

THE UNDERGROUND RAILWAY, NEW YORK CITY.

NUMBER VI.

Continued from page 387.

Division number two of the work commences at 79th street, ends at 102d street, and is under the charge of Mr. Sverre Lee, C.E. In this division is embraced a specimen of almost every description of construction upon the road. From 79th street to a point 27 feet 7 1/2 inches south of the south side of 80th street, a distance of about 173 feet, is a piece of beam

with rubble masonry 3 feet 6 inches in thickness, and on the inside of each of the side tunnels with brickwork 1 foot 4 inches thick, thus giving to each abutment a thickness, inclusive of linings, of 15 feet 6 inches. Through each of these inner abutments are cut two man holes, 7 feet in width and 75 feet apart.

The roofs of the tunnels are semi-circular arches: that of the central arch with a rise of 12 feet 6 inches and a span of 25 feet, and that of each of the side tunnels with a span of 16 feet and rise of 8 feet, each with a uniform thickness of 2 feet. The ventilation is by means of cylindrical shafts, in

the three tunnels. At the end of these tunnels begins the large tapering tunnel. It consists of a brick segmental arch with a span of 68 feet in the clear, and rise of 15 feet 8 inches at the south end, and thence tapering off to a span of 50 feet in the clear and rise of 12 feet 9 inches at its north end, 165 feet further north. The springing lines of the arch are 12 feet above railroad grade, and start from the solid ledge wherever possible. Throughout its entire length, it is lined up to springing line with rubble masonry 5 feet thick. Wherever its springs from the ledge, the skewbacks consist of two courses, and abut against the ledge, hammered off to receive them.

