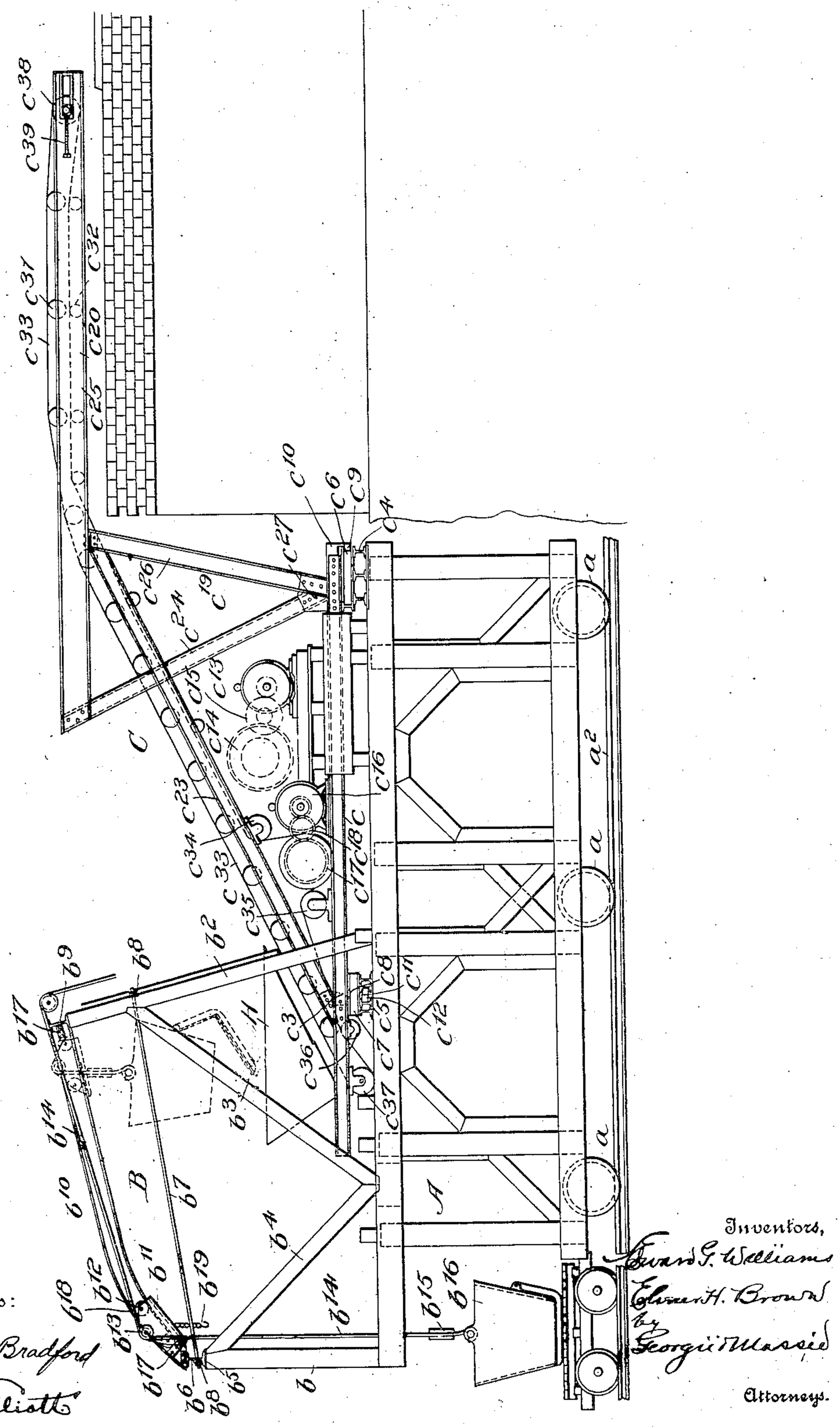
No. 829,903. PATENTED AUG. 28, 1906.

E. G. WILLIAMS & E. H. BROWN.

MACHINE FOR HANDLING MATERIAL FOR TUNNEL ARCH CONSTRUCTION.

APPLICATION FILED APR. 3, 1906. 4 SHEETS—SHEET 1.

Fig. 1



Witnesses:

Edwin L. Bradford

R. M. Elliott

Inventors,

Edward G. Williams

Edward H. Brown

by George H. Massie

Attorneys.

No. 829,908. PATENTED AUG. 28, 1906.

E. G. WILLIAMS & E. H. BROWN.

MACHINE FOR HANDLING MATERIAL FOR TUNNEL ARCH CONSTRUCTION.

APPLICATION FILED APR. 3, 1906.

