shown in the green part of the spectrum. In preparing a red filter of the proper character with "Rose Bengales," the same must be combined with a filter which absorbs blue and blue-green. The film of "Rose Bengale" is to be so prepared that the filter, when dry should allow light waves down to wave length 590 $\mu\mu$ to pass through.

As medium amounts for the preparation of a red filter, 1.5 cubic centimeters of a 2 per cent solution of "Rose Bengale" in water to 18 to 20 cubic centimeters gelatine solution are taken, and 9 to 10 cubic centimeters of this mixture are then applied to 80 square centimeters plate surface.

If a plate, prepared in this manner, be combined with another tightly-fitting covering plate, which is colored with a yellow dye (best prepared with gelatine and a 4 per cent tartrazine solution) an extraordinarily quick-acting red filter is obtained, giving in every respect the desired position of absorption for the ethyl red plate. A great deal now depends upon the proper preparation of the green filter. An incorrectly toned filter causes as many poor results in the reproducing of colors as a bad exposure. The preparation of the green filter has consequently been very difficult. The adaptability of the green filter depends mainly upon the amount of violet rays which are allowed to pass through.

Suitable green filters can be prepared by using "brilliant acid green." Most green dyes tend to allow the extreme red rays to pass, which, however, is unimportant. Brilliant acid green, shade VI B, is best adapted for the ethyl red plate. To 6 cubic centimeters gelatine solution (for 80 square centimeters plate surface) add 1.6 cubic centimeter brilliant acid green (1:100), and to this solution 4 to 8 drops tartrazine solution (1:25).

By this means exclusion of the violet and the required retardation of blue rays is obtained.

The blue filter offers very little difficulty. It is necessary, at least in strong blue-green sensitive plates, to exclude only those rays lying in the green part of the spectrum. Light having at most a wave length of 480 should pass through. On the other hand, it is desirable that, in the reproduction of deep red tones of the original, the blue filter should allow the red of the spectrum to pass unhindered. The recipe for the violet dye is as follows: For 80 square centimeters plate surface, take 13 cubic centimeters gelatine solution, to which 2 cubic centimeters new victoria blue and 2 cubic centimeters methyl violet solution (1:250) are added.

The bright dye, however, demands too short a time of exposure. It is therefore better to retard the exposure. This is brought about by means of a very thin tartrazine disk, which is first so toned down that the blue filter permits a medium exposure. For the ethyl red plate an extra thin covering disk suffices for the equal exposure of red and blue. The required covering disk should contain 5 to 6 drops tartrazine solution (1:25) to about 120 cubic centimeters gelatine. From this short description of the colored filters, it is evident that it is possible to expose nearly the same length of time with the red and blue filters. The green filter, however, requires a much shorter period. A retardation of the green filter to about the same exposure is very difficult to bring about without seriously disturbing the curve of transmission. For the proper preparation of the color filters the following requirements are to be strictly observed:

1. A dark room free from dust.
2. Skill and painstaking care in handling.
3. A suitable cement or adhesive substance.
4. Careful observation of cement temperature and cautious warming of the plate after cementing.

Filters prepared in this way will last for a long time if not exposed directly for hours to the sunlight, which, however, is not probable in the usual method of working.

Prof. Miethe has a red filter which he has used just two years, making hundreds of exposures with it, in spite of which it has not changed in the least.

We come now to the description of the apparatus. This is made rather small in order to be easily carried. The best size for plates is 9 x 8 centimeters (Figs. 1, 2, 3).

As has been already mentioned, the exposure should be made as quickly as possible. Hence very fast lenses are required. The three images must also exactly register. A long focal distance is therefore necessary and an apochromatic lens. The choice of the latter, however, is rather limited, as apochromatic corrected lenses, i. e., those possessing a like focal distance for the main light rays, unfortunately do not transmit the light very rapidly. For a 9 x 8 centimeter plate a strong portrait anastigmatic lens, such as Prof. Miethe uses, of at least 180 millimeters focus is not adaptable. The camera differs very little from the usual form (Fig. 4), the main difference being that it is provided with a plate-holder (Fig. 4), whereby the three exposures can be made upon one plate of 9 x 24 centimeter dimension (Fig. 5), such plates being uniformly and easily developed. The three glass filters are brought immediately before the sensitive plate (Fig. 3). A ground glass just behind the color filters serves to focus the object properly.

