No. 817,657. PATENTED APR. 10, 1906.

P. E. McDONNELL, Sr.

ART OR PROCESS OF LOWERING RIVER TUNNELS.

APPLICATION FILED DEC. 16, 1905.

2 SHEETS—SHEET 1.

Fig. 1.

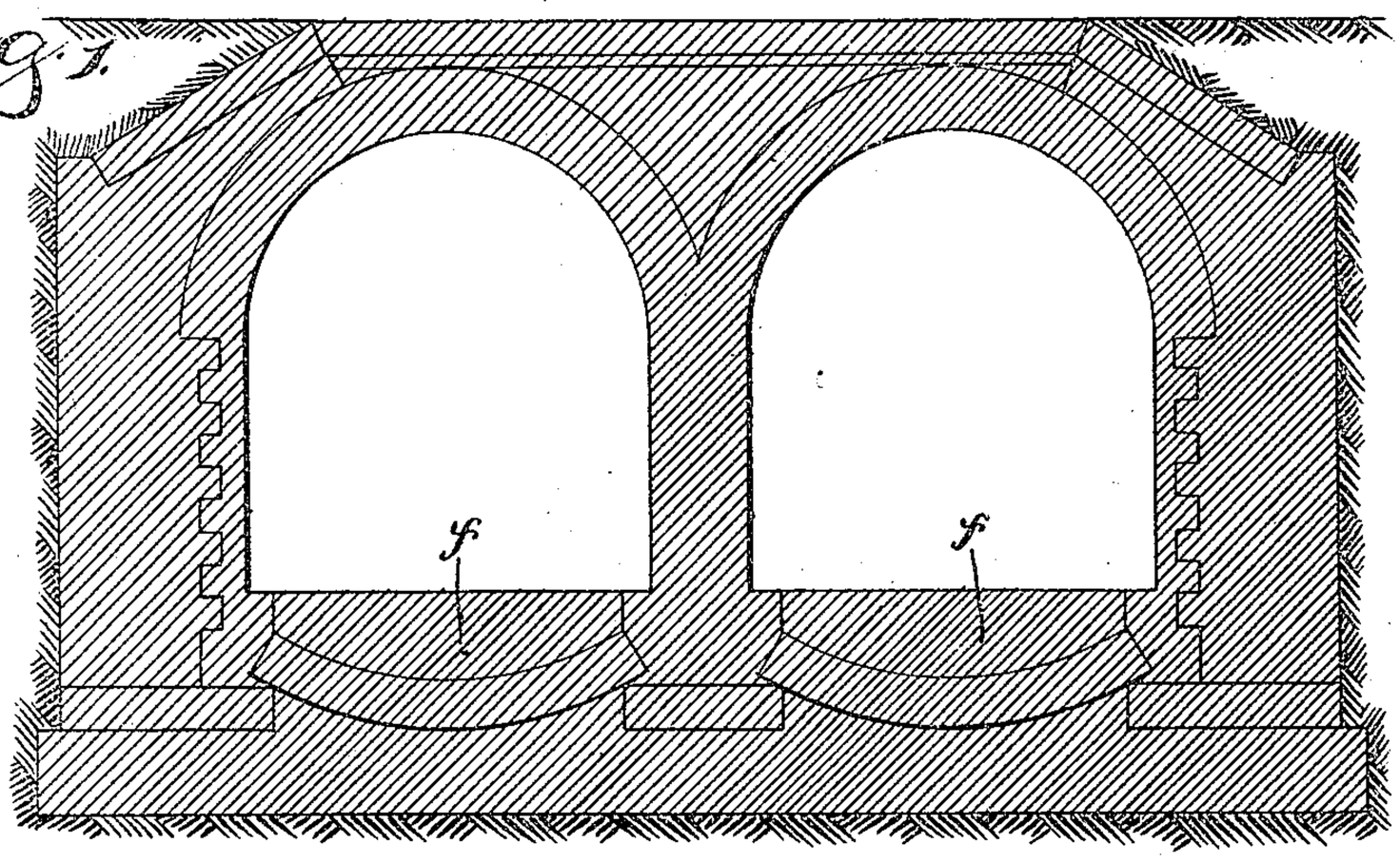


Fig. 2.

