H. FRIEND.

BRIDGE CONSTRUCTION.

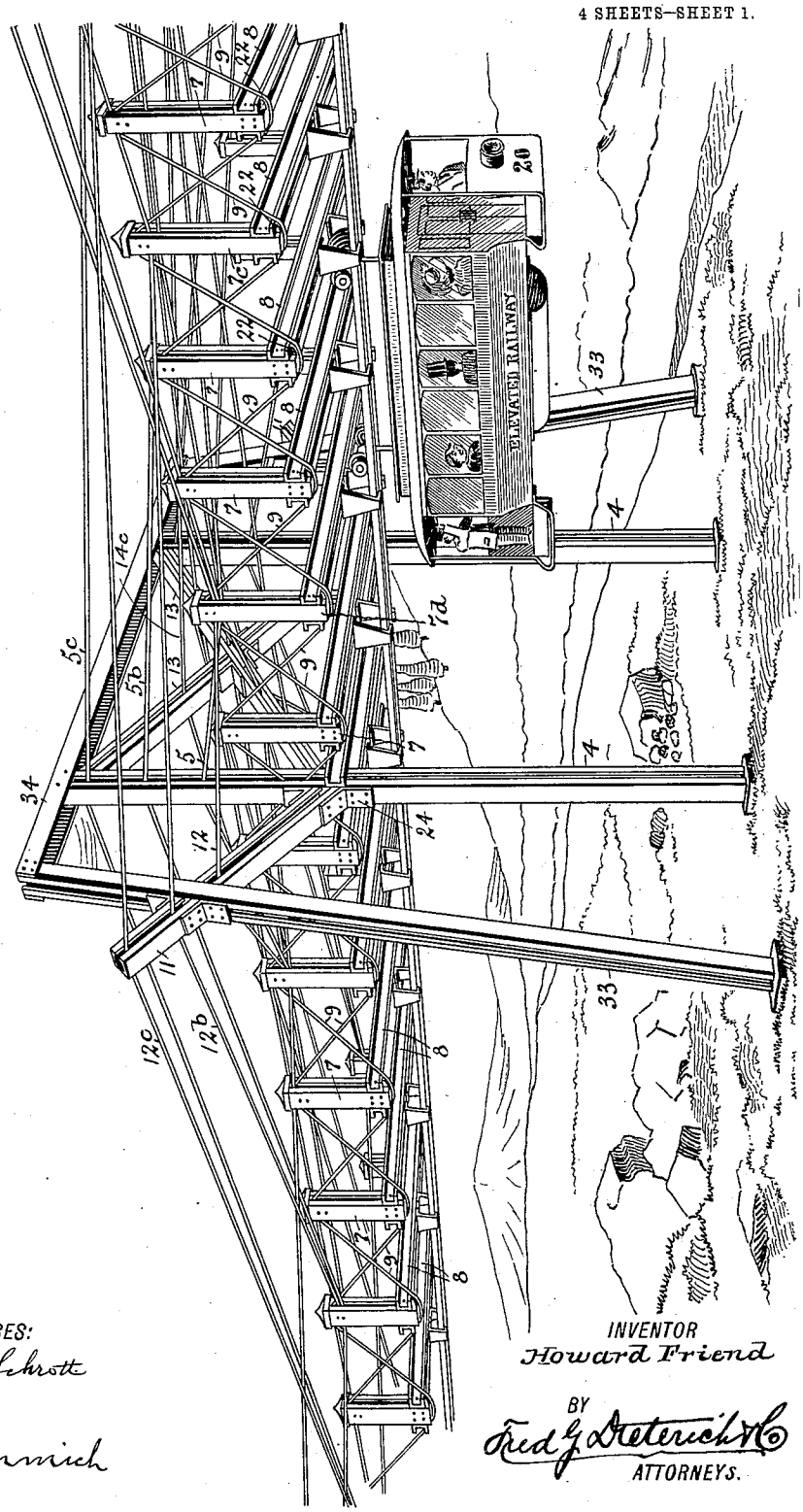
APPLICATION FILED MAY 19, 1909.

1,052,048.

Patented Feb. 4, 1913.

4 SHEETS—SHEET 1.

Fig. 1.



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4 SHEETS—SHEET 2.

