THE UNDERGROUND RAILWAY, NEW YORK CITY.

In London the Underground Railway system has been in operation for eleven years, and so great has been its success, so fully does it meet the requirements of the population, that every year adds to its extension. Opened in 1863 with a section of 4½ miles, from Bishop's Road to Farringdon street, it has been constantly extended, until now it has a length of about 13 miles; while new extensions, costing some twelve millions of dollars, are this year in progress of construction. Many millions of passengers are annually conveyed over these underground tracks, which extend beneath the streets in all directions, uniting the principal centers of trade, intersecting all the great railway lines, and, by their marvelous capacity for traffic, facilitating the enormous transactions of daily business, for which London is so renowned.

It is gratifying to know that this system, so thoroughly tried by long experience, so certain and fruitful in promoting municipal life and prosperity, is about to be inaugurated here in New York. For many years it has been urgently needed, but it is only within a very recent period that the construction was actually begun. The Underground Railway in New York is projected to run from the Harlem river, on the north, down through the heart of the city, under Fourth avenue and Broadway, to the Battery, 8¾ miles. It will, in course of time, naturally have other extensions, among the most obvious of which are tunnels under the North and East rivers, to Jersey City and Brooklyn.

Before entering upon the details of this new railway, we would call the attention of our readers to the remarkably advantageous natural position of New York city, for the purposes of business and commerce, and to the location of some of the other great and interesting engineering works besides the Underground Railway, which are now going on in our midst. Referring to the diagram, Fig. 1, it will be seen that New York city occupies a narrow tongue of land, surrounded on both sides by deep rivers, with illimitable dock room, and a magnificent land-locked bay, more than sufficient to accommodate the commerce of the world. At the Narrows, the gateway to the Lower Bay and the ocean, some of the most massive fortifications are in progress, and the shores on either side, for long distances, bristle with lines of fifteen inch cannon in readiness for defence. The bay and ocean prospects from the hights at the Narrows are superb, and are not surpassed even by the far-famed views of the Bay of Naples. At the left stand the shores of New Jersey, where the Erie, the Pennsylvania, the New Jersey Central, and other great railways from the North, South, and West concentrate. The traffic is at present all conveyed over the river by ferry boats. The freight cars are run upon the decks of great barges, and towed across by tugs, a most convenient, quick, and economical method.

The new docks, which are to surround the water fronts of New York, are now in course of construction, and embrace engineering works of great magnitude. The docks are to consist of iron, granite, and artificial stone, and will involve expenses to the amount of a hundred millions or more of dollars.

On the right is seen the position of the great suspension bridge between Brooklyn and New York, built at the joint expense of the two cities, and expected to cost from fifteen to twenty millions of dollars. This will be the largest suspension bridge in the world, the clear span between the towers being 1,600 feet. The towers are now approaching completion

Further up the East River, the Hell Gate Rocks are specified. Here it is that the important work of tunneling the bed of the East river is now going on, for the purpose of removing its rocky bottom, which impedes navigation. The general plan of the work is to honeycomb the rocks with tunnels, then fill them with nitro-glycerin and explode the mass, thus deepening the river. This work, costing an immense sum, has been in progress for three years past, but no time has been fixed for the grand final explosion. Still further north runs the Harlem river, over which various fine bridges, and underneath its bottom various tunnels, at the extremities of our city avenues, are soon to be constructed, to accommodate the wants of a fast-increasing population.

