(No Model.)

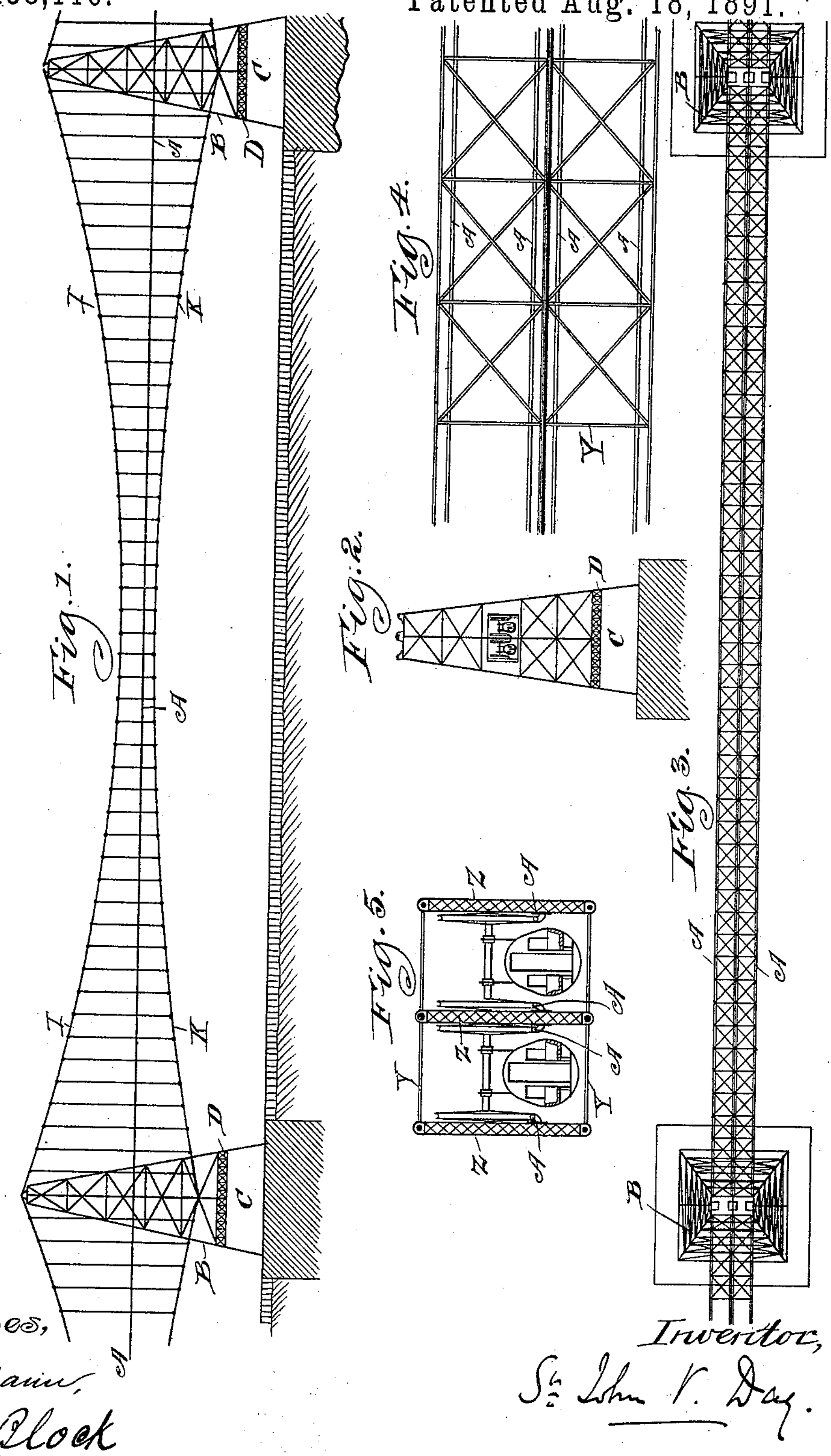
5 Sheets—Sheet 1.

ST. JOHN V. DAY.

ELEVATED RAILWAY PLANT.

No. 458,116.

Patented Aug. 18, 1891.



