

Oct. 21, 1947.

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2,429,332

SUSPENSION BRIDGE

Filed Oct. 14, 1944

2 Sheets-Sheet 1

Fig. 1



Fig. 2

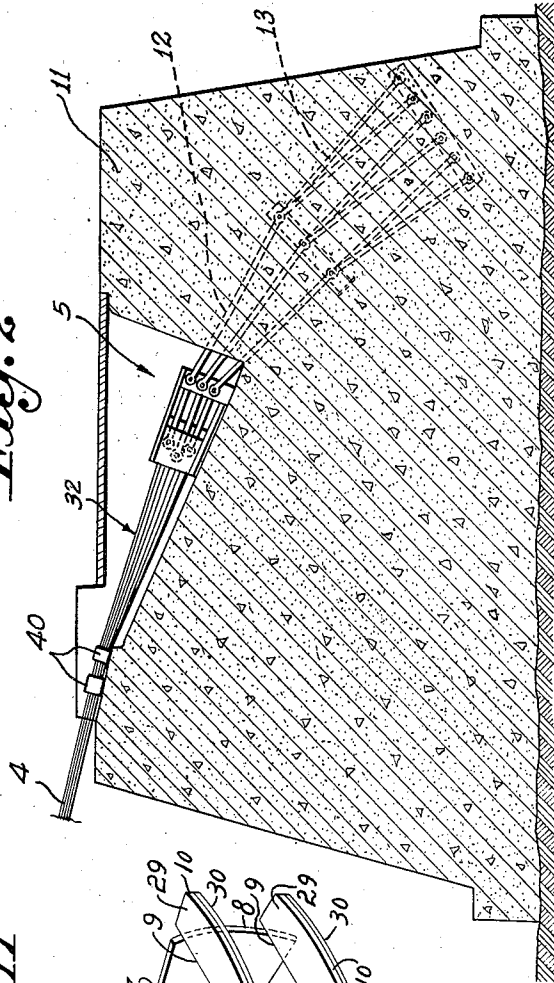
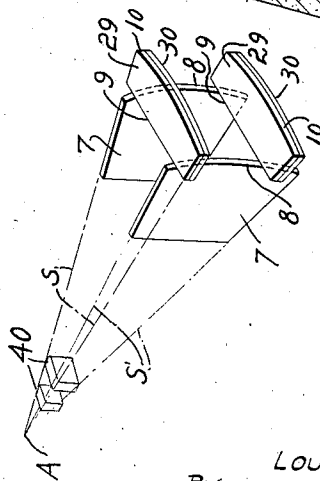


