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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

INAUGURATION OF THE RAPID TRANSIT SUBWAY.

With the opening of the Rapid Transit Subway, New York city is placed in possession of what is undoubtedly the most complete and up-to-date system of rapid transit to be found in any part of the world. This is due to the fact that it was planned on an ambitious scale, that the engineers were not hampered by any exacting considerations of economy, and that being the latest of the great subway systems to be opened, it has the advantage of the experience that has been gained in London, Budapest, Paris, and Berlin.

To the SCIENTIFIC AMERICAN the auspicious inauguration of this great work is peculiarly gratifying; for from the time that the present plans took practical shape, this journal has been a most earnest advocate of the construction of just such a road as has now been opened. There is also a sentimental interest attaching to the event, in the fact that the very first attempt at the construction of an underground system, and the plans therefor, were due to the initiative of one of the Editors and proprietors of this journal. Indeed, several hundred feet of subway was constructed and still exists below Broadway at City Hall Park. That early effort, made in the year 1870, was doomed to failure, mainly because the electric motor had not yet made its appearance, and the public was not educated up to the advantages of subway travel.

On an occasion like the present, with the road actually completed and in successful operation, we are apt to accept the result with but little consideration of the vast amount of patience, technical skill, far-sighted prescience, and unbounded faith, that were necessary on the part of the sponsors of this great engineering and financial undertaking. Acknowledgments are certainly due to the members of the Rapid Transit Commission, with Alexander E. Orr at their head, for the large amount of time that they have given, entirely without compensation, to serving the best interests of the city; to William Barclay Parsons, the Chief Engineer of the Commission, and his staff of assistants, for having shown such good judgment in the planning and carrying out of this great piece of engineering work under conditions that were extremely trying, and in many cases entirely without precedent in their profession; to John B. Macdonald, who provided the plant and vast organization for the execution of the work, and has redeemed his pledge to complete this $35,000,000 contract practically within the contract time; and finally, to August Belmont and his associates, who, at a time when the Rapid Transit Commissioners were very doubtful as to whether they could secure a bidder with the courage and the resources necessary for such a great and comparatively untried piece of work, stepped into the breach, and provided the vast sums of money that were called for.

It is gratifying to know that at the very time when these twenty-one miles of additional transit facilities are being opened to the public, the Rapid Transit Commissioners have elaborate plans made for further extensions of the system. The growth of New York city, and the increasing percentage of its inhabitants that use the various systems of transportation, render necessary further extensions of the Subway, in order to cope with the steadily increasing volume of travel. First in order of importance comes the projected line below Lexington Avenue, which will give to the east side of New York facilities similar to those enjoyed by the west side. With this should be named the line beneath Broadway from Forty-second Street to the Post Office; or if that is not deemed advisable, the line down Seventh Avenue, intersecting the new Pennsylvania station at Thirty-third Street. Within two years' time the extension from the City Hall to the Battery, and under the East River to Flatbush Avenue, Brooklyn, will be completed; and in anticipation of this, work will be begun at an early date upon the extension of this road by way of Flatbush Avenue to the Ocean Parkway. With these three extensions under way, Greater New York should be in a fair way to keep pace with the increasing traffic of the city for several years to come.

COST OF ELECTRIC WATER POWER PLANTS.

The cost of water-driven electric plants per kilowatt capacity varies much with the nature of the fall, the type of the hydraulic development, and the amount of head.

For a given head of water the natural, vertical fall costs least to develop per unit of power. Next in economy of construction is a plant whose head of water is derived from a short series of steep rapids. For either of these cases the only dam necessary is a low one at the head of the falls or rapids, to gather the water into penstocks that drop to the generating station.

If the fall is vertical, the length of penstock need be little more than the height, and the generating station may be close to the foot. Even in the case of steep rapids the length of penstock from their head to the power house at the foot may be only a few rods.

As the rapids or low falls are scattered from several thousand feet to several miles along a stream, the necessary penstock, to bring water from their head and deliver it to a power house at their foot, lengthens into a pipe line. In such a case a canal may be used instead of a pipe line, and the penstock may still be a short pipe, that connects the end of the canal with the power house. Whether the canal or the pipe line is used, the cost of the development per unit of power will increase materially with the length.

If the bed of the stream has only a moderate descent of five or ten feet per mile, it will probably be cheaper to build a comparatively high dam and set the water back a few miles, than to dig a canal or lay a pipe line to carry the discharge of the stream over the same distance. Near the foot of such a dam at one end, a power house may be located and supplied with water through short penstocks much as in the case of a natural, vertical fall.

For a given head of water, the erection of a dam to create that head, or the construction of a long pipe line or canal for the purpose of maintaining a head, are the most costly types of development. If, however, the pipe line, though several miles in length, supplies water to the wheels at a very high head, the cost of the development may be very moderate per horse-power. This fact is illustrated in many of the California plants, at one of which a head of more than 1,900 feet on the wheels is maintained by a pipe line several miles long.