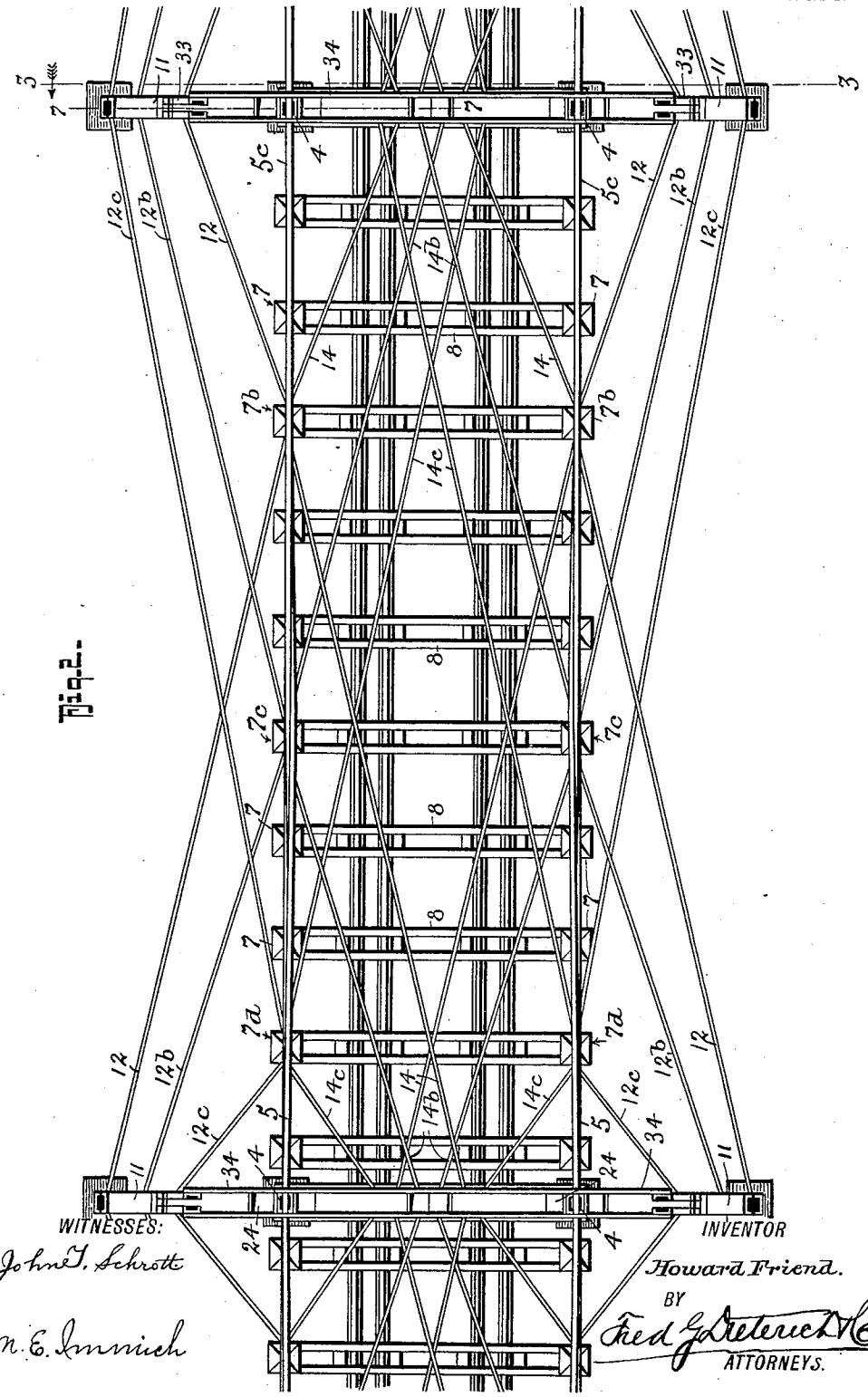

Fig. 2.

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4 SHEETS—SHEET 3.

Fig. 3.