Fig. 11



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Fig. 3

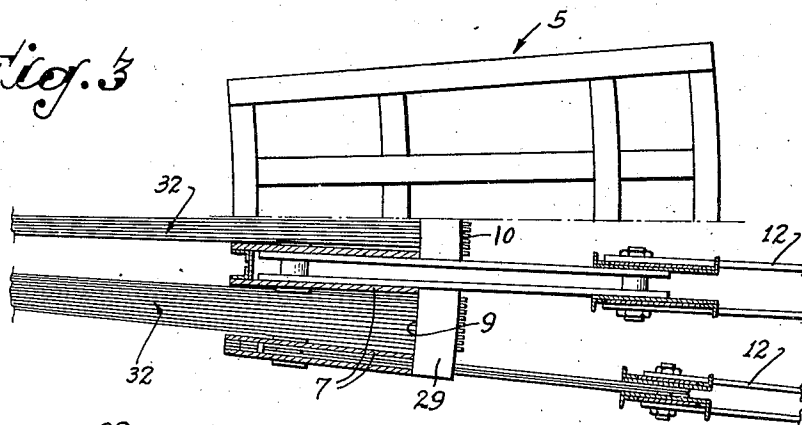


Fig. 4

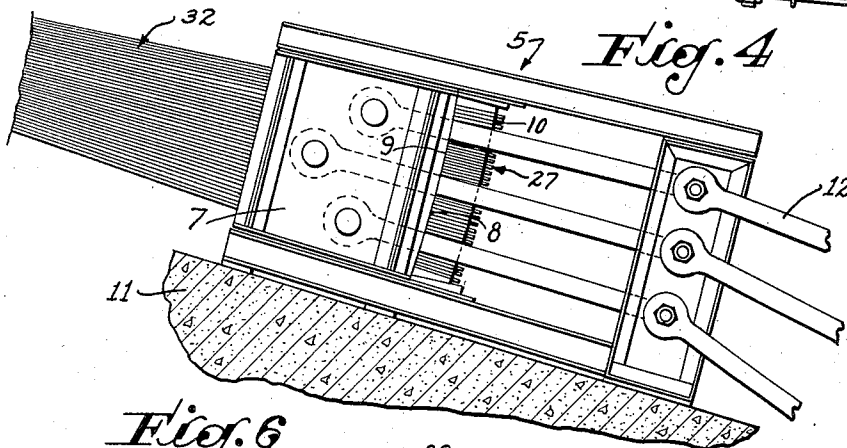


Fig. 6

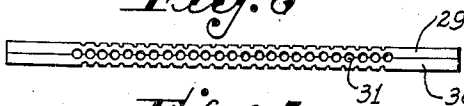


Fig. 5

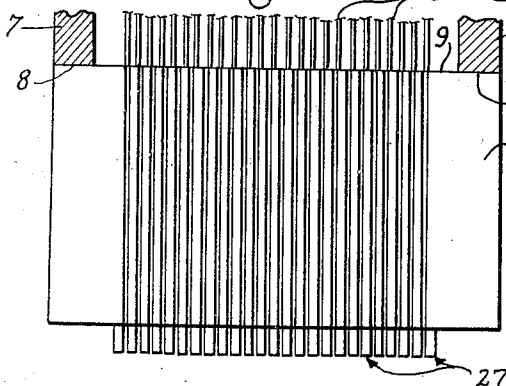


Fig. 8

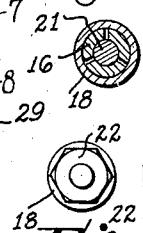


Fig. 7

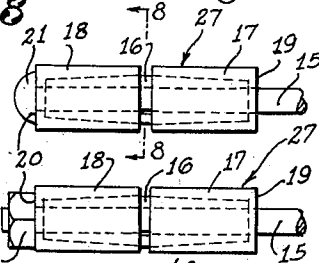


Fig. 10

Fig. 9

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SUSPENSION BRIDGE

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Application October 14, 1944, Serial No. 558,653

4 Claims. (Cl. 14—21)

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My invention relates to suspension bridges having cables formed of wire. Such bridges are generally, but not always, used to span a river or other body of water, and my invention will be described for convenience as if it were so used.

In the present type of bridge and in a bridge embodying my invention, a massive abutment, generally designated as an anchorage, is provided at each end of the bridge, which abutment carries what may be termed an "attachment structure," to which one end of each of the cables is secured, the attachment being solidly anchored in place on the anchorage.

The usual method of building such a bridge is to first erect a small temporary suspension bridge, and to string the individual wires of the cable from attachment structure to attachment structure, to which the ends of the wires are attached by temporary fastenings and suspended on temporary supports at the towers, the floor of the temporary bridge being used as a working platform, where the wires are bunched and bound together to form a round cable, which is then covered with suitable lashings and a protective covering. Suspension bridge cables are now commonly made upon the floor of such a temporary bridge.

It is an object of my invention to construct a cable for a suspension bridge without the use of a temporary bridge, each wire of the cable being strung from attachment structure to attachment structure, and each end of each wire being secured to the attachment structure in approximately its final position without the support of such a temporary bridge.

In bridges as now constructed, in which the cable is assembled in approximately circular section from the floor of a temporary bridge, it is extremely difficult to equally stress all the wires of the cable, and a relatively high factor of safety must be applied. It is an object of my invention to provide a structure having an equally high factor of safety, but to reduce the cost by a definite and logical arrangement of the individual wires so that they will be more nearly equally stressed than is now possible, and by eliminating the large bending stresses now induced in the wires by bending around the strand shoes used as attachments at the anchorages.

It is further an object of my invention to produce a cable of approximately rectangular, and usually square section. The individual wires, as they leave the attachment members, are evenly disposed over a rectangular section, and they can then be assembled in contact with each other

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in a rectangular cable, if they are initially of the proper length, so that they are each subjected to the same stress in the completed cable.

Further objects and advantages will be made evident hereinafter.

