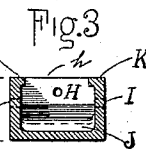
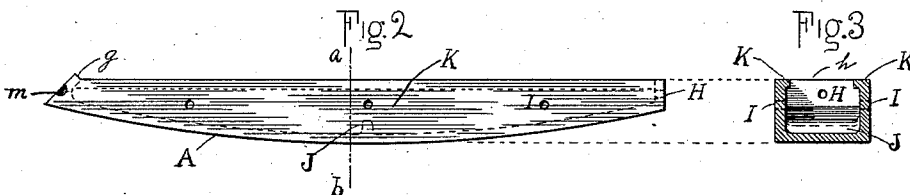
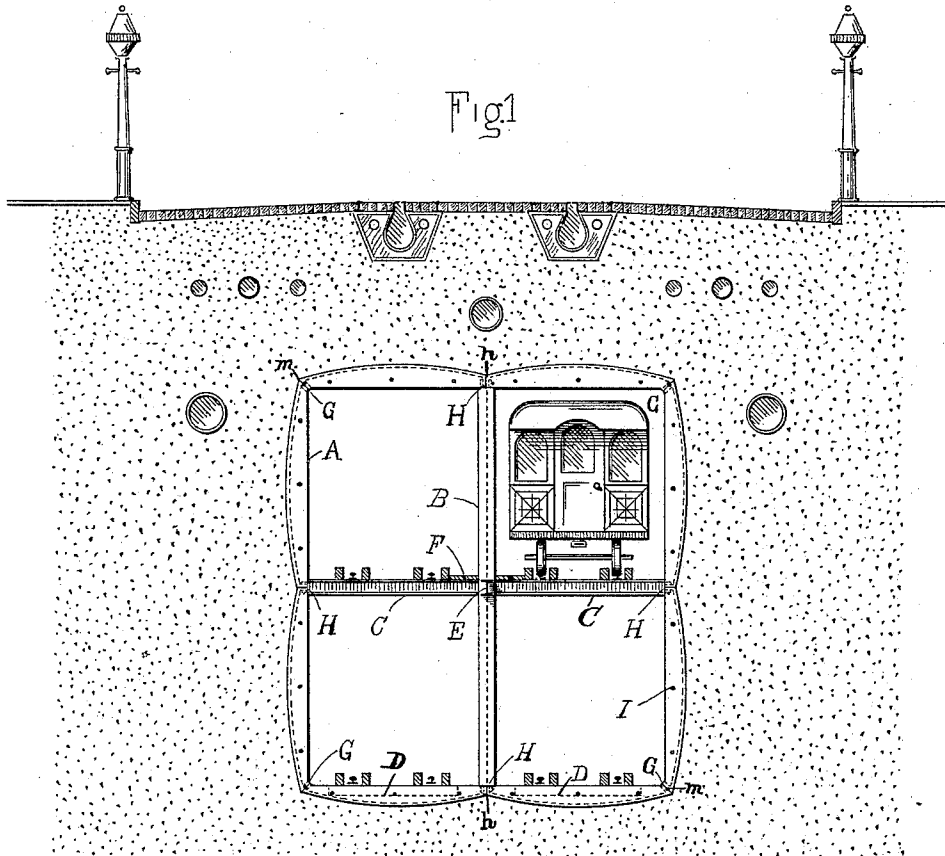


(No Model.)

J. W. RENO.
RAILWAY TUNNEL CONSTRUCTION.

No. 469,453.

Patented Feb. 23, 1892.



WITNESSES:
Francis P. Reilly,
W. F. Brickel,

INVENTOR
J. W. Reno
BY
S. M. Doornheer,
ATTORNEY.

UNITED STATES PATENT OFFICE.

JESSE W. RENO, OF NEW YORK, N. Y.

RAILWAY-TUNNEL CONSTRUCTION.

SPECIFICATION forming part of Letters Patent No. 469,453, dated February 23, 1892.

Application filed September 9, 1891. Serial No. 405,190. (No model.)

To all whom it may concern:

Be it known that I, JESSE W. RENO, of the city of New York, in the county and State of New York, have invented a new and useful Improvement in the Construction of Tunnels for Railways and for other Purposes, which invention is fully set forth and illustrated in the following specification and accompanying drawings.

The object of this invention is to provide a tunnel for railways which may be constructed in locations where soft or wet ground will be encountered, such as sands, clays, and quick-sands.

The invention will first be described in detail, and then particularly set forth in the claims.

In the accompanying drawings, Figure 1 shows a transverse sectional elevation of a railway-tunnel construction embodying my invention located under a city street and cable road-bed. Fig. 2 shows a longitudinal side view of one of the girder-panels forming the casing of the tunnel hereinafter described. Fig. 3 is a cross-section taken through Fig. 2 at the line *a b*.

In said figures the several parts are respectively indicated by reference-letters, as below described.

