this case, he argues, the man and the car pass each other at a speed of four miles an hour, the speed of the man, like that of the upper leap-frog car, being independent of any speed possessed by the object over which he is moving.

The fallacy of this last argument is due to the very common error of confusing absolute and relative speed, or speed with reference to a fixed object such as the ground, and speed with reference to a moving object such as the lower leap-frog car, or the train on which a man is walking.

In the case of the leap-frog cars, the lower car is moving (let us say south) past a fixed point on the ground at a speed of eight miles an hour. The upper car is moving (let us say north) at eight miles an hour with reference to the same fixed point on the ground.

The cars, therefore, are approaching each other at a speed of $8 + 8 = 16$ miles per hour, and if they were on different tracks, side by side, they would pass each other at a speed of sixteen miles per hour.

But they are on the same track, and one has to climb over the other.

What effect does this climbing have on the speed of the cars?

It absorbs some of the momentum of each car, and reduces the speed proportionately. Most of the energy absorbed is expended in lifting the north-going car through a height of six feet and a smaller portion of the energy is expended in overcoming the increased friction, shock, etc.

The loss is divided between the two cars (action and reaction being equal and opposite) and it amounts to a reduction of about four miles per hour in the speed of each car.

During the time that the north-going car is passing over the south-going car, the only new element that is introduced affecting the speed of the two cars with reference to the ground, or the *absolute* speed, is the work done in lifting one car and in overcoming increased friction, shock, etc.

This expenditure of energy results, as is shown when the cars are in actual operation, in reducing the speed of each car from eight to four miles per hour, speed being reckoned with reference to a fixed point on the ground.

Hence, while the cars are passing each other, the north-going car passes a fixed point on the ground at a speed of four miles per hour, and the south-going car passes the same point at a speed of four miles per hour, and they, therefore, pass each other at a speed of $4 + 4 = 8$ miles per hour.

Let us consider the leap-frog car problem under two conditions, A and B.

CONDITION A: If the lower car formed part of a train that carried upon its roof tracks that were, say, five hundred yards long, and the upper car started from rest on these tracks on the roof at the same time that the train containing the lower car started from rest, in the opposite direction, on its own tracks on the ground, and if by the time the two cars met, each car had accelerated to eight miles an hour *with reference to the track on which its own wheels were turning*, then the cars would pass each other at a speed of eight miles per hour only.

CONDITION B: But in the case in question the conditions are totally different. Both the upper car and the lower car start and accelerate to a speed of eight miles per hour on the *same* tracks *on the ground*. When they meet, the upper car, moving at an *absolute* velocity of eight miles per hour, passes on to a pair of rails that already have an *absolute* velocity of eight miles per hour in the opposite direction. The resultant *relative* velocity, as between the upper car and the rails on the roof of the lower car (and, therefore, the lower car itself) is evidently $8 + 8$ miles per hour (if we disregard friction and climbing effort) or $4 + 4$ miles per hour, if we allow for these.

The man walking toward the rear of a train is an analogous case to Condition A, but not to Condition B.

To make it analogous to Condition B the man must be walking towards the rear of the train *on the ground* at four miles per hour, and then, still facing the rear and still moving four miles per hour, he must *step on the train*.

His legs will be knocked from under him; but for the instant of time before he falls, and his body strikes the train and is retarded, he will be passing the train at $60 + 4 = 64$ miles per hour.

Similarly, at the instant that the forward trucks of the upper car first strike the inclined rails of the lower car, they are passing these rails at a speed of $8 + 8 = 16$ miles per hour. The retardation immediately commences, and is at its maximum effect by the time the steep grade to the roof has been surmounted, when the relative passing speed has slowed to about 8 miles an hour.

RUSSIAN ARMY HYDROGEN BALLOONS.