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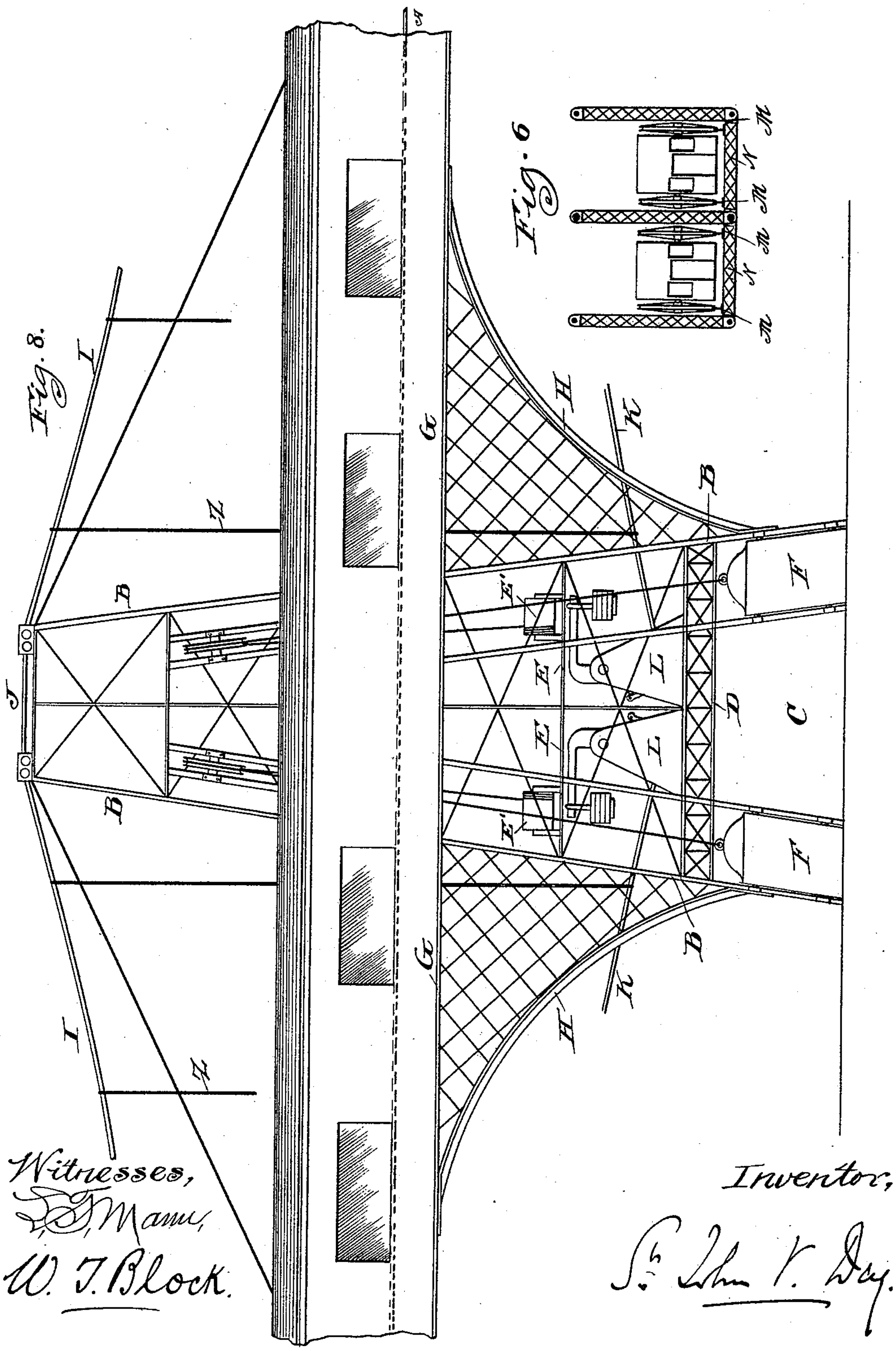
(No Model.) 5 Sheets—Sheet 2.

ST. JOHN V. DAY.

ELEVATED RAILWAY PLANT.

No. 458,116. Patented Aug. 18, 1891.