The filters are firmly attached to, or set into the holder (Fig. 3). The plate-holder is then inserted in place of the ground glass. By means of a pneumatic release, the plate holder and filters are made to drop from top to bottom in the slide apparatus, passing successively before the lens (Figs. 3, 4, 5). The three accompanying photographs were made from a plate exposed in this manner. It is not possible to state the length of time necessary for exposure, this depending mainly upon the lens, the diaphragm, and the light. It is advisable to stop down as much as possible in order to facilitate registration.

As the ethyl red plate is very sensitive to red, the time of exposure for red and blue, behind properly chosen filters, can be taken from 1:1 to 1:4. The exposure for green is much less. Another point to be emphasized is that in preparing ethyl red plates, they should be dried with the utmost dispatch.

Highly sensitive dry plates are to be carefully dusted and worked in a bath containing: ethyl red, 0.1 gramme; alcohol, 300 cubic centimeters; distilled water, 5,000 cubic centimeters; ammonia, 50 cubic centimeters.

The washing must be done in absolute darkness, the plates rinsed under the water tap for 2 to 3 minutes, and then quickly dried. If the plates are long in drying they do not work well and fog easily. If, however, they be dried within 15 minutes, brilliant results can be obtained.

Prof. Miethe dries his plates in a current of air which passes between water pipes, whereby the escaping moisture from the air is quickly condensed upon the pipes. The air being now dry is slightly heated and then passes off over the plates. The plates dry in about 12 minutes. The developing and further arranging of a 9 x 24 centimeter plate with the three negatives (each 9 x 8) is the same as that of a usual plate.

THE PROJECTION APPARATUS.

Colored projections were shown for the first time by Prof. Miethe in the Urania Theater, Berlin, in the winter of 1903. The projecting apparatus used upon this occasion was built by the well-known firm of Ferdinand Ernecke, Berlin, manufacturers of precision instruments, being assisted by the scientific manager of the Urania, Dr. Donath. The apparatus consists of 3 arc lights (hand regulated) and consumes the enormous current of 200 amperes, or 45 horse power, only 10 per cent of this being transformed into light, while the other 90 per cent passes off in the form of heat, thus making it very difficult to protect the light condensers and to keep them from cracking.

These light condensers consist of 3 lenses each, and are insulated against the heat of the carbons by means of a hard glass plate. In front of the condensers are the cooling receptacles, which also act as filters for different light rays, being filled with the three respective solutions, above described for filters.

A voltmeter is provided for each lamp whereby the current and potential in each pair of carbons is carefully regulated. The lantern slides are inserted between the condensers and their projecting lenses.

The 9 x 24 centimeter plates (positives) are cut into three parts; the red, green, and blue positive being then glued on to another larger plate at equal distances from each other and corresponding to the distance between lenses.

This method permits quicker handling of the apparatus, making a focusing of the lenses for each picture unnecessary. The lenses were made by the firm of Voigtländer & Son, Braunwick, being triple-anastigmatic and exactly alike in focus, transmission of light, etc., and, of course, very expensive. Owing to the small number of lenses, very little light is lost through reflection or absorption.

The apparatus is as near perfect as the skill of the mechanic will permit. It can also be used with lamps of less current consumption (15 to 20 amperes) by substituting smaller carbons.

Longitude Difference Between Greenwich and Paris.

The investigations concerning the longitude difference between Greenwich and Paris have now been completed. The work has been of a particularly arduous and protracted nature, necessitating enormous calculations. Altogether the English and French observers have carried out 230 observations, equivalent to eighty nights' work each. Two English and two French observers have been engaged upon the task. The observations were made at Greenwich and Paris simultaneously, and in order to obtain absolutely similar results the instruments were frequently interchanged. The results of these observations have proved both the Greenwich and Paris existent meridians to be erroneous, the calculations finally working out just between the two. The discrepancy, however, is very minute, being only a small fraction of a second.

