A coat of moisture forms in an instant, but it is not possible to obtain water in any quantity with this method, as the heat of the flame soon vaporizes the coat of moisture, and leaves the surface of the iron warm, and dry. The flame from a common gas burner will also deposit water, but in addition it will deposit carbon from the hydrocarbon in the city gas, and is consequently less suited to the experiment.

Fig. 1 illustrates an experiment designed to prove the formation of water by the combustion of a simple hydrogen flame in air. The large flask at the left is fitted with two necks as shown, one of which has a funnel tube for supplying dilute sulphuric acid, which falls upon zinc fragments in the bottom. The other neck is provided with a glass tube which siphons down, so to speak, in an upright jar filled with a solution of permanganate of potash for purifying the hydrogen liberated from the sulphuric acid. The second jar contains concentrated sulphuric acid for removing moisture from the gas, and the bent "U" tube fragments of calcium chloride, also for the purpose of removing any traces of moisture. The result of this arrangement is perfectly dry hydrogen gas at the bent outlet tube. Immediately upon pouring the dilute acid upon the zinc fragments, the hydrogen is liberated, and passes through the system. The jet should not be kindled for some few seconds, for fear of an explosion of the mixture of gas and air. A safe plan consists in filling a small test tube with the gas as it issues, and testing that. If it cracks, it indicates a mixture of air and gas. It it burns quietly, it may be used at once to light the jet with. Now, on holding a large, cold bell glass over the flame, the water vapor soon condenses, and falls in drops into a glass provided for the purpose. For a continued production of water, it will be found necessary to keep the bell jar cool from the outside, by cloths wet with ice water.

In order to illustrate the definite formation of water, two glass globes with necks should be employed, as illustrated in Fig. 2. The one at the left is partially filled with cupric oxide, and is attached by means of a short piece of rubber tubing to a similar empty globe. The bulb containing the cupric oxide is now attached to the little burner from the "U" tube by means of a rubber coupling, and the stream of hydrogen allowed to flow through the entire system. After a few moments the bulb containing the cupric oxide is heated by means of a Bunsen burner, or alcohol lamp, lightly at first, then strongly. The oxygen from the cupric oxide is liberated by the heating, and combines with the hydrogen which is passing through. Water is formed by this combination, which collects in the bulb at the right as indicated. In order to prove the definite composition of water by means of this experiment, it is only necessary to weigh the bulb containing the cupric oxide before and after the experiment, in order to ascertain the quantity of oxygen taken up by the hydrogen, and to weigh the second bulb empty and when containing the water resultant from the union. Knowing the weight of water, and the weight of oxygen, it is a most simple matter to calculate the quantity of hydrogen. On these general lines, it was calculated by the writer, using the data available regarding the gasoline furnace, that at least three pints of water had been formed, and evenly "sprinkled" over the polished, unprotected lathe.

NIAGARA FALLS HYDRAULIC POWER PLANT.

In the present number we conclude a series of articles on Niagara, the first of which, on "Niagara as an Industrial Center," appeared in our issue of May 27. On June 17 we illustrated the many handsome bridges which have been thrown across the Niagara gorge in the past fifty years, and on July 22 we gave a lengthy description of the 50,000 horse power electric plant of the Niagara Falls Power Company. In the first-named article it was shown that taking into account all the turbines that are at present in use, big and little, of the total theoretical horse power of 7,500,000 at the falls, only about 50,000 horse power is at present being developed and actually utilized, either as hydraulic or electrical power, for industrial and transportation purposes. This total, however, is constantly being increased, as the various additions which are being made to existing plants are brought into operation; and it will not be many months before the total amount of power developed will have increased by fifty per cent.

So much attention has been directed to the Niagara Falls Power Plant, with its present capacity of 40,000 horse power and actual output of from 20,000 to 30,000 horse power, that the public has not realized the size and rapidly growing importance of the Niagara Falls Hydraulic Power Plant, which has at present a capacity of 13,000 horse power, and has an enlargement under way which will increase its total capacity to 20,000 horse power. The method of developing the hydraulic power differs widely from that which has been employed with the Niagara Falls Power Plant, where, it will be remembered, the water is led in from the river above the falls by a short length of canal to the power house, and delivered through penstocks to a set of turbines which work under a head of 135 feet. The tailrace for the latter consists of a great tunnel with a fall of 50 feet in a length of 7,000 feet, and the water is finally discharged into the lower river at a point below the falls.