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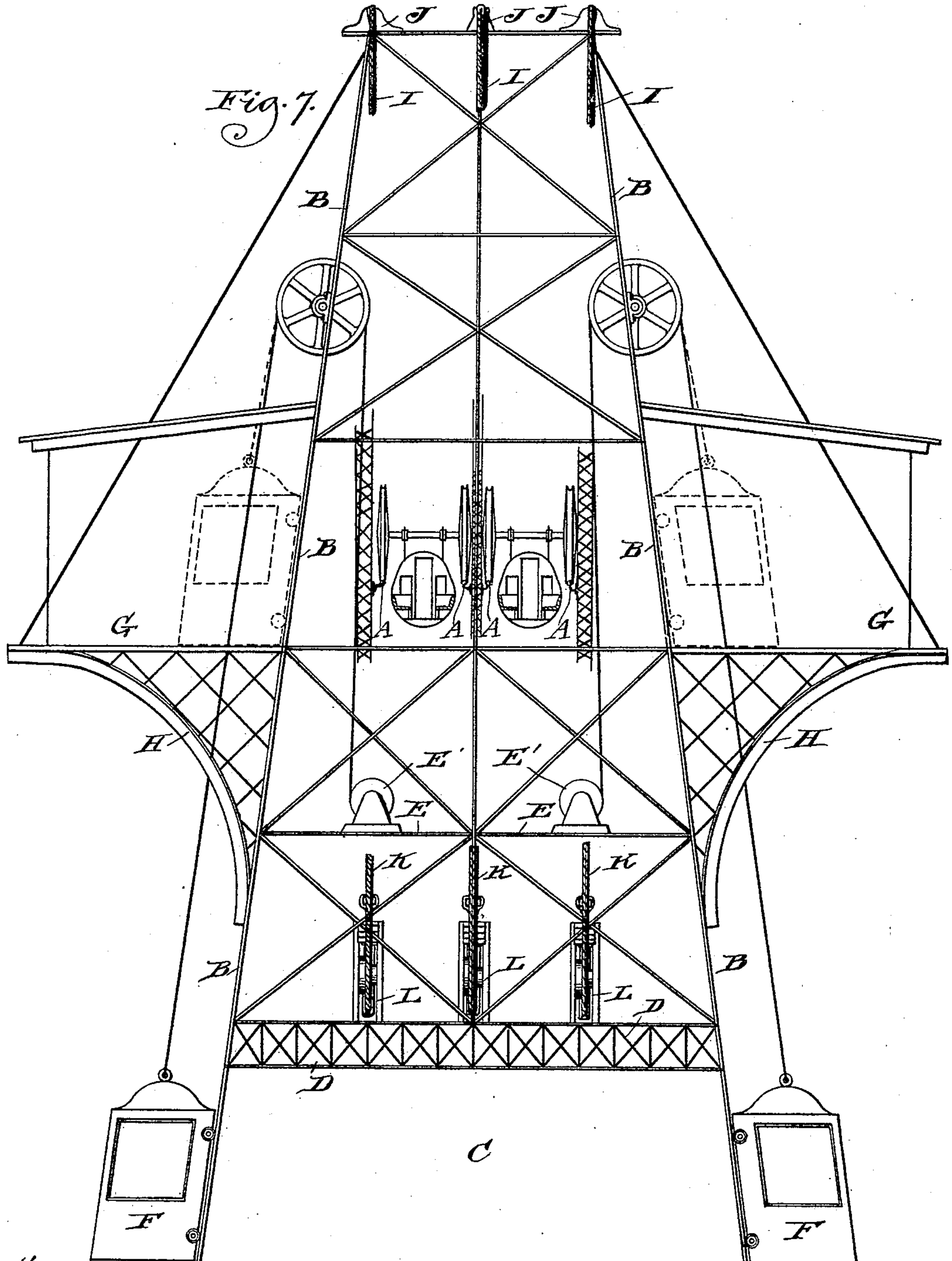
(No Model.) 5 Sheets—Sheet 3.

ST. JOHN V. DAY.

ELEVATED RAILWAY PLANT.

No. 458,116. Patented Aug. 18, 1891.

Fig. 7.



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ST. JOHN V. DAY.

ELEVATED RAILWAY PLANT.

No. 458,116. Patented Aug. 18, 1891.

Fig. 8'

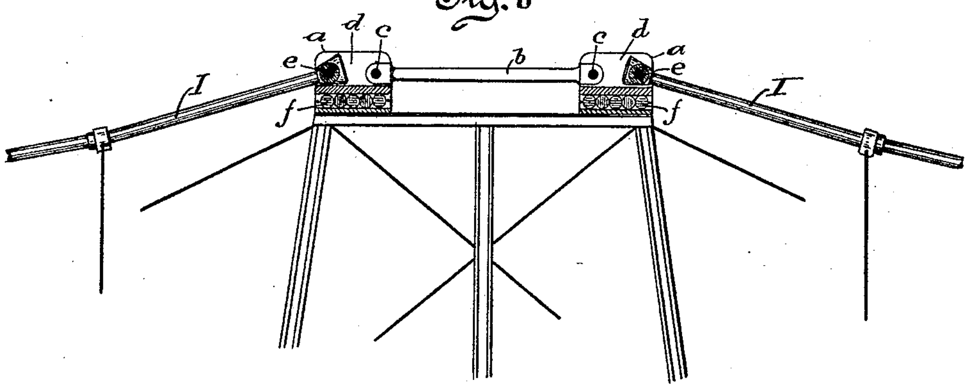


Fig. 8"