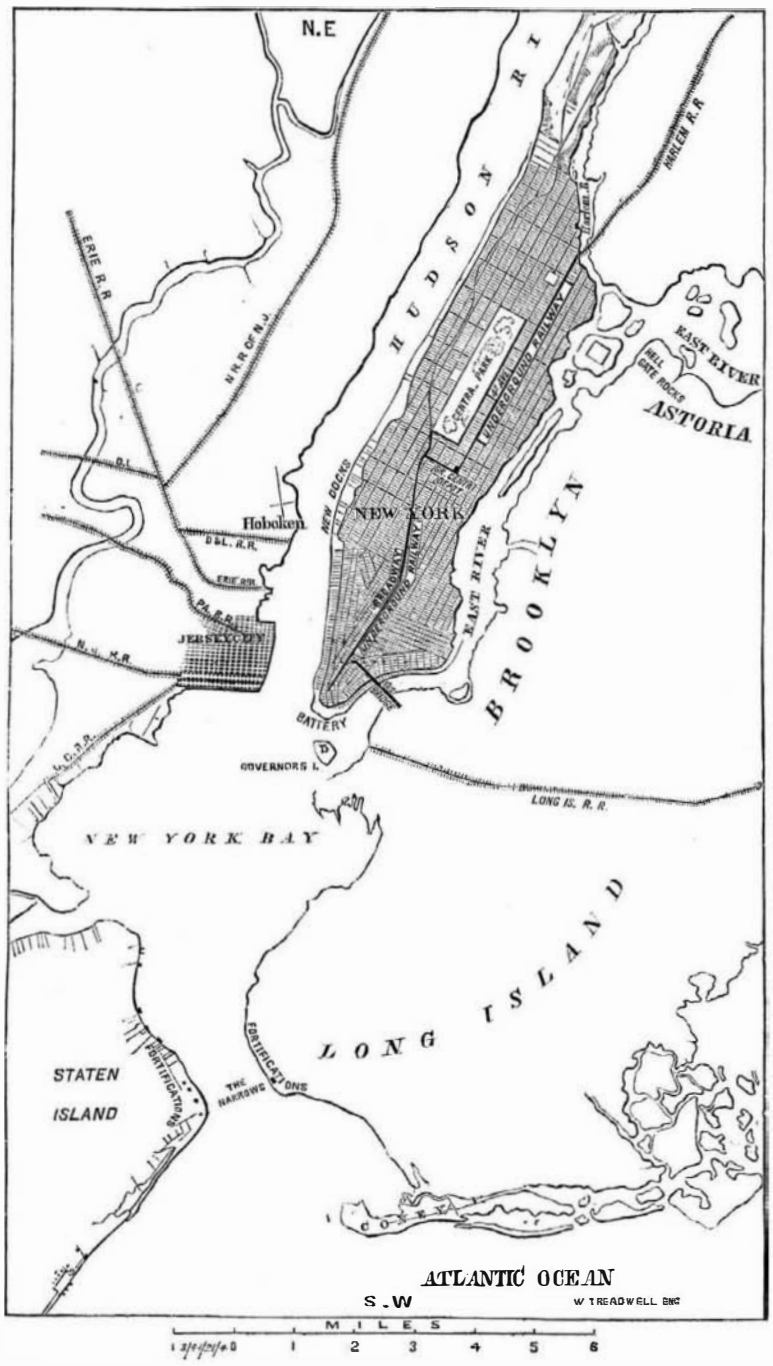

FIG. 1. DIAGRAM SHOWING THE POSITION OF THE BAY AND CITY OF NEW YORK, FORTIFICATIONS, SUSPENSION BRIDGE, HELL GATE WORKS, NEW DOCKS, UNDERGROUND RAILWAYS, ETC.

In the middle of the city lies Central Park, which, with its lands, roads, and architectural structures, has, so far, cost the city over eight millions of dollars. Along the banks of the North River, above the Central Park, but communicating therewith by noble drives and avenues, new parks have been laid out, in addition to which there are over thirty miles of pleasure roads and avenues, Museums of Art, of Natural History, Zoological Gardens, and other public establishments, projected and in progress. Taken altogether, there are few places where so many important improvements are going on as in New York, and there can be no question but that in due time it will become one of the most attractive cities in the world.

Turn we now to a consideration of one of our latest and best city improvements—the underground railway system, the objective of which is the Grand Central Depot, which is located at the junction of 42d street and Fourth avenue. This is the great railway center of the city. Here terminate or begin the tracks of the New York Central and Hudson River Railways, which, with their connections, reach to the far South and West, extending even to the shores of the Pacific Ocean, and receiving direct tribute from all parts of the country, save the immediate Southern seaboard regions. Here also center the tracks of the Harlem Railway, which reach northerly to Canada, and of the New York, New Haven, and Hartford Railway, extending easterly to Boston, Maine, New Brunswick, and Northeast Canada.

The Grand Central Depot building is an immense structure, the largest of the kind in this country. Its length is 690 feet, breadth 240 feet, hight from railway grade to center of glass roof, 109 feet 7 inches. This depot, together with the adjoining car sheds, engine houses, freight depots, and coal yards, covers an area, in round numbers, of 830,900 square feet, or a little over nineteen acres.