Referring to the drawings, which are for illustrative purposes only and which disclose my preferred method of constructing and erecting a suspension bridge:

Fig. 1 is a side elevation of a suspension bridge; Fig. 2 is a side elevation of a cable attachment structure;

Fig. 3 is a plan view of the attachment structure, certain parts being omitted to facilitate better understanding thereof;

Fig. 4 is an elevation of the structure shown in Fig. 3;

Fig. 5 is a plan view of two attachment plates; Fig. 6 is an end view of the attachment plates shown in Fig. 5;

Fig. 7 is a side elevation of a wire end or head; Fig. 8 is a cross section taken on the line 8—8 of Fig. 7;

Fig. 9 is a side elevation of an alternative form of wire end or head;

Fig. 10 is an end elevation of the wire end or head shown in Fig. 9;

Fig. 11 is a diagram shown in perspective illustrating the curvature of the side and attachment plates.

In Fig. 1 I show a suspension bridge as seen when looking north over a river 1 having an east bank 2 and a west bank 3. It is, of course, understood that the bridge need not necessarily be over a river, and the points of the compass used herein were adopted purely for descriptive purposes. The cable 4 of the bridge is attached at its east end to an attachment structure 5 and at its west end to an attachment structure 6. A plurality of cables 4 are, of course, used in an actual bridge.

The attachment structures 5 and 6 are each mounted on an anchorage 11, the east anchorage being shown in Fig. 2, this anchorage being usually a block of concrete heavy enough to take the pull of the cables 4. The attachment structures 5 and 6 are duplicates of each other, the east attachment structure being shown in Figs. 3 and 4. This structure 5 is anchored by eye bars 12 and 13 to members embedded in the anchorage 11. The cables 4 are secured in the attachment structures 5 and 6 in a novel manner which will hereinafter be explained. The cables 4 pass over an east tower 25 and a west tower 26.

It is, of course, understood that suspension

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bridges, like all other bridges, are carefully designed, and detail drawings are prepared for all the parts thereof. The length and position of the catenary formed by the cables 4 are carefully calculated. The finished cable 4 is rectangular and preferably square, and it may consist of 25 layers of wire each containing 25 wires, a layer being a single row of wires extending horizontally.

If the attachment structures and attachment members are properly designed, and the wires of each layer all have the same effective length, the wires will fall into their natural places in the cable and form a compact cable in which the wires are equally stressed. This length is carefully calculated, and the wires are cut to the proper length preferably before being taken to the bridge site. Heads are formed or secured on both ends of each individual wire 15. These heads may be of various forms, those shown in Figs. 7 to 10, inclusive, being quite convenient. In both the form shown in Figs. 7 and 8 and that shown in Figs. 9 and 10, a double coned inner split sleeve 16 is used, this sleeve being in three parts. As shown in Fig. 7, each of the sleeves is of a definite diameter in the center and tapers toward the ends. A primary collar 17 and a secondary collar 18 each have a conical opening fitting over the sleeve. The sleeve 16 has a cylindrical opening therethrough to receive the wire 15. The river end 19 of each primary collar 17 abuts against an attachment means, as will be later explained. The direct pull of the wires 15, which are slightly corrugated where they pass through the sleeve, is transmitted to the sleeve, the three parts of which are pressed with considerable pressure against the wire. The pull is transmitted from the sleeves to the primary collars 17. The nut or projection 21 or 22 at the end of each wire is merely for the purpose of preventing the secondary collar 18 from working loose. As the stress is put on the wire, this stress is taken by an attachment plate which thrusts against the river end 19 of each collar 17, the collars 17 and 18 being forced toward each other, thus compressing the split sleeve 16 against the wire 15 and gripping it firmly. The heads shown are a preferred form, and, obviously, mechanically equivalent heads might be formed by other means. All that is needed is to provide an enlarged head on each end of each wire 15 to take the pull of that wire. These heads are generally designated by the numeral 27.