At the recent Aerostatic Congress which was held at St. Petersburg, Dr. Helbig described the new hydrogen generators which the Russian army is using for field work in connection with war balloons. The new apparatus has now been adopted by the aerostatic corps of the army. The process is designed to reduce the weight of the apparatus as much as possible, so as to make it easier to transport. Up to the present, hydrogen has been prepared for balloons by acting on iron with dilute sulphuric acid. But there is another reaction which is available, that of alkaline hydrates upon aluminium, in which hydrogen gas is given off.* Two different types of apparatus have been designed for the army, one for field work, mounted on a carriage, and a second for mountain use. These apparatus are built of iron, as the alkaline solutions have no effect upon that metal. A gas generator and a scrubber form the two different parts. The generator contains a caustic soda solution, in which is placed an iron basket containing aluminium scrap. At the upper part, the generator is connected with the scrubber by a long sheet iron tube. The gas bubbles through the water contained in the scrubber, leaving the traces of alkaline matter which are brought over. From thence the hydrogen is brought to the point where it is to be used, by a flexible tube made of canvas treated with impermeable varnish. If need be, several generators of the above type can be coupled together. The different joints of the apparatus are made by hydraulic pressure, and are very tight. When once commenced, the aluminium is attacked by the soda solution with great energy. The gas comes off very rapidly and the liquid heats up to the boiling point. But as the proportion of free soda in the solution diminishes, the reaction becomes slower. In order to finish the gas production with a sufficient activity, the generator needs a supply of caustic soda which is above the theoretical value. If the above formula is taken as the starting point, we find that to obtain 1 cubic meter (1.26 cubic yard) of hydrogen we need 1.8 pounds of aluminium and 7.9 pounds caustic soda. But as the commercial metal is generally only 99 per cent pure and the commercial soda only has 77 per cent at most of sodium hydrate, we need to use 10.3 pounds of the latter. The weight of raw materials which must be transported in order to furnish 1 cubic meter hydrogen is therefore 12 pounds. With the usual process using iron and sulphuric acid, the weight to be carried is 15.5 pounds. The new method thus gives an economy of 20 per cent as regards weight. There is also a reduction in the weight of the apparatus, which can be made much lighter, seeing that they are not built of sheet iron covered with lead, as in the other cases. The hydrogen which is obtained by the new process is of much greater purity. It does not contain any volatile hydrocarbons which increase its density and diminish the lifting force, nor any hydrogen arsenide which is often met with and renders the gas dangerous on account of its poisonous properties. The only impurities it contains are water vapor and traces of alkaline liquid. A great advantage is the use of soda, which is solid, as compared with the corrosive sulphuric acid, when we consider the question of transport. The only disadvantage which the new process shows is the cost of the hydrogen, which Dr. Helbig figures as high as $0.02 per cubic foot. Until the price of aluminium drops considerably, it is doubtful whether the process can be used except in cases where the cost is a secondary matter.

* This reaction is represented by the formula:

$$Al + 3\,NaO, HO = 3\,H + Al\,O_3, Na_3.$$

THE GOVERNMENT'S NEW COAL-TESTING PLANT.

For a long time the Kaiser's engineers have been testing the coals in the German empire. Coal measures have been surveyed and samples analyzed so that the government knows the chemical and relative values of its coking, steam-producing, domestic, and gas-producing coals. It has experimented with machines for compressing slack coal into briquettes. What was waste a few years ago now forms one of the best locomotive fuels. Slack coal is also pressed into what is called eggettes—forms small enough for stoves and grates.

The coal surveyors of France are not behind those of Germany, while Belgium profits by the investigations of both. On the British Islands lignites, peats, and even turfs, have been surveyed and their economy carefully ascertained by scientific methods. No nation has a more accurate knowledge of its fuel resource than Great Britain.

The people of the United States mine and consume more coal than do the French, Germans, or English. Our coal fields extend over more territory and supply a greater variety of mineral fuels than do the coal fields of any other people. We need coal tests more and have had them less than our competitors.

Since the first of last September the United States Geological Survey has conducted the initial line of government coal tests. They were preliminary. They were conducted under act of Congress, approved March 18, 1904. This act carried an appropriation of $30,000, increased by the general deficiency bill, approved April 17, 1904, to $60,000. Resulting from these preliminary tests came a suggestion of how more than a million dollars may be saved to the federal government annually in coaling naval vessels, at the same time increasing the efficiency of cruisers and men-of-war. The suggestion is still more important to manufacturers using coal under boilers. These dominating facts led Congress at the last session to appropriate $200,000 for a continuation of the tests.