SPIER FALLS DAM AND POWER PLANT.

BY WALTER H. MAIN.

The imposing power plant which is now nearing completion at Spier Falls, which is located about ten miles above Glens Falls, in this State, has scarcely attracted the attention which its magnitude demands; for when the complete plant, as now laid out, has been installed, the ten great turbines will have an aggregate capacity of 50,000 horse power, which is equal to that of the famous electric plant as originally installed at Niagara Falls. The site of the dam was selected because of the natural advantage conferred by a fall of the Hudson River, which is well adapted at this spot to the creation of a great reservoir. The river flows between the Luzerne Mountains on the north, and Mount McGregor on the south, and the two form a valley which at this point is about half a mile in width. The underlying rock is of good quality, well adapted as a foundation for masonry, and the watershed of the Hudson above the reservoir contains about 25,000 square miles.

The dam, of which we present several illustrations, has a total length of 1,800 feet and contains 181,000 cubic yards of masonry. It is built of a fine quality of granite which was obtained from the Saratoga hills. At its deepest point it measures 156 feet from bedrock to crest, and a cross-section at this point shows a total width of base of 115 feet. The structure is virtually composed of three parts. Its northerly section, which abuts on the Warren County shore, is 820 feet in length and rises to an elevation of 80 feet. This is separated by a wing wall 10 feet in thickness from the southerly portion, which extends for 550 feet and is 90 feet in height. South of this is the canal, 420 feet in length, by which the water is led from the reservoir to the fore-bay at the back of the power house. At the fore-bay it is led by ten steel tubes, each 12 feet in diameter, to as many 54-inch turbines, which will be run under a 90-foot head. Each turbine will be direct-connected to a generator of 5,000-horse-power capacity. The ten units will be located in a handsome power house, 400 feet in length, which will be built of brick and steel, and will conform in every respect to the best modern construction and finish for large hydraulic-electric power plants. In order to secure the greatest possible head of water, the power house is located in what was formerly the bed of the river. The total cost of the plant is about $2,000,000.

The marketing of the power (a problem which in some of the larger power plants that have been constructed of late years has proved to be more serious than was anticipated) has presented no difficulties, because of the large number of important towns and manufacturing centers that are within easy reach. Within a radius of 50 miles are Glens Falls, with its shirt factories and other industries; Saratoga, with its big demand for electric lighting; Troy, which produces more collars, cuffs, and shirts than any other city in the world; Schenectady, with its great electrical and locomotive works; Watervliet, with the United States arsenal and gun factory, and Albany, the capital of the State. Throughout this section there are many hundreds of miles of interurban trolley lines, which find cheaper power in the dammed-up energy of the Hudson River, than in their own coal-fed power plants. So promising is the demand, that thirty years' contracts have been made for practically the entire output of the plant.

The provision for transmitting the power was a large undertaking in itself. A right of way for pole lines was secured, the three-phase system was installed, and mounted linemen, in relays of fifteen miles patrol every foot of the line each day. All the linemen are kept in communication with the switchboard by a private telephone line, and the loss of power due to defects of transmission is practically nothing. The power is distributed as alternating current of high voltage to sub-stations in the various cities and towns, where it is transformed and stepped-down to the particular voltage required by the consumer.

Berliner's Airship.

Emile Berliner, well known for his microphone-telephone transmitter, the gramophone, and other inventions, announces that he has devised an aeroplane. From the newspaper accounts thus far published, it seems that his contrivance is made of aluminium and tin-plate, with ribs of oak and metal tubing. The whole machine is 10 feet wide by 14 feet long.

The escalator at the 23d Street station of the Sixth Avenue elevated railroad, New York city, which has been shut down recently, has now resumed regular operation. Some time ago the motor driving the escalator was connected to take current from the third rail. It was found, however, that the voltage fluctuates over a considerably wider range than had been anticipated and the shut-down was necessary in order that alterations might be made in the motor to secure better speed regulation. During the interval that the electrical changes were in progress, the receipts of the station showed a marked falling off.

