No. 620,102.

Patented Feb. 28, 1899.

B. F. CARPENTER.

TUNNELING DEVICE.

(Application filed May 4, 1898.)

(No Model.)

2 Sheets—Sheet 1.

Fig. 1.

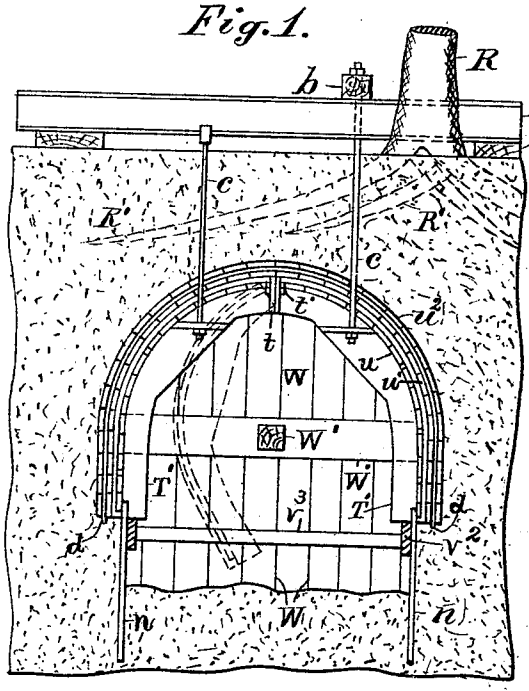

Fig. 3.

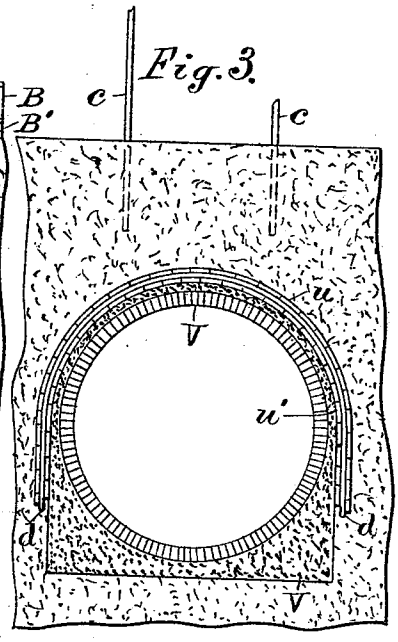

Fig. 2.

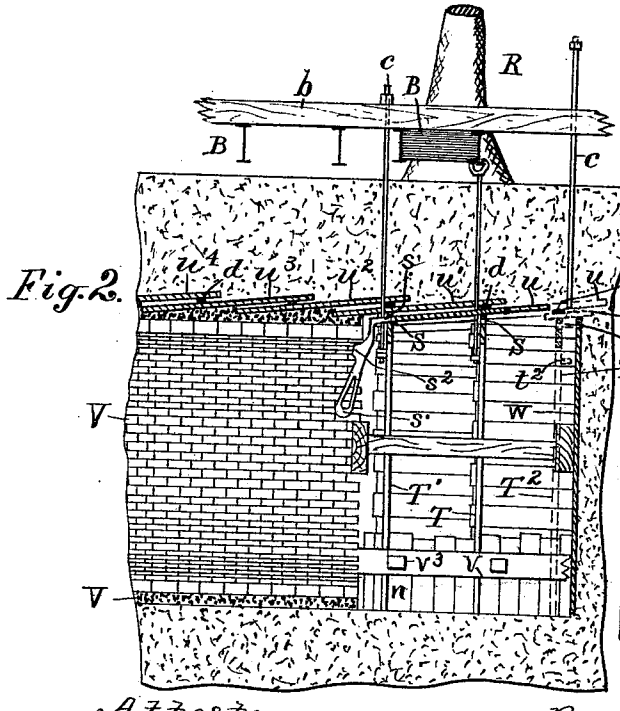

Fig. 4.

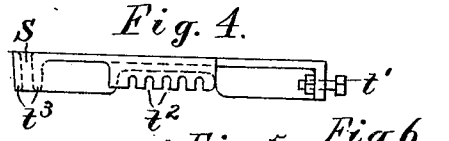

Fig. 5.