The existing northerly section of underground railway extends from the entrance of the Grand Central Depot, on 45th street, northerly, under the surface of Fourth avenue, to the Harlem river, at 133d street, a distance of 4¼ miles, where the track rises to and crosses a fine railway bridge over that stream. This portion is now almost finished, and is expected to be opened for traffic in January. The southerly portion, known as the Broadway Underground Railway, from the Grand Central Depot to the Battery, was finally authorized by the Legislature, in May, 1874, and will be pushed as soon as the financial requisites, now in progress, are settled.

The northerly portion has been built by the Harlem Railway Company, under the supervision of a State engineer commission, consisting of Alfred W. Craven, C.E., Allan Campbell, C. E., the Engineer of the Department of Public Works, and the Engineer of the New York and Harlem Railway. The commission appointed to supervise the construction of the southerly portion, under Broadway, consists of George S. Green, C.E., Allan Campbell, C. E., and James P. Kirkwood, C. E. On the completion of these two sections, the city of New York will possess a magnificent continuous line of fast railway tracks, 8¾ miles long, through its center, over which passenger and freight trains of every class may travel from Harlem to the Battery at the highest speed, and at the cheapest rates, without disturbance of inhabitants.

The Underground Railway commences, as we have stated, at the north front of the Grand Central Depot, and here, for a short distance, the tracks for the accommodation of the cross street traffic are spanned by bridges, the first of which, at 45th street, is placed directly in front of the entrance of the depot. See engraving, Fig. 2. The gradients, depths, character of works, and position of the road bed, in respect to the surface or grade of Fourth avenue, are given in our profile diagram, Fig. 3.

To a very great extent, the work now in course of construction, on Fourth avenue, must be regarded as the necessary consequence of the building of the Grand Central Depot, and the centering of the great railways we have mentioned at one terminus. The authority for the work was