In the case of the Niagara Falls Hydraulic Power Plant, the water is taken from the river above the falls by an open canal and led to a point about a mile below the falls, where it passes through penstocks to turbines that are situated within a power house, which is built close to the water's edge at the bottom of the gorge, as shown in the two illustrations on the first page. The advantage of the latter system is that the effective head is considerably increased, the loss of the head in the tunnel being 50 feet and in the canal only 2 feet. By suitably constructing the tailrace, an additional head of several feet is secured below the turbines, with the result that the total effective head of the hydraulic power plant is 210 feet. The total length of the surface canal is 4,400 feet, its present width at the entrance is 250 feet, and in 400 feet the width narrows down to 70 feet. At this width it continues into a basin which is located about 300 feet back from the edge of the gorge above the power house. The basin runs parallel with the edge of the cliff and is about 400 feet long by 70 feet wide. The company owns sufficient right of way to increase the width of the canal to 100 feet, if it desires to do so. For 40 feet of the present width of the canal the channel is 14 feet deep, and for the remaining 30 feet it is 8 feet deep. The work of widening the canal is now in progress.

The power house is a substantial building of stone with a steel truss roof. Water is led down to the power house by means of two penstocks, one of which is 8 feet and the other 11 feet in diameter. The original section of the building was completed in 1896, and an 8-foot penstock serves to convey water to four Leffel turbines, of 2,250 horse power each, which operate eight generators, six of which supply power to the lower works of the Pittsburg Reduction Company, while the other two furnish power for the operation of the Niagara Falls and Lewiston Railway, better known as the "Great Gorge" route, illustrations of which will be found in the SCIENTIFIC AMERICAN of March 28, 1896. The operation of the original installation was so satisfactory that a large addition was immediately commenced, and the building was increased to the size shown in our illustration. It now measures 100 feet by 120 feet. The addition to the plant consists of five wheels of the Jonval-Geyelin type, each of 2,500 horse power. Our illustrations show one of the new wheels in place. These wheels are fed by a new 11-foot penstock, which has a capacity of 12,000 horse power. It leaves the forebay with an elliptical bell mouth which measures about 20 feet by 11 feet, and is carried out horizontally from the cliff, supported on two heavy steel beams for a distance of 60 feet, and then drops vertically nearly 200 feet to the power house. For about fifty feet of its length beneath the power house floor it is 13 feet in diameter, and, after passing beneath two of the wheels, its diameter is reduced to 7 feet, beyond which point it tapers off into a cone 18 inches in diameter, and finally ends in an air-chamber, which is 4 feet in diameter by 15 feet in height. The object of the air-chamber is to cushion the vertical movement of such a great mass of water and prevent injurious shocks to the machinery. The steel used in the construction of the penstock varies from a thickness of $\frac{5}{8}$ of an inch at the top to $1\frac{1}{8}$ inches at the bottom.

Above the horizontal portion of the penstock beneath the floor are carried a series of five 60-inch hydraulic valves which are placed horizontally and serve to conduct the water from the penstock up to the five turbines which are placed immediately above them. These valves, with their supporting girders, are shown in the lower illustration of our first page. The water flows through the valves to the turbines and is admitted by a gate to the guide-wheels, and through them to the runners. From the sides of the turbine the discharge pipes project laterally and then downwardly to connect with draught tubes 22 feet 8 inches in length, the use of which makes it possible to utilize in part the atmospheric pressure, and increase the effective head of the turbines accordingly. The turbine wheels are made of bronze, and they are located in the draught-tube casing, one on each side of the casing proper. The pair weighs 5.095 pounds. They are mounted upon a horizontal shaft and are directly connected to a general electric generator, which supplies current to the new chlorate of potash plant of the National Electrolytic Company, located on the top of the cliff.