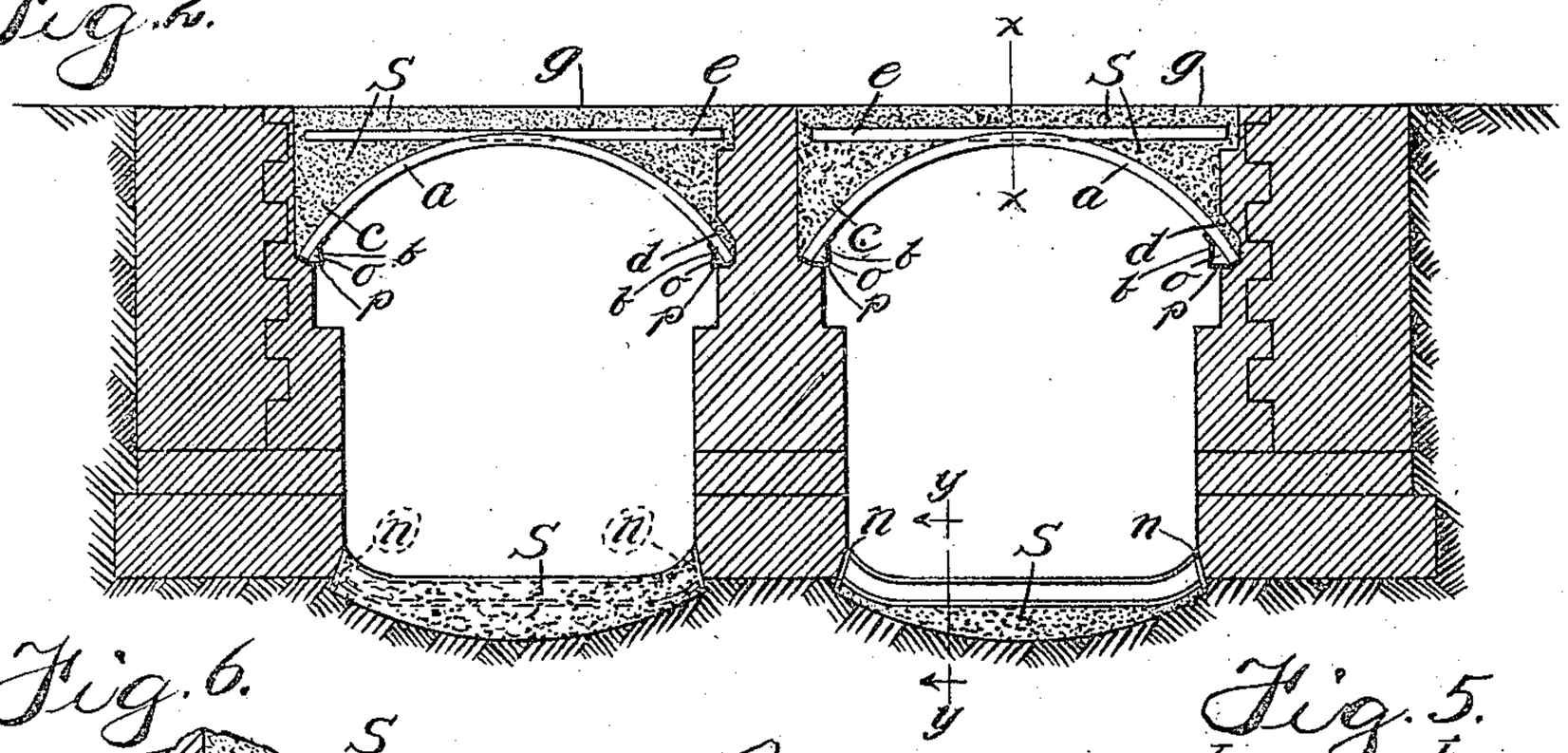


Fig. 6.

