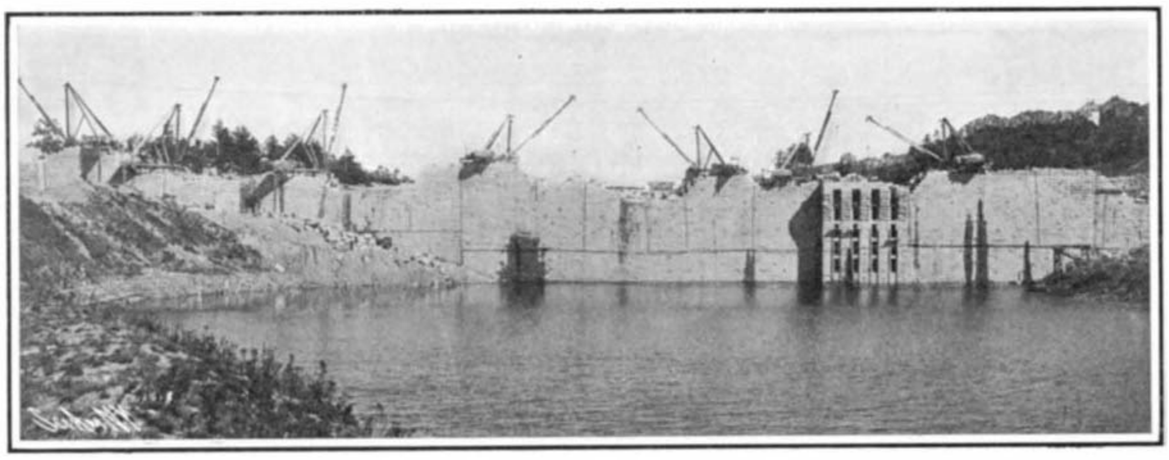
THE WACHUSETT RESERVOIR FOR BOSTON WATER SUPPLY.

The completion of the great Wachusett reservoir, for the water supply of the city of Boston and certain neighboring towns and districts, marks the practical conclusion of a great work, which attracted public attention as far back as 1893, when the Legislature authorized the State Board of Health to prepare a plan for a suitable water supply for the city of Boston and its suburbs. At that time Boston was receiving about 57 million gallons daily from a watershed 120 miles square. About five-eighths of this supply came from Sudbury River and its tributaries, and the remainder from Lakes Mystic and Cochituate. There was barely sufficient water to meet the needs of the people, which it was estimated would, in 1895, amount to 84 million gallons daily. In 1895 the Legislature created the Metropolitan Water Board to act for the State.

The plan outlined for future needs was a generous one. A big dam was to be built across the Nashua River near Clinton, which is 35 miles from Boston, to impound 63 billion gallons; thence the water was to be conveyed by a new aqueduct to the new Sudbury reservoir; thence the combined waters of the Nashua, Sudbury, and Cochituate systems were to be carried to the city of Boston, to Chestnut Hill, and to Spot Pond, whence they were to be distributed to the various cities and towns of the metropolitan district, thereby insuring a minimum daily supply of 173 million gallons.

The most important element in these works was the construction of the Wachusett dam and reservoir in Worcester County. The site selected was a most excellent one. The dam serves to impound the waters of the Nashua watershed, which has an area of about 118 square miles, and is capable of yielding, even in a series of very dry years, 105 million gallons of water daily. The conformation of the watershed and of the Nashua Valley was particularly favorable to the location of the reservoir. Near the town of Clinton the valley narrows at a point where good rock foundation is obtained, and presents an excellent side for a dam. Above this point the valley spreads out into a wide natural basin, admirably adapted for reservoir purposes. So favorable is the topography in this basin, that, by the construction of a dam 1,250 feet in length, of which length only 750 feet has a depth from high water to rock exceeding 40 feet, it has been possible to impound over 63 billion gallons of water, thereby forming what is by far the largest fresh-water reservoir in the world. As will be seen from the accompanying table showing the comparative dimensions of some of the most notable reservoirs of the world, the Wachusett reservoir is considerably the largest, having in fact twice the capacity of the Croton dam for the water supply of New York city.



