tion. 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.