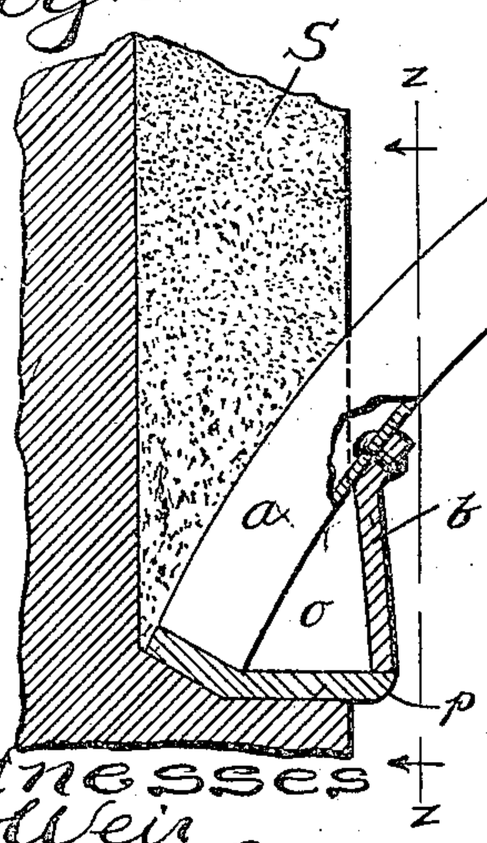


Fig. 7.

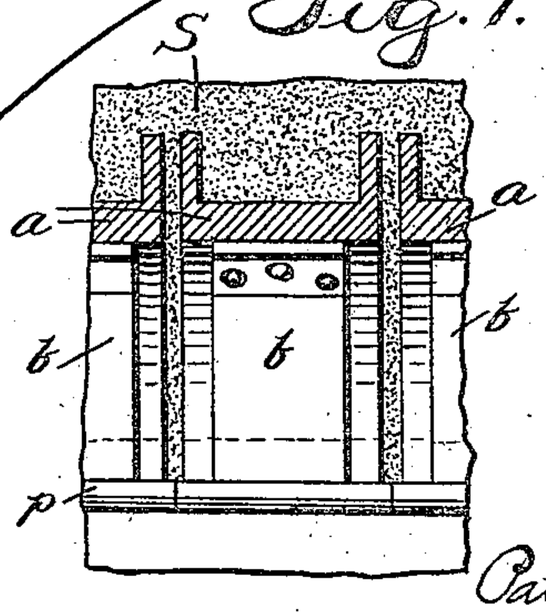


Fig. 5.

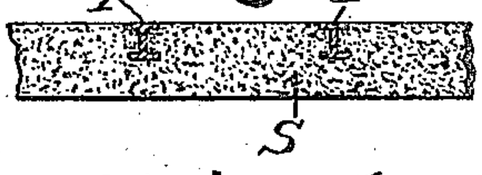
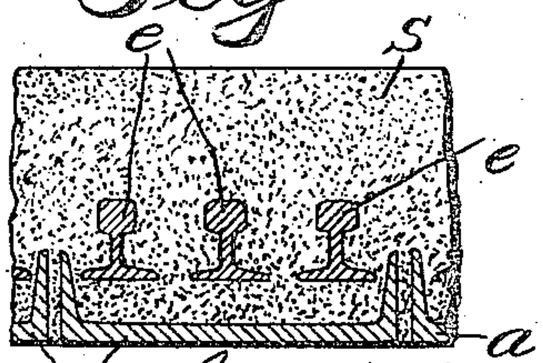


Fig. 4.



Witnesses
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Jno. D. Perry

Inventor:
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APPLICATION FILED DEC. 16, 1905.