Under the terms of the appropriation the United States Geological Survey is now entering upon a comprehensive and scientific examination of our coals and lignites. Two conditions attach to the availability of the appropriation: (1) Samples of coal in car lots must be furnished at the testing plant free to the government; (2) the service of machines, apparatus, and devices used in making the tests must be free. As coal mine operators and transportation companies are deeply interested in these tests, no difficulty attended the first condition. When the preliminary tests were made the plant lacked somewhat in unity and adaptation. The equipment is now closely standardized and reconciled to one purpose.

The director of the United States Geological Survey appointed Messrs. E. W. Parker, J. A. Holmes, and M. R. Campbell, a committee to conduct the investigation. This committee erected the necessary buildings and established the testing plant on a terminal railroad in Forest Park, St. Louis, Missouri. Many of the superintendents and operators who made the preliminary are now engaged in making the formal tests, so that the plant is served by trained men. The same building, stacks, scales, etc., are used. Some of the equipment has been repaired. All has been readjusted. Some has been added. The main parts of the equipment are engines, boilers, conveyors, generators, motors, washing machines, gas machines, briquetting machines, coke ovens, and a chemical laboratory. The qualities of the coals are ascertained by analyses, by steam tests, gas-producer tests, coking tests, briquetting tests, and washing tests. From twenty-minute readings a log is made of each test. These tests will be tabulated and printed in a report for distribution as any other public document in the Department of the Interior.

Each steam test will require ten hours and consume approximately 10,000 pounds of coal. Each log will show the number of the test, name of the sample, size and condition of the coal, and twelve technical items composing the standard method of steam tests approved by the American Society of Mechanical Engineers. The sample will be tested for economy of fast, slow, or medium feeding, and for size of grate.

Each gas-producer test will continue thirty hours and consume approximately 10,000 pounds of coal. The coking tests will require forty hours and consume in each charge approximately 10,000 pounds of coal. Results of washed samples will be compared with results of unwashed. The results of the briquetting will show the general character of the product, its behavior in weathers, its behavior in burning, and its crushing strength. Eggettes will be made and tested. Experiments will be made with binders. All facts gleaned will be printed in comprehensive tables.

Now the question arises, what feature of the results of the preliminary experiments induced Congress to depart from its general policy and to make a liberal appropriation for continuing the operation of this coal-testing plant? Of course the chemist and the engineer will be interested from a mere technical standpoint, but of what benefit were the preliminary assays to the mass of people? Sixty-five carloads of sample coals from seventeen States were received. The results were:

1. Fourteen bituminous coals from nine States show a power efficiency in the gas-producer plant two and one-half times as great as their power efficiency under the boiler—put in another way, one ton of these coals used in the gas-producer plant developed as much power as two and one-half tons of the same coal used under the steam boiler.

2. Eggettes and briquettes may be made from the slack of some soft coals and probably from the culm of hard coals.

3. Lignites from North Dakota and Texas have shown unexpected high power-producing qualities when used in the gas producer. More than one-third of North Dakota is underlaid with lignites. These are the major results. The minor results are not unimportant.

The method of obtaining fair run-of-mine samples is of prime importance. One member of the committee devotes his entire time to field work. His method is interesting, but the details are too special and complicated to be given here; suffice it to say that it is practically impossible for operators to obtain assays from selected or unfair samples.

For the first time the government is taking steps to give its citizens information relating to our coal measures—information long since in the hands of German and French cittizens relating to their coal measures. Gas engines of prodigious power are coming into operation. Every year shows an increase in power and an improvement in performance. The yearly coal bill of the United States navy approximates $2,500,000. The gas engine would save half this sum and enable war vessels to make longer voyages with greater ease and rapidity. Such is the meaning of this new coal-testing plant. What it means to States like North Dakota, with large mines of lignites, no one can tell.

POWER SITES ABOUT NIAGARA FALLS.

BY ALTON D. ADAMS.

Lake Erie stands 573 feet, and Lake Ontario 246 feet above sea level, so that Niagara River drops 327 feet in its course of 27 miles between them. Nearly all of this fall is concentrated in that part of the river between Port Day, in the city of Niagara Falls, and the foot of the Niagara Escarpment at Lewiston and Queenston, a distance of about eight miles.