View of Dam from the Upstream Side.

COMPARATIVE TABLE OF AREAS, DEPTHS, AND CAPACITIES OF STORAGE RESERVOIRS, WITH HEIGHTS AND LENGTHS OF DAMS.

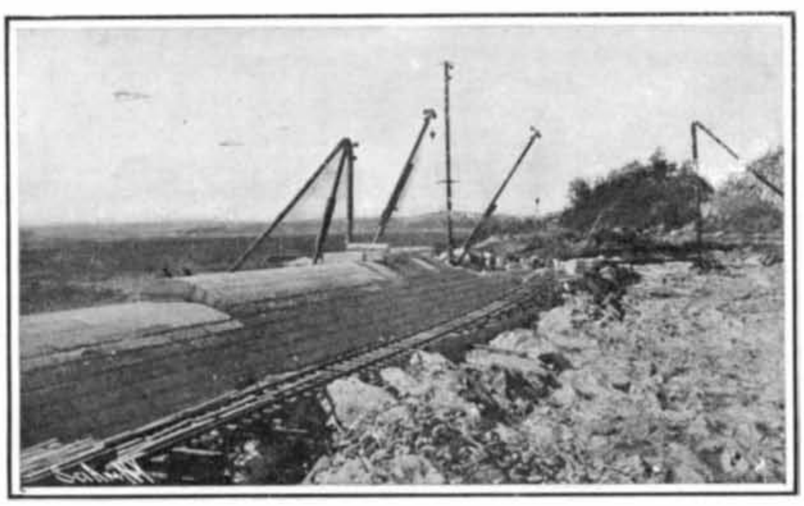
Name and Location of Reservoir.	Area (Square Miles).	Average Depth (Feet).	Maximum Height of Dam. Above Ground	Maximum Height of Dam. Above Rock	Length of Dam (Feet).	Capacity (Million Gallons).
Wachusett reservoir Mass	6 56	46	129	158	1,250	63,068
Nira, near Poona, India	7 25	27	100	......	3,000	41,143
Tansa, Bombay, India	5.50	33	127	131	8,770	37,500
Khadakvasla, Poona India	5.50	32	100	107	5,080	36,737
San Mateo, Cal.	......	......	170	......		32,000
New Croton, N. Y.	......	......	157	290	1,270	32,000
Elan and Claerwen, Birmingham, Eng., waterworks (total for six reservoirs).	2.34	43	98 to 128	......	4,460	20,838
All Boston waterworks reservoirs combined	5.82	14	14 to 65	......	......	15,867
Vyrnwy, Liverpool, Eng	1.75	......	84	129	1,350	14,560
Sodom, N. Y.	......	......	72	89	500	9,500
Hemet, San Jacinto, Cal	......	......	150	......	200	8,500
Sudbury reservoir, Boston water works	1.91	19	65	70	1,865	7,438
Titicus, N. Y.	......	......	105	115	......	7,000

NOTE.—The heights of dams are given from the ground and rock up to the level of full reservoir. The lengths of dams are the distances across the valleys at the level of full reservoir on the line of the main dam. The capacities are given in United States gallons.