2 SHEETS—SHEET 2.

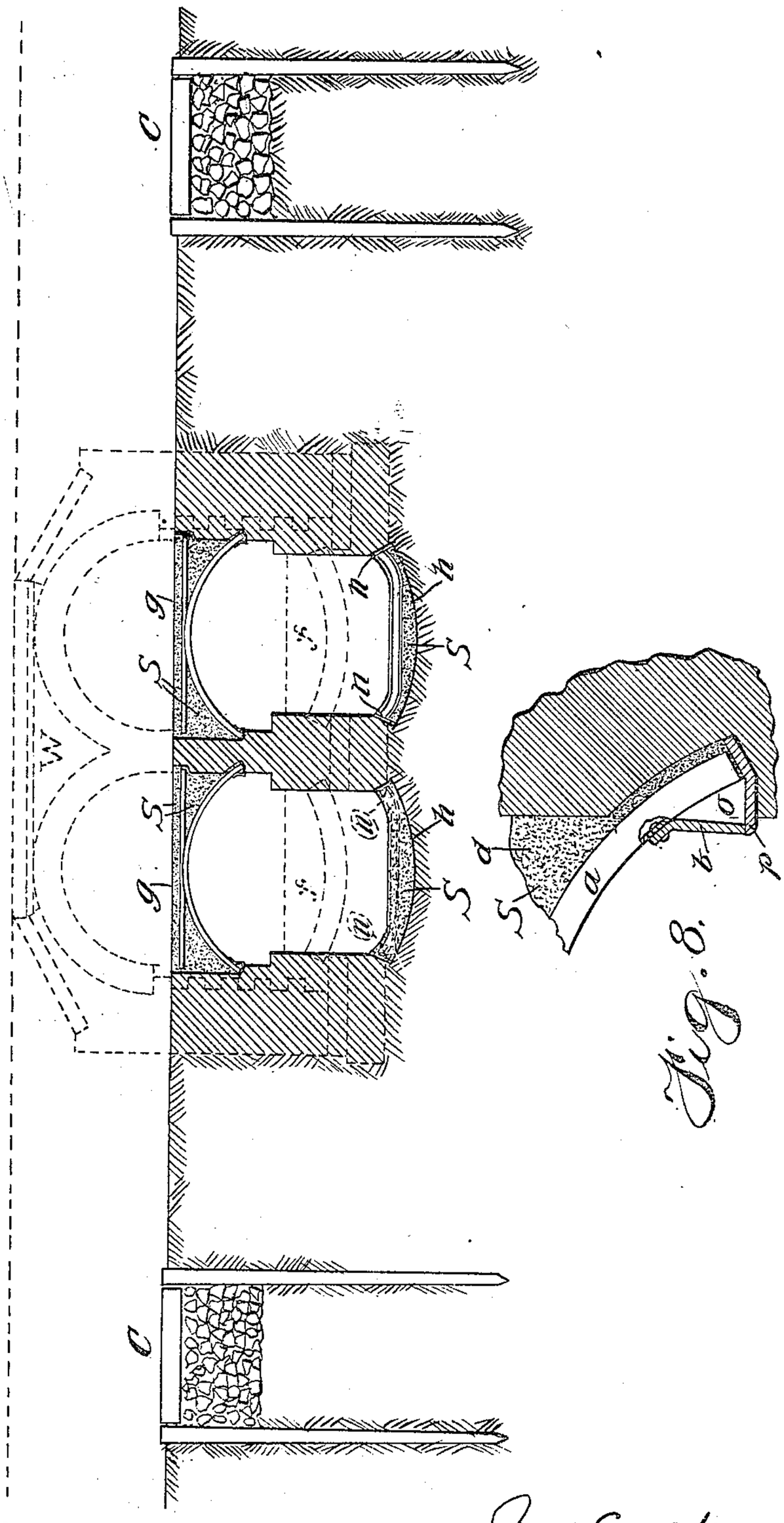

Fig. 3.

Fig. 8.

Witnesses:
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UNITED STATES PATENT OFFICE.

PATRICK ENEAS McDONNELL, SR., OF CHICAGO, ILLINOIS.

ART OR PROCESS OF LOWERING RIVER-TUNNELS.

No. 817,657. Specification of Letters Patent. Patented April 10, 1906.

Application filed December 16, 1905. Serial No. 292,113.