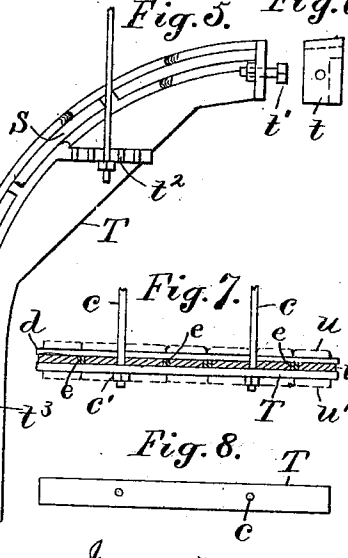

Fig. 6.

Fig. 7.

Fig. 8.

Inventor.

Benjamin F. Carpenter,

per Thomas S. Crane

Atty.

Attest:

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Edw. F. Kinsey.

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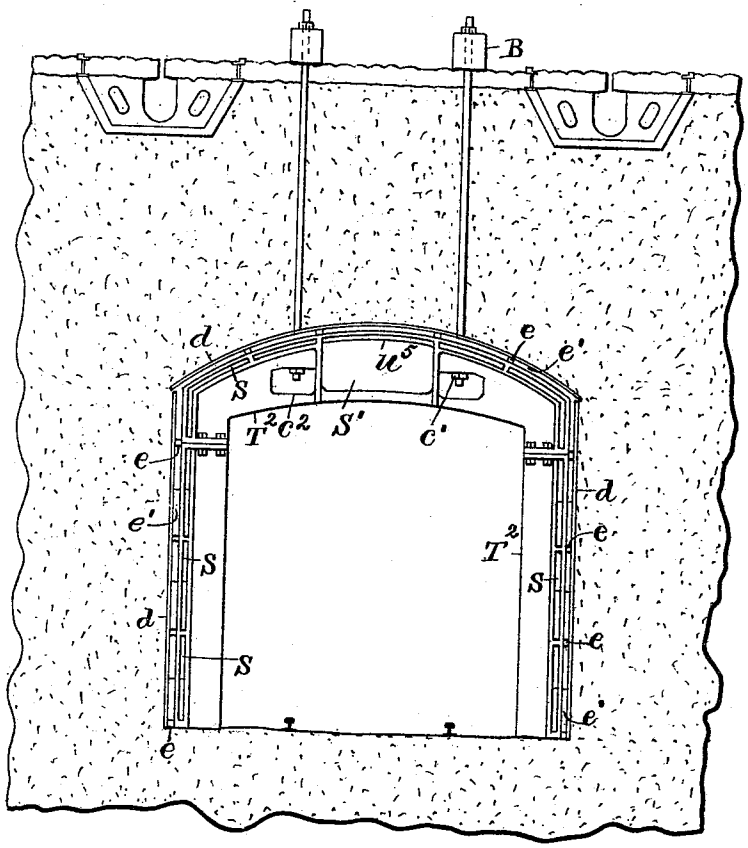
2 Sheets—Sheet 2.

Fig. 9.



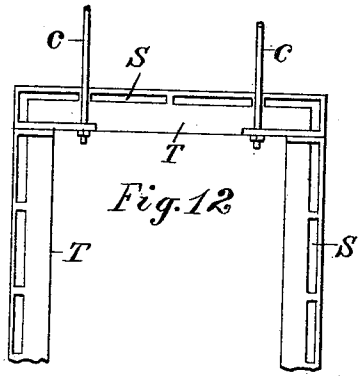


Fig. 12.

Fig. 10.

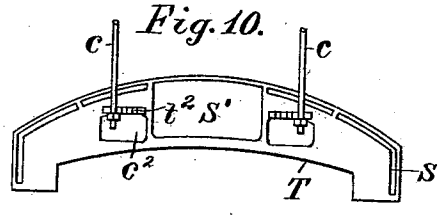
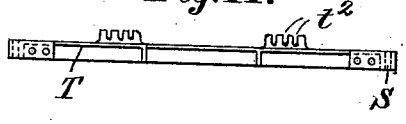


Fig. 11.



