Aug. 13, 1935. C. C. SUNDERLAND 2,011,168

SUSPENSION BRIDGE

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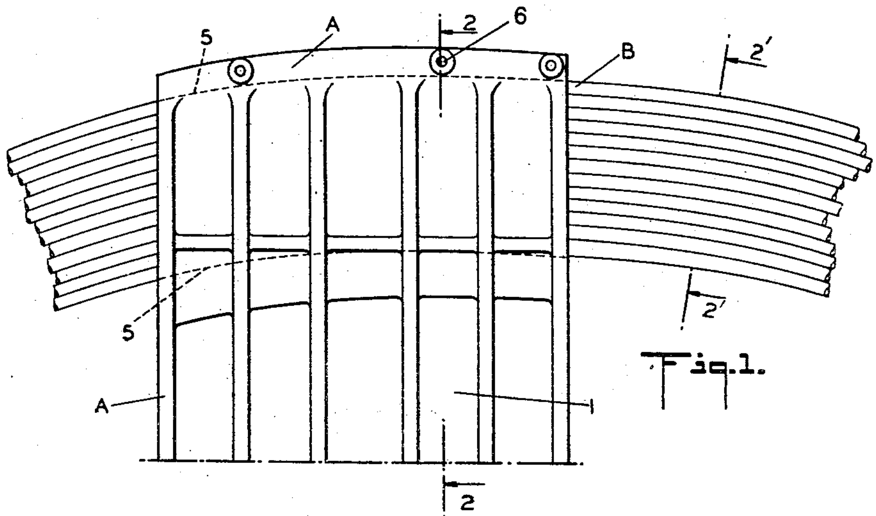

Fig. 1.