A walking-beam, working over the main casing, operates the gate which is connected to the beam by $2\frac{1}{2}$-inch rods extending down through the glands into the casing. Above the walking-beam is an air cylinder 36 inches in height, with a diameter of $20\frac{1}{2}$ inches. The turbine is controlled by a Reynolds governor. It should be mentioned that there are thirty-four buckets on the runners with a total area of 140·25 square inches. On the guide-wheel there are twenty buckets with a total area of 149·53 square inches. The General Electric Company's generator is shown in our illustration. It has fourteen poles and runs at 257 revolutions per minute, giving an output of 5,000 amperes at 175 volts. This represents a capacity of 875 kilowatts or about 1,200 horse power. The current is carried to the chlorate of potash works on aluminium cables, the lower part of which is made in bar form and the upper part in the form of well insulated cables. The dynamo for the Buffalo and Niagara Falls Electric Light and Power Company is of 700 kilowatts output capacity at 2,200 volts pressure.

The completion of the five Jonval Geyelin turbines will raise the total horse power at this station to 20,000, but it is intended to build another 11-foot penstock and increase the total horse power of the plant to 30,000, which will be the maximum that can be developed from the present upper basin. Ultimately, however, it is intended to extend the basin along the cliff beyond the present factories of the small users of the company's water power, and carry down other penstocks to a new power house at the edge of the river. The company has sufficient room to install a total of 100,000 horse power, which is well within their grant of 125,000 horse power. The present capacity of the canal is about 40,000 horse power, but the company has a force of dredges which are continually at work enlarging and deepening it.

Visitors to Niagara will have noticed the cascades of water which fall from the side of the cliff in varying quantities in the immediate neighborhood of the company's power house. These streams are the tailraces of the various smaller factories which are built at the edge of the cliff, and take water from the company's basin behind them. The turbines operate under heads of from 60 to 100 feet In some cases they are sunk in wheel-pits and discharge through tunnels, while in others a cutting is made through the face of the cliff. The total hydraulic power thus developed is about 7,500.

This brings us to the close of a subject which we have treated at considerable length because we believe that there is a great demand for complete information upon a matter of such importance as the utilization of the energy of the falls.

Isolated statements of work done in this or that establishment at Niagara Falls have been published from time to time, but these are not sufficient to give such a comprehensive view of the subject as we have endeavored to set forth in these articles. While the work of developing this great source of hydraulic power has not gone forward with the rapidity which was popularly expected, it must at least be admitted that what has been done has been carried out on conservative lines and with such a measure of success as promises well for the future.

Trouble with a Cycle Path.

A cycle path in the upper part of New York State was opened to the public, and soon after complaints began to pour in from riders whose tires had been punctured on the new track. There was no reason why a perfect riding path should not be obtained. An inspection of the first two hundred yards of the path, where most of the punctures were caused, failed to reveal the cause of the difficulty. No amount of sweeping sufficed to clear away the obstruction. Finally, however, it was learned that the cinders for the first quarter of a mile of the path had been secured at a shoe factory and that there were tacks in the cinders. According to The American Exporter, the head of the factory, when learning the facts, offered to share with the county the expense of laying fresh cinders. Before this was done, however, one of the riders had a framework of wood made and fitted with rollers and a handle so that it could be operated like a carpet-sweeper, and then placed six large and powerful magnets in it. They were so arranged that they would almost scrape the ground when the machine was operated. This was run back and forth over the ground until the last piece of metal was removed from the path.

A Gigantic Megaphone.

An enormous megaphone has been erected at Faulkner's Island, Conn., on the government lighthouse reservation, for testing a new system of fog signals. The megaphone is 17 feet long and 7 feet in diameter at the mouth. Attached to it is a $1\frac{1}{2}$-inch steam siren. The whole contrivance is mounted on a circular platform 28 feet in diameter, so that it can be revolved to any point of the compass. Different signals may be made for each point of the compass. The object of the invention is to throw the sound waves in a certain direction to the exclusion of any other direction, so that any vessel approaching the signaling station in a fog shall hear only the sound which is given when the megaphone is pointed directly at it. That is to say, if the signal means north, the fog signal must be due north of the vessel, or those on the latter could not hear that particular signal. The instrument has been tested and it is found that the sound was heard 10 miles away when the observer was standing in a line with the axis of the megaphone, but nothing could be heard of the sounds sent to other points of the compass when at a distance of a mile or more from the instrument.