Attest:
Jacob Marx
Edw. F. Kinsey.

Inventor.
Benjamin F. Carpenter,
per Thomas S. Crane, Atty.

UNITED STATES PATENT OFFICE.

BENJAMIN F. CARPENTER, OF ROSELLE, NEW JERSEY.

TUNNELING DEVICE.

SPECIFICATION forming part of Letters Patent No. 620,102, dated February 28, 1899.

Original application filed December 16, 1897, Serial No. 662,164. Divided and this application filed May 4, 1898. Serial No. 679,739. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN F. CARPENTER, a citizen of the United States, residing at Roselle, county of Union, State of New Jersey, have invented certain new and useful Improvements in Tunneling Devices, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

The present invention relates to a method of constructing a tunnel beneath a street, park, or other body of earth without disturbing the surface of the earth, which method consists in supporting the unbroken surface material by suspension during the excavating of the tunnel and the erecting of the underground supports, and the present application is a division of my application, Serial No. 662,164, filed December 16, 1897, for patent upon improvement in the art of tunneling. In such prior application I have claimed the above-described method broadly and have filed the present application to claim specifically the means for temporarily suspending the surface material by metallic frames adapted to support poling-boards during the excavation of the material and until the permanent structure is erected within such boards. To support the material between the surface and the roof of the excavation, rods are extended downward through the soil or pavement into the upper line of the intended excavation, the rods being inserted at suitable intervals upon a line determined by a previous survey upon the surface. In the present construction two or three metallic frames having the same contour at the top as the roof of the proposed tunnel are formed with holes or lugs to engage the suspending-rods, which are provided at such intervals that the adjacent frames may support both ends of the poling-boards. As the excavation progresses the frames are successively introduced into the heading beneath the front ends of the poling-boards and support the same as other boards are driven forward sufficiently to remove the earth and insert another frame. The frame is preferably made in sections with suitable fastening devices, so that the parts of the frame may be readily transported into the heading and bolted together when assembled in their operative position.

The primary object of the frame is to support the load imposed by the superincumbent material, and it may therefore be used exclusively for such purpose and timber framing be employed when necessary to support the embankments or sides of the tunnel, or the frame may be provided with legs or posts extending down the sides of the heading, and thus serve also to sustain the poling-boards at the sides of the excavation.

To introduce the frames successively in the heading, the excavation is made within the front ends of the poling-boards a little beyond the line of the suspending-rod, and the face-boards, if needed, are then erected and the frame applied to such rods, so that other poling-boards may be driven forward to support the earth during the succeeding excavation.

The construction and operation of the frames will be understood by reference to the annexed drawings, in which—

Figure 1 is a cross-section of a sewer-tunnel with the surface soil supported adjacent to the roots of a tree. Fig. 2 is a longitudinal section of the same at the center line. Fig. 3 is a cross-section of the completed tunnel; Fig. 4, an elevation of one-half of the frame shown in Fig. 1. Fig. 5 shows the bottom end of such frame; Fig. 6, the joint-flange upon the top end of such frame. Fig. 7 is an edge view of a bar-frame with poling-boards; Fig. 8, a plan view of the frame and suspending-rods; Fig. 9, a section of a tunnel beneath street-railroad tracks with a frame having flat arch. Fig. 10 is an elevation of the top of the frame shown in Fig. 9; Fig. 11, the lower side of such top piece, and Fig. 12 an elevation of a frame with flat top.

Figs. 1 and 9 show slotted frames made of cast-iron, and Figs. 7 and 8 a frame of a flat wrought iron or steel bar.

Figs. 1 and 2 show frames adapted to excavate a round-top tunnel for a sewer in earth which requires the use of poling-boards at the sides and top of the tunnel.

By suspending the frames which support the poling-boards the boards can be inserted

and driven much more rapidly than where timber frames are used, and where it is necessary to employ frames at the roof and sides of the excavation my construction furnishes a great advantage, as the frames are made in parts bolted together, which permits the arrangement of the parts and the erection of the frames with much less labor than where the timber frames are used.