At Port Day the approximate level of Niagara River is 560 feet above tide water, and at Lewiston the river surface is only a little above that of Lake Ontario, so that the fall between these points is about 313 feet.

It may thus be seen that the perpendicular plunge of 163 feet at Niagara Falls, on the American side of the river, is only about one-half of its total drop in a distance of eight miles. A little below Port Day, and some three-fourths mile above the falls, the upper rapids begin, and from their head to the foot of the falls the drop is about 210 feet. From the foot of the falls to the head of Whirlpool Rapids near the old suspension bridge, something less than two miles below, the descent of the river is comparatively slight, but from this latter point to the Devil's Hole at the mouth of Bloody Run there is a fall of approximately 90 feet in a distance of less than two miles.

Looking at a large scale map of Niagara River and of the east and west ends respectively of lakes Erie and Ontario, with the above facts as to the fall of the river in mind, several practicable plans of power development present themselves. As the east end of Lake Erie extends parallel with the west end of Lake Ontario, and only 27 miles therefrom, for a distance of more than 40 miles, it is evidently possible to dig a canal north and south across this territory between the lakes and thus obtain a water head equal to almost their entire difference of level. This plan is rendered all the more practicable by the fact that the land between the lakes has few changes in elevation save along the Escarpment, where it drops down to the Ontario level, and that this Escarpment is 6 to 7 miles south of the Lake Ontario shore line, so that the length of a power canal need be only about 20 miles. Power development on these lines has already been carried out on quite an extensive scale by firms who draw water from the Welland Canal. Among the plants thus operated is a large electric installation whence energy is transmitted 35 miles to Hamilton, Ontario. Further developments of similar kind may be expected in the future. The most serious impediment in the way of such plants is the great cost of a 20-mile canal, but this impediment will not retard development until the capacity of the Welland Canal is reached.

Another glance at a large scale map of Niagara River shows that its great sweep north of Grand Island, from Tonawanda to Niagara Falls, a distance of some 6 miles, gives a shore line of that length from which canals may be dug either to the Escarpment about 9 miles to the north, or to points on the Niagara River below the rapids, only six or seven miles away. The situation is made more favorable for power development on this plan by the fact that the territory through which such canals would run is very nearly flat, and lies only a few feet above the level of the upper river. Power developments on this plan would have an available head of about 300 feet of water. On the Canadian side of the river the situation is less favorable for canals similar to those just suggested, because such canals would necessarily be longer and their cuts would be much deeper. The favorable situation for canals and power plants on the American side of the river has already attracted attention. Among several such projects the most prominent may be mentioned, which contemplates the construction of a canal 37,500 feet long from La Salle to the Devil's Hole, a deep ravine in the bank of Niagara River just north of the city limits of Niagara Falls. The head of water thus made available is 300 feet.

Most of the power developments now under construction, or in operation, are centered about Niagara Falls, and draw water from the river above only to discharge it into the gorge just below the great cataract. On the American side of the falls there are two such plants, both in operation, one of which conveys the water across the city of Niagara Falls in an open canal, and the other discharges through a deep horizontal tunnel cut in solid rock. Both of these plants take water from the river at or above Port Day, and thus take advantage of the rapids above the falls as well as of the latter. On the Canadian side of the river three large power plants are under construction, and a fourth much smaller plant is operating. One of the three large plants takes its water from the river above the rapids, and thus obtains a head of more than 200 feet, like that of the plants on the American side, but the other two large Canadian plants draw their water from the very midst of the rapids, and so have somewhat lower heads. All three of these large Canadian plants discharge their water near the foot of the Horseshoe Falls, two through horizontal tunnels, and one from a power house located in the gorge below. One of these tunnels opens directly behind the foot of the Falls.

The small plant just mentioned utilizes less than one-half of the available head, and discharges its water high up on the face of the perpendicular cliff that forms the side of the gorge.