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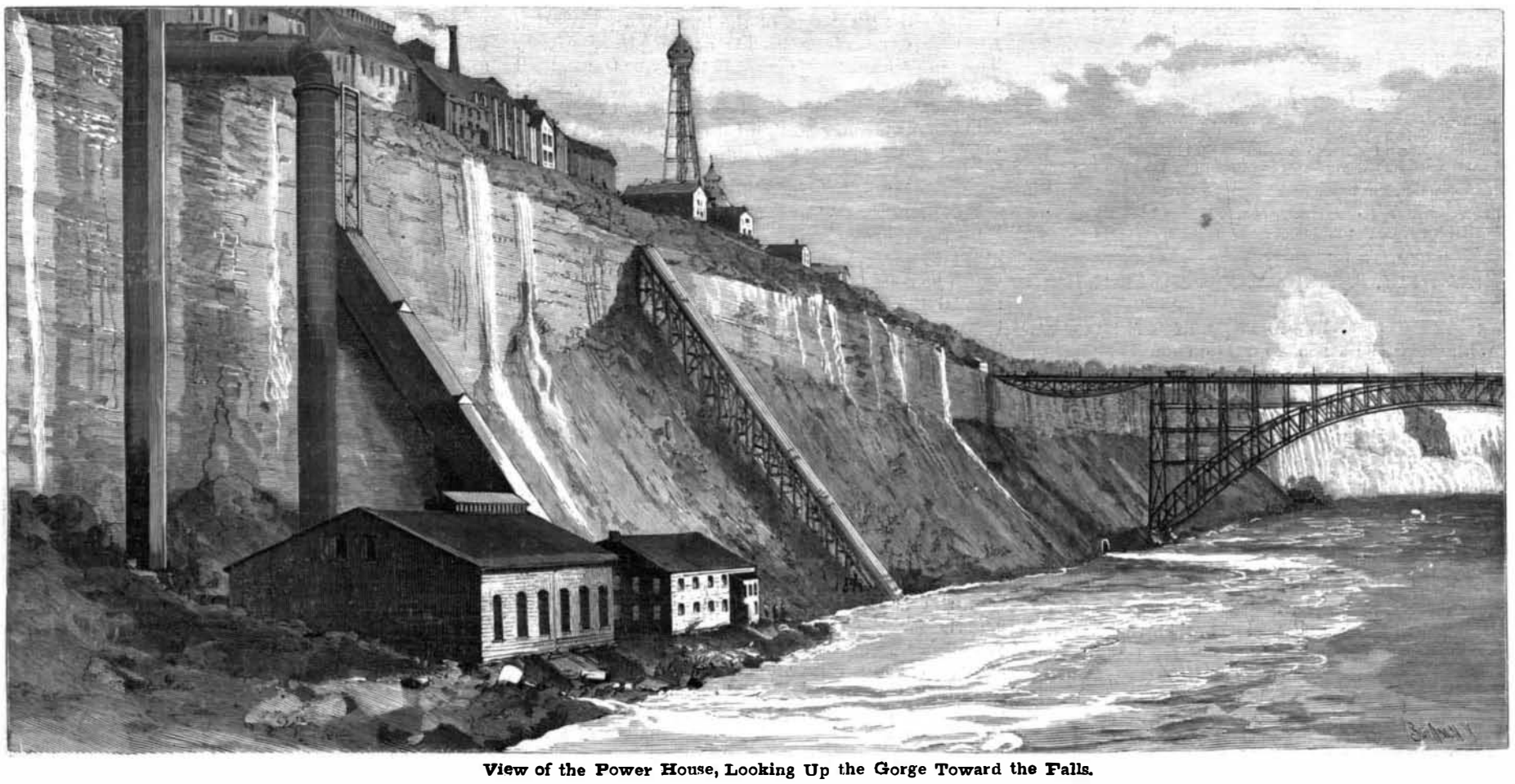
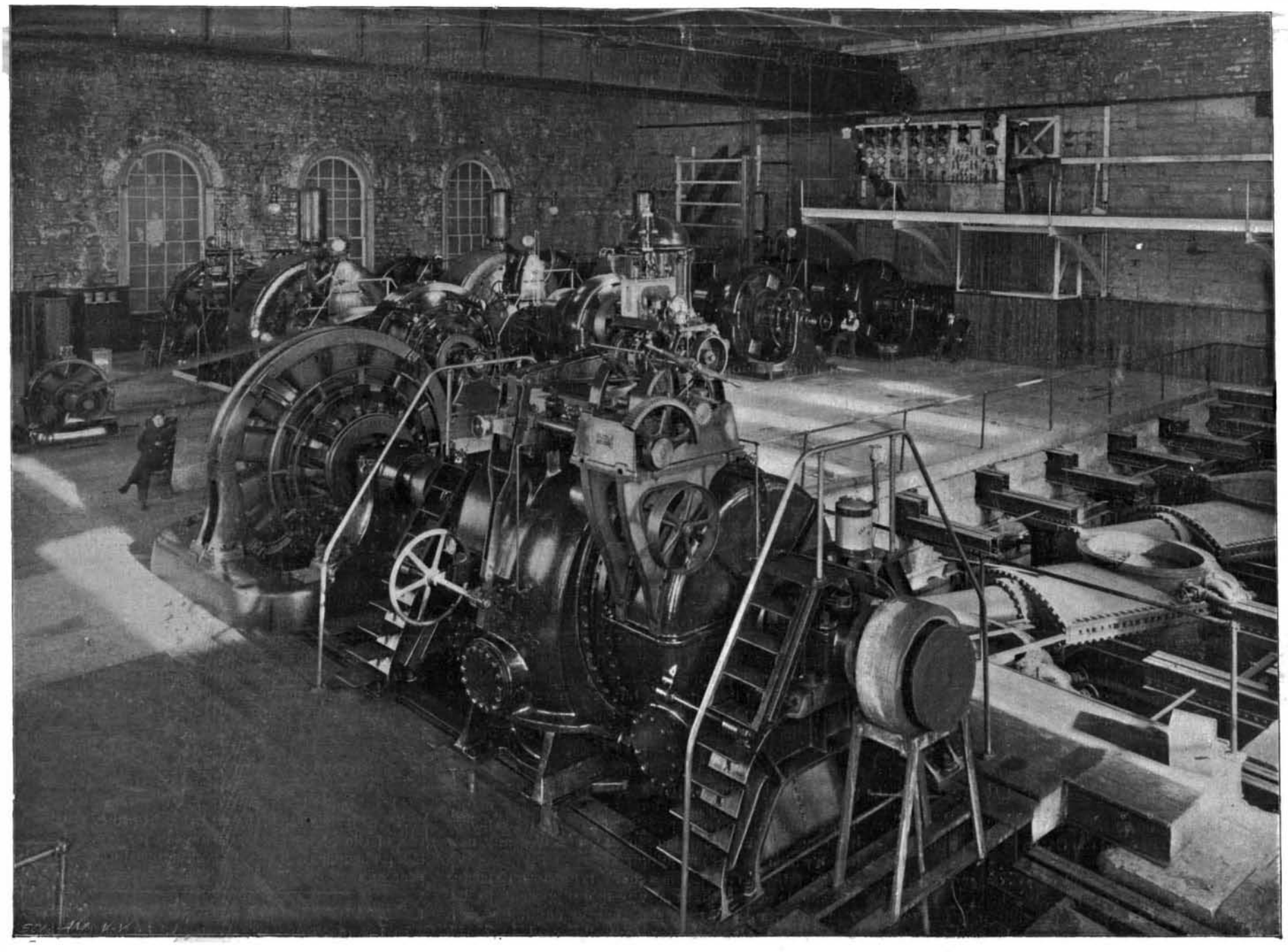


