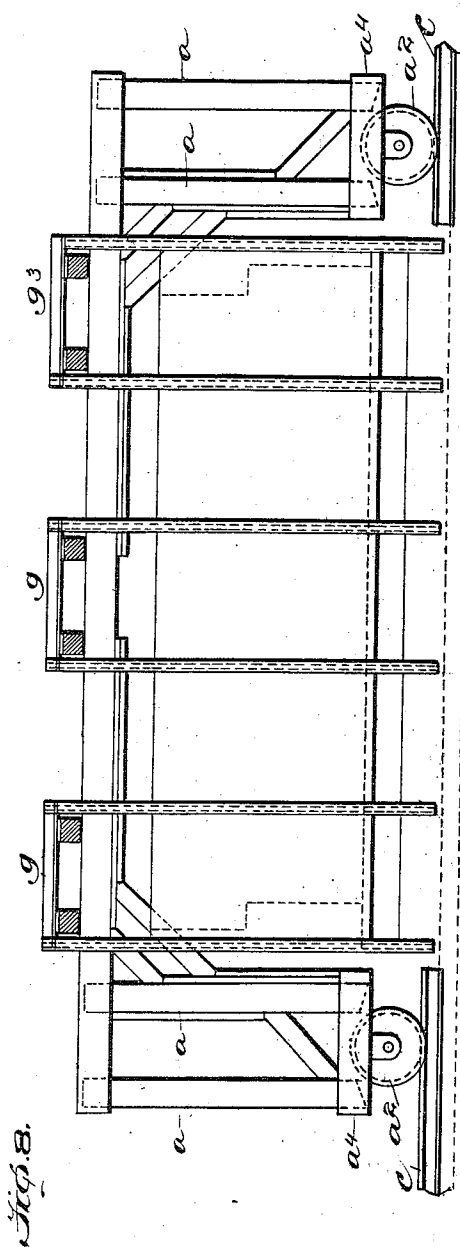
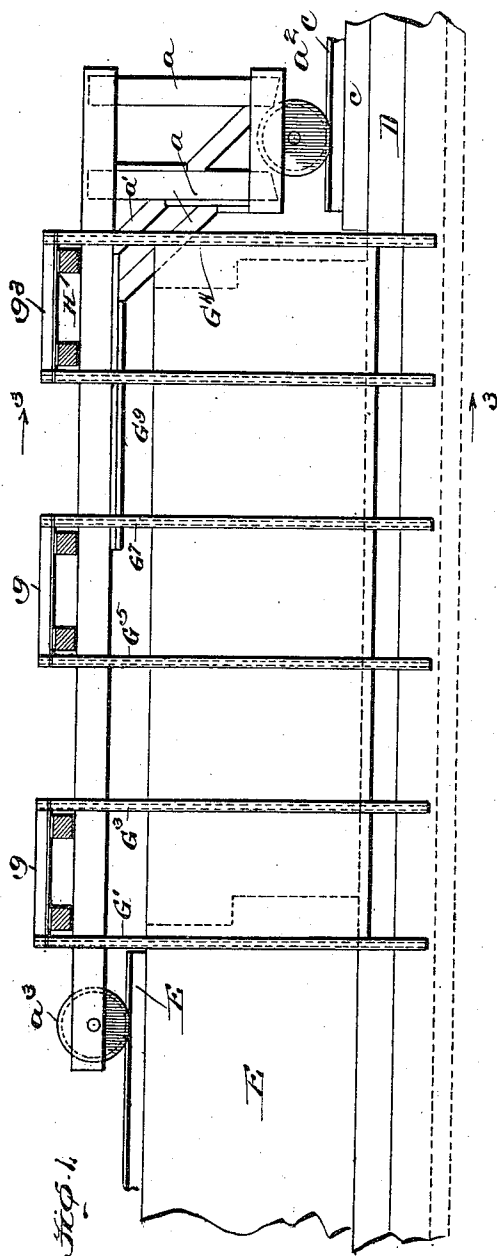


E. G. WILLIAMS & E. H. BROWN.
FORM FOR TUNNEL WORK.
APPLICATION FILED NOV. 21, 1906.

1,017,029.