Engineering Notes.

There have been launched in the United Kingdom during the past six months 290 vessels, totaling 565,343 tons gross, as compared with 289 vessels, of 668,533 tons gross, in the first half of last year.

It was recently announced that a train from London to Plymouth on the Great Western Railway had made a run of 246 miles in 233¾ minutes, thus establishing a world's record for a long-distance run. The officials of the Lake Shore & Michigan Southern have promptly given out figures which disprove this claim. On May 21, 1903, the Twentieth Century Limited left Cleveland at 4.02 A. M., and arrived at Elkhart, Ind., at 7.23 A. M., making 246.12 miles in 221 minutes.

From the returns compiled by Lloyd's Register of Shipping, it appears that, excluding warships, there were 426 vessels of 1,028,099 tons gross under construction in the United Kingdom at the close of the quarter ended June 30, 1903. The return shows an increase in the tonnage under construction of about 54,000 tons as compared with the figures for last quarter, but a decrease of about 385,000 tons as compared with the total reached in September, 1901, which is the highest on record.

The new dock which is being built at Boulogne, and which will be called the Bassin Loubet, is to be a deep tidal dock, without gates, and rectangular in form; the north and south quays will each be 350 yards in length, the west side 219 yards, and the east 165 yards. Alongside the north quay there will be a depth of 13 feet at low spring tides; at the south quay there is to be a depth of 25 feet at lowest spring tide to enable ocean liners to lie alongside it at low water. The dock, which will cover an area of 16 acres, will be entered from the east end. The Bassin Loubet is to occupy the site of the Capécure sands and sand battery. The latter has been entirely removed and set up on a new breakwater.

Writers in the English press appear to have been much exercised over certain statements made by a Woolwich gunsmith in support of his claim for compensation against a railway company who seek to acquire his premises for the improvement of their line. The gunsmith, who occupies quite ordinary premises adjoining the railway station, asked the modest sum of £2,684 for being turned out against his will, and in explanation of his demand said that his profits ranged from 200 to 800 per cent, one specialty of his, described as a wind-gage, which cost 9s. to make, selling for £2 14s. On gunpowder he made an average profit of 200 per cent. These figures are enough to make the mouth water, but they are questionable.

A paper was read before the Association of German Engineers, by Prof. Schmoller, of Berlin University, entitled "The Borderland between Technical Progress and Practical Economics." He said that "In the year 1750, when Germany had a population of 18,000,000, of whom 9,000,000 were laborers, the proportion of the physical power exerted by the human factor in economic activity was to the power exerted by machinery in the ratio of one to one. In the year 1895, when Germany had a population of 56,000,000, of whom 28,000,000 belonged to the laboring classes, the proportion of manual labor to labor done by machinery was as one to six, or, according to other estimates, as one to ten. Nevertheless, it was recognized that the machine without the superintendence of the human factor was merely an automaton, and that its productivity could only be immeasurably increased in cases where industrial processes could be resolved into a variety of constantly recurring and identical movements."

The British Admiralty has experienced considerable difficulty in the storage of the steam coal for the war vessels at the coaling bases, since the fuel is injuriously affected by wind and water both in volume and calorific power when stored in bulk. To overcome these disadvantages, which are more serious than may be supposed, an ingenious floating coal depot is being constructed for the Admiralty. In design it resembles an enormous tank capable of holding 12,000 tons. It comprises a waterproof steel framework, very similar in design to the hull of a cubical battleship, and into this is sunk a central shaft, which lets down into an open area corresponding in dimensions with the base of the depot. Pumps are provided to remove any water that may leak into this chamber, while periodically the men descend the shaft to release the coal outside as it settles downward. The vessels containing the coal are moored alongside the tank, and the fuel is removed from their holds by means of four traveling cranes which shoot it through hatchways—one provided to each crane—into the body of the tank. The coal gradually settles downward, and when it is desired to coal a vessel, it is drawn from the bottom of the reservoir through scoops and transferred to the bunkers of the warship. By this means it is anticipated that it will be possible to keep the coal as fresh for months as if it had only been drawn from the mines as required.