To all whom it may concern:

Be it known that I, PATRICK ENEAS McDONNELL, Sr., a citizen of the United States, and a resident of Chicago, in the county of Cook and State of Illinois, have invented a new, useful, effective, and cheap method of tunnel construction and the lowering of river-tunnels, and while it has especial relation and is more particularly intended for use where the changed conditions of the river or other causes necessitate the lowering of a tunnel that a deeper waterway may be provided, which at present is the case in the city of Chicago, Illinois, concerning the tunnels under the Chicago river, yet in some of its features it is applicable to the construction of new tunnels.

The main object of my invention is to provide an improved arrangement of the constructive parts in the lowering of a river-tunnel, whereby the greatest strength of the material used may be available, thus using the least material possible and enabling the use of material of such quality and form as to give the greatest strength with a view of reducing the thickness of the lowered tunnel-roof from that of a present tunnel-roof, so as to obviate the greater sinking of the floor of the lowered tunnel to allow of a greater depth of water above its new roof.

Another object is to provide a bench and housing within the tunnel, which may be used for electric wires of any nature.

A still further object is to provide a solid road-bed to which car-rails may be fastened; also, to provide a protection from the crushing in of the thin wall of the roof of the tunnel by marine vessels that may reach below the depth of such wall by the construction of separate walls apart from the tunnel; also, the method of operation in the construction of the lowering, whereby the navigation and flow of water of the river under which a tunnel is to be lowered may not be stopped while the process of lowering is prosecuted—this by a further extension of one of the walls of the coffer-dam at a certain point in the progress of the work, which will be hereinafter described.

Other objects and advantages of the invention will be disclosed in the subjoined description and explanation.

In order to enable others skilled in the art to which my invention pertains to make and use the same, I will now proceed to describe it, referring to the accompanying drawings, in which—

Figure 1 is a cross-sectional view of the part of a tunnel under the water-bed of a river and may represent an existing tunnel now under the Chicago river, excepting a foot-path, which is not shown. Fig. 2 is a cross-sectional view of the same at the same point, showing the lowered tunnel complete at that point and lowered according to the scale of the drawings to be about six (6) feet, and yet leaving the bore of the tunnel the same size as before lowering. Fig. 3 is a cross-sectional view of the tunnel at the same point, showing the lowered tunnel complete at that point, as in Fig. 2, and also showing the parts of the walls of the old roof in dotted lines (marked W) that would be above the new roof and that would be removed after the new roof's completion; also, a protecting-wall C on each side of and apart from the lowered tunnel to prevent marine vessels that may have a keelage that would strike the top of the thin wall of the lowered tunnel from coming in contact with it, the said protecting-walls being shown as extending above a horizontal plane at the top of the lowered tunnel. Fig. 4 is an enlarged sectional view of a part of the upper new roof-wall running lengthwise with the tunnel at its narrowest point, taken on line *x x* of Fig. 2, showing the arrangement of the channel-iron arches *a* and iron beams *e* and their surrounding concrete S. Fig. 5 is a sectional view of a part of the lower new floor-wall running lengthwise with the tunnel, taken on line *y y* of Fig. 2, showing the arrangement of I-beams and their surrounding concrete S. Fig. 6 is an enlarged cross-sectional view of one of the newly-prepared side walls of the tunnel at *c*, (see Fig. 2,) showing the end of one of the channel-iron arches *a* resting on a plate *p*, backed up by a brace *b*. Fig. 7 is an inner view, partly in section and partly in elevation, of a portion of one of the newly-prepared side walls, showing the arrangement of the channel-iron arches *a*, foot-plates *p*, and braces *b* with their backing of concrete S, the said view being taken on line *z z* of Fig. 6 looking in the direction indicated by the arrows; and Fig. 8 is an enlarged sectional view of that part of one of the newly-prepared walls at *d*, (see Fig. 2,) showing the opposite end to *c* of the arch *a* and is the counterpart of the end at *c*, with the exception that it shows that the old wall does not require to be cut away as much as at the end *c* of the arch.