Patented Feb. 13, 1912.

3 SHEETS—SHEET 1.



Witnesses

E. O. Biedebrand
N. Reynolds

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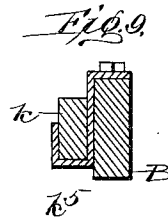
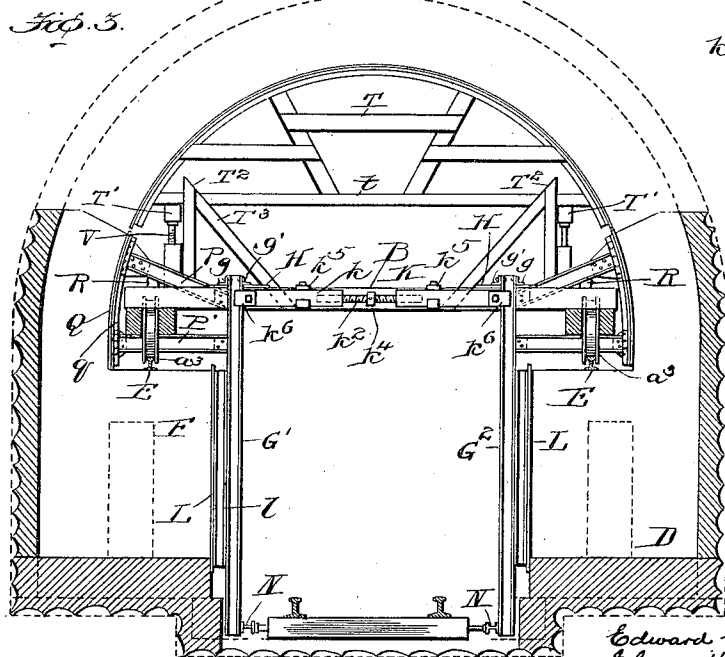
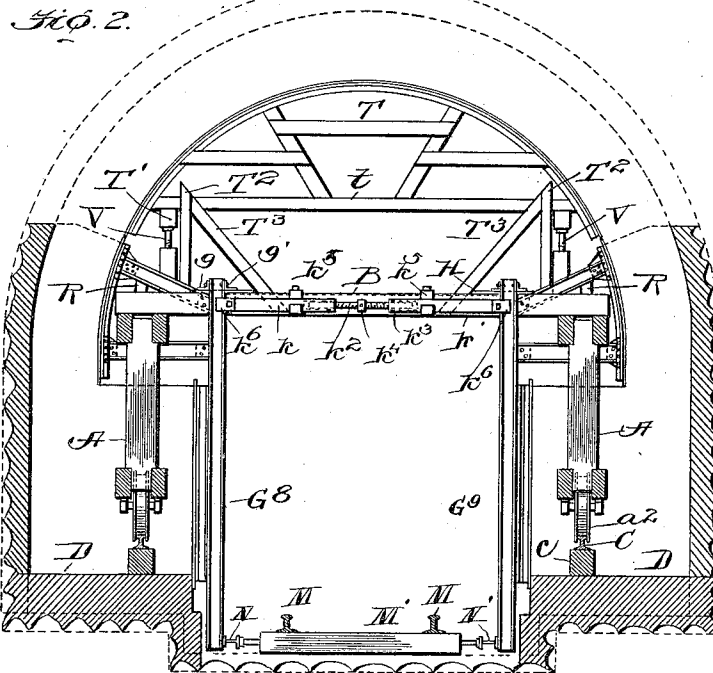
their Attorneys.

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3 SHEETS—SHEET 2.