4 SHEETS—SHEET 2.

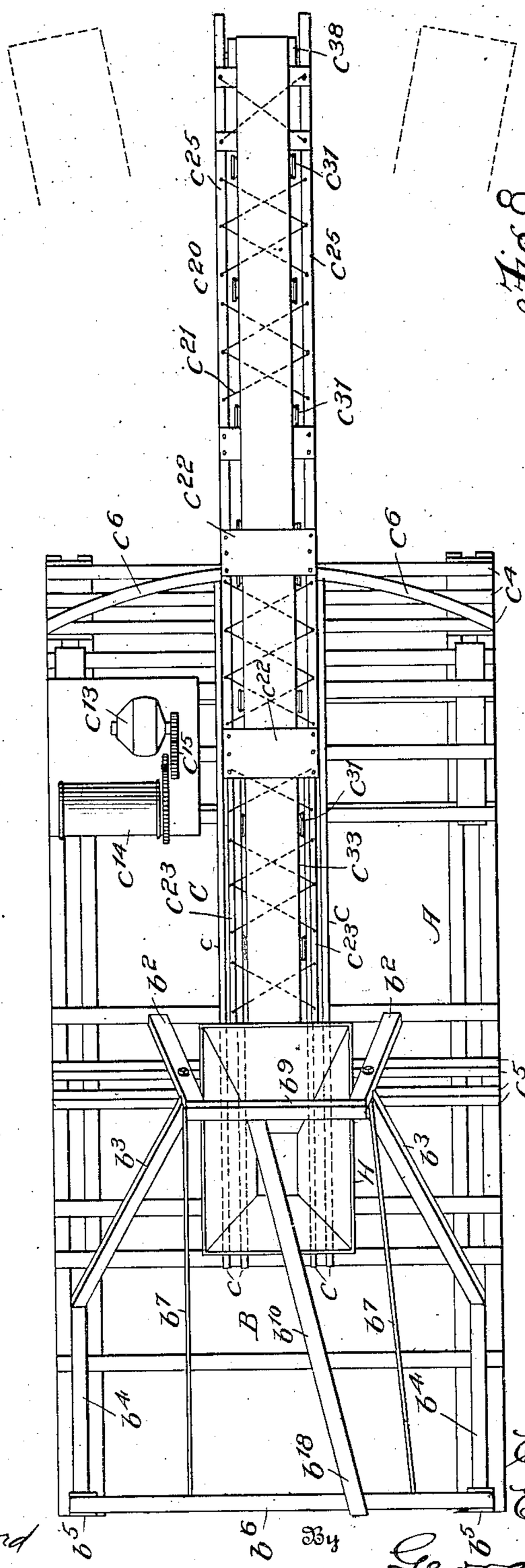


Fig. 2.

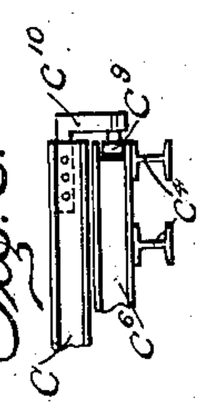


Fig. 8.

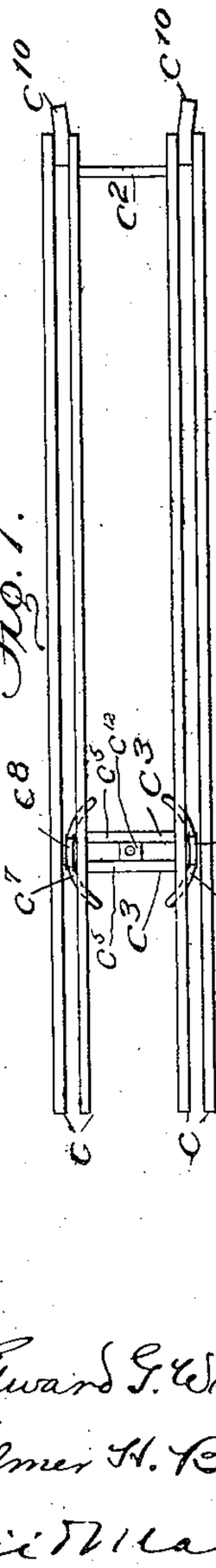


Fig. 7.

Witnesses:

Edwin L. Bradford

R. M. Elliott

Inventors,

Edward G. Williams

Elmer H. Brown

By Georgii Niassid

Attorneys.

No. 829,903. PATENTED AUG. 28, 1906.

E. G. WILLIAMS & E. H. BROWN.

MACHINE FOR HANDLING MATERIAL FOR TUNNEL ARCH CONSTRUCTION.

APPLICATION FILED APR. 3, 1906.