View of the Power House, Looking Up the Gorge Toward the Falls.



Interior of the 20,000 H. P. Power House.

NIAGARA FALLS HYDRAULIC POWER PLANT.—[See page 310.]

Science Notes.

On the basis of results of previous exhibitions at Paris, it is assumed that 52,588,280 people will pass through the turnstiles, and it is possible that the total number may reach 60,000,000.

A series of lectures will be given in New York city under the auspices of Arctic Club of the America by those who have actually made explorations in the Far North. Among those who will lecture will be Prof. W. H. Brewer, H. L. Bridgman, Walter Wellman, and Dr. F. A. Cook. The proceeds will be given to the furthering of Polar research.

The death of Mr. Hamilton Y. Castner, the chemist, was announced a short time ago. He invented a process for producing sodium which enabled aluminium to be produced at a comparatively low price. He also invented a process for the electrolytical production of alkali and bleaching powder from common salt, and a process for making cheaply cyanide of potassium.

In an official report of a government inspector of factories for Coburg Gotha some interesting figures are given as to the labor of children under fourteen years who make buttons, toys, etc., at their homes. They work from 4¼ to 6 hours a day, and earn in button-making from $\frac{1}{16}$ of a cent to 7 cents; in doll-making from 2⅛ to 18½ cents; from work on toys, 1⅞ to 14 cents.

A French journal tells a story about a dog which belonged to an English dentist. The dog was scarcely able to support life owing to the loss of its teeth. The dentist made an artificial set, including four canine teeth and four molars mounted on a plate in the ordinary way. The dog now eats meat and even gnaws bones without difficulty and he has gained considerably in weight.

It is proposed owing to the number of accidents which occur each year that the Maine legislature pass a law prohibiting the wearing by hunters of buff-colored clothes which may be mistaken at a distance for a deer. Ordinary hunting clothes are the worst possible thing for a man to wear in the northern woods. Accidents have been most frequent and several hunters are killed annually, often being shot by their friends who think they see a deer.

A German doctor has devised a plan for massaging rheumatic joints. He takes the patient's hand and puts it in a deep glass which is two-thirds full of quicksilver. The mercury exerts an equal pressure on every portion of the fingers and the pressure increases rapidly as the fingers sink further into it. The hand is alternately plunged and raised about twenty or thirty times at each treatment, and after a second visit there is a marked diminution of the swelling.

Great Salt Lake is receding on account of the excessive drain made upon it by irrigation enterprises. This lake is not fed by underground springs, but by the Jordan and other rivers, and when the waters of these streams is intercepted for irrigation purposes the water supply of the Salt Lake is, of course, diminished so that the evaporation which is constantly going on is not made up by a new supply. In time it looks as if the lake will be only a bed of dry salt.

Baled shavings are a standard article of commerce and are largely used for stable bedding and padding in straw boxes as it is finer and there is less waste. It is also more sanitary, being more absorbent, and in the case of pine, cedar, fir or spruce shavings, pitch and turpentine in them neutralize the manure and do away with the usual stable odors. Owing to the fineness of the shavings, an uneasy horse cannot paw the bedding out from under him as he does when straw is used. Feed dealers in cities now sell quantities of baled shavings for this purpose. They are also used for packing.

A remarkable collection of films for moving picture machinery are now being developed at the laboratory of Mr. Edison in West Orange. The pictures are of the Klondike and are intended for the exhibit Mr. Edison is to make at the Paris Exposition. The entire series will show actual life in the Klondike as it has never before been shown. The positive pictures on the film are nine times the size of the ordinary ones, and in order to use the larger film it was necessary to reduce the speed of the camera from forty-five to twenty pictures a second. The reduction of speed has, of course, resulted in a gain in clearness.

A great German airship is being constructed in a dockyard. It is being built on a floating raft, and at present it resembles the skeleton of a huge vessel. It was built of such delicate material as to suggest an enormous bird-cage. It is made entirely of aluminium, and the outer skin will be stretched on this framework. Inside a number of large balloons will be placed. A gallery and cars all made of aluminium will be placed underneath; engines are provided to drive the airship. The total lifting capacity of the airship will be about 10 tons, which is sufficient for it to carry enough stores and ballast to permit of its remaining in the air for some days; $350,000 has been expended upon this experiment. **For full details see the current SUPPLEMENT.**

Engineering Notes.