Witnesses

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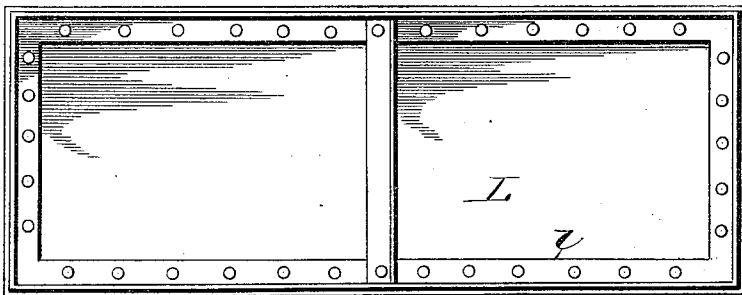
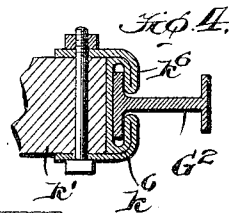
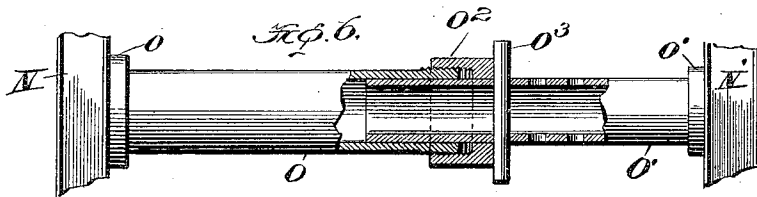
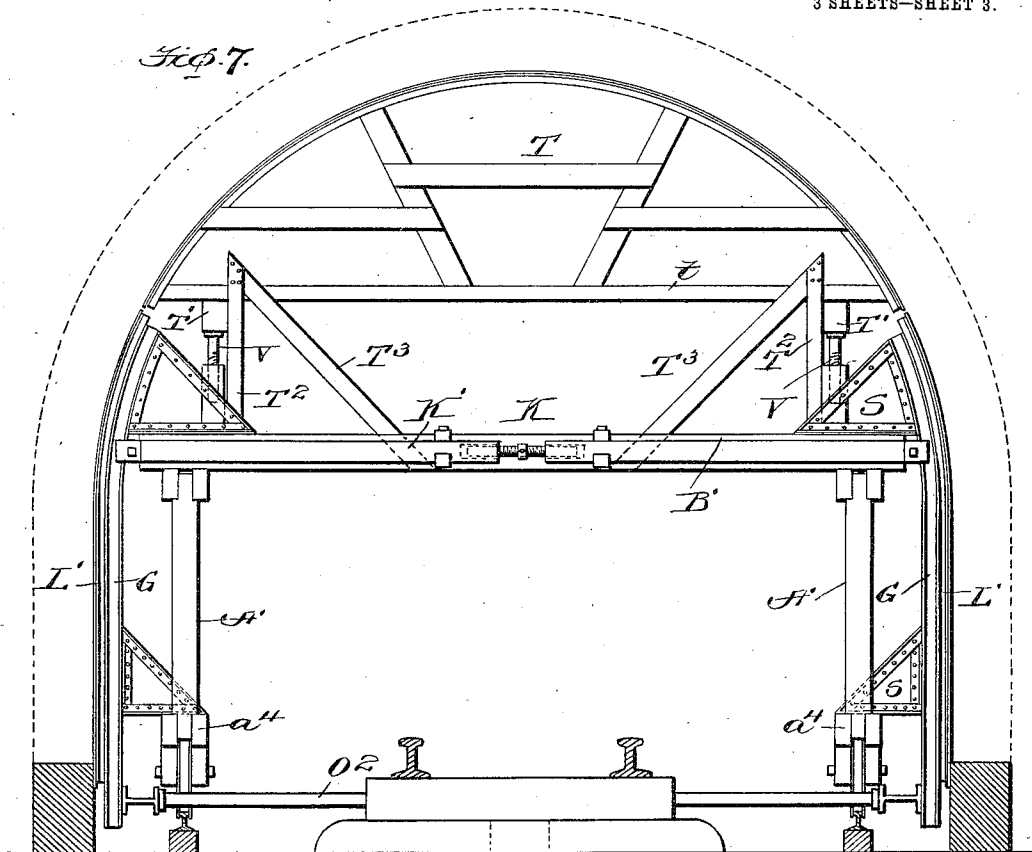
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3 SHEETS—SHEET 3.



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UNITED STATES PATENT OFFICE.