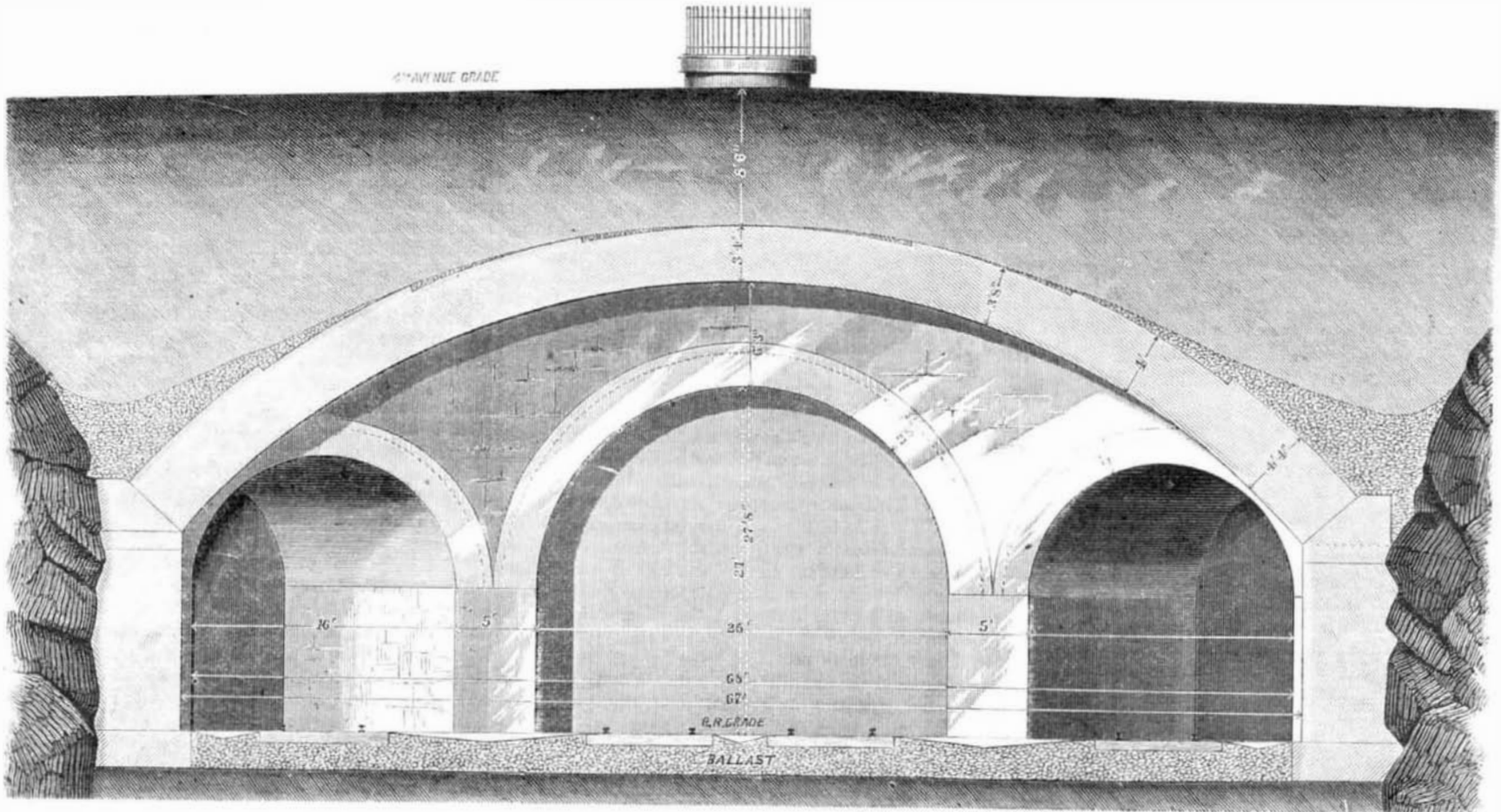


Fig. 15.—THE UNDERGROUND RAILWAY IN NEW YORK.—THE GREAT ARCH NEAR 95th STREET.

tunneling; from this latter point to 92d street extends a section of brick tunneling, 3,237 1/2 length; from 92d street to the north side of 94th street is the rock tunnel, 550 feet in length; from the north side of 94th street to a point 31 feet 6 inches north of the north side of 95th street is the partly rock and partly brick tunnel, 287 1/2 feet long; from this latter point to the north side of 96th street is the tunnel known as the large tapering tunnel, whose length is 250 feet; from 96th street to the north side of 98th street, there occurs an open cut, 537 1/2 feet in length; and finally from this point commences the stone viaduct.

We have in previous impressions described in detail sections of the beam and brick tunnel and open cut, and shall not, therefore, repeat the description in connection with similar work on this section, but merely point out in what respects, if in any, these tunnels differ from the one already described. The beam tunnel at the south end of the division is precisely similar to that on the first division. In the beam tunnel, however, which extends from south of 80th street to 92d street, several noticeable changes have been made. Thus from 80th to the center of 85th street, the roof of the large central tunnel is changed from a semi-circular to an elliptical arch, with a rise of 8 feet 10 inches, as is shown in Fig. 12, page 371. The reason for this change will be apparent by a glance at the profile of the road on page 308, which shows the difference of grades to be too small to admit of an arch of 13 feet 6 inches rise. Again, from the center of 85th street to the south side of 88th street, six rubble masonry abutments are built, so that each of the three arches rests upon two separate abutments of its own; the space between the two inside abutments, east and west (that is, between the abutment of the central arch and the inner abutment of the side arch), is filled in with dry rubble masonry up to the springing lines, and the spandrels above the springing lines with rubble cement masonry. The central arch is also elliptical. From 88th to 92d street, the tunnel is the same as that from 80th street to the center of 85th street. Omitting, for the present, the description of the rock tunnel from 92d to 94th street, we will take up that of the partly rock and partly brick tunnels.

These tunnels begin at the north side of 94th street, where the rock was not of sufficient strength and depth to allow of a rock tunnel, and consist of three brick arches supported upon four abutments of rock formed by three parallel cuttings through the rock. The two outside abutments are chipped off smooth, and lined with 16 inches of brick, carried up to the springing lines, which are 8 feet 6 inches above grade. The two inner abutments are composed of rock, carried up above the springing lines, of an average thickness of 10 feet 8 inches, and lined on the inside of the central tunnel

general character the same as those already described, but only 6 feet in diameter in the clear, and of a depth depending on the difference of grades.

From a point 101 feet 10 inches north of the end of the rock tunnel, the two side tunnels begin to curve in gradually toward the central tunnel, which they intersect 191 feet further north. The radius of this curve is, for the center of the tracks in each of the side tunnels, 1432.7 feet, and for the center of the tunnels themselves, 1772.7 feet. From the point where this curvature starts, the inner and outer abutments are lined, each of them, with rubble masonry 3 feet thick, coursed; the courses being not less than 16 inches, and the