Owing to the high premiums demanded of railroad employes by insurance companies, the Chicago & Alton Railroad Company have inaugurated a new plan. The company proposes to defray half the premium of each policy, the men to pay the other half. This is certainly very liberal on behalf of the railway corporation.

The water supply of Havana is collected from springs at the base of a range of coral hills, and carried through a masonry aqueduct 33,000 feet long to a reservoir holding 21,000,000 gallons. The consumption and waste of water in the city is estimated at 173 gallons per capita daily. The city is supplied by gravity from the reservoir.

A company has been formed for the purpose of bringing sea water to London from an intake at Lancing in Sussex, from whence the water is to be pumped to a level of nearly 500 feet at the top of Steyning Hill. It will then flow by gravitation through a main to Battersea and thence across the Thames to Cromwell Road, South Kensington, whence branches are to be laid for service in other districts.

Large sums of money will be spent on river and harbor work at New York, and Gen. Wilson, Chief of Engineers, estimates that $200,000 will be required for removing rock in the East River and Hell Gate; $500,000 for widening and deepening the Harlem River; $100,000 for the maintenance of the present channels in New York Harbor, and $332,000 for increasing the depth of the new Bay Ridge channel from 26 to 40 feet.

An express train will be run between Berlin and Bucharest with a bi-weekly direct service to Kustendjie, whence the Roumanian steamers ply to Constantinople. The new service will reduce the duration of the journey from Berlin to Bucharest to thirty-three instead of forty-one hours. The Orient Express via Belgrade and Sofia has hitherto taken sixty-four hours. By the improved service it is estimated it will occupy only forty-eight hours.

At White Haven, Pa., there is an auxiliary fire system. The borough owns a fire engine, but the streets are so steep that delay follows any attempt to get it to the fire. It is therefore utilized as a stationary engine. In the center of the town there is a small reservoir holding about 1,800 gallons of water, and it is connected with the city mains. From this engine house radiate three separate lines of 4-inch pipes, covering the area of the town, with hydrants at the intersection of the streets. In case of a fire the engine is connected with the pipe system, the suction pipe is dropped into the reservoir, and water is allowed to run into the reservoir from the city mains. The system has proved very effective.

A curious accident took place at Brookfield, Indiana. A local freight train was backed into a siding to allow a fast freight train to pass. The switch was left open, however, and the fast freight traveling at the rate of thirty miles an hour dashed into it. The crews of both trains jumped. The impact of the collision was so severe as to drive the tender of the stationary train off its trucks and telescoping a cattle car which was loaded with coal, it rested half on the top of the third car. On the fast freight a car loaded with hogs was telescoped by one loaded with shelled corn and the animals not killed in the collision were smothered by the corn. It is said that the locomotives are so interlocked that dynamite will be required to separate them.

In the County of Down, Ireland, is a steel-plate road known as the Benbrook and Newry Railway. It is 3 miles long and has a rise of 180 feet. It has been in operation for sixteen years. It is an ordinary railway of 3 feet gage. All the trains are both freight and passenger. The passenger line is built of ordinary steel rails, outside of and adjoining which is a lower line of steel rails. The wagons are without flanges on the wheels and run on the lower outside rails. The inner rails for the cars are high enough above the outer rail to act as a guide to the wagons, keeping them on the track. The wagons are brought to the train over regular streets and roads by horses. There is no delay in hitching them to the train. The entire cost of the road was slightly less than $78,000.

Work has begun on the alterations which are to be made in the interior of the Grand Central Station, at New York. This work involves the building of a huge waiting-room at the Forty-second Street end of the building. This will be utilized by all of the roads running into the station and will prevent the confusion which now exists by having three separate waiting-rooms. Seventy-six feet of the train-shed will be required in addition to the present waiting-room of the New York, New Haven & Hartford Railroad. A subway which will pass underneath the tracks will first be built. This will be used for the handling of baggage. Lifts will be provided at every platform to raise and lower the baggage. The work has been delayed for some time owing to the difficulty in getting a sufficient amount of steel. It is thought that eight months will be consumed in making the changes and the cost of the work is estimated at $500,000.

