

## THE UNDERGROUND RAILWAY, NEW YORK CITY.

## NUMBER VII.

Continued from page 402.

The centering for the great 68 feet arch near 95th street, shown in the engraving in our last article, page 402, was put up and the arch turned while the trains were constantly passing and repassing beneath it. The centering was of itself a considerable work. In Fig. 17 we give an elevation thereof. It consists of a series of frames or ribs placed 5 feet 6 inches apart, from side to side. The back piece of the frame consists of two polygonal frames of boards 9 x 3 inches, so arranged that the boards of one frame break joints with those of the other, the joints, as usual, being in the direction of the

end of the back piece rests. The other vertical support, 10 x 6 inches, single, is placed nearer the center of the tunnel, and rises to the back pieces. The inclined shore, 12 x 6 inches, starts from the foot of this latter shore, and rises to the under side of the horizontal tie, where it abuts against a straining beam 4 x 6 inches, placed underneath this latter. These shores are strengthened by string pieces, 2 x 9 inches, double, and rest upon a sill placed transversely to the axis of the tunnel. Under this sill, and resting upon longitudinal timbers, 8 x 6 inches, are the wedges (three sets for each end of the rib) by which the frame is keyed up. The laggings are 3 inch plank.

The frames are braced together by two beams, 8 x 12 inches, placed horizontally across the upper side of the horizontal tie beam, and also by six other beams (three for each end of the

the clear, and the height 16 feet 8 inches. The arches are semi-circular. Their center is 36 feet east and west from the center of the central tunnel. This latter has a span in the clear of 27 feet; and as the side tunnels have each a span of 16 feet, we have, for the thickness of the rock walls separating the side and central tunnels, 14 feet 8 inches. The middle tunnel is unlined, but the face of the rock is trimmed off to a very fair degree of smoothness. The two side tunnels, however, are each of them lined with brick 16 inches thick, and the space between the rock and the brick filled in with concrete.

The ventilation is effected through circular shafts sunk over the summits of these tunnels, at the usual distance apart. These shafts are lined with brick 16 inches thick, and are 6 feet in diameter in the clear, and coped on top with