Electrical Notes.

Statistics prepared by the United States Census Bureau show that upward of 502 million dollars is invested in the electric light and power undertakings of that country, which number 3,619, and that the gross yearly earnings of these amounted to upward of 85 million dollars. The total annual expenses amounted to 67.7 million dollars, of which about 20½ million dollars was paid in salaries and wages, and 22.8 million dollars for supplies and materials. The horse power of the machinery installed totaled 1,758,175, of which 381,134 were generated by 1,378 turbines, and the remainder by 5.921 steam engines. The total output for the year in kilowatt hours was 2,437,218,732 units.

The Miller signaling system has been adopted for the Severn tunnel on the Great Western Railway. The tunnel is 4 miles and 600 yards in length. With the new signaling system the tunnel will be divided into sections of 1,200 yards length, thus permitting more than one train on the same line in the tunnel at the same time and with perfect safety. The usual semaphore signals at the sides of the line will be supplemented by "repeat" signals indicated in the cab of each locomotive before the eyes of the driver. This system, which can only be used in connection with electrical track circuit signaling is in successful operation in the Park Avenue tunnel of the New York Central Railway.

It has been decided by the Prussian State Railways Administration to run all the trains on the suburban railway between Berlin and Lichterfelde by electricity. This is said to be an outcome of the long series of trials on the military railway between Berlin and Zossen, which proved the advantage of propelling trains by electric power. An experimental train has been running on the Berlin-Lichterfelde section for the past month with much success. Locomotives by this time are entirely banished from the line. The method of working is by motor cars, each train consisting of two long coaches, one second and one third class, each with separate compartments for smokers. The advent of electrical working on one of Berlin's suburban lines is regarded as the beginning of a new era in railway locomotion in that city, which will soon see steam haulage on all the suburban lines displaced by electric propulsion.

In the investigation of the conductivity of ordinary air, by H. Geitel and C. T. R. Wilson, a certain amount of uncertainty is introduced in the determination of the capacity of the electroscope. In a method proposed by F. Harms, in the Phys. Zeitschr., this uncertainty is avoided. The method consists in determining the rate of discharge from a body suspended in air, and the potential measuring apparatus is only connected with the body at the instant of measuring the potential. The charged body is a brass sphere suspended on a glass thread, it is charged to a certain potential by means of a battery, and after a certain time has elapsed, it is connected to the electrometer and its potential is measured. It is again charged to the original potential, and after a different interval of time its potential is again measured, and so on, each experiment giving one point on the curve of discharge. The experiments give the number of ions used and regenerated per second, and cubic centimeters in air at 19 deg. C. as 28, while C. T. R. Wilson's experiments gave from 14 to 19 at 15 deg.

D. Negreano, in a communication to the Paris Academy of Science, described a new process for separating metallic powders from inert matters. On an insulated metal plate the pulverized mixture is placed, the plate being connected to the negative terminal of a Wimshurst machine. On bringing up to the plate a metal disk connected to the positive terminal of the machine and projecting the pulverized substance in a vertical direction by means of a special blowing machine, the metallic powder is found to be repelled and partly deposited on the upper parts of the disk. The separation will occur readily when operating with sand and metal grains; experiments with sand grains and very small copper and bronze grains have shown nearly the whole of the metal to be deposited on the disk. This phenomenon is explained as follows: in the space between the metal plate and disk, the combination of which constitutes an air condenser, the field being uniform, the flux will be perpendicular to the disk; in the neighborhood of the edges of the disk the lines of force will undergo a bending effect, so that the lines parting from the plate beyond of the surface facing the disk will be curved in toward and made to terminate on the latter, this being the path followed by the metallic particles deposited. The above process may serve in some cases to separate a mixture of finely divided metals. When applied to a mixture of brass and copper particles, for example, experiment shows that the brass will be repelled and deposited on the metal disk. The process may, as well, be applied to separating the metallic part of an ore from the gangue.