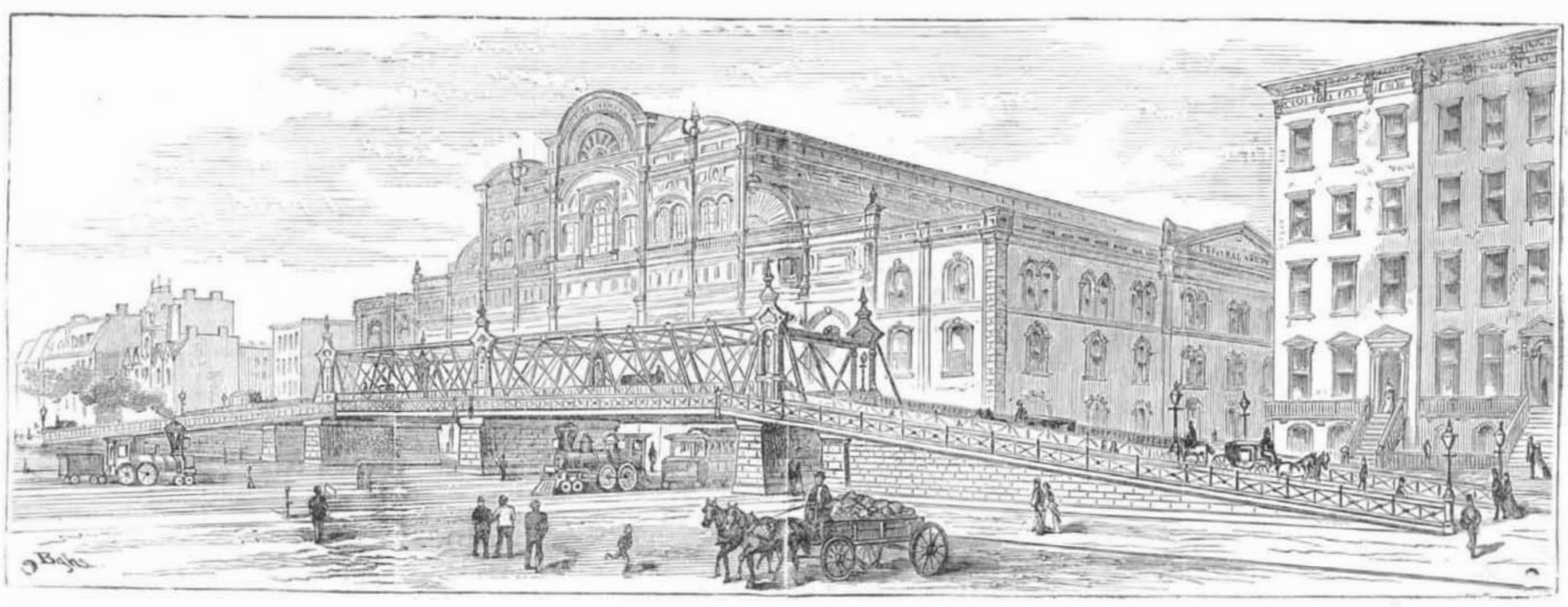

Fig. 2.—THE UNDERGROUND RAILWAY IN NEW YORK. THE FIRST BRIDGE AND GRAND CENTRAL DEPOT, 45TH STREET.

passed by the State Legislature on the 14th of May, 1872. By the provisions of the act, the New York and Harlem Railway Company is directed to construct open cuts, bridges, tuunels, and a viaduct, at certain specified places, to lay temporary tracks, and alter the grade of the cross streets wherever necessary; the gas, water, and sewer pipes are ordered to be removed by the corporations owning them, and the Mayor and Aldermen of the city forbidden to obstruct, and authorized to adopt and facilitate, the work; the total expense of which is to be borne in equal proportions by the city and the railway company; that sustained by the city to be raised by a tax on real and personal property. A Board of Engineers was also created, who should have entire control and charge of the work, receiving, in return for their services, $8 for every day employed. In accordance with the requirements of the act, a Board of Engineers was appointed consisting of Alfred W. Craven, Allan Campbell, the Engineer of the Department of Public Works, Edward H. Tracy, and the Engineer of the Harlem Railway Company, the late Isaac C. Buckhout.

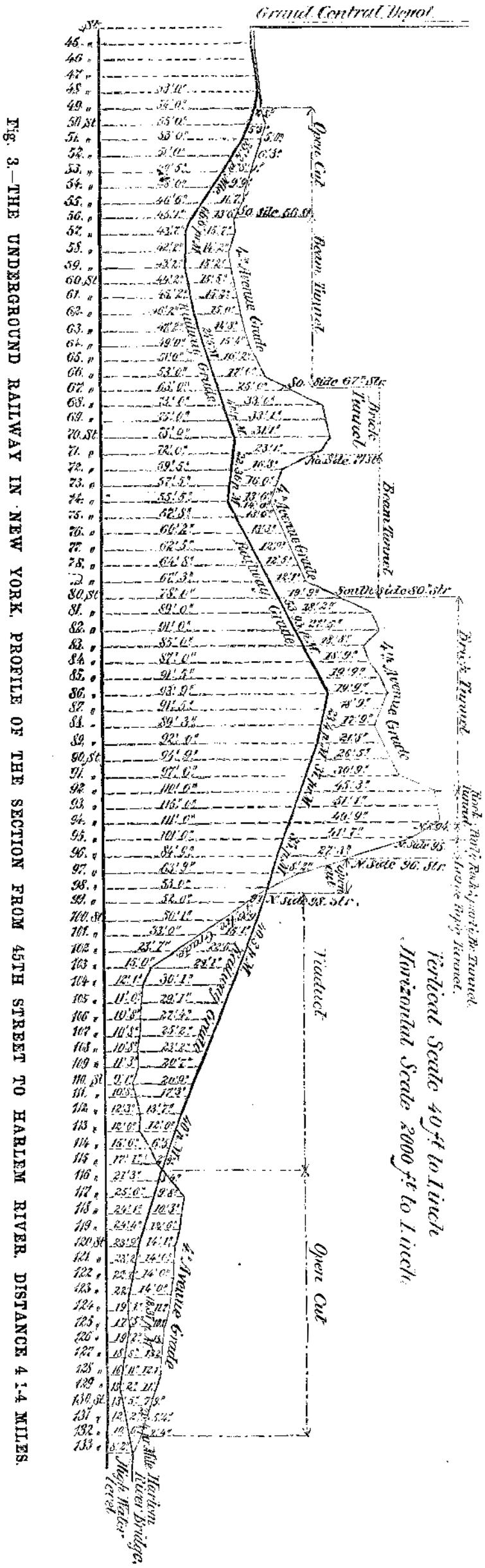

FIG. 3.—THE UNDERGROUND RAILWAY IN NEW YORK. PROFILE OF THE SECTION FROM 45TH STREET TO HARLEM RIVER. DISTANCE 4 1-4 MILES.