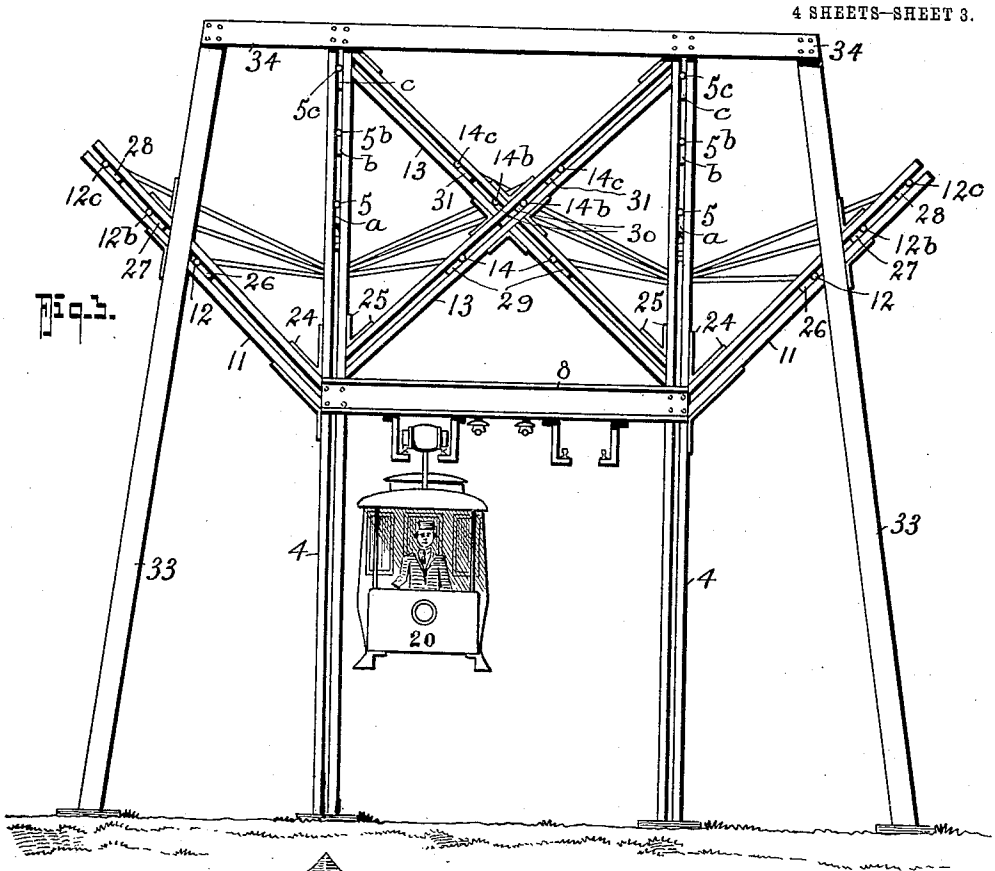
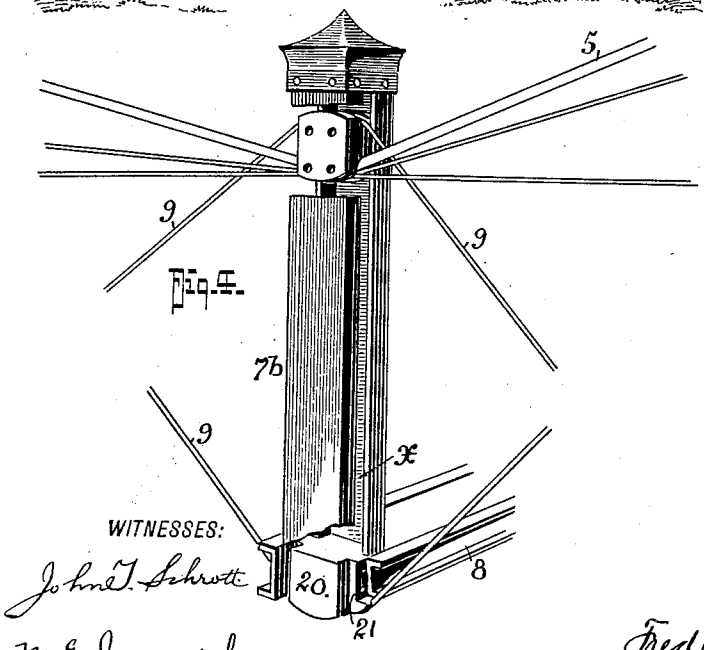


Fig. 4.