4 SHEETS—SHEET 3.

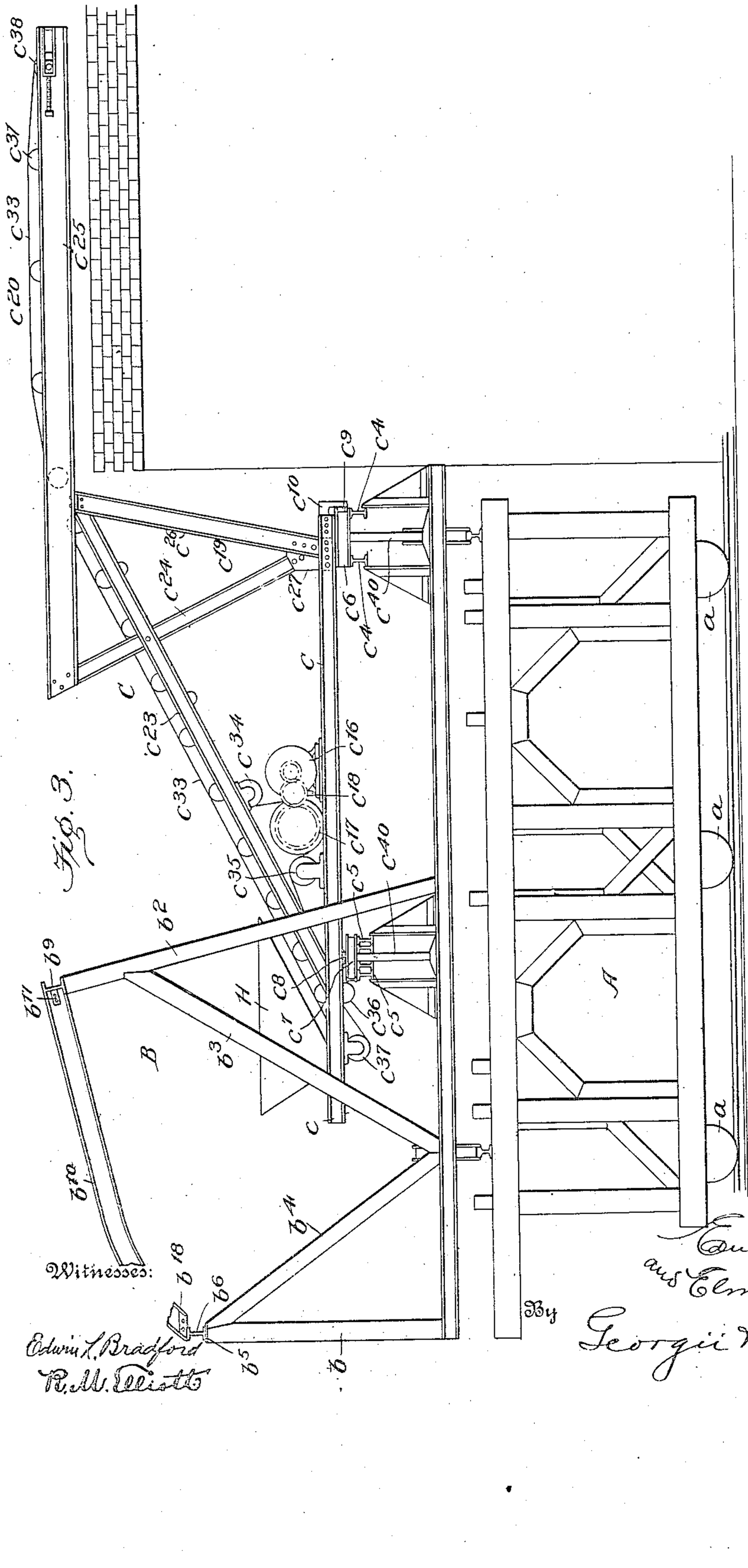


Fig. 3.

Witnesses:

Edwin L. Bradford

R. M. Elliott

Inventors,

Edward G. Williams

and Elmer H. Brown

By Georgii Massie

Attorneys.

No. 829,903. PATENTED AUG. 28, 1906.

E. G. WILLIAMS & E. H. BROWN.

MACHINE FOR HANDLING MATERIAL FOR TUNNEL ARCH CONSTRUCTION.

APPLICATION FILED APR. 3, 1906.

4 SHEETS—SHEET 4.

Fig. 5.