The thickness of the arch varies at the springing line and at the crown, and these dimensions again vary with the span. Thus at the south end where the span is 68 feet and rise 15 feet 8 inches, the thickness of the arch is 4 feet 4 inches at the springing lines; a little further up the arch, it is 4 feet; still further up, 3 feet 8 inches, and at the crown, 3 feet 4 inches, thus losing 1 foot in thickness from springing line to crown. At the north end, where the span is 50 feet and the rise 12 feet 9 inches, the arch is 3 feet 4 inches in thickness at the springing line and 2 feet 4 inches at the crown. It will be observed that the arch also loses 1 foot in thickness at the skewbacks between the two ends. This is of course

accomplished by a series of three offsets of 4 inches each, passing around the arch, all of which occur at the ventilating shafts. For instance, between the south end and the first ventilator, the arch at the crown is 3 feet 4 inches; from the first to the second ventilator, 3 feet; from second to third 2 feet 8 inches, and from the third to the end of the tunnel, 2 feet 4 inches. The details of this tapering tunnel will perhaps be best understood by a glance at Fig. 15, which represents a cross section of the tapering tunnel taken at the junction of the two side tunnels with the central tunnel, and shows the three tunnels in question, as also the segmental arch with its varying thickness. It will be remembered that the tunnel preceding the tapering tunnel has a total height from railroad grade to the crown of the arch of 21 feet, and that this tapering tunnel has a total height in the clear of 27 feet 2 inches. The manner of joining these two tunnels is illustrated in Fig. 16. The roof of the central tunnel, which has elsewhere a thickness of 2 feet, is increased to 2 feet 8 inches for a distance of 5 feet around the face, and on the back of the arch at this point is built a rubble retaining wall, 7 feet 4 inches high, 3 feet at the bottom by 1 foot at the top, which is on a level with the back of the tapering tunnel. The back of the retaining wall is lined with concrete. The joining at the face of the two small tunnels is made in a precisely analogous way.

As this arch is one of unusual span, we shall take occasion in our next article to describe the centering on which it was curved.

Immense Photographs.

Photographs have been made of the new Opera House, Paris, 4 feet 3 inches in length, and 3 feet 4 inches in height. They were obtained in one single piece, by well known processes, and with the aid of a large and specially constructed camera.

All the lines of the pictures are of remarkable excellence, the moldings, the busts, the medallions, and even the minutest details being reproduced with rare perfection. The attempt is being made to secure pictures even larger than this.

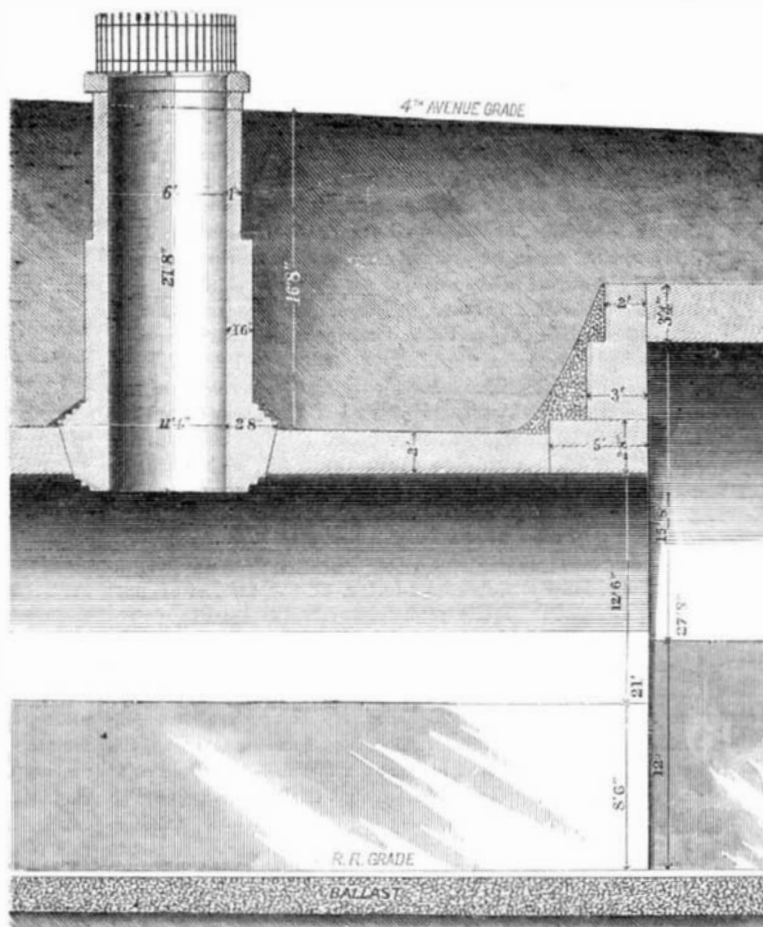


Fig. 16.—THE UNDERGROUND RAILWAY IN NEW YORK.—JUNCTION OF THE TUNNELS NEAR 96th STREET.

joins cut to lay 1/4 inch. Owing to the curving of the side tunnels, the inner abutments are made somewhat wedge-shaped, tapering off from a thickness of 15 feet 6 inches at the point of curvature to one of 5 feet at the intersection of