I will now proceed to describe the operation of construction in lowering the tunnel. Starting about the middle of the tunnel to be lowered, the old side walls are cut away, as shown at *c* and *d*, the area of the cut-away portion at *d* being preferably less than the cut-away portion at *c*. The foot-plates *p*, which have their outer portions slightly inclined, are then bedded in position, and the channel-iron arches *a*, having the braces *b* attached to their lower surfaces, are then set upon the foot-plates *p* by first raising their ends *c* toward the roof and placing their ends *d* on the foot-plates *p* on the opposite wall and then lowering the ends *c* to their foot-plates. The concrete is then filled in between the vertical walls of the tunnel and the upper surface of the arches to a point about level with the top of the arches, where the iron beams *e* are laid horizontally and transversely of the tunnel, when the concrete filling may be continued to the line *g* of Figs. 2 and 3 of the drawings. This constitutes the thickness of the new roof as compared with the old roof shown as well as the material used, and its construction should be prosecuted from the central point under the river toward each end continuously that the concrete may not have any separation, which it would have if allowed to "set" at a stopping-point.

The old floors *f* (see Figs. 1 and 2) are cut away to the line *h* (see Fig. 3) and new floors (see Fig. 5) are laid, which floors are made of concrete and I-beams I, having iron foot-plates *n*, as shown in Figs. 2 and 3, set at the ends of each beam. The foot-plates *n* and *p*, which are made of iron, are for the purpose of giving a more solid surface and greater area for the thin ends of the I-beams and channel-iron arches, respectively, to act against as braces than the concrete alone would give.

The cutting away of the old floors *f* may be in progress as soon after some of the new roof is completed as practical and the new floors laid, which should also be in a continuous manner for the reason of the concrete setting, as stated, as well as to keep as near as possible a full pressure against the tunnel-walls.

Having completed the new floors and the new roofs, the old roof-walls W (see Fig. 3) may be removed by the usual method of coffer-dam, with the exception that in the case of the tunnels under the Chicago river or the like the coffer-dam should extend only from one side of the river to about the center thereof, thus leaving one-half of the river navigable. When the first half part of the old roof-wall shall have been removed and while yet dry within the coffer-dam, the coffer-dam wall in the center of the river running across the tunnel should be extended from the top of the old wall of the tunnel down to the top of the new wall of the lowered tunnel (see line *g*, Fig. 3) by a new wall of proper material that can be readily removed with this center wall when the entire old roof is removed. Thus the center wall of the coffer-dam will do for both halves of the river with the one construction, while one-half of the river will always be open free for use.

The protecting-walls C, (see Fig. 3,) which are preferably made of piles and rubble-stone, extend at their upper edges above the top of the new roof of the lowered tunnel on each side thereof and may be constructed at any time either before the completion of the lowered tunnel or after its completion. It is apparent that these protecting-walls may be employed in connection with a tunnel which has not been lowered and will afford protection therefor.

The openings O in the side walls at *c* and *d* of Fig. 2, formed by the arches *a*, foot-plates *p*, and braces *b*, (shown more clearly in the enlarged sectional views, Figs. 6 and 8,) can be used for the purpose of housing electric wires of any nature, and the spaces between the braces *b*, as shown in Fig. 7, are purposely constructed so that the wires may be inserted and taken care of. Doors of suitable kind and material may be used to close these spaces and may be opened to permit of access to the interior of the housing when desired.

The I-beams I in the new floors (see Fig. 5) are purposely laid flush with the surface of the concrete, so that street-car or other rails may be bolted to them, thus making a solid road-bed with the least thickness of material for such purpose. As these I-beams extend transversely of the tunnel and are slightly upturned or curved at their ends and are braced by the foot-plates *n*, it is apparent that a very strong and durable floor or road-bed will be afforded.

It is obvious that trolley-wires for street-cars may be attached to the arches *a* of the roof of the tunnel, and the necessary arrangements or appliances for hanging such wires may be placed in position on the arches before they are lifted and placed in position.

From the foregoing and by reference to the drawings it will be seen and clearly understood that while my invention appertains more especially to the lowering of tunnels which have already been constructed, yet some of the features of the invention may be employed in the construction of new tunnels. For instance, the protecting-walls C may be located one on each side of a new tunnel as a safeguard against it being crushed in or damaged by the keels of vessels, or the improved way of forming and supporting the roof of the tunnel may be employed in a new one, and the same may be said of the improved road-bed.