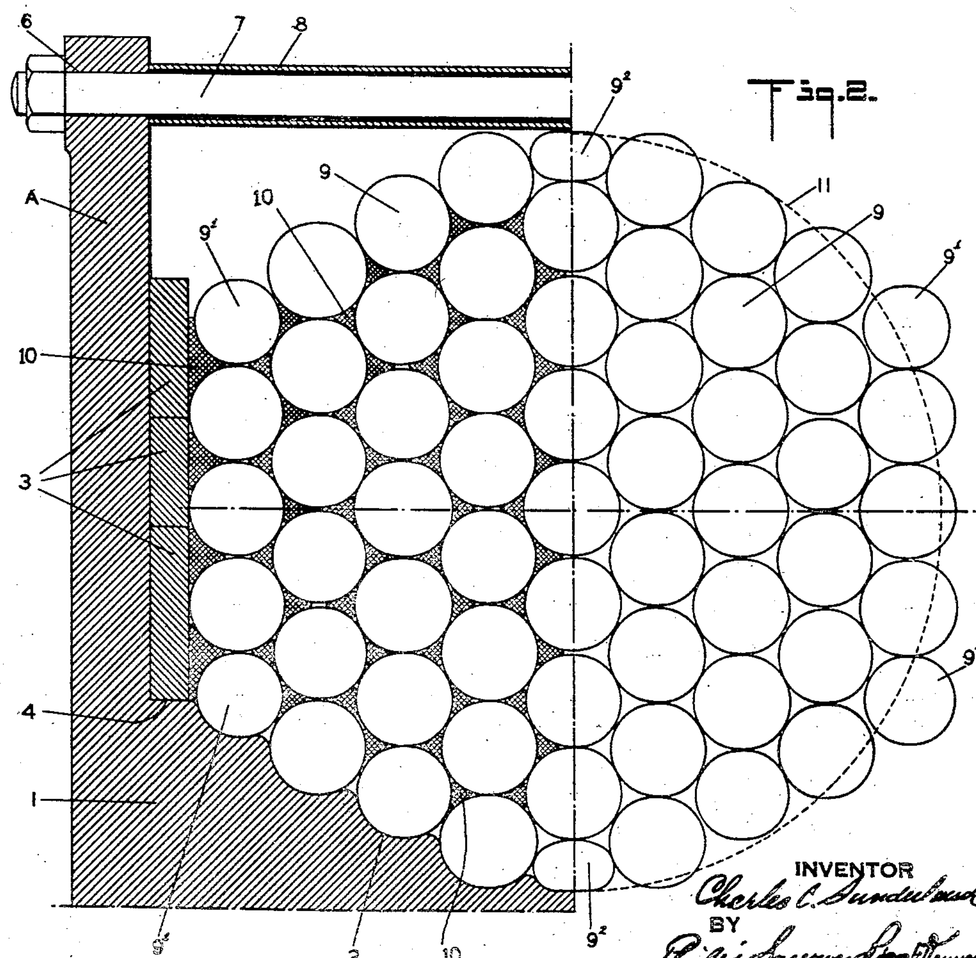

Fig. 2.

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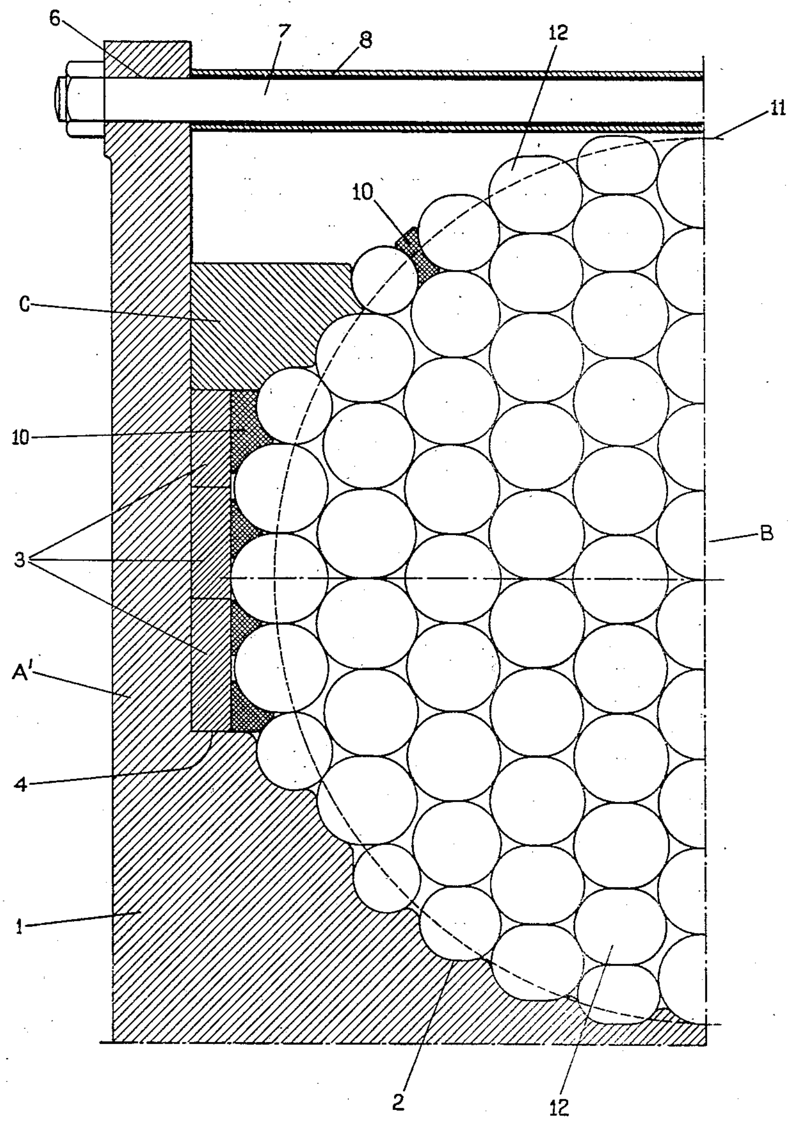
Fig. 3.



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SUSPENSION BRIDGE

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9 Claims. (Cl. 14—22)

This invention relates to improvements in suspension bridges, and more particularly to improvements in parallel-wire main cables of such bridges, in methods of constructing cables of such type, and in supporting saddles for such cables.

