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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.

PENNSYLVANIA RAILROAD TERMINAL STATION AND TUNNEL.

The many recent rumors regarding the construction of trunk line railroad tunnels beneath the Hudson and East Rivers have culminated in an authorized publication of the plans of the Pennsylvania Railroad and the Long Island Railroad for a great central station in Manhattan Island and a series of through tunnels between New Jersey and Long Island. The tunnels will commence in Jersey beyond the Hackensack Meadows, and will run, side by side, in two 18-foot tubes beneath the Hudson River. Near the Manhattan shore the two tubes will diverge, one being carried under West 31st Street and the other below West 32d Street. At Tenth Avenue the tubes will open into a vast central station, which will extend from Tenth Avenue to Seventh Avenue. From Tenth Avenue to a point between Ninth and Eighth Avenues the station will be one block in width, and from there to Seventh Avenue it will be two blocks in width, reaching from 31st to 33d Streets. From Seventh Avenue eastwardly the road will consist of three tracks laid in three separate tubes, there being a single tube beneath 31st, 32d and 33d Streets. When the East River is reached, the three tunnels will swing northward and converge toward Long Island, where they will reach the surface, in the neighborhood of Thompson Avenue.

The great central station, which will have an extreme length of 1,500 feet and an extreme width of 520 feet, will be a truly gigantic affair, the platforms alone aggregating two miles in length. It will be a through station, as distinguished from the terminal stations of the New York Central at 42d Street, or of the Pennsylvania Road on the New Jersey side of the river. It will probably form the busiest center of traffic in the world, for in spite of the fact that it is largely a through station, the plans show provision for twenty-five tracks on the large amount of space, four and a half city blocks in all, which will be included in the station. Extending over the tracks there will be a bridge 100 feet wide, which will reach from 31st to 33d Streets. The approach to the bridge will be by an evenly-graded carriageway at each end. From the bridge stairways will lead down to the platform, and in the whole disposition and operation of the station the very latest appliances for handling baggage, ticket offices, etc., will be employed.

The tubes will have an internal diameter of 18 feet, and in the work of carrying them beneath the East River it is not expected that any novel or complicated features will be encountered. Beneath the Hudson River, however, the work of driving the tunnels is rendered difficult by the great depth of the silt and mud on the river bottom, which extends to 100 feet or more before a firm material is reached. This part of the tunnel is to be built on a new principle which has been designed and patented by Mr. Jacobs, the Consulting Engineer of the Long Island Railroad. It consists practically of a single-track bridge, inclosed in an 18-foot steel tube, with supporting piers extending down from the truss-work to a secure footing on the underlying hardpan. This method of construction is an entirely novel one, and if it should be finally adopted, the building of this part of the tunnel will be watched with the keenest interest throughout the engineering world.

The importance of the great work outlined above can scarcely be overestimated. With the exception of the New York Central Station, there is no trunk line station on Manhattan Island, all the western roads terminating on the western shore of the Hudson River. The scheme is the outcome of the recent acquisition by the Pennsylvania Railroad of the Long Island system, and its completion will at once link the Long Island railways with the great Pennsylvania system. It will be possible to take a car from Long Island direct to Chicago or San Francisco, and it may bring into prominence once more the dream of the late Austin Corbin of a great terminal shipping point at Montauk Point for a line of transatlantic passenger vessels. The construction of this tunnel, moreover, will postpone indefinitely, probably forever, the construction of the much-talked-of bridge or bridges across the Hudson River. There has never been any question of the relative economy of tunnels over bridges of the magnitude of the North River structure, and if the tunnels, as will probably prove to be the case, are expeditiously operated, free from objections in the way of poor ventilation and from other discomforts, we may look to see them adopted exclusively for railway travel between Manhattan Island and the New Jersey shore.

NICARAGUA OR PANAMA.