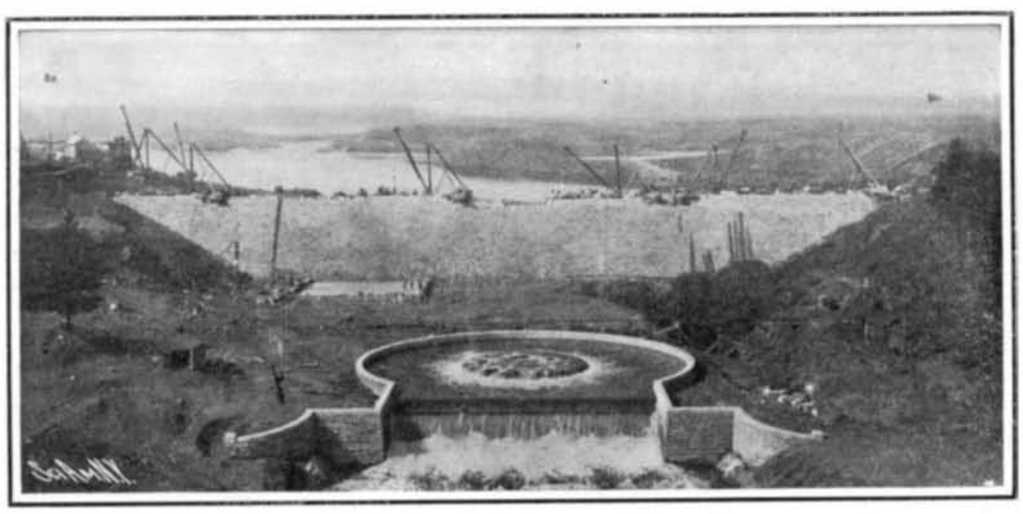
The dam has in cross section the same general form as that of the new Croton dam. It extends 10 feet above the high-water level of the reservoir. It is 19 feet in thickness at the water level, and at 145 feet below the waterline the thickness increases to 120 feet. It is built entirely of first-class masonry laid in cement. The maximum depth from high water to the rock at the downstream edge of the dam is 158 feet.

Nature has provided at the northerly end of the dam an excellent site for the construction of a waste weir and channel for the overflow of surplus water during floods. This waste weir has a length of 450 feet. For the greater part of its length, the crest is constructed at the level of the full reservoir; but for a length of 120 feet, the crest, as shown in one of our engravings, is a few feet higher; and by the use of movable gates on the lower level of the crest, it will be possible to raise the height of water in the dam by several feet, if desired. The gate house of the main dam is served by four 48-inch pipes, which perform the double purpose of supplying water to the aqueduct leading to the Sudbury watershed, and of conveying the waste water to the river below the dam. These pipes alone, because of the large head upon them when the reservoir is about full, will have sufficient capacity to take care, unaided, of the waters of a large freshet. The combined relief afforded by these pipes and spillway above mentioned will give ample protection against the severest floods that can occur in the watershed above.

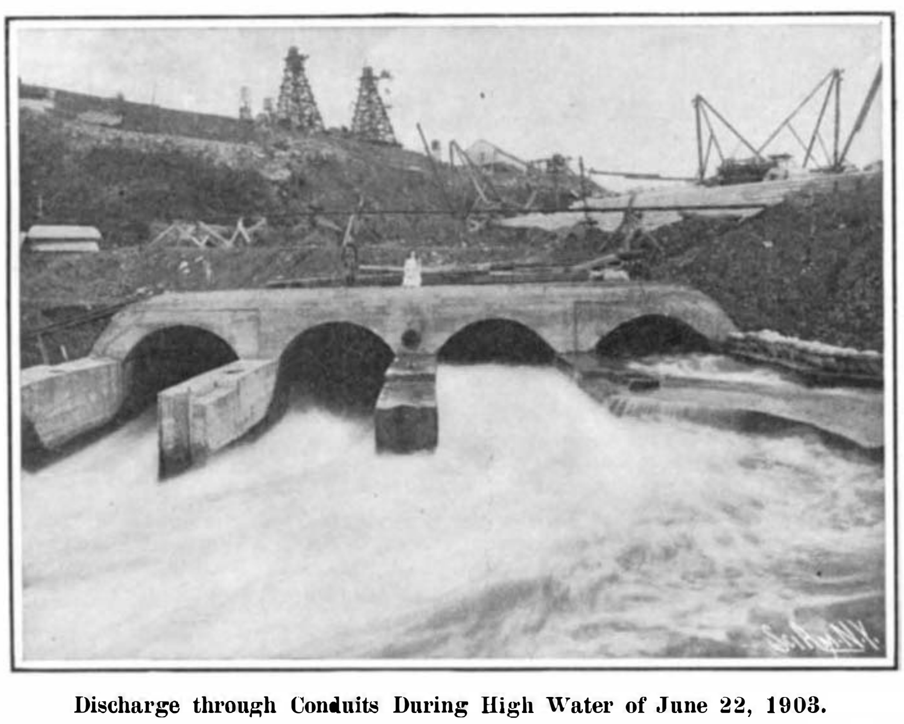
The construction of the masonry of the dam was by