The invention as applied to a cable, hexagonal before compacting, consists in the arrangement of parallel strands so that the cable before compacting has straight vertical sides instead of the usual straight horizontal sides, and in saddles of special form adapted especially for the support of such a cable and in certain methods, features of construction and combinations, all as fully described and particularly claimed herein. In its broader aspect the invention may be employed with cables having various forms before compacting, the characteristic relation between the strands of the uncompacted cable being retained.

In the drawings:

Figure 1 is a schematic side elevation of a saddle and portion of an uncompacted main cable resting in it;

Figure 2 is a schematic composite cross section, the left half being taken on the line 2—2 of Figure 1 and the right half being taken on the line 2′—2′ of Figure 1, only half sections being shown because the saddle, uncompacted and compacted cable are symmetric about a longitudinal vertical central plane; and

Figure 3 is a section of an uncompacted cable in which the number and sizes of strands have been changed so that the cable no longer presents a hexagonal appearance, a half section only being shown because the cable is symmetrical in the same way as that of Figures 1 and 2.

The improved saddle A of the invention is shown in Figure 1 and the left half of Figure 2, and includes the saddle body 1 with side walls and base and having cable-bearing grooves 2, cable-bearing side blocks 3, and steps 4 which support the blocks 3. The grooves 2, blocks 3, and steps 4 are curved longitudinally of the saddle to conform to the cable arc indicated by the dotted lines 5 of Figure 1. The saddle A also includes bolt holes 6 and retaining bolts 7 encased in sheaths 8. The saddle may be mounted upon a supporting tower of a suspension bridge in the usual way.

The novelty of the saddle of the invention resides in the transverse arrangement of its cable bearing surfaces, grooves 2 and inner surfaces of blocks 3, which include vertical lateral bearing surfaces and sloped lower bearing surfaces. As is apparent from the drawings, the grooves 2 are approximately alined along two upwardly diverging lines to form two lower bearing surfaces sloped at about thirty degrees to the horizontal and the faces of the blocks 3 are vertical, with the result that the bearing surfaces as a whole approximate in cross section to four sides of a hexagon two of whose sides are vertical. As shown, the lower bearing surfaces formed by the grooves 2 are sloped at somewhat less than 30 degrees to the horizontal to accommodate a cable slumped slightly from hexagonal form, and the grooves are not perfectly alined because they are intended to accommodate a cable having strands of different sizes.

It will be observed that the improved saddle of the invention furnishes definite side support to a cable placed in it and consequently is well adapted to sustaining wind load and may be used without side supporting lugs to support the upper faces of the cable.

In constructing the improved cable B of the invention, parallel strands 9, 9^1 and 9^2 are placed over saddles A, each strand being anchored at its ends and forming end spans between anchorages and saddles and center spans between saddles. Each strand is composed of a great number of parallel wires bound together by removable or breakable seizings in the usual way, and is indicated only in outline because it does not differ in construction from strands heretofore employed. Fillers 10, preferably of zinc, are inserted in the interstices between strands and saddles and between portions of strands which lie in a saddle, the function of these fillers 10 being to maintain strands in desired position and to minimize slumping of the strands from circular to oval form, a condition which results from the tension on strands and weight of superincumbent strands. As weights, tensions and proportions are different in different cables, each particular cable must be analyzed to determine where fillers should be inserted.

The position of strands in the uncompacted cable is the same in the saddles and outside the saddles, sections on the lines 2—2 and 2′—2′ being substantially the same and typical of the whole uncompacted cable except where the strands diverge near an anchorage assembly.

The strands of the uncompacted cable are arranged in vertical rows of adjacent strands, strands of adjacent rows being staggered, and form a cable of roughly hexagonal cross section, two opposite sides and a major diameter of which are vertical, and a minor diameter of which is horizontal. By major diameter is meant a diameter passing through two opposite vertices and by minor diameter is meant a diameter perpendicular to two opposite sides, regardless of the length of the diameters. The cable thus has two vertical side faces and upper and lower faces inclined in cross section at about thirty degrees to the horizontal. The angle of inclination shown is about twenty-eight degrees, due to a slight slumping of the cable from hexagonal form, and lines bounding the faces of the cable in cross section are slightly curved instead of straight because of varied strand sizes and shapes. As both cable and bearing surfaces are curved longitudinally, the term "cross section" is used in the sense of "normal section"; the term "transversely" refers to the appearance in such normal section; angles of inclination are measured in the planes of normal sections; and "vertical diameter" is used to mean a normal diameter lying in a vertical longitudinal central plane.