EDWARD G. WILLIAMS AND ELMER H. BROWN, OF WASHINGTON, DISTRICT OF COLUMBIA.

FORM FOR TUNNEL-WORK.

1,017,029.

Specification of Letters Patent.

Patented Feb. 13, 1912.

Application filed November 21, 1906. Serial No. 344,423.

To all whom it may concern:

Be it known that we, EDWARD G. WILLIAMS and ELMER H. BROWN, citizens of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Forms for Tunnel-Work; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

Our invention relates to improvements in forms for tunnel work.

The object of our invention is to provide an apparatus by which the cost of placing the forms for concrete and similar work in tunnels will be materially reduced, as also the time requisite for the completion of the tunnel.

With this general object in view and some others which will be obvious to those skilled in the art from the description hereinafter, an apparatus embodying our invention consists in the features, details of construction and combination of parts which will first be described in connection with the accompanying drawings and then particularly pointed out in the claims.

In the drawings, Figure 1 is a side elevation, partly in section of an apparatus embodying our invention; Fig. 2 is a transverse section of the apparatus, on the line 3—3, Fig. 1; Fig. 3 is an elevation of one end of such apparatus, illustrating it in place in a tunnel which is shown in section; Fig. 4, a detail view showing one of the connections; Fig. 5, a detail view of one of the forms, and Fig. 6, a detail view of one of the lower retaining devices. Fig. 7 is an end view, and Fig. 8 a side elevation of another embodiment of our invention. Fig. 9 is a detail view of a hanger.

In Figs. 1, 2 and 3 we have shown an embodiment of our apparatus particularly advantageous for use in placing the concrete in a tunnel driven through rock and provided with off-set concrete walls having ducts for electric cables and the like.

Referring to the drawings, it will be seen that our device comprises a carriage open beneath so as to leave the tunnel passage way entirely unobstructed, so that the

tunnel tracks will not be blocked by the apparatus and hence the traffic through the completed portion of the tunnel to the heading will not be impeded. This is an important feature of our invention, because it permits the work of placing the concrete lining to be carried on at a reasonable distance behind the work of driving, or excavating the tunnel, without interfering with the latter work.

The carriage comprises two side supports A connected at their tops by suitable means such as the beams B. The side supports A are arranged to be moved longitudinally from time to time during the progress of the work. In the present construction, where the tunnel is provided with an off-set, we support one end of each side-support on the finished concrete, as for example, on the concrete offset, while the other end of each side-support is carried from the foundation of the tunnel-wall in advance of the completed portion of such wall. In order to do this, each side support A is provided at what we term its forward end, with a leg frame, in this case consisting of posts a suitably connected to the corresponding side-support, braces a' being provided, if necessary, as shown in the drawing, Fig. 1. In order to reduce friction when moving the side-supports longitudinally, the leg-frames are provided with rollers or track-wheels, as indicated at a^2 which rest upon rails that we will designate as front rails, indicated at C, Figs. 1 and 2, these front rails being laid in sections equal to the length of concrete placed at one time, the rails resting upon longitudinal sleepers c placed upon the top of the foundation of the tunnel walls, this foundation being indicated at D. The other end of each side support is carried upon a completed portion of the wall of the tunnel, in the present case by means of a roller or wheel, a^3 , which runs upon a rail E, laid in sections of suitable length and carried by the completed off-set portion F of the tunnel wall.

Upon the carriage are mounted transversely movable form-carriers, comprising, in the present example, a plurality of dependent I-beams G^1 to G^{12} arranged in pairs on each side of the tunnel-passageway, each

pair being connected at the upper ends in any suitable manner, as for example, by angle-irons g, g' arranged one on each side of the pair of I-beams and riveted or otherwise secured thereto. The connecting members g, g' of each pair of I-beams are slidable upon plates H , secured to the top surfaces of the beams B . The pair of I-beams on one side of the apparatus and the corresponding pair on the opposite side of the apparatus may be designated as a set. By our arrangement, as will be understood from the drawings, the two pairs of a set are movable toward and from each other, and to hold the pairs at the desired distance apart suitable means is provided at the top and at the extreme bottom of the I-beams. In the present instance, this means consists of a top-retaining device and a bottom retaining device, the latter being of such a nature as not to interfere with the traffic through the completed portion of the tunnel.