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4 SHEETS—SHEET 4.

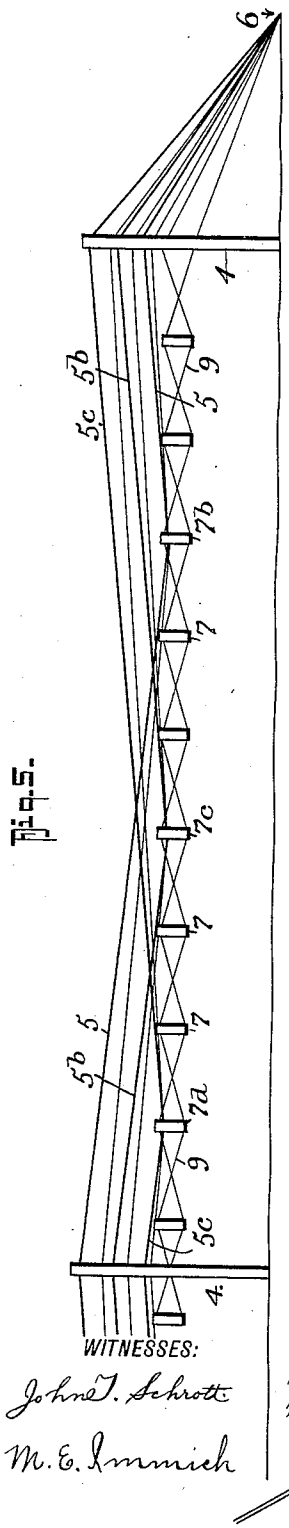

Fig. 5.

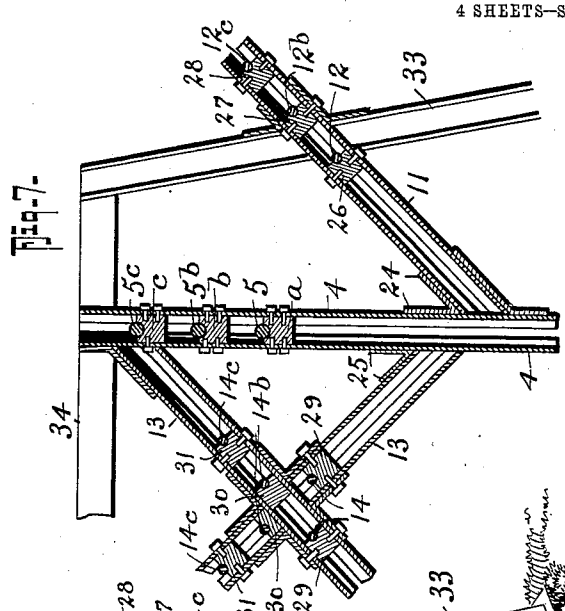

Fig. 7.