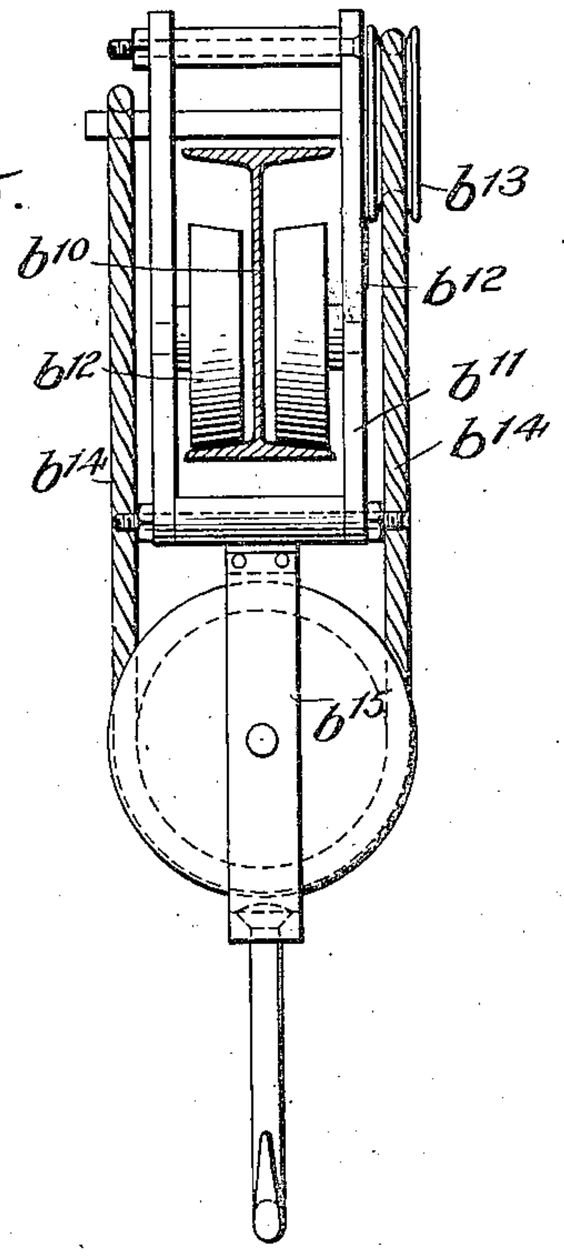
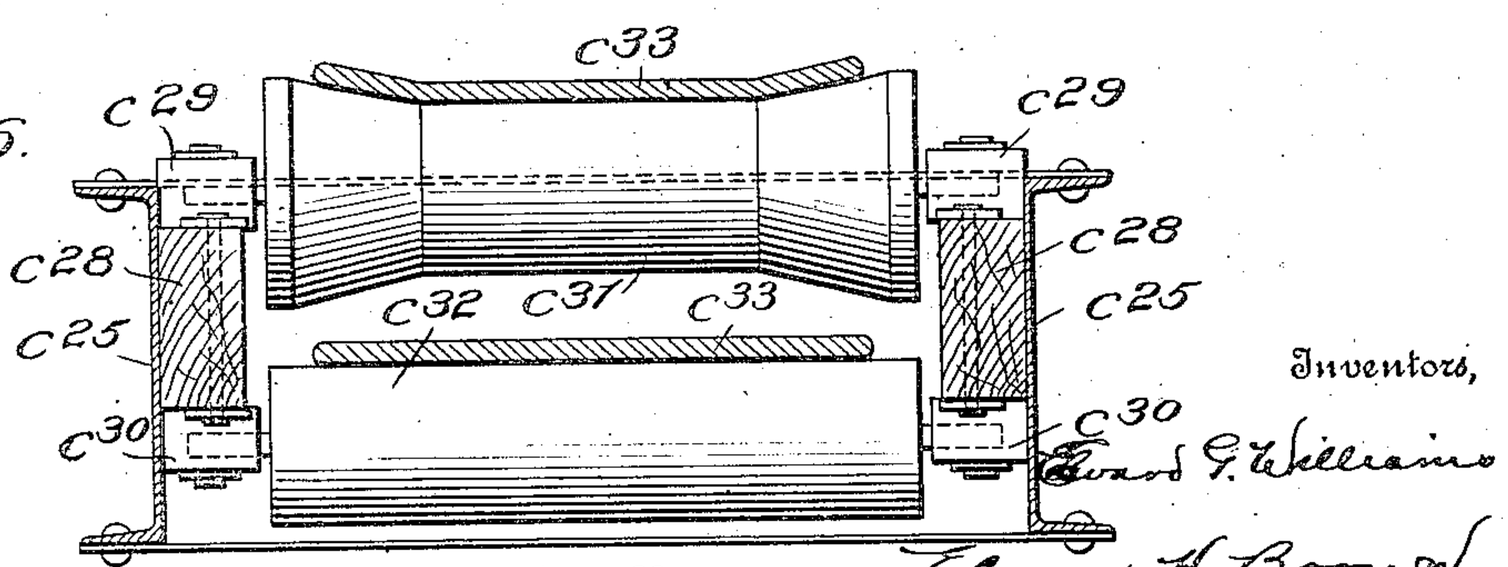


Fig. 4.

Fig. 6.



Witnesses:

Edwin L. Bradford

R. M. Elliott

Inventors,

Edward G. Williams

Elmer H. Brown

By Georgii Massie

Attorneys.

UNITED STATES PATENT OFFICE.

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

MACHINE FOR HANDLING MATERIAL FOR TUNNEL-ARCH CONSTRUCTION.

No. 829,903. Specification of Letters Patent. Patented Aug. 28, 1906.