In the present construction each top retaining device consists of a cross strut composed of two parts k, k' spread apart by a jack screw device k^2 , having right and left hand threaded ends which enter corresponding threaded sockets k^3 secured in the adjacent ends of the two parts k, k' of the cross strut, as will be clear from Fig. 2. The jack-screw device is provided with a central collar, k^4 having holes for the insertion of a pin or spanner by which the screw may be turned to force the two parts of the cross strut apart or to draw them toward each other.

The cross-strut is supported from the corresponding beams B of the carriage, by brackets or hangers k^5 secured to the said beams B , and extending beneath but unsecured to the cross-struts. Each of the cross-struts is connected at its end to the respective dependent I-beam G^1-G^{12} in any suitable manner. In the present example, each end of each strut is provided with a pair of inwardly flanged jaws k^6 fixed to the ends of the strut and having the flanges arranged to engage the flange of the corresponding I-beam. (See Fig. 4.) By such a connection between a cross-strut and the corresponding I-beams, the latter may be drawn toward each other, and away from the walls of the tunnel by operating the jack-screw devices k^2 to draw the two parts k, k' of the cross strut together.

The dependent I-beams G^1-G^{12} carry the wall-forms for the concrete walls, these forms being indicated at L and consisting of sections of sheet metal reinforced by angle iron frames, l , which are secured to the dependent I-beams in any suitable way as for example by bolts and nuts whereby the sections may be removed readily. The sections when in place form a smooth and

continuous wall on each side of the tunnel, against which the concrete may be rammed.

The lower or bottom retaining device consists of removable means independent of the carriage for holding the lower ends of the dependent I-beams at the desired distance apart, while not interfering with the passage-way through the tunnel. It is assumed, of course, that the tunnel will be provided during construction, with a suitable roadway, as for example, a railway track, such a track being composed of rails M , Fig. 2, supported above the floor of the tunnel as for example by ties M' , which are spaced at intervals in the usual way, whereby between the ties a space is left beneath the rails M .

The dependent I-beams on each side are provided at their lower ends with a longitudinal girder N, N' , consisting in the present instance of an I-beam secured to the inner face of the respective dependent I-beams G^1-G^{12} . Between the longitudinal girders N, N' are placed the bottom retaining devices each of which passes transversely across the tunnel floor in a space between the ties and beneath the rails, as will be clear from Fig. 6. The said bottom retaining devices are made in such a way as to permit the insertion of them beneath the track and between the ties and their removal when desired, without any interference with the track. In the present example, the said bottom retaining devices are composed of two tubes O, O' , one of which is telescopic in the other. The outer ends of the tubes are provided with shoes o, o' which can bear on the respective longitudinal girders N, N' .

In order to hold the tubes with their shoes at the proper distance apart and yet to permit the collapsing of the tubes when it is desired to remove them, a suitable locking means is provided. In the present instance, the larger tube has its inner end threaded and over this is screwed a cap, o^2 which bears against a pin or key o^3 passing transversely through a hole in the smaller tube, as will be clear from Fig. 6. By removing the pin o^3 the smaller tube may be telescoped completely into the larger tube, and the two may be inserted in this collapsed condition, beneath the rails and between the ties. Then the smaller tube may be drawn out, the pin inserted and the cap o^2 adjusted with a wrench, to bring the two shoes o, o' into bearing contact with the longitudinal girders N, N' , whereby the latter and the forms are held at the proper distances apart against the pressure of any concrete which is afterward put in place against the forms. When the concrete has set, the cap o^2 may be screwed farther onto the large tube O , thus loosening its bearing against the pin o^3 and allowing the latter

to be driven out easily from the small tube, which may then be telescoped into the large tube, and both removed from between the ties and beneath the rails, the space between the ties usually being sufficient to allow this to be done.