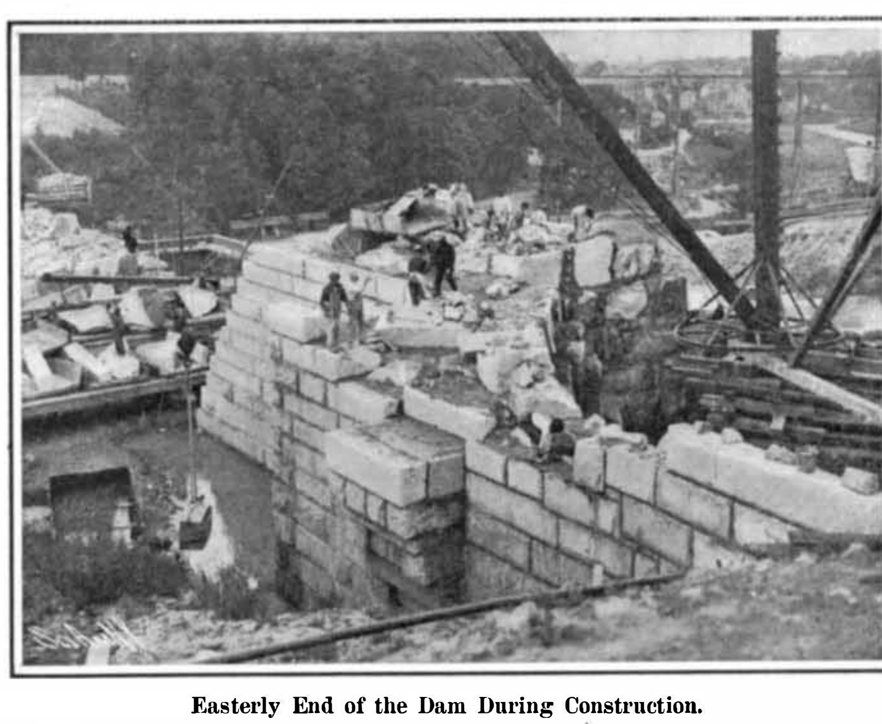
The Waste Weir from the East.



Pool and Spillway Below the Dam.



Discharge through Conduits During High Water of June 22, 1903.



Easterly End of the Dam During Construction.

THE WACHUSETT RESERVOIR FOR BOSTON WATER SUPPLY.

no means all the work that had to be done to impound this 63 billion gallons of water. Huge dikes had to be built to the north and south of the main dam, to fill in certain low places in the higher contour lines of the dam, and prevent the outflow of water in those two localities. Moreover, the Metropolitan Water Board very wisely reached the conclusion that the brush, peat, mud, and minor organic accumulations at the bottom or along the sides of reservoirs and basins soiled the water and infected it with living organisms. Consequently, they determined to undertake the heroic task of scraping the surface soil from the whole of the 6½ square miles occupied by the reservoir, carrying out this cleaning operation until either bedrock, sand, or mineral earth was reached. An average of 9 inches of black loam was taken from the wooded land, and 11½ inches from the cleared land. Now, this general cleaning up served a double purpose; for it not only insured a better quality of water, but the material removed served for the construction of the great north dike, which runs along the northerly side of the reservoir for a total length of 8,550 feet. This dike extends 15 feet above the high-water level, and it is 50 feet in width at the top. On the reservoir side of the embankment, the slope consists of a thick bed of impervious gravel covered with heavy riprap. There is another dike on the southerly side of the reservoir, which is one half a mile in length, and extends 10 feet above the high-water level. This dike consists of an earth embankment, with an impervious concrete core wall, which is carried down to the solid rock and extends vertically as a diaphragm through the center of the earth dam until its top is above high-water level. It should be mentioned that the removal of the greater part of the soil was done by means of a railway and special soil-scraping material. The magnitude of this soil removal is shown by its total cost, which reached the sum of $3,000,000.