A special advantage is secured by suspending the frames which hold the poling-boards, as the entire space within the excavation is unobstructed, thus permitting the erection of masonry in smaller tunnels than heretofore.

As timber frames depend wholly upon supports from within the tunnel, such supports must remain until the masonry is constructed, and in the case of a small tunnel like that for a sewer the supports substantially prevent the erection of masonry and render such small constructions of masonry impracticable except in an open trench. By the present invention the tunnel may be driven and the mason-work completed without disturbing the surface soil or injuriously affecting the roots of growing trees and shrubs, and the obstruction of traffic upon the surface when in streets is thus wholly avoided, as well as the injury which is inflicted upon growing objects and the surface of the ground in parks when a tunnel or sewer is built in an open trench and the earth is thrown upon the surface at the top of the same.

The term "frame" is used herein to designate the metallic beam or girder which is sustained by suspension-rods inserted in the earth in advance of the excavation by surveying the route of the tunnel upon the surface and properly arranging beams to hang the rods therefrom. Such girder may be a flat bar of wood or metal suspended by the rods and used in practice with an additional bar or flat strap held above the same in contact with the previously-driven boards by removable wedges, such wedges maintaining temporary spaces between the bar and strap in which the points of the poling-boards are driven.

Where the frame is made in sections of cast metal, it is preferably formed of a flat plate having slots in the edge, the outer sides of which serve to guide the boards, and the inner sides of the slots may be fitted close to the boards or extended into the plate a considerable distance to reach the masonry when finishing the same close to the frame.

Fig. 1 shows a frame with round top divided vertically at the middle, while Figs. 9 and 12 show the top beam or girder in one piece, with legs bolted thereto at the ends to sustain lateral poling-boards.

Figs. 7 and 8 show the girder as a flat bar with the suspension-rods extended through the same to support it.

Although these frames are of such diverse form, their use is identical and the method of applying and driving the poling-boards is the same with all.

In Figs. 1 and 2 the two parts of the frame form each one side of the arch and are formed at the joint with flanges t to receive bolts t'. The suspension-rods c are inserted in the earth in advance, and beams B or other surface supports are provided to hang the rods therefrom. Notched lugs t^2 are provided upon the frames to receive the lower ends of the suspension-rods, which are adjusted by nuts c below the lugs, and thus serve to wholly sustain the load upon the frames. Each frame is provided with slots S in its margin, through which the poling-boards are driven. Two rods are shown provided to sustain the frame, and such pairs of rods should be arranged at suitable distance apart to receive the lugs of the frames and space them suitably in the heading to support both ends of the poling-boards.

During the excavation of the tunnel a pair of the frame parts T is introduced when each pair of bolts or rods is encountered, and the frame parts are then set in the position shown in Fig. 1 and bolted together at the center.

Fig. 2 shows the facing-boards W at the end of the heading, one of the frames T in which the poling-boards are being driven, and another of the frames T′ in proximity to the finished masonry, ready for removal when the poling-boards are freed from the same by pushing them past the edge of the frame. The masonry is built up nearly to such frame, and the face-boards W are supported by bars and braces W′ against the end of such masonry. Footing-boards n are shown driven at the sides of the excavation in contact with the legs of the frame and braced by bars v^3 and beams v^2. The excavation is carried forward, so that the face-boards may be set beyond the line of the rods c to permit the application of a frame to such rods.

Fig. 1 shows the frame T′ with the points of one set of poling-boards w' around the margin of the frame and the butts of a succeeding set in the slots S. To guide the points of the boards, the strap or bar d is sustained around the edge of the frame by the blocks or wedges e, and after each board is driven forward the wedges may be loosened or removed to make room for the other boards.