In order to make the lower retaining devices capable of adjustment to various lengths, the smaller tube, instead of having only one pin hole may be provided with a plurality of such holes, into any one of which the pin o^3 may be inserted, the total axial movement of the cap o^2 being about equal to or preferably slightly more than the distance between any two pin-holes. In this way the pin o^3 and the pin holes permit the rough adjustment of the length of the lower retaining device while the screw-threaded cap o^2 permits the final finer adjustment of the length of such retaining device, and permits the gradual and ready release of the strain on the pin o^3 so that the same can then be removed without difficulty.

In connection with the forms for the walls are also provided forms for a part of the arch more particularly for the lower parts of the arch. In the present embodiment of the invention, these partial arch forms are carried from the depending I-beams G^1 - G^{12} , as will now be described. To the said depending I-beams are attached lateral supporting devices each consisting of an upper brace P and a lower brace P' , these two extending outward from the corresponding depending I-beam and having their outer ends secured to the curved partial arch form Q , which forms are made in sections and reinforced with angle-iron frames q .

In order to add strength to the structure, a stringer R may be placed longitudinally upon the beams B as shown in Fig. 2 to which stringer the upper braces P may be attached. The said stringers, R , however, are not attached to the beams B , but merely rest upon the same, and hence, are capable of movement transversely of the tunnels.

In the embodiment of the invention thus far described, the forms are set by moving the carriage along its rails, which are laid in sections ahead of it, until the forms are at the desired place. Then the jack-screw devices k^2 are turned to spread the forms apart to the required distance. The lower retaining devices are then put in place beneath the track of the tunnel and between the ties, and said lower retaining devices are spread to force the bottoms of the wall-forms to the required distance apart. This adjustment of the apparatus brings the partial arch forms to the proper position. The concrete is then filled in behind the forms, in any desired way, but particularly by a machine for this purpose,

such for example as is shown and described in our Patent No. 829903. When the concrete is sufficiently set to permit the removal of the forms, this is done by first loosening the top and bottom retaining devices by means of the jack-screws k^2 and the caps o^2 , until the strain is off the forms, and then removing the lower retaining devices and drawing in the tops of the wall forms by still further operating the jack-screws k^2 , until the wall forms are sufficiently clear of the concrete wall to permit the longitudinal movement of the carriage and forms to the next position. The act of withdrawing the wall forms from the set concrete also frees the partial arch forms from the concrete lower portions of the arch. When the carriage and its attached forms have been moved lengthwise of the tunnel a distance equal to the total length of the forms, the apparatus is quickly put in position for the placing of the next portion of the concrete by spreading the top retaining devices and putting in place the lower retaining devices in the manner hereinbefore explained.

Figs. 7 and 8 show another embodiment of the invention, particularly arranged for use in a tunnel where the walls are not off-set but join substantially flush with the inner face of the arch. In this construction the side frames A' extend downward close to the tunnel floor and are provided with wheels, running on tracks laid close to the tunnel walls. The form supports G , consisting of I-beams, are supported from the carriage by suitable means, as for example by the upper and lower plate brackets S , S' , the upper brackets S , resting upon the beams B' of the carriage, while the lower brackets rest upon the lower sills, a^4 , of the side frames A' of the carriage. The form supports G are straight from the springing line of the arch downward and serve to carry the wall-forms L' , while the upper ends of the said form supports are curved as shown and carry the partial arch forms which are arranged to have their entire surfaces continuous with those of the wall forms. The forms are made and attached in substantially the same way as the wall forms described in connection with Figs. 1 and 2. The upper and lower retaining devices K' and O^2 are substantially the same as hereinbefore described in connection with Figs. 1 and 2, as will be clear from Fig. 7.

Upon the substructure or carriage, either the structure shown in Fig. 1 or that shown in Fig. 7, is mounted a centering T , which is movable vertically toward and from the carriage, by means of suitable elevating mechanism as for example the jacks V which are mounted upon the beams B' of the carriage and bear against stringers T' upon which the lower chords t of the center-

ing rest. The centering is guided in its vertical movements by posts T^2 secured to the carriage and bearing against the inner faces of the stringers T' respectively, these posts T^2 being braced by the braces T^3 as will be clear from Fig. 7.