Perhaps the most important single factor bearing on the cost of water power development is the available head. As a rule, the cost of the development per unit of power will increase as the head decreases, other factors remaining the same. The lower the head, the greater must usually be the mass of the dam, the larger must be the canal, penstocks, and power house, and the heavier must be the water wheels and electric generators, per horse-power developed. For wheels and generators the weight per unit of output decreases as the speed of revolution increases, and this speed goes up with the head of water. The mass of the dam, and the sizes of the canal and penstocks, increase with the volume of water to be handled, and this volume grows larger as the head decreases per horse-power of capacity.

With heads that range from as low as 10 up to nearly 2,000 feet, created in some cases by natural falls, in others by canals or pipe lines miles in length, and in still others entirely by dams, the cost of hydro-electric plants is subject to wide variations. In a very general way it may be said that a complete water power development with its electric generating station will cost anywhere from $50 to more than $300 per kilowatt of capacity. Somewhere about midway between these extremes the cost of the majority of hydro-electric plants will be found. The figures just named have nothing to do with the cost of transmission or distribution lines, which depends on factors that are but little influenced by the type of water power development. While these very general statements of cost for water power plants have a limited value, a knowledge of costs under definite conditions of development is much more useful. Several examples are therefore given of the costs of plants that have been constructed and are in operation, but the names of these plants are withheld for obvious reasons.

In one case a head of 14 feet was created almost entirely by the erection of a stone masonry dam across a small river. From one end of this dam a short canal several hundred feet long conveys the water to the electric generating station on the river bank below. The station building is constructed of stone, concrete, brick, and steel, with a floor area sufficient for two direct-connected generators of 800 kilowatts total capacity, and with a traveling crane overhead. For the real estate, the construction of the dam, canal, and power house, and the complete equipment of the latter to develop 800 kilowatts, the approximate cost was $190 per kilowatt of generator capacity. On another small river a head of 23 feet was created in part by a natural fall in the bed rock of the stream, and in part by a masonry dam. From one end of this dam a steel penstock was carried to a brick power house nearby. This power house was equipped with direct-connected water wheels and generators, and with transformers for an output of 1,500 kilowatts. For this complete hydraulic and electric plant the approximate cost was $160 per kilowatt of generator capacity.

For a hydro-electric plant of 800 kilowatts capacity, with a water head of 30 feet, the total cost will be about $175 per kilowatt, as it now appears when nearly completed. In this case a concrete dam creates the smaller part of the head, and the greater part is due to a natural fall and rapids in the river bed. To connect the water behind the dam with the power house below these rapids, a canal more than 1,000 feet long is employed. The power house is of masonry construction, the wheels and generators are direct connected, and there are no step-up transformers. In contrast with the above figures, a certain plant with a head of about 450 feet is reported to have cost about $30 per kilowatt capacity, exclusive of the electrical equipment.

TO STIMULATE CHEMICAL DISCOVERY.

The California Grape Acid Association offers $25,000 to any person who will devise a process to utilize grapes for grape acid, and in evidence of good faith has deposited this amount in the hands of a San Francisco banker, to be paid to the successful discoverer of the process.

On the Pacific coast, especially in California, are unlimited tracts adapted to the profitable cultivation of grapes, only a small proportion being employed at this time, owing to the limited demand in the United States for products of the vineyard. It is estimated that California alone could easily, were all the land available planted to grapes, supply twenty times the present demand for fruit, wine, brandy, or raisins. Compared with Europe, the consumption of wine in the United States is infinitesimally small. California, for instance, produces 30,000,000 gallons of wine yearly, which would supply only two-thirds of the annual consumption of the 450,000 inhabitants living in Rome, the capital of Italy.

In all vineyard products the normal market conditions of the country indicate an over-supply; but could the list of products of the vine be increased in numbers, the advantage both to the country and to agriculture would be great. The United States is now practically dependent upon European chemists and wine countries for its supplies of cream of tartar and tartaric acid, both derived from argol, which is the lees of wine, and imported in great quantities. Cream of tartar is an essential element in the manufacture of the best qualities of baking powder. No substitute has yet been discovered that does not deteriorate the quality of baking powder made from it. If, therefore, cream of tartar could be manufactured direct from grape juice, instead of from wine lees, this country would at once become independent of Europe, and in time an exporter. The vineyardists would find an outlet for all the grapes they could raise, and lands now unproductive could be made to yield profitable crops. To stimulate this important discovery, the association offers the large reward, to the end that California grapes, now worth ten dollars a ton, and containing 20 per cent of saccharine, may be utilized to produce grape acid. The association realizes also that if a cheap method of producing grape acid is discovered, other latent products, now unknown or unsuspected, may be evolved that will be of benefit to the agriculturist.

Prof. Hilgard, director of the Agricultural Experiment Station at the University of California, writes that "the possible production of tartaric acid from grape juice by means of the action of a special ferment I regard as one of the most hopeful methods for the attainment of the end in view, even though no such ferment has as yet been discovered. A close investigation of the manner in which tartaric acid is formed in the grape itself would be an important step toward the desired result."

As the consumption of wine and raisins in the United States is now below the normal production of these articles, the discovery of processes in which a wider diversity of products of the vineyard might result would extend vine planting to a much greater number of acres and encourage the development of regions now practically unproductive. The offer of the association has excited the attention of a large number of European scientists, who have submitted papers descriptive of the methods they advocate. All such will be carefully demonstrated by the committee to which they have been referred. A conclusion will be announced before the close of the year 1904