Application filed April 3, 1906. Serial No. 309,683.

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 a Machine for Handling Material for Tunnel-Arch Construction; 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.

This invention relates to tunnel construction.

In soft-ground tunnels, where the overlying material is supported temporarily by timbering before the permanent masonry is constructed, there is a comparatively small working space left between the completed permanent tunnel-arch and the temporary timbering to receive the backfill. The same is true in the construction of rock-tunnels, where timbering may or may not be necessary, but where some form of artificial lining is considered advisable and where it is necessary to fill the space existing between the exterior surface of the completed arch and the rock or timbering above.

Where the permanent arch has been constructed of any material selected—such as concrete, brick, stone, iron, or steel—it is necessary to fill the remaining space over the arch with whatever material has been selected for backfill, usually concrete, earth, broken stone, or gravel, or a combination of these, such as a haunch and crown filling of concrete directly over and around the arch with earth filling above. Owing to the fact that no feasible mechanical appliance has been constructed that would work effectively in this contracted space the filling has heretofore been handled by being passed upward and back into position by shoveling or by some similar laborious procedure.

To eliminate the above-named objectionable features in a tunnel construction and to expedite and to cheapen the work is the object of the present invention, and this object is secured by the provision of a novel and thoroughly practical form of apparatus that will in a rapid, continuous, and positive manner deliver the material to any point on the exterior surface or radius of a tunnel-arch irrespective of its width and inward beyond the face of the tunnel to any reasonable distance. In addition, where the tunnel-arch is built of concrete the same conditions described as to restricted space exist between the surfaces of the forms on which the arch is constructed and the timbering above, or in a rock-tunnel the natural rock surface above. Under these conditions—that is, with a concrete arch—the arch itself as well as the haunch filling and backfilling can be built in an expeditious and economical manner by the apparatus hereinafter described. Mechanisms for accomplishing these results are exhibited in the accompanying drawings, in which like characters of reference indicate corresponding parts, and in which—

Figure 1 is a view in side elevation exhibiting one embodiment of the invention. Fig. 2 is a plan view of the apparatus shown in Fig. 1 with certain of the parts omitted. Fig. 3 is a view in side elevation of a modified form of the invention. Fig. 4 is a view in end elevation of the apparatus shown in Fig. 3. Figs. 5 and 6 are detail views of portions of the apparatus. Fig. 7 is a view in plan of a portion of the substructure. Fig. 8 is a detail view, on an enlarged scale, of a portion of the mechanism as shown in Fig. 1.

Referring to the drawings, and to Figs. 1 and 2 thereof, A designates the tower or substructure of the apparatus, which may be of any preferred construction, and supports a deck preferably of the full width of the tunnel. The tower is mounted upon suitable wheels *a*, that travel on tracks a^2, disposed parallel with but outside of the tracks for the excavating and other mechanisms employed in constructing tunnels. The framework of the tower is of such height that the deck will be elevated a sufficient distance above the track-bed to permit all of the rolling-stock employed in removing the excavated material and supplying the building material freely to travel without interruption, so that each of the apparatuses may operate without in the least interfering with the others, and thus expedite and further the operations that are being carried on.

At the front portion of the deck is mounted a stationary hoisting apparatus, designated generally B, and at its rear portion is mounted a cantaliver swinging conveyer, designated generally C. The hoisting apparatus B embodies a framework consisting in this

instance of a pair of vertical end posts b, a pair of intermediate inclined posts b^2, and two pairs of oppositely-inclined braces b^3 and b^4, the lower ends of which are socketed in the deck. The upper ends of the braces b^3 are mortised into the posts b^2, while the upper ends of the braces b^4 bear against a cross-plate b^5, firmly bolted to the upper ends of the posts b and to which is secured an I-beam b^6. To hold the posts b and b^2 against yielding to any strain to which they may be subjected and which would tend to distort the frame tie-rods b^7 are employed that pass through the posts b^2, braces b^3, and web of the beam b^6, and are adjusted as to tension by terminal nuts b^8, that bear against the posts b^2 and web of the beam b^6.

The frame thus generally above described has been found thoroughly efficient in operation in resisting strains and withstanding hard usage; but, as will be obvious, other forms could readily be constructed that would serve equally well for the same purpose, and therefore it is to be understood that the invention is not to be limited to the particular arrangement herein shown and described.