Fig. 2 shows in full lines the situation of two of the frames T and T′, with the poling-boards supported by the same, when the heading has been advanced sufficiently to receive a third frame T^2, which is indicated by dotted lines adjacent to the face-boards W. Before the frame T^2 is inserted the most advanced poling-boards are driven past the rods c, and when the new frame is applied to such rods the strap d is wedged against such board by wedges e, which are shown most clearly in Fig. 9, forming spaces e' outside the margin of the frame. The sets of boards used successively with the frames are designated in

Fig. 2 by the letters u u', &c. The poling-boards u are shown in full lines with their rear ends resting in the slots S of the frame T'; but such boards before the frame T^2 is inserted would be driven forward to the position indicated by dotted lines at their forward ends to free the boards from the slots in the frame T'. A drift s is provided to penetrate the slot, being held in position against the end of the board by a handle s', and provided with a seat s^2, to which a hammer can be applied when driving a board through a slot. The frame T' can then be removed by disconnecting the bolts t' at the center flanges t and swinging the sides of the frame parts inwardly, as indicated in dotted lines, within the left side of the arch in Fig. 1. After passing the frame T' the rear ends of the boards u are driven toward the frame T, leaving their rear ends projected from the frame sufficiently to be engaged by the masonry when built up to the frame, as indicated at the rear side of the frame T'. When the frame T^2 is secured in place, poling-boards should be inserted through the slots S in the frame T and inclined outwardly to enter the spaces e' around the frame T^2, and the driving of such boards forward over the face-boards W furnishes a support for the surrounding earth when the face-boards are taken down to carry the heading forward to or beyond the next pair of suspension-rods. The masonry is built as close to each frame as is compatible with the driving of the poling-boards, and two or three frames may thus serve to brace all the poling-boards that are used.

Where it is not convenient to carry the masonry forward as rapidly as the heading is extended, other frames and poling-boards may be used until the masonry can be built. The frames T and T' are shown applied to the forward sides of the suspension-rods, with the lugs t^2 upon the rear side of the frame to engage such rods; but the frame T^2 is shown applied to the rear side of the rods, which may be effected by turning the frame with the lugs upon the forward side.

When building the brickwork close to the frame, as represented in Fig. 1, the operator can lay the bricks to a certain height without difficulty; but to enable him to reach the top of the arch from the front end enlargement is made of the slot-opening S' in the top of the frame in Fig. 9 at and near the center, through which the bricks and mortar may be placed upon the top of the arch, so as to stay there securely. Openings c^2 are also shown below the bolt-lugs t^2 in Figs. 9 and 10 to reach the nuts upon the lower ends of the rods c when applying the frame in front of the rods, as may be done contiguous to the facing-boards W.

The slots S are shown in Fig. 4 extended between flanges t^3 at such an inclination as to guide the poling-boards toward the outer edge of the preceding frame; but the outer side of the slot furnishes all the guide that is necessary for each board, and the slot may therefore be made of any width upon the inner side. The top of the frame which is shown in Fig. 9 illustrates this feature of the slots, as the poling-boards u^5 are shown driven in contact with the upper side of the opening S', the remainder of the opening permitting the operator to stand upon the forward side of the frame when necessary to apply the bricks through the opening to the top of the adjacent brickwork.

The beams B, which sustain the rods c, are shown supported at their opposite ends upon stringers B', which are extended along the ground beyond the side lines of the tunnel to relieve the earth over the excavation from any load, and the left-hand rod in Fig. 1 is shown attached to the beam by a stirrup, while the right-hand rod is inserted through a strip b, resting upon the tops of the beams.

A tree R is shown in Figs. 1 and 2, with roots R' extending into the earth over the tunnel, thus illustrating the great facility afforded by this invention for tunneling under parks filled with growing trees and shrubs without disturbing or injuring such growth in the least.

Observation has shown that the roots of most trees penetrate the ground but little over four feet, and tunnels may therefore be made beneath the surface at that depth with the frames I have invented and the removal of the trees avoided, which is required with an open excavation.

It will be noticed in Fig. 1 that the suspension-beams B are set transverse to the line of the tunnel; but such arrangement is not admissible where the tunnel is extended beneath car-tracks, and Fig. 9 therefore shows an arrangement of beams extended longitudinally between the car-tracks C and serving to sustain the frames without obstructing the traffic upon the track. Such beams may be made considerably longer than the heading, and thus avoid throwing any load upon the earth over such part of the tunnel, the forward ends of the beams resting over the solid earth and the rear ends of the beams resting over the finished masonry of the tunnel.