The time is rapidly approaching when the nation, through its representatives, will be called upon to decide where the great Isthmian Canal shall be built. The President's commission has done its work, which consisted not merely in a thorough survey of the Nicaragua route, but an examination on the spot of the Panama scheme. Although the work of the Commission included a survey of all other supposedly practicable routes for a canal, it has always been well understood that the actual question to be decided was that of the relative advantages of the routes at Nicaragua and Panama.

A valuable contribution to the literature on this subject is a pamphlet which embodies the gist of an address to the Chamber of Commerce of the City of New York, recently delivered by the former Engineer-in-Chief of the Panama Canal, Mr. Philippe Bunau-Varilla. The address, which will be found in full in the current issue of the SUPPLEMENT, consists of a comparison of Nicaragua with Panama, based chiefly upon the preliminary report of the Isthmian Canal Commission of 1900, and the report of the Nicaragua Canal Commission, 1897 to 1899. The figures in his address which are not taken from those two American reports have been drawn from the report of the Technical Commission of the new Panama Canal Company, which contains the names of some of our most distinguished American hydraulic engineers. Although this address is, as was to be expected, a strong argument in favor of the superior claims of the Panama Canal, the facts and figures given are based upon authentic data, and the high technical authority of the ex-Chief Engineer of the Panama Canal renders it a very timely addition to the literature upon this most important subject.

RESPECTIVE LENGTHS OF CANAL NAVIGATION.—According to the figures given by the Isthmian Canal Commission, the total length of the canal navigation at Nicaragua will be 120.53 miles, to which are to be added 66 miles in free deep water, either in river or lake, making a total length of 186.53 miles from ocean to ocean. Of the 120.53 miles of canal, 22.19 miles will consist of an artificial channel dug below the bottom of Nicaragua Lake, and 27.96 miles will consist of a similar channel dug through sand and silt below the bed of the upper San Juan River, the larger part of which excavation will be more than 16 feet below the natural bed of that river. At Panama there are only 38 miles of canal navigation proper and 7 miles of deep-water navigation through the artificial lake which will be formed by the Bohio dam.

DEPTH OF GREAT CUTS.—The great Culebra cut is not to-day what it was when the old Panama Company was undertaking the work of construction. Originally 274 feet in depth, it has been reduced by the constant work which has been going on under the new company until to-day only 110 feet of excavation remains to be done. On the Nicaragua route there is one cut of 297 feet in depth, and there are others of 218 and 170 feet in the low valley of the San Juan River. On the question of the relative difficulty of constructing the great dams which are the essential features of each project, Mr. Bunau-Varilla quotes the Isthmian Canal Commission as stating that the Bohio dam can be built of earth as well as of masonry, whereas the great dam across the San Juan River at Boca San Carlos would be the most difficult engineering work in connection with the project, since it would necessitate compressed air foundations to a depth of 100 feet below low-water level of the river, and would have a total height of 150 feet from crest to foundation.

CURRENTS.—After drawing attention to the fact that nine locks are necessary at Nicaragua and only five at Panama, and that the level to which ships will have to be lifted will be at Nicaragua 110 feet and at Panama 90 feet, all of the locks of Panama being founded on rock and five only of the Nicaragua locks having the same advantage, the author of the paper passes on to the most important question of river currents, concerning which he says: "The San Juan River, having a much larger watershed than the Chagres River, and from two to two and one-half times more rain falling at Nicaragua than at Panama, the quantity of water that must pass off is much greater at Nicaragua, and must generate more permanent and intense currents than will be the case at Panama, where the great floods of the river are of very short duration and do not occur at more frequent intervals than three years." Ten years' measurements show that the average discharge of the Chagres River, where the Chagres and the canal have the same location, has been about 3,400 cubic feet a second; while measurements taken in 1898 in the San Juan River show the average mean discharge above the mouth of the San Carlos to be 25,000 cubic feet a second. Moreover, the total rainfall in 1898 was but slightly over 201 inches, whereas in 1890 it was 296 inches, 214 for 1891, and 291 for 1892, so that the discharge of the San Juan River would seem to average, in a series of years, from 35,000 to 40,000 cubic feet per second for the whole year, or from ten to twelve times more than that of the River Chagres. In this connection it is asked, "What will be the effect of this great fall of water on the canal channel where this channel lies in the bed of the San Juan River?"