Secured to and connecting the upper ends of the posts b^2 is an I-beam b^9, to an intermediate portion of which is bolted or otherwise secured the upper end of an inclined I-beam b^{10}, the lower end of which is downcurved and suitably secured to the beam b^6 adjacent to one of the braces b^4. The beam b^{10} constitutes a track for a trolley, comprising ahead b^{11}, two rollers b^{12}, and a sheave b^{13}. The rollers are disposed on opposite sides of the web of the beam b^{10} and are designed to travel on the upper faces of the under flanges thereof, as shown in Fig. 5. The sheave is disposed on one side of the head and is engaged by a hoisting-rope b^{14}, which has one end secured to the head on the side opposite the sheave and its other end connected with a suitable hoisting mechanism hereinafter described. The bend or loop of the rope is engaged by the sheave of a hook-block b^{15}, which is provided for the purpose of elevating the bucket b^{16}, that supplies the filling material, and is furnished with the usual dumping-door to be operated by hand. To limit the movements of the trolley relative to the beam b^{10}, stops b^{17} are provided at the terminals of the track with which the head engages at the limit of its forward and rearward movements. The track b^{10} is herein shown as laterally deflected or obliquely-disposed relatively to the longitudinal center line of the deck to clear overhead trolley-wires and also to permit the use of the hoisting or elevating apparatus with a two-track tunnel, as it will be seen that under these conditions the platform-car supporting the bucket will always be disposed close to one side of the tower, and thus in position to allow the hook-block to engage the bucket. If, however, the track were single and provided with sidings, there would be stretches in its length where the platform-car would be equally distanced from the sides of the tower, and the bucket could not, under such conditions, be lifted, unless the track b^{10} were straight, whence it will be seen that the obliquely-disposed track is necessary in tunnels employing double tracks. The track may, however, if preferred be disposed parallel with the longitudinal center line of the deck.

The object in having the lower end portion b^{18} of the track b^{10} downturned or curved, as more clearly shown in Fig. 1, is to prevent the trolley from moving backward when draft is first applied to the hoisting-rope b^{14}, which would cause the rope to assume an angular position, with the result that the bucket would contact with the deck-timbers, and thus interfere with the operation of the apparatus. When the bucket has reached the limit of its upward movement, it is attached by a workman to the trolley by means of a hook b^{19}, carried by a short section of chain secured to the trolley-head, and which is hooked into engagement with the bail of the bucket, so that when the latter has been moved to the position shown in dotted lines in Fig. 1 and is dumped upon the hoisting-drum being reversed to allow the bucket to resume its normal position the bucket will not drop into the material-receiving hopper H, which would otherwise result if the hook b^{19} were not provided.

The swinging conveyer C, which constitutes one of the essential features of this invention comprises in part a base consisting of a plurality of channel sill-beams c, that are connected and transversely braced at their forward and adjacent to their rear ends by trusses c^2 and c^3. Disposed beneath the sill-beams is series of transverse I-beams c^4 and c^5, that are suitably secured to the deck-timbers, and each series of the beams c^4 and c^5 carries curved I-beam tracks c^6 and c^7, respectively, the track c^6 being carried by the beams c^4 and the track c^7 by the beam c^5. The upper faces of the latter track are engaged by rollers c^8, carried by the sill-beams c, while the base-flanges of the former track are engaged by pairs of rollers c^9, carried by brackets c^{10}, rigid with the sill-beams c. The base is centered for swinging movement in a horizontal plane by a pin c^{11}, that is carried by the trusses c^3 and engages a bearing c^{12}, supported by the inner pair of transverse I-beams c^5, as clearly shown in Fig. 1.

Supported in any preferred manner upon the sill-beam c is an electric hoisting-engine consisting generally of an electric motor c^{13}, a drum c^{14}, and power-transmission gearing c^{15}; and a conveyer-belt-driving apparatus comprising generally an electric motor c^{16}, a drum c^{17}, and a power-transmission gearing c^{18}.

Owing to the contracted space which these mechanisms must necessarily occupy, it is preferred that they shall be electrically driven; but, as will be obvious, other forms of mechanisms may be employed, if preferable, and still be within the scope of the invention.

The conveyer-frame comprises an angularly disposed feed-section c^{19} and a horizontally-disposed discharge-section c^{20}, the frame members of which are connected and braced by cross-trusses c^{21} and brace-plates c^{22}, the frame members being rigid throughout their entire length and having permanent angular disposition relative to each other. The feed-section c^{19} is composed of two structural iron stringers or members c^{23}, the lower end portions of which are suitably secured to the sill-beams c and the upper portions to a pair of posts c^{26}. The discharge-section c^{20} is composed of two structural-iron stringers or members c^{25}, that are secured to and supported at their rear ends by the pair of posts c^{24} and intermediate of their ends by a second pair of posts c^{26}. The lower ends of the two pairs of posts are secured to foot-plates c^{27}, that are firmly bolted and riveted to the sill-beams c.

By the arrangement of the stringers and posts as described it will be seen that it constitutes a cantaliver-frame, and not only is the forward end of the feed-section of the conveyer-frame supported against downward yield, but that the discharge-section as a whole is braced both against lifting at its rear end and dropping at its forward end, so that its positive retention in a horizontal plane at all times is assured. This is a feature of the utmost importance, inasmuch as owing to the contracted space in which the apparatus works no overhead guys can be employed to support the forward end of the conveyer-frame, and as the downward pressure on the discharge-section is very great it is absolutely necessary that some efficient means be provided to counteract any tendency on the part of the frame to yield, and this is effectively secured by the arrangement of cantalivers shown.