Motor Cars as Feeders to Trunk Railroads

A service of motor cars, for feeding its trunk railroad, has been established by the Great Western Company of England between the station at Helston, in Cornwall, and the Lizard, some eleven miles distant, and to which there is no railroad communication at present. A short time ago we drew attention to the possibilities of the automobile to act as feeders to trunk railroads, especially in inaccessible places, or where the traffic is not sufficiently extensive to render any other means of communication remunerative. The cars which the Great Western railroad have selected for their service are the Milne-Daimler gasoline vehicles developing 16 horse power on the brake. There is accommodation for 32 passengers. The journey between the Lizard and Helston station, which is over a somewhat hilly road, will occupy approximately 1¼ hours. This service is purely experimental, but should it prove successful, similar services will be initiated, upon other sections of the railroad system where the townships or villages are located some distance from the railroad.

The Great Western Company are also completing arrangements for the introduction of a railroad motor car service upon the section of their track extending from Stonehouse to Chatford, through the Stroud Valley, a distance of about seven miles. The power in this instance will be steam, the motor being carried in a compartment at one end of the vehicle. The length of the car over all is to be 56 feet by 9 feet, 3¼ inches maximum width. It will be built on the bogey principle, and will weigh 34½ tons, with accommodation for 42 passengers. The seats will be placed longitudinally on either side of a central gangway. The motor compartment will be inclosed right in and will be scarcely distinguishable from the remainder of the vehicle. The funnel will protrude slightly above the roofing of the car. The power to be generated will be sufficient to supply a tractive energy up to 30 miles per hour. The motor will not be fitted with reverse motion, as it is to be controlled and driven from either end of the car. The introduction of these steam motor cars is due to the severe competition of the local street surface railroads, which, since conversion to electric traction, have conveyed the larger bulk of the passenger traffic formerly carried by the railroad trains. It is thus anticipated that by the employment of the single motor coaches for short distances, the railroad company will be able to regain the whole of its former traffic, especially as the service will be quicker, and thereby constitute a powerful rival to the street surface cars.

Death of Frederick Law Olmsted.

On August 28, Frederick Law Olmsted, the famous American landscape architect, died at Waverly, Mass. Hardly a city in the Union has not at some period made use of Mr. Olmsted's genius. It was in 1856 that Mr. Olmsted and Mr. Vaux made plans for New York Central Park. From that time on Mr. Olmsted's efforts were given almost entirely to the work of landscape gardening. With Mr. Vaux, Mr. Olmsted prepared complete designs for Prospect Park, Brooklyn, laid out public parks in Buffalo, the South Parks of Chicago, and the Chicago suburb of Riverside, as well as many other large and small parks of a similar nature in other places. In 1875 he severed his connection with Mr. Vaux and became the salaried landscape architect of New York city. In 1878, he planned Boston's system of parks, for which purpose he moved to Brookline, near Boston. Perhaps his most recent famous undertaking was the laying out of the World's Fair Grounds in Chicago, for the splendid success of which enterprise he received honorary degrees from Harvard and Yale.

The Current Supplement.

It is the purpose of the editor to publish in the SUPPLEMENT, in three installments, an article by Emile Guarini on "Mechanical Handling of Coal and Coke in France." The first installment appears in the current SUPPLEMENT, No. 1445. The system described, although not quite so absolutely mechanical as the American system, is nevertheless interesting. Airships are just now much in the public eye, for which reason an article on the development of the flying machine should be welcome. William Metcalf discusses "Springs." The Dettmar electric speed indicator for locomotives and other vehicles is described in full. Many illustrations accompany the text. Charles E. Randall presents an account of Utah's "hot-pots." Not the least interesting article in the SUPPLEMENT is Lord Kelvin's striking mathematical analysis of ether and gravitational matter through infinite space, discussing as it does the possible density of the luminiferous medium and the mechanical value of a cubic mile of sunlight. Randolph I. Geare presents some information on "Savage Tattooing," in addition to that to be found on another page.