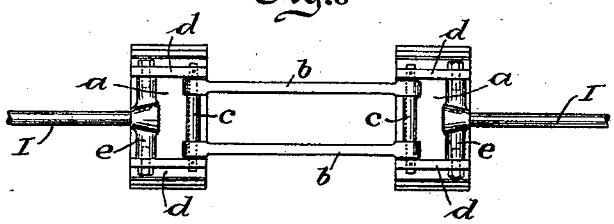
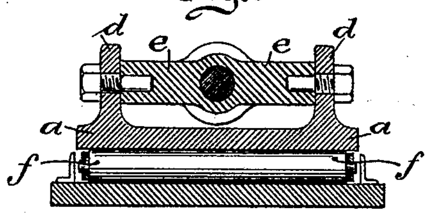


Fig. 8'''



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(No Model.) 5 Sheets—Sheet 5.

ST. JOHN V. DAY.

ELEVATED RAILWAY PLANT.

No. 458,116. Patented Aug. 18, 1891.

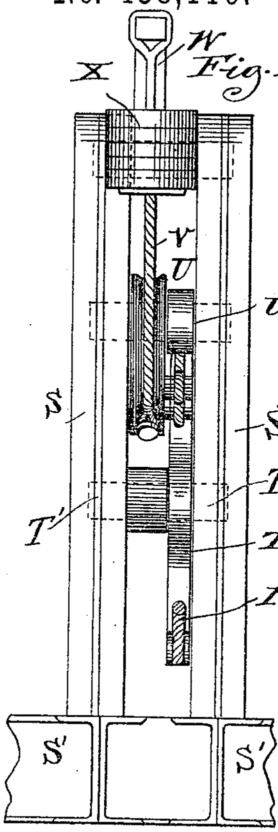

Fig. 14.

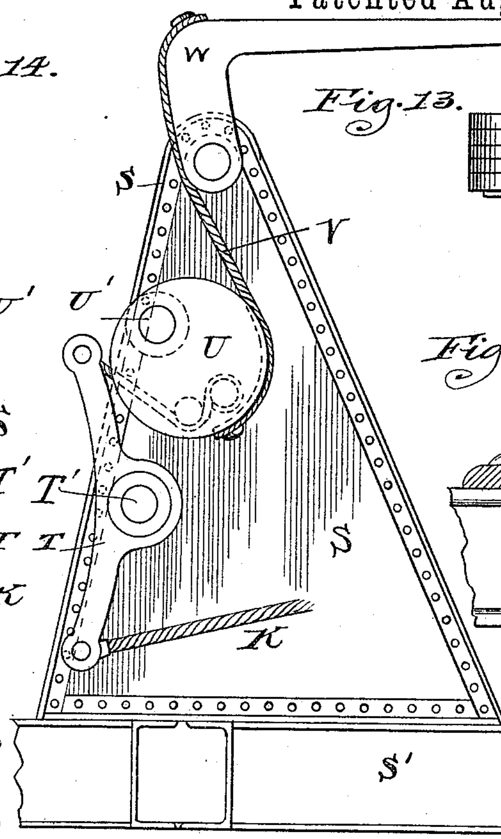

Fig. 13.

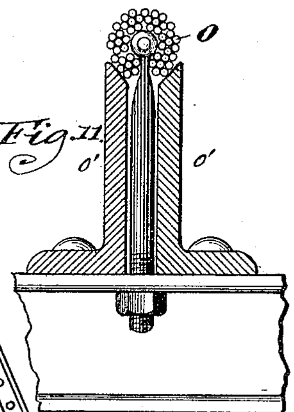

Fig. 11.

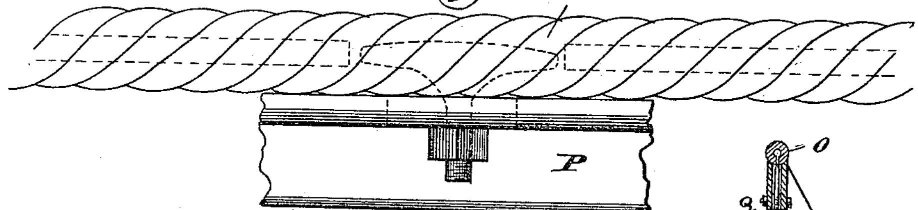

Fig. 9.