After all strands are in place, the cable is compacted along its spans into as near as may be circular cross section by applying opposed pressures which compact the cable chiefly horizontally and is bound to retain it in compacted form; in and near the saddles the cable is not compacted and near the anchorage the cable is not compacted but splayed for anchoring the strands as usual. Strand seizings are removed before compacting or broken in compacting so that the form of component strands is lost and the compacted cable is composed of a great number of parallel wires closely packed together. The arc 11 indicates the form of the compacted cable in relation to the uncompacted cable at the same point, the compacted cable being shown only in outline because of the great number and close compaction of its component wires.

As will be observed, four corner strands 9^1 of the cable are of relatively small size, two corner strands 9^2 are of relatively small size and pronouncedly oval form, and the remainder of the strands 9, are of slightly varying sizes. The object of these variations in size and form is to aid in providing an uncompacted cable such that vertical wire movement during compacting will be minimized and the compacted cable will have substantially the same vertical diameter as the uncompacted cable. The vertical diameter which the compacted cable will have is computed from the number and size of component wires and the closeness of compacting possible. Vertical wire movement is minimized by providing as nearly as possible along each horizontal line through the uncompacted cable the same amount of material as will be found along that line in the compacted cable. No rule can be given for varying strand sizes and shapes to achieve these objects, but the desirable variations in any cable may be computed by methods well understood in the art.

Uncompacted main cables heretofore constructed have been of roughly hexagonal cross section, but the strands have been placed in horizontal rows of adjacent strands, so that the cross sectional hexagon of the cable has two opposite sides horizontal. This construction will be referred to for convenience as a "flat bottom cable" and the construction of the present invention as a "flat side cable". The flat bottom cable construction involves excessive vertical wire movement in compacting, as horizontal movement of a strand pushes it directly toward an adjacent strand. In compacting the flat side cable of the present invention a strand is pushed toward an interstice, not toward an adjacent strand, so that vertical wire movement is materially reduced. Analysis of the flat bottom cable of the prior art and of the flat side cable of this invention shows the less extent of vertical wire movement in compacting the latter when all strands are of the same size and shape, and further reveals that vertical wire movement may be reduced, by varying strand sizes, to a greater degree in the latter than in the former.

Among the many advantages of the invention over the prior art, are: vertical wire movement in compacting is minimized, resulting in greater ease in compacting and less tension within the finished cable and on its bindings; fillers may be inserted in any and all interstices within a saddle and a strand is supported at five points before the weight of another strand is placed upon it, resulting in less slumping of the strands; the uncompacted cable has the same vertical diameter as the compacted cable and its horizontal diameter is not determined by the width of a roll of adjacent strands in a slumped condition, resulting again in greater ease in compacting and a more nearly circular compacted cable having less undesirable tension; the compacted cable is more nearly of the same size as the uncompacted cable, so that splay castings may be applied more readily and nearer the saddles; strands are arranged in vertical rows and may be anchored in vertical rows without crossing one another as they diverge from a splay casting toward an anchorage, resulting in less abuse of the wires at such splay castings and permitting the strands to be laid in the splay casting immediately without use of temporary supports; strands may be positioned in the saddles with greater ease and the lifting straps or grommets used in positioning them removed more readily.

It will be understood that the invention may be practiced as disclosed, but employing, in place of separate wires in the cable strands, small strands made up of a plurality of wires laid up helically or parallel, and these small strands laid up parallel into the larger strands of the cable. The term wire herein, therefore, is intended to include such primary strands as well as individual wires. The polygonal form of the cable, also, may be varied from the hexagonal form shown, while retaining the invention defined by the claims not limited in terms to the hexagonal form.