Estimates, plans, and specifications were prepared and bids opened for the work in the same year. Of all the bids offered, that of Messrs. Dillon, Clyde & Co. was selected, this firm contracting to do the work iu the manner required for the sum of $6,395,070, or $285 per running foot, which was proportioned as follows:

Earth excavation and embankment	$579,000
Rock excavation in open cut	701,000
" " " tunnels	255,000
Retaining walls	1,013,000
Parapet walls	100,000
Foundation walls	238,400
Granite coping	134,700
Plank used in foundation	70,000
Piling used in foundation	182,200
Concrete	23,800
Removal of sewer, water, and gas pipe	300,200
Drain pipe	6,800
Ballasting	57,000
Brickwork in arches, etc	708,500
Blue stone	34,300
Bridge from 79th street, exclusive of parapet, coping, excavation, and drain pipe	334,100
Iron bridges and approaches	388,000
Wrought iron	498,500
Cast iron	23,500
Iron railing	79,200
Felting	36,500
Temporary track	50,000
10 per cent for contingencies	581.370
Total	$6,395,070

Late in the fall of 1872, ground was broken and the work commenced by the contractors and their sub-contractors, under the supervision of the Board of Engineers already mentioned, with Mr. I. C. Buckhout, of the Harlem Railway Company, as Superintending Engineer, Mr. W. L Dearborn, C.E., as Resident Engineer, Mr. F. S. Curtis, C. E., Principal Assistant, and a corps of four Division Assistants, Messrs. Geo. S. Baxter, C E., S. F. Dayo, C.E., Sevene Lee, C. E., and Milford Berrian, C.E. The names of the sub-contractors will be mentioned in connection with the work done by them.

We will briefly give the general plan of the work, and then pass to a detailed description of its parts, premising that, for the drawings which we publish and for much valuable information, we are indebted to the courtesy of Mr. F. S. Curtis, the principal assistant resident engineer, and to Mr. Horan, the chiefof the drafting department.

In plan, the work consists of a four track railway, reaching from 42d street to the Harlem river, a distance of four and a quarter miles, and, with the exception of that portion passing over the viaduct on the Harlem flats, everywhere sunken below the level of the street, and covered in with tunneling over as large a part of the distance as the grade of the road and the grade of the avenue will admit. On that portion of the line which is covered with tunnels, three kinds of tunneling have been used, depending upon the character of the ground and the difference between road grade and avenue grade. Thus wherever sufficient headway could be obtained, arched brick tunnels are used; wherever the headway was too small to admit of an arched tunnel, a flat top beam tunnel is used; and where the headway was too small to permit the use of the beam tunnel, open cuts, spanned at the street crossings by iron plate girder bridges, sixty feet in width, were of necessity resorted to. The third kind of tunnel referred to is the rock tunnel at 92d street. The reason for the use of these three kinds of tunneling will, perhaps, appear more evident by a glance at the accompanying profile, Fig. 3, which, being so greatly reduced, will throw into bold relief the various grades used on the railroad and the avenue, and the difference between them, and will afford a good idea of the various species of work involved. It will there be noticed that the grade of the road begins to fall gradually from 45th to 48th streets, and that from this point to 57th street it increases rapidly, falling in this space 25 feet, 66·6 feet in the mile, which is the heaviest grade on the road. From 57th to 59th streets the grade runs level, then rises to 70th street through a hight of 15 feet and 9 inches, is again level to 71st street, falls between 71st and 73d streets 2 feet 4 inches, or 22·36 feet in the mile; is once more level to 74th street; rises 32·5 feet, or 53 9 in the mile, to 86th street, at which point begins the long descending grade which crosses the viaduct and extends to 129th street, falling in the distance 69·8 feet, after which begins the up grade, which reaches the street level at 133d street and Harlem Bridge.