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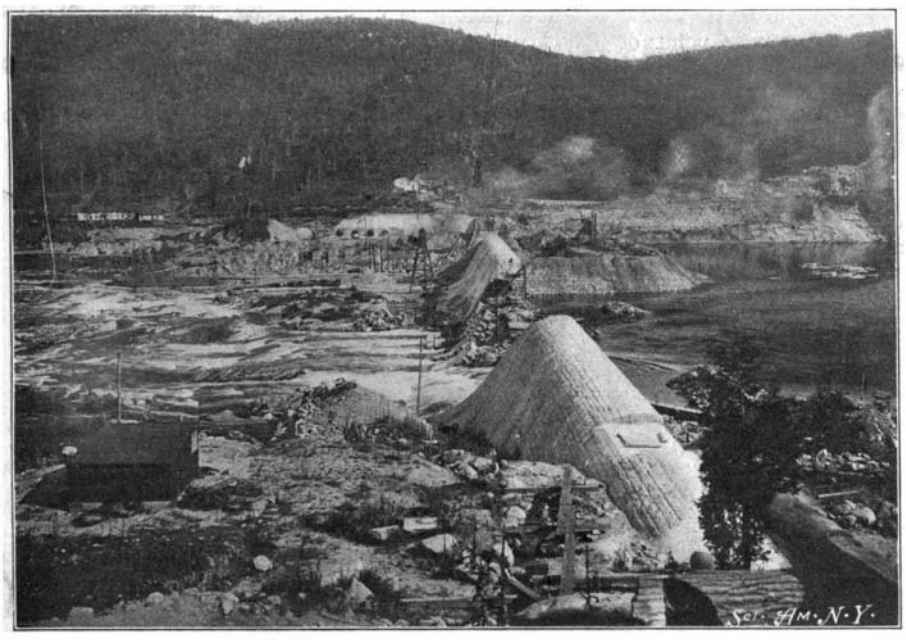
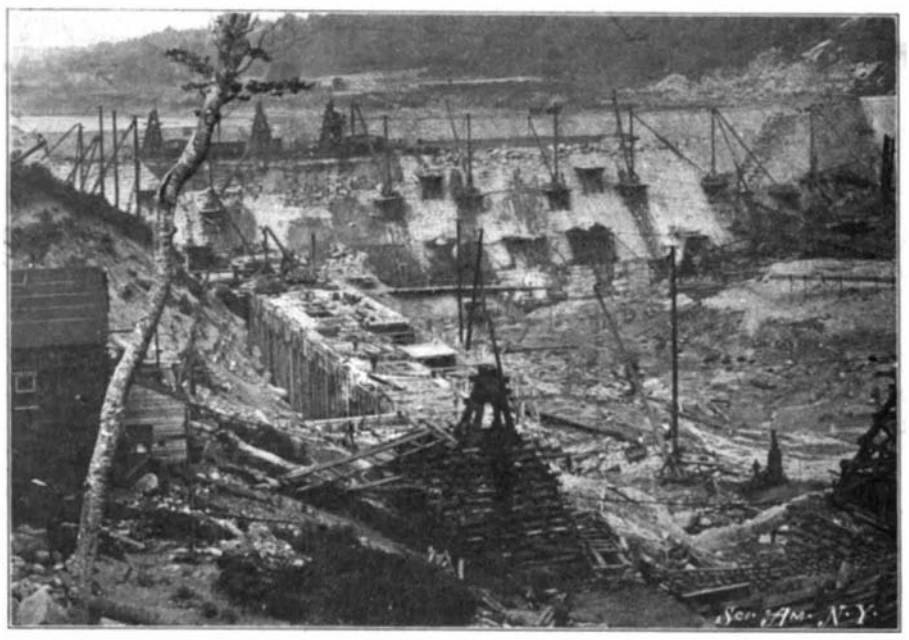
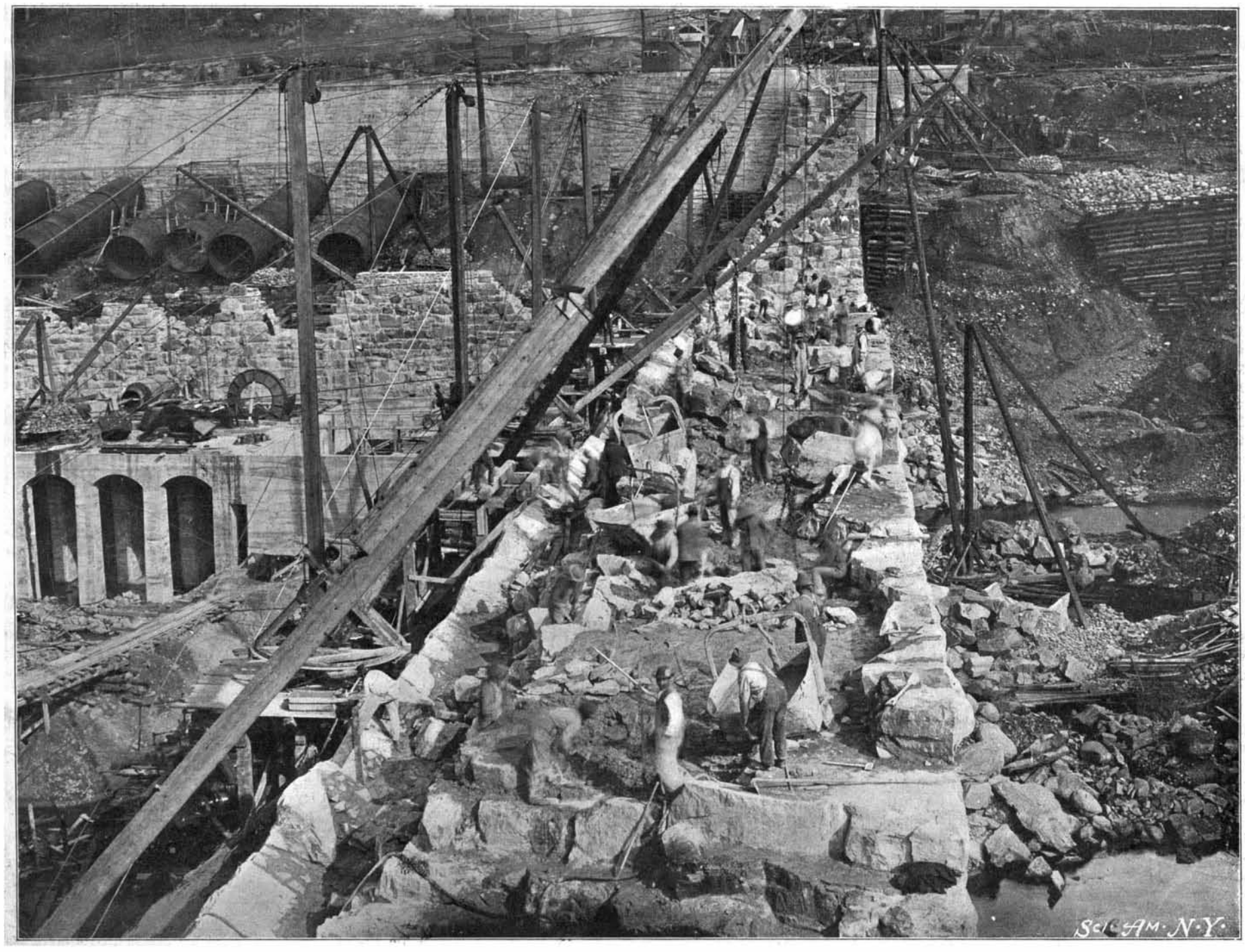


Showing Down-Stream Face of Partially Completed Dam.



View from Below Dam, Power House in Foreground.



View Showing the Main Dam, the 12-Foot Penstocks, the Floor and Tailrace of the Power House.

THE 50,000 HORSEPOWER POWER HOUSE AT SPIER FALLS.—[See page 186.]