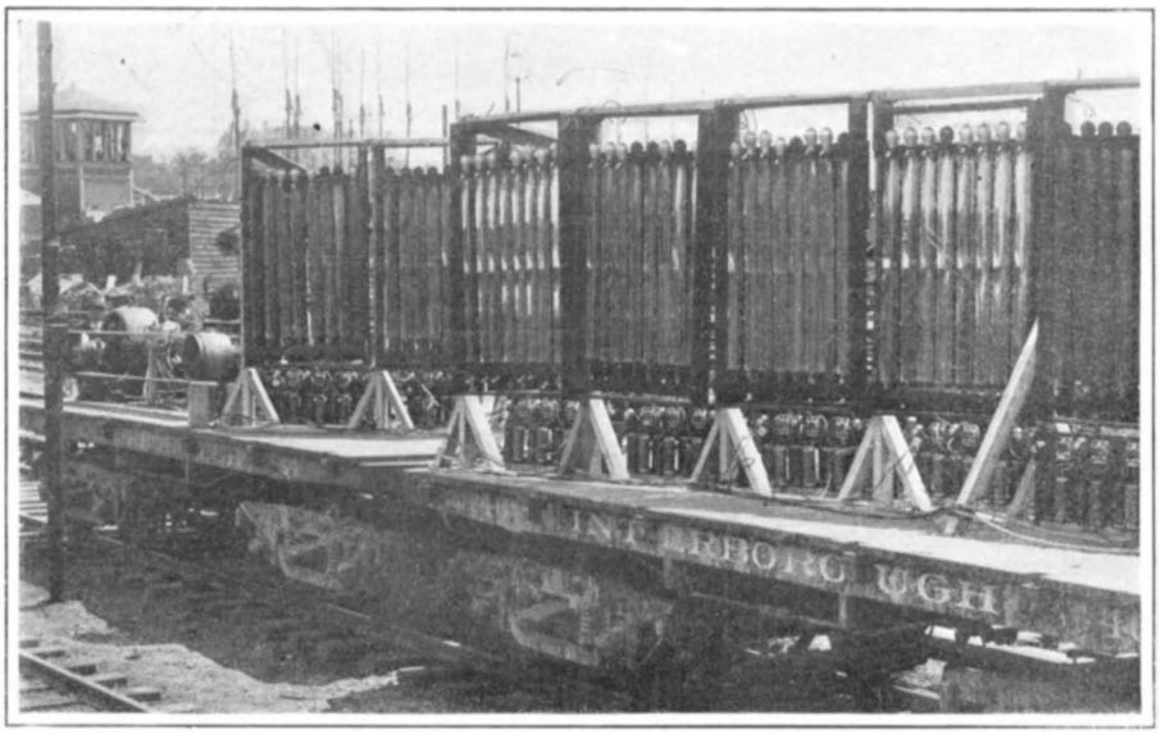
The area flooded by the new reservoir includes 2,000 acres of cleared land, 1,801 acres of wooded land, 81 acres of stump land, and 313 acres of water surface. The elevation of the reservoir is 385 feet above the Boston water works base, thus affording an adequate height to reach the highest buildings in Boston. It is interesting to note that preliminary to the soil-clearing operations, it was necessary to remove, among other buildings, 6 mills, 4 churches, 6 schoolhouses, and 224 dwellings. Moreover, 1,711 people dwelt upon the land required by the reservoir. The mere settlement of claims formed a large part of the expense, the outlay for which reached a sum of over $2,000,000.