At 56th street the railway grade is 13·6 feet below avenue grade; and at this point, the headway not being sufficient for an arched brick tunnel, a beam tunnel commences and extends to point 24feet 9½ inches south of the south side of 67th street. Here the railway is 25 feet below the street; and the ground rising rapidiy, a headway is obtained sufficient for an arched tunnel, which extends to a point 29 feet 2 inches north of the north side of 71st street, where the beam tunnels again begin and reach to 27 feet 7½ inches south of the south side of 80th street, where the ground commences to rise rapidly and the brick tunnels once more appear, ending at the beginning of the rock tunnel at 92d street. This tunnel is about 550 feet long and is followed by the partly rock and partly brick tunnels, which end at a point 31 feet 6 inches north of the north side of 95th street, and from this point to north side of 96th street extends a tapering tunnel formed by three tunnels passing into one. At 96th street the difference of grade is about 27 feet; and from this point, the land falls so rapidly to the Harlem flats that at 97th street the difference of grades is but 8 feet 2 inches, and consequently from this point to 98th street extends an open cut, ending at the south end of the viaduct, which reaches thence to the middle of the block between 115th and 116th streets, or a little over 717 feet short of a mile. [We shall continue the subject in our next and future numbers with various illustrations of the works.]

Correspondence.

The Crystalization of Carbon.

To the Editor of the Scientific American:

You refer, on page 247 of your current volume, to a new idea of making artificial diamonds by crystalizing carbon. It strikes me that the almost constant co-occurrence of native platinum or gold with diamonds is not merely fortuitous, and these metals may have something to do with the crystalization of carbon. It is a sufficiently proved fact that, at very high temperatures, chemical affinity is much modified, and perhaps disappears; the same modification may be a result of high pressure. Undoubtedly, in former geological ages, the atmospheric pressure was much higher than it is now, as is proved by the fact that liquid carbonic acid is enclosed in rock crystals. But a great pressure is also produced by a high column of water; and this may be one of the circumstances under which carbon is now crystalizing in the form of diamonds.

Let some one try a series of experiments, in which chloride of platinum, $PtCl_2$, or gold may act under the highest possible pressure on a suitable hydrocarburet (containing a maximum of carbon and a minimum of hydrogen), and see if such a decomposition as the following is possible:

$$2C_n H_m + mPt Cl_2 = 2mH Cl + mPt + 2nC,$$

in being greater than m, whereby Pt would fall down as a regulus, and C would crystalize as diamond.

If this be Nature's process of forming diamonds, the muriatic acid is of course washed away and deposited elsewhere in muriates; while the native metal and the diamonds are retained in the place of formation or carried along by the mechanical action of water. The highest pressure may be obtained by compressing water at a temperature of over 39 2° Fah., if only a material can be found for a vessel that can endure this pressure. It being desirable that the walls of the vessel are translucent, perhaps rock crystal or fluorspar could be used. But as the hydrocarburet is lighter than water, some means must be found to hold it, close to the bottom of the vessel (perhaps by means of a bladder, through which exosmosis takes place), in contact with the solution of chloride of platinum. Perhaps some liquid other than water may be desirable; but it must be lighter than the hydrocarburet, and not affect either the latter or the solution of platinum.

There is another series of experiments: It is generally known that air dissolved in water contains more oxygen than atmospheric air. Now, ozone is a modification of oxygen, produced, probably, by a denser formation of the atoms. The oxygen of the air in the water is probably turned into ozone by a high pressure, which would decompose the hydrocarburet by taking away the hydrogen and leaving the carbon, which would crystalize in the liquid. This process may have taken place where no platinum is found associated with diamonds. According to my opinion, it is worth trying whether one of these processes, or perhaps both combined, will have the result, so long sought for, of crystalizing carbon before our eyes.

W. THIESE.

Rochester, N. Y.

Professor Tyndall and the Buddhist Philosopher.

To the Editor of the Scientific American:

In your issue of October 3, page 208 of your current volume, under the caption "Candle Flames and Streaks of Cloud," you quote the Buddhist philosopher: "It cannot be said that he (Buddha) is here or there; but we can point him out by the discourses he delivered. In these, he lives;" and you add: "Science has no further word to offer."

Both the ancient philosopher and the modern professor have erred in making the destiny of man analogous to the transmutation of the correlated forces, heat, light, elec