The cable B of Figure 3 is composed of strands 12 similar to those of the cable of Figures 1 and 2 but differs from that cable in the sizes and number of its strands, which have been altered so that the uncompacted cable approximates more closely to a circular or twelve-sided form than to the hexagonal. The configuration of its sides is such that definite lateral support in the saddle cannot be provided for as great a distance and the upper outside strands may require side supports, such as the block C. However, many of the advantages already pointed out are present in this cable as the relation of its strands to one another is in many respects similar to that in the hexagonal form. It will be observed that the strands are arranged in vertical rows of adjacent strands, which furnishes a cable whose compacted and uncompacted vertical diameters are the same and which has the same advantages in anchorage arrangements as the hexagonal form. It will also be observed that since each strand is angularly related to adjacent strands in the same way as in the hexagonal cable the same advantages in compacting are present.

The method of construction will be readily understood as it involves merely the arrangement of the majority of strands, and in particular the interior strands, in vertical rows of adjacent strands, with strands of adjacent rows staggered so that internal groups of strands are arranged in small hexagons. The alterations in size and shape of the strands depend upon calculation of voids and excess material along various horizontal lines through the cable according to well understood methods and such calculation does not differ in principle from the similar calculations employed with hexagonal cables.

A saddle A' of a generally similar design to that of Figures 1 and 2 may be employed, the number and shape of the grooves 2 being altered to conform to the cable and similar side blocks 3 being employed. Side supporting lugs of the type hitherto employed with flat bottom hexagonal cables of the prior art may be used if the tensions on the outer strands, in view of their relation to one another, are such as to require such support for the upper part of the cable. Fillers 10 may be required in addition to those shown, the number and location depending upon the factors already discussed with reference to the embodiment of Figures 1 and 2.

What is claimed is:

1. In a suspension bridge, a parallel-strand cable formed of parallel-wire strands having an uncompacted multiple-strand portion of roughly hexagonal cross section, two of whose faces are vertical, in combination with a cable-bearing saddle supporting said portion and having vertical lateral bearing surfaces and transversely sloped lower bearing surfaces.

2. In a suspension bridge, a parallel-strand cable formed of parallel-wire strands having an uncompacted multiple-strand portion, with a vertically alined central row of adjacent strands, and a compacted portion of substantially circular cross section whose vertical diameter is substantially the same as that of said uncompacted portion.

3. In a suspension bridge, a parallel-strand cable formed of parallel-wire strands having an uncompacted multiple-strand portion, which comprises vertical rows of adjacent strands with strands of adjacent rows staggered, and a compacted portion of substantially circular cross section, whose vertical diameter is substantially the same as that of said uncompacted portion.

4. In a suspension bridge, a parallel-strand cable formed of parallel-wire strands having an uncompacted multiple-strand portion of roughly polygonal cross section, the strands of which are alined in rows of adjacent strands at approximately thirty, thirty, and ninety degrees to the horizontal.

5. In a suspension bridge, a parallel-strand cable formed of parallel-wire strands and having an uncompacted multiple-strand portion of roughly polygonal cross section, with a major diameter and two faces vertical, and a compacted portion of substantially circular cross section.

6. In a suspension bridge, a parallel-strand cable formed of parallel-wire strands having an uncompacted multiple-strand portion of roughly hexagonal cross section, two of whose faces are vertical, and a compacted portion of substantially circular cross-section.

7. In a suspension bridge, a parallel-strand cable formed of parallel-wire strands having an uncompacted portion of roughly hexagonal cross section, with two vertical faces and vertical rows of adjacent strands, and with the strands of adjacent rows staggered, and a compacted portion of substantially circular cross section.

8. A parallel-strand cable having a saddle portion formed of wire strands assembled in a hexagonal group with straight vertical sides, in combination with a saddle having bearing surfaces for said straight sides of the cable and for the base sloping sides of the cable, and fillers between the strands forming said straight sides and their saddle bearing surfaces and between the strands of the cable.

9. A parallel-strand cable having a saddle portion formed of wire strands assembled in a hexagonal group with straight vertical sides comprising round strands forming the main body of the cable, smaller round strands at the upper and lower corners of the hexagon, and strands at the top and bottom corners of the hexagon shaped to fill the spaces between the adjacent strands.

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