It will be understood that the strap d operates the same as a part of the frame in furnishing openings to receive the poling-boards as the same are driven successively through the frames, and that the slots e' are formed within a loose strap instead of the solid frame, so that the frames may be successively detached from the boards, which are not driven wholly through the frame, but remain to rest upon the masonry, as the boards u' in Fig. 2. The wedges e, which form the spaces e', are removable and may be shifted, in the application of the boards, to insert their points wherever convenient. The loose strap around

the margin of the frame is thus an important attachment of the same and greatly facilitates the use and operation of the frames.

Where an arched frame is jointed in the middle, as shown in Fig. 1, the bolted flanges *t* operate to spread the legs of the frame apart as they are set in place and the bolts tightened up in the flanges, and the frame is thus more readily arranged in the required position and forced outward more firmly against the surrounding boards. I have therefore claimed such bolts and flanges for expanding the legs of the frame in place.

The appliances described herein are very cheap and easily used and afford a means not only of constructing railway-tunnels in soft soil, but of laying sewers and similar conduits in the ground without disturbing the surface of the same.

Having thus set forth the invention, what I claim herein is—

1. In the construction of tunnels, the combination, with suitable suspension-rods, of a frame shaped to fit the top of the tunnel excavation and applied to the rod or rods, as and for the purpose set forth.

2. In the construction of tunnels, the means for supporting the surface material, consisting of the suspension rod or rods *c* and the metallic frame made in parts or jointed sections, as and for the purpose set forth.

3. In the construction of tunnels, the means for supporting the surface material, consisting of the suspension rod or rods, and the metallic frame having slots in the margin to receive the poling-boards, substantially as set forth.

4. In the construction of tunnels, the means for supporting the surface material, consisting of the suspension-rods *c* and the metallic frame provided around the margin with flanges t^3 having between them the inclined slots T', as and for the purpose set forth.

5. In the construction of tunnels, the means for supporting the surface material, consisting of the metallic frame having in the margin slots for the admission of poling-boards, and provided with a series of lugs to admit the suspension-rods at different points, substantially as set forth.

6. In the construction of tunnels, the means for supporting the surface material, consisting of suitable surface supports, suspension-rods extended downward therefrom to intersect the top of the tunnel, and the iron frames sustained by such rods, with joint at the middle, and means, as the flange *t* and bolts *t'*, for drawing such joint together and thereby expanding the legs of the frame.

7. In the construction of tunnels, the combination, with suspension-rods extended from the surface into the line of the tunnel, and a frame shaped to fit the top of the tunnel excavation and sustained by such rods, of a strap wedged against the boards outside of such frame, with intermediate spaces to receive the points of poling-boards, substantially as set forth.

8. In the construction of tunnels, the combination, with a metallic frame having marginal slots for the insertion of poling-boards, of a strap wedged against the earth outside of such frame with intermediate spaces to receive the points of other poling-boards, substantially as set forth.

9. In the construction of tunnels, the combination with suitable suspension-rods, of a frame shaped to fit the top of the tunnel excavation and supported by such rods and having within the margin an opening S' adapted for the application of materials to the masonry when built close to such frame.

10. The frame for the construction of tunnels, provided in the margin with slots to receive poling-boards, and having the center slot enlarged, as in the opening S', for applying materials to masonry when built close to such frame.

11. In the construction of tunnels, a metallic frame shaped to fit the top of the tunnel excavation, and provided with side posts to support the side poling-boards, the frame having slots in the margin to receive poling-boards, substantially as herein set forth.

12. In the construction of tunnels, the means for supporting the surface material during the excavation of the tunnel, consisting of suspension-rods extended downward in a series upon the line of the tunnel to intersect the top of the same, and a beam extended above the surface longitudinally of the tunnel to sustain the upper ends of such rods, as and for the purpose set forth.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

BENJAMIN F. CARPENTER.

Witnesses:
THOMAS S. CRANE,
EDWARD F. KINSEY.