For purposes of easy power development with the head of water furnished by the great cataract and the rapids just above, the city of Niagara Falls, N. Y., is much more favorably located than is the territory directly across the river in Ontario. This is due to the fact that the river changes its course by more than a right angle as soon as it takes the great plunge, so that the city forms the acute angle between the upper and lower stretches of the river, and to the further fact that the Ontario bank grows high very rapidly, while the New York bank remains level. The narrow strip of low land on the Ontario bank of the river a little above the falls, forming Queen Victoria Park, has its water front entirely taken up by the four power plants already located there. If other plants are to be located on the Ontario bank of the river to utilize the head afforded by the upper rapids and the falls, canals, pipe lines, or horizontal tunnels several miles in length must be constructed, and the two former can only be carried through very deep cuts, largely in rock. On the New York side of the river several miles of low water front above the falls might easily be used for the intakes of power plants whose pipe lines, canals, or tunnels could reach the gorge below, with lengths of between one and two miles.

All of the plans for power development thus far considered involve reductions of the volume of water going over the great cataract. With an intake near the old suspension bridge on the New York side, and a tunnel about 8,000 feet long to the Devil's Hole, the entire flow of the river may be utilized, if desired, at a head of nearly ninety feet, and still leave the grandeur of the great falls undiminished.

Plans are now said to be under way for a development of this sort, and aside from the tunnel the cost is very moderate.

SCIENCE NOTES.

A wild grape vine upon the shores of Mobile Bay about one mile north of Daphne, Ala., is commonly known as the "General Jackson vine," from the fact that Gen. Andrew Jackson twice pitched his tent under it during his campaigns against the Seminole Indians. This vine in June, 1897, was reported to have a circumference of 6 feet 1 inch at its base. Its age was estimated at that time to exceed 100 years.

In no respect have the services of engineering science to public health science been more conspicuous than in the application and the further study of the principles involved in the processes of water purification. It has lately been shown, for example, that the introduction of pure water supplies has in many cases so conspicuously lowered the general death rate as to make it impossible to escape the conclusions (1) that the germs of a greater number of infectious diseases than was formerly supposed are capable of prolonged life in, and ready conveyance by, public water supplies, and (2), as a promising possibility, that as the result of the greater purity of the water supply the physiological resistance of the consumers of pure water is enhanced, in some manner as yet unknown; the net result being that the general death rate is lowered to such an extent as to lead to a rapid increase of population in communities previously stationary or multiplying far less rapidly.

According to Dr. Charles Davison, F.G.S., of Birmingham, England, a violent earthquake occurred on Saturday, July 15, last, of which, however, no news has yet reached us. The professor possesses a well-equipped seismological station, and as he entered his observatory at 10 o'clock on the above morning he had the rare opportunity of witnessing the instrument recording a distant earth tremor of exceptional violence. As he approached the instrument, the point of the writing lever was just beginning to register the first of the preliminary tremors—those which traverse the body of the earth by the shortest possible route. Quickly these tremors increased in magnitude, becoming also longer in period, and it was soon evident that the advance waves of an earthquake of the first order were crossing the country. In about sixteen minutes from the start these early tremors were succeeded and dwarfed by long-period undulations, which had traveled along the surface of the earth. Dr. Davison said that never before has he seen waves so large depicted on the smoked paper. Several times the pointer struck the time-marking lever near one edge of the paper, and then swept seven or eight inches across, almost to the other edge, and once beyond it, so that had he not been there to adjust the pointer immediately, the remainder of the record would have been lost. Generally, the movement was a slow, steady march, each oscillation being completed in slightly less than half a minute. But often the pointer seemed to hesitate or stagger, either to recover itself, or to swing back in the opposite direction. The extensive oscillations lasted for about ten minutes; then they decreased, though irregularly, in size until, after twenty minutes more, they were no larger than the concluding undulations of many another distant shock. At about quarter-past twelve the movement ended with waves which, traveling along the surface in the opposite direction through the antipodes of the center of disturbance, reached Birmingham, enfeebled by their long journey, but strong enough to leave a distinctly visible trace. The origin of the earthquake must have been distant from England by about 4,000 miles, so that it may have been situated in Venezuela, in India near Lahore, or in Russian Turkestan. In any event, according to the record of the seismological station, the earthquake was of great magnitude, exceeding any that has occurred within recent years.