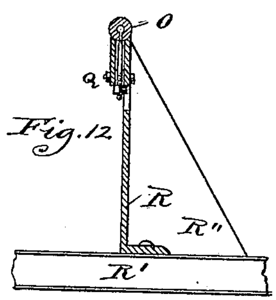

Fig. 12.

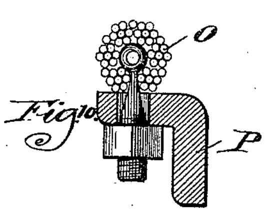

Fig. 10.

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UNITED STATES PATENT OFFICE.

ST. JOHN V. DAY, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE DAY ELEVATED RAILWAY PLANT COMPANY, OF SAME PLACE.

ELEVATED-RAILWAY PLANT.

SPECIFICATION forming part of Letters Patent No. 458,116, dated August 18, 1891.

Application filed December 13, 1890. Serial No. 374,626. (No model.)

To all whom it may concern:

Be it known that I, ST. JOHN VINCENT DAY, of Devonshire, England, but now residing in Chicago, Illinois, have made a new and useful Improvement in Elevated-Railway Plants, of which the following is a clear, full, and exact description.

My improvement relates to that class of elevated-railway plants wherein the structure which carries the rails consists partly of an upper and under cable connected together with vertical ties, the upper cable being curved downward in a catenary, parabola, or other suitable curved form, while the under cable is curved upward, but under my improvement to a much less extent than the upper cable is curved downward. For example, the versed sine of the curve of the lower cable may very conveniently be about one-half of the length of the versed sine of the curve of the upper cable. This feature of constructing an elevated railway of the kind under consideration has the advantage of lowering the level of the rails much nearer to the surface of the street or other part of the earth's surface over which the line is carried. When a tensile stress is applied to the ends of these curved cables, that stress is communicated to the vertical ties, by which they are connected together in a vertical plane, so that these ties are pulled tight vertically by the tension upon each differentially-curved cable, so that the structure becomes braced throughout.

In elevated railways of this class as hitherto devised it has been proposed to keep the two parallel bays of the braced cable structure, which carries the rail-cables between them, disconnected, saving at the top of the piers or columns which constitute the support of the ends of each bay, and to have the two rail-cables wholly disconnected transversely, whereby the cars are allowed to be suspended upon and between the rail-cables and that below the axles of the wheels which roll upon the said rail-cables without any other support, saving that due to the retention of the cables in gage between the supporting-brackets by the flanges of the wheels of the train when traveling upon them. I maintain the gage of the rails or rail-cables of elevated railways of the class referred to by cross-ties and without or with diagonal bracing beneath the rails or rail-cables, or both beneath as well as at the upper part of the vertical ties, and instead of carrying the rail-cables in brackets projecting laterally inward from the vertical ties, as hitherto, I carry these rail-cables on vertical supports attached directly to the lower cross-ties, or I dispense with cables as rails and substitute for them, in combination with my improved braced cable structure, girder-rails, which may be of sufficient depth in themselves to remain rigid under a rolling load between the points of support for them furnished by the bottom cross-ties, or they may be laid upon longitudinal girders between the cross-ties. The cross-ties are rigidly connected to the vertical ties. This arrangement permits of the use on elevated railways of the class referred to of passenger-cars and electric-motor cars or other locomotive-engines having their carrying as well as driving wheels either above or below the cars, and while strictly maintaining the gage of the rail-cables or rails at all times independently of the flanges of the wheels of the engine and cars composing a train, these ties, with or without diagonal bracing, constitute an open bottom to the structure, which does not impede the light or offer serious resistance to the wind, besides which it has the further advantage in the event of the derailment of a train of preventing the train from falling, as hitherto, between the cable-rails into a street or other part of the earth's surface over or upon which such an elevated railway is erected.

In the case of street-railways constructed according to the improved elevated system herein referred to I utilize some of the towers or piers which become necessary to carry the braced cables at the requisite height above the street to partly constitute and wholly support the platforms with offices and waiting-rooms and all other equipment generally comprised in a road-side station of an elevated railway. This I effect by cantalevers projecting out from opposite sides of the tower in the direction of their length and with shorter cantalevers projecting outward in the direction of their width, so as to provide a floor or platform area of the requisite length and width at or about the level of the rails. I also combine in these towers or piers, which contain or carry a railway-station, one, two, or more passenger-elevators for enabling passengers to be transferred with ease and rapidity from the street to the platform, or vice versa.