Electrical Notes.

During the recent yacht races, a visitor to them on board the "Ponce" sent a wireless telegram to engage a room at the Hotel Netherland.

The Compagnie Gènérale de Traction, which has 60 miles of railway track in Paris, will use the Diatto electrical traction system on all its lines.

A new type of electric railway car is being used in Brussels the object of which is to reduce air resistance. The front of the car is triangular in shape, the controller and motorman being stationed in the angle. It has been found that the new car is very efficient.

The director of the Meteorological Observatory on Mt. Blanc has been considering the advisability of installing the Marconi wireless telegraphy system upon the mountain. The ordinary system of telegraphy is used normally, but the great snow-drifts have played havoc with the telegraph wires. It is believed that the wireless system of telegraphy would prove not only valuable from a scientific point of view, but would also increase the safety of travelers upon the mountain.

Granite is not usually considered to be an insulator, but one of the electrical journals reports that insulators are made as follows: Maine granite is crushed and molded into form and fused at 3,000° F. It resists all but hydrofluoric acid, and does not crush at a lower pressure than 14,560 pounds per square inch, and gives a tensile strength of 480 pounds per square inch; 56,600 volts were required to pierce one-quarter of an inch of this material in the shape of cup insulators.

The Santa Ana River, which comes out of the San Bernardino Mountains, is now used to transmit power to Los Angeles, some 82 miles distant. Nine thousand horse power is consumed in propelling machinery, moving street cars, and in heating and illuminating the buildings in Los Angeles, besides furnishing power for several villages around. After being used to generate power, the mountain stream is gathered into a conduit and led down the mountain side to irrigate the orchards and groves in San Bernardino Valley.

The Atchison, Topeka and Santa Fé Railway will be lighted by electricity generated from the car axles, and the locomotive headlights will be supplied from the same source. Each car will have a separate plant consisting of a dynamo and storage batteries, and the full train will have electrical equipment equal to over 4,900 candle power exclusive of the locomotive headlight. These trains will be the longest solid axle-light ones in the world, and will be the first to carry so large a lighting service derived exclusively from the car axles.

A school for trolley-car motormen is maintained by the Brooklyn Rapid Transit Company. Cars are run on the tracks about Fort Hamilton and Coney Island. Instead of having simply a room to practice in with controller and brake equipments, the men in Brooklyn actually operate the cars under competent instructors. School cars of various grades are used. In one car the use of the controller is taught, and in the next the use of the brake, and on the third the car as a whole is handled. The entire course takes from a day to a week. This is a rather better system than putting green motormen on cars which are actually run through the crowded streets of the city.

Hans S. Beattie, of the Metropolitan Street Railway Company, who was formerly Street Cleaning Commissioner of New York, considers that the street railway system might be used to help solve the garbage and ashes problem in New York, and to aid in the expeditious removal of snow and ice. The withdrawal of 300 horses and carts from the most congested part of New York during the busy hours of the day would, in itself, be a benefit. If the street car lines should be utilized, many of the dumps which now occupy valuable piers could be done away with, and the rental value of these dumping stations if they should be released to the commerce of a port would bring in a substantial financial return to the city.

A gravity balance, invented by Prof. Pollock and Prof. Threlfall, was described by the latter at a recent meeting of the British Association. In brief, the apparatus consists of a quartz fiber fixed at its ends and stretched horizontally; the fiber carries at its center a light wire at right angles to its length, and loaded. The fiber is twisted until the wire is only just in stable equilibrium, under which circumstances a very small change in the value of gravity will cause it to tilt through a measurable angle. The instrument is so delicate that it can detect changes in gravity which amount to less than two-millionths of the whole acceleration of gravity. The instrument is portable, and has been used in coast survey work in Australia, during which time it traveled 6,000 miles, and it has been brought to England, and its sensitiveness is still unimpaired. The short pendulums used in the United States Coast Survey gave results accurate to four parts in a million, this being, however, the mean observations with three such pendulums, and not the record of a single instrument. It will be remembered that Prof. Vernon Boys has used quartz fiber for many years for delicate scientific instruments.