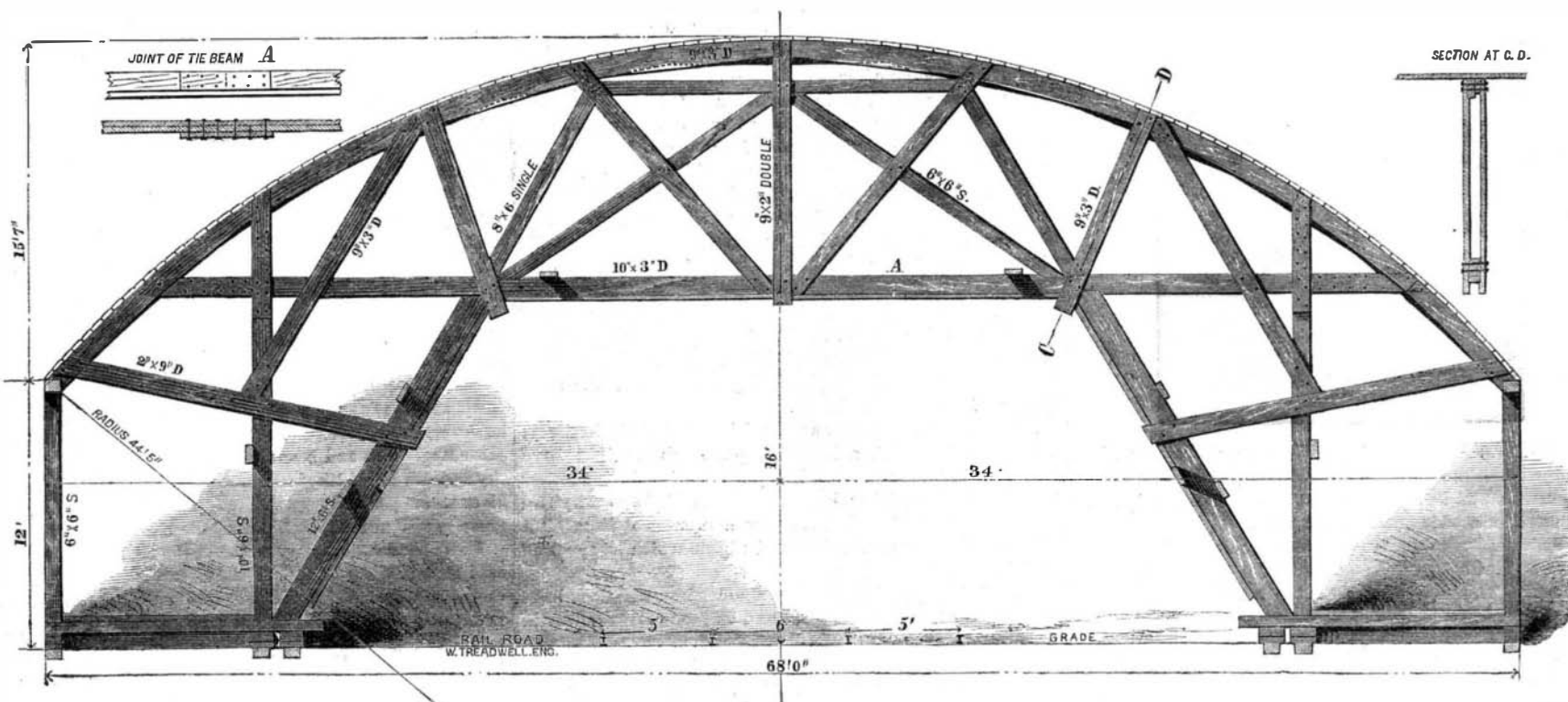


Fig. 17.—THE UNDERGROUND RAILWAY IN NEW YORK.—CENTERING OF THE GREAT ARCH, FOURTH AVENUE, NEAR 95th STREET.

radius of curvature, which, for the intrados of the 68 feet span, is 44 feet 5 inches. The back piece is strengthened and prevented from spreading laterally by a compound horizontal tie beam, composed of four beams 10 x 3 inches, placed in pairs and joined a little to one side of the center by a spliced joint, as shown in Fig. 17. This tie beam is placed a little above the springing line. Quite close to the crown is also placed a straining beam, 6 x 6 inches, single, supported by two inclined struts, 8 x 6 inches, single. The long horizontal tie beam is connected with the back piece by one vertical and four inclined ties, each composed of two pieces of timber which clamp the back piece and tie between them. The dimensions of the beams of the vertical tie, which is placed in the center of the span, are 9 x 2 inches, and those of two of the inclined ties, 9 x 3 inches. These ties are braced by single beams, 6 x 6 inches and 8 x 6 inches, placed in such wise as to convey the pressure on the back piece directly to the points of support of the frame. These supports are so arranged as to leave sufficient room for the passage of trains. They consist of three beams for each end of the rib, two vertical and one inclined. One of these, 6 x 6 inches, is placed upright against the abutment, a horizontal beam 3 x 5 inches, on which the

rib), placed, one along the backs of the vertical shores, and two along the backs of the inclined shores. On the outside of these latter supports are placed inclined beams, 8 x 6 inches, which bind the frames in sets of three, the beam passing from the foot of the shore of one rib across the middle of the shore of the second to the top of that of the third rib. From here another beam passes to the foot of the sixth rib, and so on. The ribs at the end of the tunnel, where the span is fifty feet and the radius of the intrados 31 feet, differ from the ribs just described in that they want the vertical shores and the ties joining it with the back piece. The inclined shore in this case rises from the foot of the abutment.

The rock tunnels commence at 92d street and extend to the north side of 94th street, a distance of some 550 feet. It will be remembered that at this point on the road was the old rock tunnel. This tunnel now forms the large central tunnel, and on each side of it was excavated a single tunnel. The three tunnels as they now exist are shown in cross section in Fig. 18. The two single tunnels are 18 feet high from the railroad grade to the top of the arched roof, and 18 feet 8 inches wide at the bottom: or, allowing 32 inches for the thickness of the two side linings, the span becomes 16 feet in

pene-hammered granite coping 10 x 18 inches, surmounted by an iron railing. During the excavation of the tunnel, these ventilating shafts served also as working shafts, the headings being carried forward north and south from the bases of them, and the excavated rock raised to the surface by a small steam engine.

The blasting was done in the most careful manner, the charges in the neighborhood of the dividing wall being so regulated as not to injure them in any manner. The drilling was done partly by hand and partly by steam, and the amount of rock thus excavated was, in the tunnels, 25,406 cubic yards; in the open cut, 37,200 cubic yards.