In addition to the stringers c^{25} the discharge-section embodies two wooden reinforcing frame-pieces c^{28}, Fig. 6, that are bolted to the stringers and carry on their upper and lower edges journal-boxes c^{29} and c^{30}, the former of which support spool-shaped conveyer-belt guide-rollers c^{31} and the latter cylindrical conveyer-belt guide-rollers c^{32}. The stringers c^{23} carry similar journal-boxes and guide-rollers. These rollers are engaged by the endless conveyer-belt c^{33}, which is of the usual or any preferred construction and works on the upper surfaces of the two sets of guide-rollers, as clearly shown in Fig. 6. In addition to the guide-rollers the stringers carry a snub-roller c^{34}, while the sill-beams support two similar snub-rollers c^{35} and c^{36}, as shown in Fig. 1. The belt at its lower end passes around a pulley c^{37}, carried by the beams c, and at its upper end around a pulley c^{38}, having combined with it a tensioning device, (designated generally c^{39}.) It will be noted by reference to Fig. 1 that contrary to the usual practice the conveyer-belt is driven at a point some distance from its lower end, thus to afford more room for and protection to the driving mechanism.

The hopper H, that receives the concrete from the bucket, is supported near the rear end of the base and discharges near the lower end of the conveyer-belt and is provided with the usual hinged bottom to be operated by hand to discharge its contents. It will be noted by reference to Fig. 1 that the trolley will be stopped at a point on the track b^{10}, that will bring the bottom of the bucket directly over the hopper, so that accurate discharge of the contents of the former will be assured.

As will be seen with reference to Fig. 1 the conveyer-belt passes around the two sets of guide-rollers, thence over the snub-roller c^{34}, thence around the drum c^{17}, thence over the snub-rollers c^{35} and c^{36}, and thence around the roller c^{37}. The face of the drum is preferably covered by india-rubber to give it the maximum adhesion, and a coöperative relation between the belt and the drum is always secured by means of the tension device c^{39}.

The apparatus shown in Figs. 1 and 2 is adapted for work upon single tunnels of standard width; but where the apparatus is to be used in connection with a tunnel of double width it is essential that means be provided whereby the free end of the conveyer-frame may be permitted to traverse a desired arc without contact with the arch-timbers. Various mechanisms may be employed for this purpose, that shown in Fig. 3 being one arrangement that has been found efficient for the purpose and which consists in supporting the sill-beams upon jacks c^{40}, which by being operated in the usual manner will raise or lower the conveyer-frame any predetermined distance, and thus in a practical manner secure the object sought.

Where the apparatus is to be used in conjunction with a single tunnel containing four or more tracks, the arc that will necessarily have to be traversed by the conveyer-frame to deposit the filling will be so great that the material would be deposited at such distance from the rammers as to require extra shoveling, and to obviate this an additional tower or substructure D may be employed, as shown in Fig. 4, which will occupy a position alongside the tower upon which the mechanism is supported, and as soon as an effective area of the tunnel has been supplied with the filling the superstructure will be shifted from the first tower A to the supplemental tower D, and when the work has been completed by the apparatus on this tower the

superstructure is again reshifted to the first tower A, and so on. The second tower will be constructed in all particulars as the first tower, and also will be of a sufficient height between its deck and the track-bed to form a passage-way to permit the rolling-stock employed in the construction of the tunnel to pass thereunder.

It will be seen from the foregoing description that by the apparatus herein described provision is made for supplying backfilling or other material in a positive and expeditious manner to any part of an arch for adjusting the conveyer relatively to the radius of the arch, thus to permit of the filling or other material being supplied at the haunches and for adapting the apparatus for use in tunnels of any size.

As will be manifest, by mechanically feeding or delivering the backfilling or other material to the place where it is distributed a large number of employees heretofore necessary in wheeling the material in barrows will be dispensed with, thereby effecting a large saving in time, labor, and expense in the construction of tunnels.

Owing to the simplicity of the construction of the apparatus liability of derangement in use is reduced to a minimum, and, further, in case of damage repairs may readily and easily be effected, as all the parts may be constructed in standard sizes and be thus interchangeable.

What we claim is—

1. In a machine for handling material for tunnel-arch construction, a conveyer having its discharge end disposed in a substantially horizontal plane, a cantaliver as described for supporting the said end, and means for vertically adjusting the said end while maintaining it in such plane.

2. In a machine for handling material for tunnel-arch construction, a conveyer having its discharge end disposed in a substantially horizontal plane, a cantaliver as described for supporting the said end, means for vertically adjusting the said end while maintaining it in such plane, and means for supplying material to the conveyer.