The method of constructing the tunnel is as follows: A rectangular hydraulic cutting-shield of any approved design, having a cutting-edge of the same outline as the periphery of the tunnel proper, is placed in position in an underground heading. Flanged girder-panels A, (shown enlarged in Fig. 2,) which form one section of the tunnel-casing, are then placed in position within the backwardly-projecting shell of the header-shield. These flanged girder-panels are preferably made of cast-iron, having the curved shape shown in Fig. 2 and of a cross-section such as shown in Fig. 3. The flanges K of said panels increase in sectional area along their upper edges, as shown in Fig. 3 at the points K, thus adding greatly to their strength. Said panels are also provided with a cross-web J, Figs. 2 and 3. At the four corners G of the tunnel proper said panels are provided with flanges *g*, the angles of the faces of which are preferably forty-five degrees, and through which bolts may be passed to secure two pan-

els together. A tarred packing may be inserted between said flanges, if desired, thus making said corners G water-tight. To resist the tendency of one panel to slip upon the other in the direction of the face of the flanges *g*, due to inward pressure upon the roof, floor, or sides of the tunnel, a key or dowel-pin, preferably round in cross-section and about eight inches in length, may be driven into the hole or keyway *m*, provided in said flanges. The pin or key extending half in one pair of panels and half in the adjacent pair longitudinally of the tunnel and also into a "half-hole" in each panel, as indicated at *m*, Fig. 2, will thus tie together four adjacent panels at the corners G.

The panels A are bolted together through their flanges K by means of bolts passed through holes I in said flanges. At the four points H said panels are also bolted together by bolts passed through their flanges *h*.

The letter B indicates vertical columns, and C transverse girders, said columns and girders being erected along the tunnel at the points where four of the girder-panels A come together. The vertical member or column B is in one piece, and preferably an I-beam shape, so that the transverse I-beams C C can be easily attached to it. At the points of intersection of the vertical and horizontal members B C are fixed short iron or steel beams, preferably I-beams, (shown in section at E,) which connect adjacent columns and serve to brace or stiffen the members B and C along the axis of the tunnel. At the four positions H each girder-panel A may be provided with a projecting lug or shoulder, which will thus secure in position in the manner of a socket the vertical and transverse bracing-beams B and C.

In order to fill in the space left by the hood of the shield as it is advanced by the hydraulic jacks, a grouting of liquid cement may be forced in through holes made for that purpose in the panels composing each belt or section of the tunnel. Such grouting will protect the iron from corrosion and seal up all cracks.

It will be evident that when the flanged girder-panels A are bolted together through their flanges they form a very strong tunnel-casing, impervious to water and other fluid

substances in the soil. As their name implies, said panels act as girders to resist the external pressure upon the tunnel in both vertical and horizontal directions. By this construction there is obtained a very great economy in space over tunnels of circular cross-section because of the necessarily rectangular outline of the standard cars. The panels A are preferably about two feet in width—that is, in their dimension parallel with the axis of the tunnel—so that the horizontal and vertical braces B C will occur at intervals two feet apart along the tunnel. In order to further economize space and also to reduce the cost of construction, the horizontal braces or girders C C may be used as cross-ties for the upper pair of railway-tracks and guard-rails, as shown in Fig. 1.

It will be observed that while the horizontal and vertical braces B C are preferably only about two feet apart, thus giving a very strong construction to the tunnel proper, they yet leave it practically open in the interior and give opportunity for the air to circulate between the four trackways, thus permitting of a single system of ventilation for the whole tunnel containing all the four tracks. This open interior structure of the tunnel proper is also of great importance when it is contemplated to run trains through the tunnel at high speed, for in this case the air-resistance becomes a large factor, unless, as in this construction, opportunity is given for the air to part in front of the rapidly-moving train. Another advantage is that the track-inspectors and workmen may stand in the openings between the vertical columns B, so that they will be out of danger from passing trains. As shown in Fig. 1, a board walk F is provided for their use for said purpose.

The design of the flanged girder-panels A is such that practically all the space within the iron shell of the tunnel proper can be utilized. Thus the cross-ties for the lower set of tracks can be set in cement in the spaces

between the flanges of the girder-panels composing the floor of the tunnel, as shown in dotted lines D in Fig. 1. The corresponding spaces in the panels composing the roof of the tunnel may be utilized for locating insulators to support electric conductors or wires about six inches above the roofs of the cars. The spaces between the transverse girders C C will also afford ample room for locating insulators to support electric conductors for the lower pair of car-tracks.

Having thus fully described my said invention, I claim—

1. In a subterranean railway structure or tunnel, the combination of girder-panels forming the sides, floor, and roof of the same, and vertical and horizontal beams or braces dividing the structure into four compartments or trackways, substantially as and for the purposes set forth.

2. In a subterranean railway structure or tunnel, the combination of girder-panels forming the sides, floor, and roof of the same, vertical and horizontal beams or braces abutting against adjacent panels at their common points of intersection, and shorter beams or braces attached to said vertical and transverse beams at their points of intersection, substantially as and for the purposes set forth.

3. A girder-panel for subterranean railway structures or tunnels, consisting of a curved shell and interior side flanges and having an interior mitered end flange provided with a keyway for the insertion of a locking pin or key.

4. In a subterranean railway structure or tunnel, the combination of a series of girder-panels united by bolts and locking dowel-pins or keys, substantially as and for the purposes set forth.

JESSE W. RENO.

Witnesses:

JACOB WASHBURN,
FRANCIS P. REILLY.