## Singular Cause of a Boiler Explosion.

The tube of a boiler recently exploded in a foundry at Liège, Belgium, caused, as shown on examination, by the corrosive action of ferrous sulphate and sulphuric acid, derived from the sulphur in the coal fuel. The discovery strongly points to the necessity of carefully and frequently cleaning the forward portions of the boiler tubes, and other parts which do not come in direct contact with the flame.

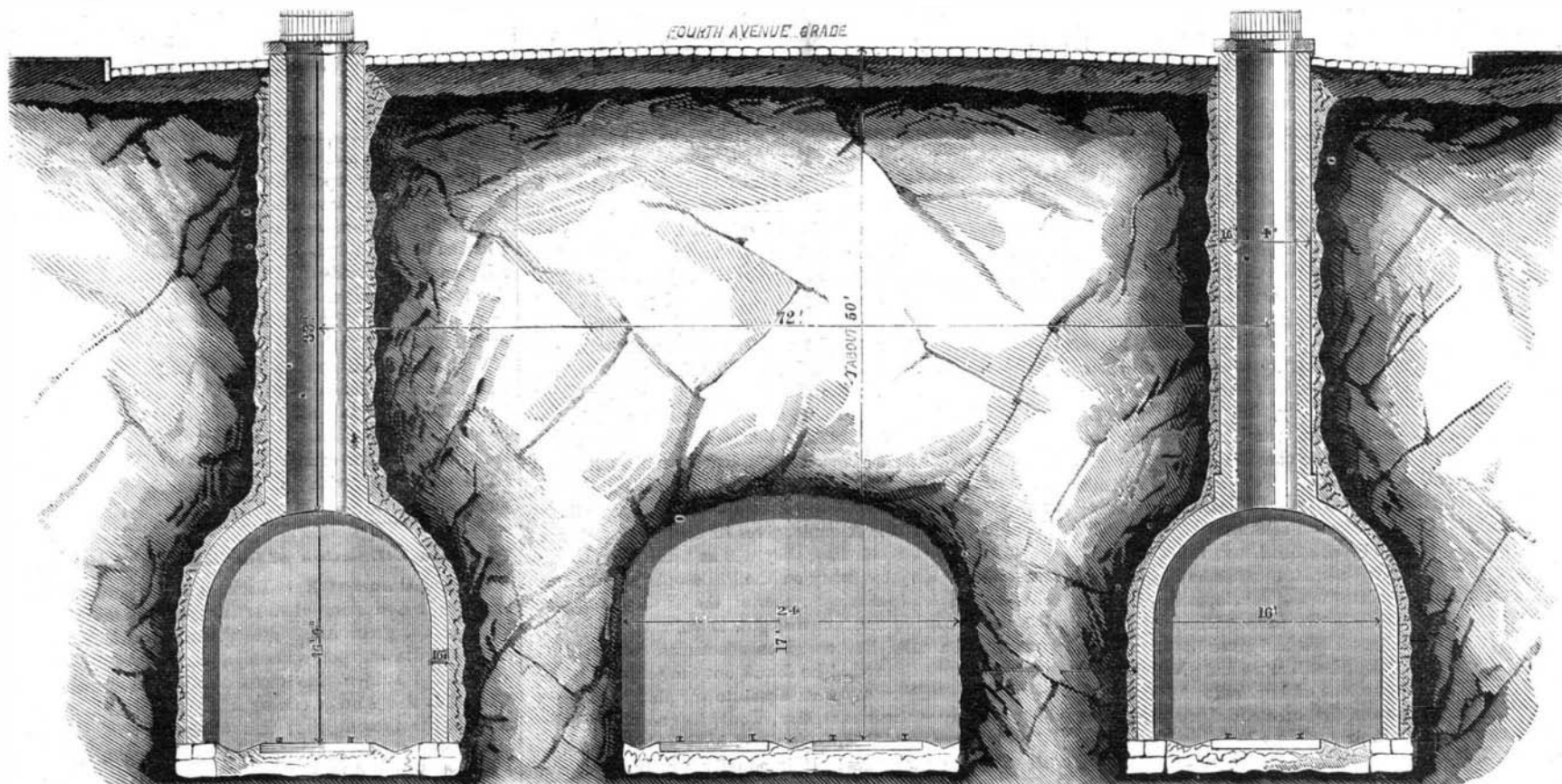


Fig. 18.—THE UNDERGROUND RAILWAY IN NEW YORK.—THE ROCK TUNNELS, FOURTH AVENUE, BETWEEN 92d AND 94th STREETS.