In braced cable structures for carrying elevated railways as hitherto devised it has been proposed to make both the upper and lower cables, which constitute several bays, continuous over the length of a number of such bays, each cable being fixed at one end and stretched taut by weighted levers at the other. According to my improvement I make one of these cables, either the upper or lower cable, continuous over several bays and the other discontinuous—that is to say, composed of short portions, each equal to a bay in the chord of its curved length, and having either one end of each portion rigidly fastened to a pier, while the other end is fastened to a compensating lever-tension device, or both ends of each such shorter portions of cable may be connected to such tension devices, or the discontinuous cables may have both ends attached rigidly to adjacent pairs, in either of which cases the bracing of the structure is effected by the weighting or production of tension on one of the cables only of each series of pairs of bays, and which may be either the upper or the lower cable, as aforesaid. It is, however, preferable to make the upper cable continuous instead of the lower cable, and for this reason that the horizontal component of the forces acting upon the piers by the discontinuous cable is in that case exerted upon them with a much less length of leverage than happens when the discontinuous cable is placed at the upper part of the piers, for in this position the horizontal component acts upon a lever whose length is that of the entire height of the pier or tower, thereby necessitating a much heavier and stiffer tower or pier to resist the stress of the horizontal component.

My improvement also includes a compound lever-tension device for drawing the cables taut, by which I dispense with the great length of levers and much of the heavy weights hitherto proposed to be used.

In the drawings, the several parts of the improvement are of necessity shown more or less detached from each other. They nevertheless jointly form parts of a system and are operated together.

Figure 1 is a diagram representing in outline one entire span or bay and portions of two adjacent spans or bays of a braced cable elevated railway of the kind herein referred to, showing a portion of my improvement embodied therein. Fig. 2 is a transverse diagram or outline view of the same, showing an "up" and a "down" track. Fig. 3 is a plan. Fig. 4 is a plan of a portion of a span or bay on a larger scale, showing the cross-ties y and bracing connecting the bays together transversely. Fig. 5 is a cross-section at or near to the center of a span or bay, showing lattice-work vertical ties z, also cross-ties at bottom and top of the structure. Fig. 6 is a transverse section of a portion of the elevated railway near the center of the span, showing transverse ties y with cross-beams and bracing at the bottom only with the vertical ties z of open-lattice structure. Fig. 7 is a transverse view of one of the towers or piers on a larger scale, showing the arrangement thereof when utilized as a station on a line of elevated railway of the kind referred to. Fig. 8 is a side elevation, partly in diagram or outline and on a less scale than Fig. 7, of one of the towers or piers arranged as a combined tower or pier and station with elevators, saddles, and tension devices for imparting the necessary tensile stresses to the structure. It is here explained that the towers or piers which carry the braced structure between stations are of similar construction to those shown at Figs. 1, 2, 3, 7, and 8, excepting that the portions which carry the platforms and their equipment, also the elevators, as hereinafter described, are dispensed with. Fig. 8′ is an enlarged view of the upper part of a pier, showing the construction of the saddles and their connections, partly in section. Fig. 8″ is a plan of Fig. 8. Fig. 8‴ is an enlarged transverse section of one of the end blocks of the saddle, showing the rollers and cable connections thereto. Fig. 9 is a side elevation of a rail-cable, showing the means of attaching it to the side brackets of elevated railways of the kind referred to or to such brackets which may be carried vertically upon the cross-beams at the bottom of the structure. Fig. 10 is a transverse view of Fig. 9. Fig. 11 is a transverse section of a rail-cable, one of its T-headed fastenings, and the continuous or discontinuous support for the same. Fig. 12 is a similar section. Fig. 13 is a side elevation, and Fig. 14 an end elevation, of the compound compensating lever device for stretching the cables with the necessary degree of tensile stress and for maintaining them at all times at the necessary normal tensile stress.

The same letters of reference denote the same parts.

In Fig. 1 of the annexed drawings the curve of the under cable is shown of about half the height of the curve of the upper cable—that is to say, the versed sine of the curve of the lower cable is about one-half the length of the versed sine of the curve of the upper cable. The result of this arrangement is a general lowering of the total height of the structure, with a corresponding decrease in the weight or quantity of material utilized in it, while also it admits by heightening the towers or piers of giving a still larger versed sine to the upper or suspension cables, with a corresponding decrease of stress upon those upper cables as the depth of their curvature is increased.