The proper and most convenient measure of boiler furnace efficiency would be the composition of the gases leaving it, as determined by analysis. According to the above definition, a furnace would not be a portion of some steam-generating apparatus; for example, when a grate is located immediately under the boiler. In other cases, such as with many stokers, the furnace feature is only partially developed. With such fuel as anthracite coal or coke, a furnace would have a minimum value, and its maximum value would be realized with bituminous coal.

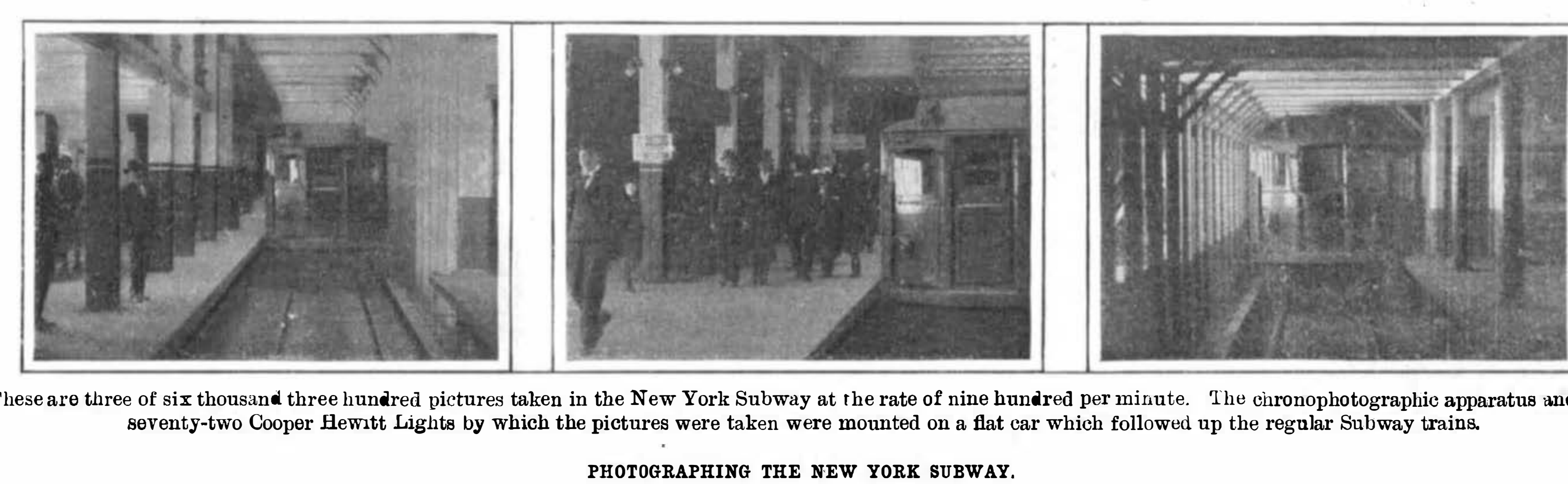
PHOTOGRAPHING THE NEW YORK SUBWAY.

BY FRANK C. PERKINS.