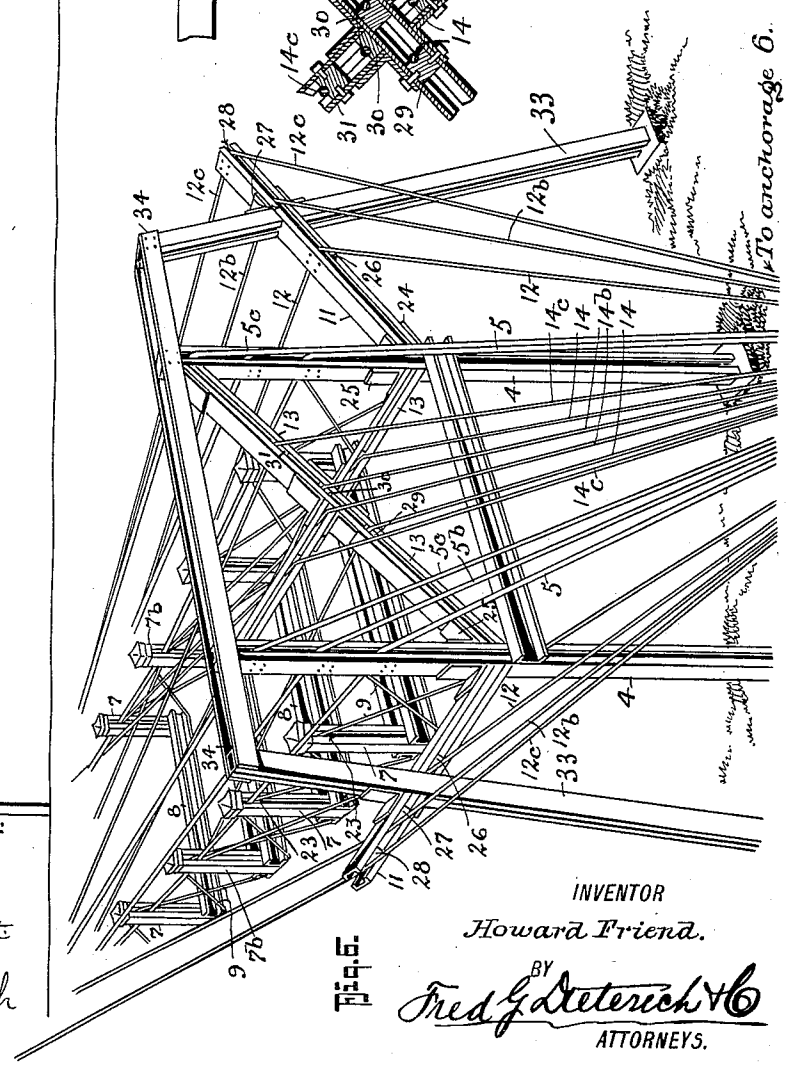

Fig. 6.

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BRIDGE CONSTRUCTION.

1,052,048. Specification of Letters Patent. Patented Feb. 4, 1913.

Application filed May 19, 1909. Serial No. 496,987.

To all whom it may concern:

Be it known that I, HOWARD FRIEND, residing at Lexington, in the county of Cleveland and State of Oklahoma, have invented a new and Improved Bridge Construction, of which the following is a specification.

My present invention comprehends certain improvements in the construction of suspension bridges, of that general type disclosed in my Patent No. 891417 dated June 23, 1908, and in my co-pending applications, Serial Numbers 458519 filed October 19, 1908 and No. 468552 filed December 21, 1908, while my said present improvements are more especially related to the construction of suspension bridges, in its generic nature, it embodies an improved truss structure adapted for supporting overhead or suspended car tracks, flumes for spanning long distances in bridging wide streams, deep gorges and the like, and in mountainous countries or points where snow blockades are frequent.

My present invention, which, in the general arrangement of the main and intermediate tower posts, the main and supplemental suspension cables and the arrangement of the saddle blocks mounted on the several posts, is similar to like named parts in my co-pending applications referred to, more specifically comprehends in connection with the parts above generally referred to, an improved system of bracing cables for reducing the lateral swaying of the bridge to the minimum, and the lateral or torsional strains incident in bridges of the general type referred to practically overcome, and in which the manner of applying the bracing cables allows them to also act as a suspension means that operates in harmony with the main and supplemental suspension cables and add strength and rigidity to the complete structure and at the same time, to a large extent, relieve the main suspension cables of the twist strains to which they are usually subjected.

With other objects in view, that will be hereinafter referred to, my present invention comprehends the peculiar construction and coöperative arrangement of the parts hereinafter fully described, specifically pointed out in the appended claims and illustrated in the drawings, in which:—

Figure 1, is a perspective view that illustrates a portion of a bridge construction that embodies my present invention. Fig. 2, is a top plan view that illustrates a span of a bridge constructed in accordance with my invention. Fig. 3 is a transverse section thereof, taken practically on the line 3—3 on Fig. 2. Fig. 4, is a perspective view of one of the intermediate tower posts, parts being broken away to the better show the arrangement of the fixed and slidable saddle blocks mounted thereon and the manner in which the suspension and bracing cables engage therewith. Fig. 5, is a diagrammatic side elevation of a single span bridge, and more especially illustrates the arrangement of the cables. Fig. 6, is a perspective view that illustrates one of the main or end towers, a portion of the roadway and arrangement of the suspension and bracing cables. Fig. 7, is a cross section thereof, taken on the line indicated by the line 7—7 on Fig. 2.