In the annexed drawings, A A represent the cables or rails upon which the rolling-stock of the railway travels. The towers or piers B B are of open truss or braced lattice structure, so arranged that the upper and lower curved cable and the devices for imparting the necessary tension to them are held by and contained within the said towers or piers. The towers or piers are made with a wide opening C at the bottom of each side, the openings being of sufficient height and width as not to impede the pedestrian or vehicular traffic on the street or roadway, the entire railway structure being generally carried at such a height above the street or roadway that the only parts connected with the street or roadway are the lower parts or legs of the towers or piers B B. I prefer the legs of the towers B B to be four in number for each tower—that is, having a leg at each corner thereof. In the towers or piers B B and just above the lowest open space next the street a strong horizontal open framing D, composed of girders and cross-beams which tie the structure together, is also arranged to carry the devices for imparting the necessary tension to the rail-cables, as well as to the upper and lower curved cables, and either on that framing or upon a horizontal framing E, Figs. 7 and 8, is carried the mechanism for operating the drums E′ for raising or lowering the elevator-cars F from the street-level to the platform G, or vice versa.

I wish it understood that in the diagrams 7 and 8 I show merely one arrangement for operating the elevator-cars F, for it is obvious that these elevator-cars may be raised and lowered by any of the known devices for effecting that end. H H are the cantalevers attached to the towers or piers B B for carrying those parts of the platforms G which project lengthwise and laterally from the sides of the ends of the piers or towers B B.

At Figs. 7 and 8 the upper curved cables I are shown as having two of their adjacent ends attached to sliding saddles J. These may be fitted with rollers or rockers between the under side and the flat top of the piers or towers B B, as is well understood, so as to move slightly horizontally on the upper part of the towers or piers B B, accordingly as variation in temperature or small movements, due to varying stresses, are or may be imparted by changing positions of the live load. In practice, however, the entire structure in its normal state is so completely braced and the compensating weighting appliances are so arranged that there is practically but very little of sensible movement of the saddles, saving that due to changes in temperature.

The sliding saddle is shown in an enlarged scale at Figs. 8′, 8″, and 8‴. The saddle is composed of two end blocks *a*, which are connected together by ties *b*, having the pins *c* passing through the blocks *a* and ties *b*. Between the outer upward projection or flange *d* of each block *a* a yoke *e* is fastened, as shown, and the ends of the upper cable I are held thereto by their ends being enlarged to hold in corresponding holes in yokes *e*. The saddles rest on rollers *f*.

As shown more especially at Fig. 8, the connection of each portion of the upper cable with the saddles J practically makes the upper cable continuous and that from end to end of each section of bays over a flat-topped tower or pier and avoids circular sheaves, which destroy the cable, but are essential to any entirely continuous or unbroken cable when so used. At one end of each such section of bays the cable I is by preference anchored to the lower platform or leg of one of the towers B B, or it may be anchored to the ground, after the manner of anchoring the chain of a suspension-bridge, while at the other end the cable is attached to the loading compensating tension device, hereinafter described, or to other equivalent compensating tension device.

As shown at Figs. 7 and 8, the lower cables K are discontinuous—that is to say, there is no direct connection between any two adjacent lengths thereof; but each end is firmly attached to the compensating device for imparting the necessary tension, hereinafter described, and shown at Figs. 12 and 13. Several compensating tension devices of this kind are shown at L L, Figs. 7 and 8, as combined in the piers or towers B B; but I wish it to be understood that any other suitable compensating tension device may be utilized for this purpose; also that instead of attaching both ends of the lower cables to a compensating tension device one end only of each section of the under cable may be attached thereto in one pier or tower B, while the other end is rigidly attached to the next pier or tower B without any such tension device. When the lower cables are made continuous and the upper cables discontinuous, then the saddles J are inverted and placed in or upon the lower floors D D, in which case the tightening compensating tension devices L are located at the upper part of the towers or piers B B.

In Fig. 6 rigid rails M M are shown carried upon the cross-beams N N, and when so employed I usually place a lining of vulcanized caoutchouc or other non-conductor of sound and of sufficient elasticity between the cross-beams N N and the foot of the rigid rails.