3. In a machine for handling material for tunnel-arch construction, a conveyer having one end disposed in a substantially horizontal plane, a cantaliver as described for supporting the said end, and means for bodily adjusting the conveyer in a vertical plane and maintaining said end in a substantially horizontal plane.

4. In a machine for handling material for tunnel-arch construction, the combination with a substructure and a stationary hoisting-frame thereon, of a conveyer laterally swinging in a horizontal plane and having its lower end disposed beneath the said frame.

5. In a machine for handling material for tunnel-arch construction, the combination with a substructure, of a stationary hoisting-frame thereon, elevating mechanism supported by the frame, a laterally-swinging conveyer having its lower end disposed beneath the frame, and a hopper supported over the conveyer.

6. In a machine for handling material for tunnel-arch construction, the combination with a tunnel having the usual tracks, of a substructure bridging the tracks and forming a passage-way in conjunction therewith and supporting elevating mechanism.

7. The combination with a substantially horizontal conveyer arranged to discharge material between a tunnel-roof and centering, of means for adjusting the said conveyer vertically while maintaining it substantially horizontal.

8. A machine for handling material for tunnel-arch construction, embodying hoisting and conveying mechanisms and two relatively movable substructures upon which the said mechanisms are interchangeably supported.

9. In a machine for handling material for tunnel-arch construction, a conveyer having a horizontally-disposed rigid section and a cantaliver-support disposed beneath the section.

10. In a machine for handling material for tunnel-arch construction, a conveyer comprising inclined and horizontally-disposed sections, and a cantaliver-support disposed beneath the horizontal section.

11. In a machine for handling material for tunnel-arch construction, a swinging conveyer comprising inclined and horizontally-disposed sections, and a cantaliver-support disposed beneath the sections.

12. In a machine for handling material for tunnel-arch construction, a swinging conveyer comprising an inclined section, a horizontally-disposed section, and a cantaliver-support with which the two sections are rigidly connected.

13. In a machine for handling material for tunnel-arch construction, the combination with a tunnel having the usual tracks, of a substructure bridging the tracks and forming a passage-way in conjunction therewith and supporting elevating and conveying mechanisms.

14. In a machine for handling material for tunnel-arch construction, the combination with a tunnel provided with the usual tracks, of a supplemental track having its rails disposed outside of the first-named tracks, and a substructure, carrying hoisting and conveying mechanisms, running on the supplemental track and forming a passage-way to permit the travel of rolling-stock over the first-named tracks.

15. A machine for handling material for tunnel-arch construction embodying hoisting and conveying mechanisms, and two sub-

structures upon which the said mechanisms are interchangeably supported.

16. In a machine for handling material for tunnel-arch construction, the combination with a tunnel having the usual tracks, of a tower bridging the tracks and forming a passage-way in conjunction therewith, a conveyer mounted upon the tower and having a substantially horizontal portion arranged to discharge material between the tunnel-roof and centering, and means for elevating material from the tunnel-tracks to the conveyer.

17. A machine for handling material for tunnel-arch construction, embodying a substructure constituting a passage-way, a conveyer mounted upon the substructure and having a substantially horizontal portion arranged to discharge material between the tunnel-roof and centering, and means for elevating material from the tunnel-floor to the conveyer.

18. In a machine for handling material for tunnel-arch construction, the combination with a substructure arranged to provide a passage-way, of a conveyer mounted upon the substructure and arranged to discharge material between the tunnel-roof and centering.

19. In a machine for handling material for tunnel-arch construction, the combination with a substructure arranged to provide a passage-way, of a conveyer mounted upon the substructure and arranged to discharge material between the tunnel-roof and centering, and means for supplying material to the conveyer.

20. In a machine for handling material for tunnel-arch construction, the combination with a substructure arranged to provide a passage-way, of a conveyer mounted upon the substructure and having a substantially horizontal portion arranged to discharge material between the tunnel-roof and centering.

21. In a machine for handling material for tunnel-arch construction, the combination with a substructure arranged to provide a passage-way, of a conveyer mounted upon the substructure and having a substantially horizontal portion arranged to discharge material between the tunnel-roof and centering, and means for supplying material to the conveyer.

22. In a machine for handling material for tunnel-arch construction, the combination with a substructure arranged to provide a passage-way, of a conveyer movable upon the substructure and arranged to discharge material between the tunnel-roof and centering.

23. In a machine for handling material for tunnel-arch construction, the combination with a substructure arranged to provide a passage-way, of a conveyer movable upon the substructure and arranged to discharge material between the tunnel-roof and centering, and means for supplying material to the conveyer.

In testimony whereof we affix our signatures to this specification in the presence of two witnesses.

EDWARD G. WILLIAMS.
ELMER H. BROWN.

Witnesses:
HENRY E. TRIPP,
C. E. WORTHINGTON.