THE QUESTION OF SILT.—It will be remembered that the original Menocal scheme contemplated the erection of a dam below the mouth of the San Carlos River. This was open to the objection that the San Carlos River, which is subjected to enormous freshets, brings down huge quantities of volcanic silt from the Costa Rican volcanic range in which it heads. The present plans have moved the dam further up the San Juan, so as to avoid these floods and the silt they bring down. Nevertheless, the canal above the dam will receive the waters of the tributary rivers Frio and Poco Sol, which, like the San Carlos, have their watershed upon the slopes of the volcanic range. The Poco Sol is estimated to have a drainage area about one-third of the San Carlos, and the question is asked: What disposal will be made of the enormous deposits of sediment brought down by this river and emptied into the canal? Leaving aside the question of amount of sediment carried down by the River San Juan, or thrown into it by its tributaries, the author of the paper furthermore remarks that the maintenance of a channel of the required width and depth is, by itself, a very difficult problem in such a powerful stream as the San Juan, since "nature does not like a regular depth and width in the bed of a great river. It is contrary to its laws."

CURVATURE.—Under the head of Curvature, the former Chief Engineer of the Panama Canal lays great stress upon a question which has never received the attention which its vast importance demands. The canal is to be used for ships of the largest ocean size, of great length and slow maneuvering ability. It is well known that steering in shallow waters is difficult and unreliable, the currents set up destroying to some extent the normal action of the helm, hence curves should be as infrequent as possible, and where they exist they should have the largest possible radius. In examining the two proposed canals on this basis, we find the most extraordinary difference; for while the Panama route has twenty-five curves in a total length of curvature of 19.5 miles, the Nicaragua route has eighty-two curves of a total length of curvature of 53.5 miles. As regards the most vital question of radius, or ease of curves, we find that in the Panama Canal, with the exception of three curves of 8,200 feet radius, all are of 10,000 feet radius, or more, while on the contrary there are sixty-nine curves in the Nicaragua Canal below 8,000 reet radius, of which no less than fifty are of 3,000 and 4,000 feet radius. Regarding this feature, the author of the paper says: "It must be borne in mind that in that part of the canal which lies in the San Juan River itself, there will be nearly 28 miles excavated into the bottom of the river to a depth of 16 feet for the larger part, and that in this portion of the route there are forty-three curves of between 3,000 and 4,000 feet radius." He maintains that this sharply-curving channel, opened as it is down into silt and sand, will be extremely difficult to maintain, since it will necessitate constant dredging in a river which carries during flood-time 100,000 cubic feet of water, or one-quarter the amount which goes over Niagara Falls. "Obviously," says Mr. Bunau-Varilla, "ships will meet there an accumulation of extreme difficulties in the way of sharp curves, heavy river currents, constant strong winds and impediments either from the dredges themselves or from the sand and silt they will have to remove. . . . In Panama the large and easy curves, absence of winds, scarcity of currents and the rarity of floods give quite a reverse impression as to the eventual facilities offered for navigation."

HARBORS AND TIME OF TRANSIT.—With regard to harbors, the advantage is generally admitted to be with Panama, since two excellent harbors exist, one at each terminus. At Nicaragua, on the other hand, the Atlantic terminal is unsatisfactory, because of the enormous quantities of sand emptied into the sea by the San Juan River, and carried across the proposed mouth of the canal by the trade winds. The harbor on the Pacific will also have to be artificially constructed. Furthermore, two additional harbors will be necessary at the entrance and exit of the canal at the great inland sea of Lake Nicaragua. Were the two canals both finished and open to traffic, the time of transit by the 45-mile Panama Canal would be only twelve hours, whereas by the 183-mile Nicaragua Canal the time of transit will be thirty-three hours.