When cable rails are used in elevated railways of the class herein referred to, I insert at suitable intervals **T**-shaped fastenings, such as O, Figs. 9 and 10. These I insert by partly untwisting the cable at the locations where it is desired to have a fastening, and I cut out a portion of the core of the cable for a length equal or about equal to the length of the head of the **T**-shaped piece. I then insert the **T**-shaped piece between two of the untwisted strands, so that its head occupies the space previously occupied by the portion of removed core. I then retwist the cable, so that the strands close together upon the T-shaped fastening and hold it firmly therein. The tail of the T-shaped fastening is provided with a screw and nut for tightening it either to a bracket P, Fig. 10, or, as I prefer, to give a continuous support to the rail-cable by two angle-irons, as shown at Fig. 11, in which latter case I make the tail of the T-shaped piece sufficiently long to fasten the rail-cable between the upper edges of the angle-irons o' o' in the manner there shown. The angle-irons shown in Fig. 11 may be of greater or less depth, accordingly as the rolling-stock which traverses upon the rail-cables is arranged with the carrying-wheels and axles either below or above the car-bodies. When the car wheels and axles are arranged above the car-bodies, the height of the angle-irons shown in Fig. 11 is preferably much increased, in which case the two angle-irons need not be continuous for their whole height, one only being made of the full requisite height, while the part which corresponds with the other angle-iron, Fig. 11, may be made of much less depth, as shown at Q, Fig. 12, and the web part R, in place of being solid metal, may be open lattice-work carried up from the cross-girders R′ of the braced structure and made rigid by gusset-pieces R″, uniting the web R with the cross-beams R′.

The cable-compensating tension device shown at Fig. 13 and 14 consists of a stout main framing S, which is firmly secured to the cross-beams S′, which are contained within and constitute part of the open framing D in the towers B B. In these Figs. 13 and 14 the end of a lower cable K is shown coupled to the lever T, which swings upon the pivot T′. The upper end of the lever T is connected to an eccentric U, as shown. The eccentric U is pivoted at U′, the pivot being carried in stout bearings in the framing S. The eccentric U is again coupled by a short piece of cable V to the lever W, upon which are carried the weights X. By means of this arrangement of compound lever compensating device not only is the great length of the lever W, which would otherwise be necessary, considerably shortened, but the weights X are correspondingly reduced, so that the entire apparatus for producing the necessary tension stress upon any or all of the cables is not only much more easily handled, but occupies a comparatively small space. The compensating device is also used for imparting the necessary tension to each of the rail-cables.

When constructing a double line of railway of the kind herein referred to with the up and down lines arranged side by side, I effect considerable economy by supporting the two central lines of rails from one overhead cable and straining it by one underneath cable, as shown at Figs. 6 and 7, in place of having two upper cables and two lower cables at the central part of the structure, as hitherto. In this case I make the upper and lower cables at the center of about twice the sectional area of the upper and lower cables at the outer side of the structure, and I dispense with a double set of vertical ties at the center, one set of such ties connecting the upper and lower central cables being sufficient.

I claim—

1. In an elevated-railway plant, the combination of the towers B B, the upper downwardly-curved cables I I, the lower upwardly-curved cables K K, the vertical ties z, and the cross-ties y, and bracing for connecting together the sides of the bays of the structure, substantially as shown and described.

2. In an elevated railway, the upper downwardly-curved cables I I, the lower upwardly-curved cables K K, the versed sine of the lower cables being less than the versed sine of the upper cables, as shown and described.

3. In an elevated-railway plant, the towers B B, the upper series of downwardly-curved cables I I, the lower series of upwardly-curved cables K K, the cables of one of said series being continuous and longitudinally movable upon their supports and the other made in separate sections extending between the towers and the vertical ties z, in combination, as shown and described.

4. In an elevated-railway plant, the towers B B, the upper downwardly-curved continuous cables I I and longitudinally movable upon their supports, the lower upwardly-curved cables K K being made in separate sections extending between the towers and the vertical ties z, in combination, as set forth.

5. In an elevated-railway plant, the towers B B, the sliding saddles J, supported in said towers, a series of upper downwardly-curved cables I I, made in sections extending between the towers, and a series of lower upwardly-curved cables, the cables of one of said series being connected with the sliding saddles and the cables of the other series being secured to the towers and the vertical ties z, in combination, as shown and described.

6. In an elevated-railway plant, the towers B B, the upper series of downwardly-curved cables I I, the lower series of upwardly-curved cables K K, the cables of one of said series being continuous and longitudinally movable in its support and the cables of the other series made on separate sections extending between the towers and connected with compensating tension devices, the vertical ties z, and the said compensating tension devices, in combination, as shown and described.

7. In the herein-described elevated-railway plant, the combination, with the cross-ties, of a support for the rail-cables consisting of the angle-iron o' o', as set forth.

8. In an elevated-railway plant, the combination of the cable rails, the T-shaped bolt

or fastening, and a seating or support for the cable rails, substantially as shown and described.

9. The herein-described compensating tension device, consisting of the lever T, the eccentric U, connected with lever T, and the weighted lever W, connected with the eccentric, constructed and arranged as shown and described.

In testimony whereof I affix my signature in the presence of two witnesses.

ST. JOHN V. DAY.

Witnesses:
WILLIARD T. BLOCK,
SIGURD DOE.