In the practical application and in the particular arrangement thereof as shown in the accompanying drawings, a pair of main tower posts 4—4 are located at each end of the span to be crossed, and which, like the similar structures disclosed in my co-pending applications are each formed of two channel irons that face each other but are separated sufficiently for the passage of cables therebetween and each of said towers carries saddle blocks hereinafter again referred to.

5, 5^b and 5^c designate the main suspension cables of which there is a set of three for each longitudinal pair of the end or main tower posts, and these, in the case of a single span structure, have their ends suitably anchored at a common point beyond each end of the bridge, as indicated by 6 on the drawings.

The main cables 5—5^b and 5^c pass over the saddle blocks *a*, *b* and *c* on the tower posts, as best shown in Fig. 7 from whence they pass to and are coöperatively joined with the intermediate posts 7^b, 7^c and 7^a, also formed of channel irons that face each other, are held spaced apart and joined to the intervening saddle blocks mounted thereon.

Combined with the main and the intermediate tower posts are a suitable number of common posts 7—7, the number of the several different types of posts used depending on the character of the space to be bridged, but when a single space of bridging is ample, said space preferably, as shown in this

application, consists of seven pairs of common posts 7, arranged between the three pairs of intermediate posts 7^b, 7^c and 7^d, and the two pairs of end tower posts 4, 4, and in the present arrangement of parts, the intermediate tower posts 7^b, 7^c and 7^d carry the vertically movable saddle blocks 20 to which the channel iron cross beams 8 are bolted to move vertically therewith, notice Fig. 4, from which it will be seen the blocks 20 have flanges 21 that ride in the slots x formed between the channel members of the posts. Cross beams 8—8 with their channel faces outermost are secured to the saddle blocks 22 that are fixedly secured in the lower ends of the common posts, as shown.

9—9 designate the supplemental suspension cables, which are arranged similar to, and perform the same function as the like cables disclosed in my other applications pending, the said cables forming the trussing cables and they pass under the fixedly held saddle blocks in the bottoms of the common posts, and the cross beams 8 attached thereto, and over the fixedly held saddle blocks 23—23 in the upper ends of the said common posts, the shore ends of the said cables 9 being suitably anchored.

The purpose of arranging the main and supplemental cables as shown and described, and combining them with the fixed and movable saddle blocks as stated is to allow for the equalization of contraction and expansion.

In my present invention, I have especially provided for increasing the capacity of the structure by preventing side sway of the complete span, *i. e.*, to prevent side swaying of all the parts of the span, from anchorage to anchorage.

Briefly stated, the means provided for preventing such side swaying and in consequence increasing the capacity and durability of the structure, consists in an improved arrangement of main and supplemental bracing cables, that are relatively so arranged with respect to the main and supplemental cables, and mounted in the several end towers in such manner that equalization of their contraction and expansion is provided for.

12, 12^b and 12^c designate the main bracing cables of my present bridge construction of which a set is used for each side of the bridge or span, the several sets being relatively arranged to pass inwardly from one set of end towers at one end of the bridge or span through predetermined ones of the intermediate towers at the corresponding sides and thence outwardly to and through the other set of end towers as will be understood by referring to the partial plan view, Fig. 2 of the drawings, the purpose of thus diagonally passing said bracing cables being later explained.

For sustaining the main bracing cables, posts 11—11 formed of channel irons, like the other posts are projected laterally and upwardly from the tower posts and at an angle of approximately forty-five degrees. Other like formed posts 13—13 are projected in parallelism with the posts 11—11 and diagonally across from one tower post 4 to its opposing or mate post 4 and the several posts 11 and 13 are grafted at the lower end to the tower posts 4—4 at points of about even height with the cross or floor beams 8, as best shown in Figs. 3, 6 and 7, by reference to which it will be seen that socket irons 24 and 25 are secured to the posts 4—4 to receive the lower ends of the posts 11 and 13, the said Fig. 7 of the drawings also clearly showing the location of three saddle blocks 26, 27 and 28 in the outside or lateral post 11 fixedly held therein, and similar sets of saddle blocks 29, 30 and 31 in the two crossed posts 13—13, the said view also showing clearly the three saddle blocks that are fixedly held in the post 4 for supporting the main cables 5—5^a and 5^b. The outer ends of the lateral posts 11—11 are grafted to supplemental brace posts 33—33 suitably anchored on shore in transverse alinement with the posts 4 4, their upper ends being bolted in a suitable manner to the ends of a cross head or beam 34 that connects the tops of the tower posts 4—4, said beam 34, as also the posts 33—33 being formed of channel irons as shown.