It will be observed that in our invention the carriage, with its wall-supports for the forms and the top and bottom retaining devices, constitute, when in place, a "through" truss, that is to say, a truss through which a roadway passes, the upper members of the truss (in this case the beams B , and B' , respectively) and the upper retaining devices being high enough above the roadway to permit the free passage of all traffic to and from the heading of the tunnel. Moreover, this "through" truss has its transverse load at its lower side carried by means removable from the truss, that is to say the load tending to force the wall-form supports on each side toward those on the opposite side, is carried at the lower ends of said supports by means which do not form a permanent part of the truss, but can be readily removed to permit the movement of the truss longitudinally from one section of the work to another. In the particular embodiments of the invention disclosed in this application this means for carrying the transverse load at the lower end is formed by the collapsible lower retaining device which constitutes no permanent part of the truss, but can be readily removed from the same and replaced.

It is to be observed, that in this invention, the lower chords t of the arch center or form are placed at a slight distance above the horizontal plane through the lower edges of the arch center, whereby a clearance space is left so that the wall-forms may be moved horizontally inward a short distance to free them from the concrete and the arch center can then be lowered a short distance to free it from the completed arch. By means of this arrangement, only a small amount of movement is necessary with either the wall-forms or the center to free the apparatus so that it can be removed to the next section. Thus but little time is lost in withdrawing and replacing the forms.

Owing to the fact that the wall-forms are transversely movable relative to the substructure, (in the present case, the carriage) a small variation in alinement of the substructure will not interfere with a proper alinement of the forms.

Having thus fully described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. In an apparatus of the class described, the combination, with a carriage open beneath, of side-wall forms bodily adjustable transversely of the carriage, and means at

the upper and lower ends of said side-wall forms to carry the lateral loads on said forms independently of the carriage.

2. In an apparatus of the class described, the combination, with a carriage open beneath, of side-wall forms bodily adjustable transversely of the carriage and arranged to be carried by the carriage, and means at the upper and lower ends of said side-wall forms and arranged to carry the lateral loads on said forms without transmitting the same to the carriage.

3. In an apparatus of the class described, the combination, with a substructure, of wall-forms supported by the substructure and bodily movable laterally with relation thereto, means arranged to carry the lateral loads on said forms without transmitting the same to the substructure, an arch-form mounted on the substructure over the wall-forms, said arch form being provided with clearance spaces to receive the upper ends of the wall-forms when the latter are drawn in and the arch-form is lowered, and means for raising and lowering the arch-form with relation to the substructure.

4. In an apparatus of the class described, the combination, with a through truss, through which the traffic of the tunnel may pass, of forms carried on opposite sides of said truss, means above the traffic passage way for holding the upper ends of the forms against displacement, and removable means out of the traffic passage way for holding the lower ends of the forms against displacement.

5. In an apparatus of the class described, the combination with the tunnel track, of a supplemental track having its rails outside the tunnel track, a carriage mounted on the supplemental track and open above the tunnel track to permit traffic over the latter, forms carried by the said carriage, and means independent of said carriage for sustaining the transverse load on said forms.

6. In an apparatus of the class described, the combination, with a carriage movable longitudinally of the tunnel, of forms supported by the carriage and bodily movable transversely relative thereto, upper retaining devices arranged to hold the forms at their upper ends, and removable lower retaining devices arranged to hold the forms at their lower ends.

7. In an apparatus of the class described, the combination, with a substructure, of wall-forms carried by said substructure, partial arch forms carried by said substructure and arranged to project outside the wall-forms, and an arch center supported by said substructure.

8. In an apparatus of the class described, the combination, with a substructure, of a plurality of dependent form-supporters at each side of said substructure and bodily

movable transversely thereto, means carried
by the substructure for holding said form
supporters apart at the upper end, remov-
able means for holding the lower ends of
5 said form supporters, and forms carried by
said form-supporters.

In testimony whereof we affix our signa-

tures to this specification, in the presence of
two witnesses.

EDWARD G. WILLIAMS.
ELMER H. BROWN.

Witnesses:

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Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents,
Washington, D. C."