Having thus described the form of and the material used and the operation of construc-

tion, as well as in the lowering, of river-tunnels, it will be understood that deviations therefrom can be made without departing from the spirit of my invention, and I therefore do not wish to be understood as confining myself specifically to that shown and described; but

What I do claim is—

1. In a tunnel structure, the combination with the side walls each having its inner upper portion recessed, a series of foot-plates resting on said recesses, transverse arches supported at their ends on the outer portions of said plates, braces secured at one of their ends to the arches and resting at their other ends on said plates near their inner edges, and concrete located on the arches between the walls, substantially as described.

2. In a tunnel structure, the combination with the side walls each having its inner upper portion recessed, a series of foot-plates resting on said recesses, transverse arches supported at their ends on the outer portions of said plates, braces secured at one of their ends to the arches and resting at their other ends on said plates near their inner edges, transversely and horizontally disposed beams located above said arches, and concrete located on the arches between the walls and embedding said beams, substantially as described.

3. In a tunnel structure, the combination with the walls and a roof therefor, of transversely-disposed beams located at the bottom and between the walls, foot-plates located at the ends of said beams, and concrete embedding the beams and plates, substantially as described.

4. In a tunnel structure, the combination with the walls, of transversely-disposed beams located at the bottom and between the walls, each of said beams having its ends upturned, foot-plates located at the ends of said beams, and concrete embedding the beams and plates, substantially as described.

5. In a tunnel structure, the combination with the side walls and a roof therefor, of a protecting-wall located on each side of the tunnel and extending at its upper end above the top of the tunnel-roof, substantially as described.

6. The herein-described step in the method of lowering river-tunnels, which consists in erecting a new roof within the tunnel at a suitable distance below the old roof while the latter is in place, substantially as described.

7. The herein-described steps in the method of lowering river-tunnels, consisting in cutting away a portion of the upper inner part of each of the side walls to form recesses therein at suitable distances below the old roof, supporting transverse arches at their ends on the bases of said recesses, and placing a mass of concrete on said arches, all while the old roof is in position, substantially as described.

8. The herein-described steps in the method of lowering river-tunnels, consisting in cutting away a portion of the upper inner part of each of the side walls to form recesses therein at suitable distances below the old roof, supporting transverse arches at their ends on the bases of said recesses, beginning at about the middle of the tunnel, and placing concrete on the arches in a continuous act toward each end of the tunnel, substantially as described.

9. The herein-described steps in the method of lowering river-tunnels, consisting in cutting away a portion of the upper inner part of each of the side walls to form recesses therein at suitable distances below the old roof, supporting transverse arches at their ends on the bases of said recesses, placing beams transversely and horizontally above the arches, beginning at about the middle of the tunnel, and placing concrete on the arches so as to embed the said beams and in a continuous act toward each end of the tunnel, substantially as described.

10. The herein-described steps in the method of lowering river-tunnels, which consists in erecting a new roof within the tunnel at a suitable distance below the old roof while the latter is in place, and removing the old floor to a suitable depth and placing a new one at the bottom of the side walls of the tunnel, substantially as described.

11. The herein-described method of lowering river-tunnels, which consists in erecting a coffer-dam from one side of the river to about its middle around the tunnel with a transverse wall over the old roof of the tunnel, cutting away a portion of the upper inner part of each of the side walls to form recesses therein at suitable distances below the old roof, supporting transverse arches at their ends on the bases of said recesses, placing a mass of concrete on said arches while the old roof is in position, exhausting the water from the coffer-dam, removing the old roof and the upper portion of the side walls within the coffer-dam, and extending the transverse wall of the coffer-dam from the top of the old wall of the tunnel down to the top of the new wall of the lowered tunnel, substantially as described.

In testimony whereof I have hereunto signed my name in the presence of two subscribing witnesses.

PATRICK ENEAS McDONNELL, SR.

In presence of—
A. S. McDONNELL,
FRANCIS A. McDONNELL.