A most interesting and novel equipment has recently been utilized in taking moving pictures in the Subway between 14th and 42d Streets in New York, showing loading and unloading of the trains, the platform scenes being taken at Grand Central Station, 33d Street, 23d Street, and 14th Street. A special car was provided by the Interborough Rapid Transit Company, as shown in the accompanying illustration, provided with seventy-two Cooper Hewitt mercury-vapor arc lamps, each of 750 candle power, producing a total of over 54,000 candle power. From a photographic point of view, on account of the great actinic quality of the light, this value is multiplied many times. There were nine banks of eight 55-inch mercury-vapor lamps mounted in frames and arranged diagonally across one flat car, so that the light was thrown immediately ahead of the car upon which the camera was mounted and to one side. The flat car containing the generating apparatus received current from the third rail, and operated a motor generator set consisting of a 40 horse-power Westinghouse direct-current quadripolar motor at a pressure of 550 volts. This motor was belted to a four-pole Westinghouse direct-current generator having a capacity of 22.5 kilowatts, and supplying a continuous current of 110 volts pressure to the Cooper Hewitt lamps, which were mounted in front of polished metal reflectors. A switchboard table was provided, upon which were mounted the necessary controlling switches, ammeters, and voltmeters. The mercury lamps were started by means of kicking coils arranged along the bottom of the frame, and the various banks of lamps were coupled together by means of fiber couplings, so arranged that the frames could be tilted forward or backward as desired. The pictures were taken by the American Mutoscope and Biograph Company, by a special machine mounted on an iron framework with several compartments, one above the other, provided with a rapid crank movement and special projecting lens, the pictures being taken at the rate of 900 per minute. The local and the express trains were open to passengers, the flat cars being located just far enough behind the rear car of the local to show the train clearly while in motion, and showing the interchange of passengers between the local and the express trains. The time of exposure was seven minutes, so that the film included 6,300 pictures. At the Grand Central Station a stop of several minutes was made, the mercury lamps illuminating the station perfectly, the crowds of passengers being taken in every detail as they were alighting from the trains, other passengers taking their places. It is stated that the details of the Subway construction were photographed with remarkable distinctness, although the trains were moving at high speeds, the high actinic power of the lamp giving excellent results. The photographs were taken under the direction of F. A. Dobson, of the Biograph Company, and L. B. Stillwell, electrical director of the Subway, while the running of the trains was under the direction of the Subway Superintendent, A. L. Merritt.



THE 54,000 CANDLE POWER COOPER HEWITT MERCURY ARC LAMPS.



These are three of six thousand three hundred pictures taken in the New York Subway at the rate of nine hundred per minute. The chronophotographic apparatus and the seventy-two Cooper Hewitt Lights by which the pictures were taken were mounted on a flat car which followed up the regular Subway trains.

PHOTOGRAPHING THE NEW YORK SUBWAY.

A contest is to be held on the occasion of the Milan Exposition of 1906, by the Association of Italian Industries for security against accidents in work. This association proposes to award the following prizes for different kinds of safety appliances. A gold medal and the sum of $1,600 will be awarded for a new device which will entirely suppress the danger to life coming from a contact which may eventually be formed between the primary and secondary circuits of an electric transformer. This apparatus is to be constructed so that while responding to its principal function it can neither interrupt nor alter the working of the transformer under the influence of a rise of tension or from an atmospheric discharge. A gold medal and the sum of $200 will be awarded for a good form of crane or hoist provided with a simple and practical device which will absolutely prevent the rotation of the cranks on the descent of the load. A gold medal and $100 is offered for a simple, strong, and effective apparatus for automatically stopping cars which are moving upon an inclined plane in case the traction cable should break. This apparatus is to be applied to already existing plants. A gold medal is to be awarded for a practical device for exhausting and collecting the dust which is formed during the sorting and cutting of rags by hand. Such a device should satisfy the proposed conditions without causing drafts which might be injurious to the workmen's health. A gold medal is offered for an apparatus for localized exhaust and successive elimination of dust which is produced during the cardage of flax tow, hemp, jute, etc. This device is to be used where the above operations are carried out so as to improve the health of the workmen, without having any harmful effects upon the neighboring localities. A gold medal is awarded for an effective device which will prevent the diffusion of dust in places where the preparation of lime and cement is carried on. Demands for admission to the concourse should be made before July 31 of this year to the above-named society, Foro Bonaparte 61, Milan. The first three devices are to be exposed in working order, while a model of the last three can be presented. Models and inventions will remain the property of the inventors. The society is to publish a description of the best apparatus.

Caseine Cement.—In 95 parts of water dissolve 5 parts of borax, and to this solution add enough caseine to obtain a mass of good consistency.