By referring again to Figs. 2, 6 and 7 of the drawings, it will be noticed that the main bracing cables 12 pass from their anchorage through the posts 11, over the saddle blocks 26—26 and from thence to the first of the intermediate tower posts, at their respective sides, see for example, 7^b, at the right of Fig. 2, the said cables passing under the same saddle blocks 23, that form the bearings for the main suspension cables 5, see Fig. 7. From the posts 7^b the bracing cables extend laterally and pass to and over the outermost saddle blocks 28, in the opposite ends of the next posts 11—11, as is clearly understood from Fig. 2 of the drawings, from whence the said bracing cables pass forwardly to the next adjacent ones 7^b of the intermediate posts referred to. Bracing cables 12^b—12^b at the opposite sides of the tower posts at one end, pass over their saddle blocks 27—27 and like cables 12—12 cross over to and pass through the posts 11—11 at the other end of the bridge, they first extending to and through the intermediate posts 7^c before they cross over, the cables 12^c 12^c being likewise arranged, they, however, passing through the last set of intermediate posts 7^d before crossing over, it being understood that the cables 12—12^b and 12^c that extend from the other end of the bridge likewise pass through the several

intermediate posts 7^a, 7^c and 7^b before they cross over to the post 11 at the near end of the bridge, as clearly disclosed by the drawings. Other sets of cables like the cables 12, 12^b and 12^c are provided, that are hereinafter termed secondary bracing cables to distinguish them from the other or primary bracing cables 12, 12^b and 12^c, and the said secondary cables are indicated by 14, 14^b and 14^c, and they also pass from the common anchorages 6—6 with the other cables. These cables 14, 14^b and 14^c are arranged for coöperating with the crossed or truss posts 13—13 which posts, it should be here stated also act as cross braces to prevent side sway of the two main tower posts 4—4. Cables 14, 14^b and 14^c from one end pass from their anchorage 6 through the cross post 13, over their respective saddle blocks 29, 30 and 31 and from thence under the saddle blocks in the tops of the intermediate tower posts 7^b, 7^c and 7^d (they having bearings on said blocks in common with the main suspension cables and the primary bracing cables, see Fig. 4) and from thence they cross over and pass through the alternate cross post 13 at the opposite end of the bridge, over the saddle blocks therein and from thence to anchorage, the cables 14, 14^b and 14^c that pass from the other anchorage to the near end of the bridge being likewise arranged and passed through their respective posts 7^b, 7^c and 7^d and from thence through the other post 13 to anchorage.

From the foregoing, taken in connection with the drawings the detailed arrangement and the construction of parts that constitute my improved bridge construction will be readily understood.

By reason of arranging the three sets of cables, the main suspension cables 5, 5^b and 5^c and the bracing cables 12, 12^b and 12^c and the other or opposing sets of bracing cables 14, 14^b and 14^c, a system of cables is provided that acts as a suspension means for supporting the intermediate and common posts between the tower or end posts in a substantial and compact manner, under economical costs of building, and by which practical provision is made for uniformly equalizing the contraction of the cables and the body structure, and throughout any length of span or spans that may be built. Furthermore, lateral swaying is reduced to a minimum and the lateral or torsional strains incident in bridges of this kind is reduced to the minimum, since the outside bracing cables 12, 12^b and 12^c are so disposed relatively to each other and so combined with the main or tower ends of the bridge and the intermediate tower posts that they also act as a suspension means jointly and uniformly with the main cables in addition to adding strength to the structure and distributing the lateral or swaying strain uniformly and also relieving the suspension cable of the twist strains to which they are usually subjected. The other bracing cables 14, 14^b and 14^c and their respective supporting posts 13 13 add still further strength to the complete structure and further aid in a proper and desired transmission of the strain uniformly to all of the cables that directly or indirectly act as suspension means.

Having thus described my invention, what I claim is:

1. A bridge span comprising a pair of oppositely disposed end towers including main tower posts, intermediate and common tower posts disposed between said end tower posts, a structure sustained by the several tower posts, a plurality of main suspension cables separately supported from the main tower posts and sustaining the intermediate tower posts, other suspension cables supported from the end tower posts that sustain the common tower posts and main bracing cables coöperatively connecting the main tower posts with some of the tower posts that are held between the end main tower posts, and supports for the said main bracing cables projecting laterally from the main tower posts.

2. A suspension bridge span that comprises a pair of oppositely disposed end main towers including main tower posts, a set of common tower posts and a set of intermediate tower posts held between said end towers, each set of common and intermediate tower posts comprising a pair of towers, and beams connecting the towers of the pair together, a structure supported by said beams, a plurality of main suspension cables supported from the end towers and engaging the intermediate tower posts to sustain the same, other suspension cables supported from the end towers and engaging the common tower posts to sustain the same, means for anchoring the several sets of cables, sets of main bracing cables, one set for each side of the bridge connecting the main tower posts with certain selected ones of the said tower posts that are held between the said end main tower posts, and supplemental bracing cables common to both sides of the bridge supported by the main tower posts.

3. In a suspension bridge of the character described, the combination with the end and the intermediate tower posts and the common tower posts, the said main tower posts each having a supplemental laterally projecting member, of a plurality of main suspension cables supported from the end tower posts that engage with and sustain the intermediate tower posts and other cables supported from the end tower posts that engage and sustain all of the intermediate tower

posts and the common posts and sets of main bracing cables, one set for each side of the bridge supported upon the laterally projecting members of the end tower posts and coöperatively connected with the several intermediate tower posts independently of the aforesaid suspension cables.

4. In a suspension bridge structure, end tower posts each having a laterally projecting supplemental member, intermediate tower posts and common tower posts, a plurality of main suspension cables supported from the end tower posts that connect with and sustain predetermined ones of the intermediate tower posts and other suspension cables supported from the end towers that connect with and sustain all of the intermediate tower posts and the common posts, and a main bracing cable for each side of the bridge structure that connects with predetermined ones of the intermediate tower posts and which are suspended from the laterally projected supplemental members of the end tower posts.

5. In a structure of the character described, the combination with the end towers including main tower posts, a set of intermediate towers including intermediate tower posts and a set of common towers including common tower posts, supplemental cables supported from the end tower posts for sustaining both sets of intermediate and common towers, vertically movable bearings in the lower ends of the intermediate tower posts under which the supplemental cables pass and engage; of saddle blocks fixedly held on the intermediate tower posts between the upper and lower ends thereof, saddle blocks fixedly held in the upper ends of the main tower posts, said fixedly held saddle blocks having a plurality of separate bearing seats, a plurality of main cables that engage the seats in the main tower blocks and pass under the fixedly held saddle blocks of the intermediate tower posts, means for anchoring the ends of all of the cables, and bracing cables connecting the main and intermediate tower posts independently of the aforementioned cables.

6. In a suspension bridge, end supporting towers and intermediate towers, suspension cables connected with the end towers that sustain the intermediate towers and brace them against vertical strains, auxiliary framing comprising arms that project laterally from the end towers and bracing cables supported on the said arms, said bracing cables sustaining the intermediate towers independently of the suspension cables, and adapted for bracing the said intermediate towers against lateral strains.

7. A suspension bridge including end supporting towers and intermediate towers and cables connected with said towers for supporting the intermediate towers and bracing same from vertical strains, combined with an auxiliary supporting framing coöperating with the end towers and cables connected with said auxiliary framing and said intermediate towers for bracing the structure against lateral strains, said last named cables comprising several distinct sets, one end of a set connected with the framing, between the tower posts at one end and with the framing at the other end of the structure at the outside of the tower posts at the respective end.

8. A suspension bridge including end supporting towers and intermediate towers and cables connected with said towers for supporting the intermediate towers and bracing same from vertical strains, combined with an auxiliary supporting framing coöperating with the end towers and cables connected with said auxiliary framing and said intermediate towers for bracing the structure against lateral strains, said last named cables comprising several distinct sets, one end of a set connected with the framing of one of the end towers and the other end of said set being connected with the framing of the other end tower outside of the tower posts, one set of said last named cables crossing another set, said sets of crossing cables being connected to said intermediate tower posts, substantially as shown and described.

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Witnesses:
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