In practice, the finished cable 4 is made up of several strands 32 for convenience in assembly. For example, the cable 4 may be made up of three strands and may contain 75 layers of 75 wires each. Each strand 32 will consist of 75 layers of 25 wires each. The ends of the wires are held in attachment plates 29 and 30; two of which are shown in Figs. 5 and 6. Each of these plates has a front edge 9 and a back edge 10 and is provided on the top and bottom thereof with grooves which form holes 31 slightly larger than the wires 15, but smaller in diameter than the heads 27. In the actual construction of a cable containing 75 layers of 75 wires each, there are 25 holes 31 between each pair of plates and 76 plates 29 and 30 for each strand and at each end of each strand. These plates are solidly clamped together in the finished bridge, and they transfer the pull of the completed cables 4; each containing 5625 or more or less wires 15. The attachment plates are secured in the attachment structures 5; the front edge of each of said attachment plates abutting on the back edges 8 of side

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plates 7, as shown in Figs. 3 and 4, the pull of the cables 4 being transmitted through the side plates 7 to the eye bars 12 and 13 and thus back to the anchorage 11 as shown in Fig. 2.

Referring to Fig. 2, the strands 32 pass to and through saddle castings 40, where they are brought together to form the cable 4. As illustrated in Fig. 11, the back edge 8 of each of said side plates 7 is curved in an arc struck from an axis A, which is located near the saddle plates 40, on the line of the intersection of the planes S of the top and bottom surfaces of the attachment plates. Similarly, the back edges 10 of the attachment plates curve in an arc struck from the axis A which is located near the saddle plates 40 on the line formed by the intersection of the planes S' of the side plates. Accordingly, the length of all wires between the center of the saddle plates 40 and the backs of the attachment plates is the same. It will be noted that the wires 15 diverge both horizontally and vertically between the saddle plates and the attachment plates. The completed bridge will usually have a plurality of cables on each side of the bridge. The backs of the attachment plates of all three strands 32 of a cable are each in an annular surface centering in a point on an axis A as above described.

Referring to Fig. 2, the wires 15, after leaving the attachment plates, pass through the saddle castings 40, where the wires 15 are consolidated to form a cable 4. Passing west of the saddle castings 40, the wires 15 are bunched together in a rectangular cable 4. Passing eastwardly from the saddle castings 40, as shown in Figs. 2, 3, and 4, the wires of each strand 32 and the strands themselves fan out to give sufficient space for the heads.

The principal advantage of my invention is that it makes a better and safer bridge. Each wire 15 carries its own safe load and occupies without interference its planned position in the final structure. The loads imposed are applied uniformly to the top of the cable 4 and, due to the parallel position of the wires in the cable, are uniformly distributed among all the wires.

I claim as my invention:

1. An attachment means for taking the pull of a cable of a suspension bridge, said cable consisting of separate wires, each wire having a head secured to the end of said wire, the head being of larger diameter than the wire, each of said heads being distinct and separate from each of the other heads; comprising: attachment plates, each of which has a plurality of grooves, each groove being of such size that a wire can lie therein but a head cannot pass therethrough so that the pull of each wire is transmitted by the head of said wire to the back of said attachment plate; two side plates, one of the ends of the front edges of each of said attachment plates abutting against the back edge of one of the said side plates, the other end of each of said attachment plates abutting against the back edge of the other of said side plates, the pull of the cable against each of said attachment plates being transmitted to said side plates; and means by which the pull of the cable on said side plates is transmitted to members secured to fixed anchorage of said bridge.
2. An attachment means for taking the pull of a cable of a suspension bridge, said cable consisting of separate wires, each having a head secured to the end of said wire, the head being of larger diameter than the wire, each of said heads being distinct and separate from each of the other

heads, comprising: attachment plates, each of which has a plurality of grooves, each groove being of such size that a wire can lie therein but a head cannot pass therethrough so that the pull of each wire is transmitted by the head of said wire to the back of said attachment plate; two side plates, one of the ends of the front edges of each of said attachment plates abutting against the back edge of one of the said side plates, the other end of each of said attachment plates abutting against the back edge of the other of said side plates, the pull of the cable against each of said attachment plates being transmitted to said side plates; and means by which the pull of the cable on said side plates is transmitted to members secured to fixed anchorage of said bridge, the back edge of each of said side plates being curved in an arc struck from an axis located on the line formed by the intersection of the planes of the top and bottom surfaces of the attachment plates.

3. An attachment means for taking the pull of a cable of a suspension bridge, said cable consisting of separate wires, each having a head secured to the end of said wire, said head being of larger diameter than the wire, each of said heads being distinct and separate from each of the other heads, comprising: attachment plates, each of which has a plurality of grooves, each groove being of such size that a wire can lie therein but a head cannot pass therethrough so that the pull of each wire is transmitted by the head of said wire to the back of said attachment plate; two side plates, one of the ends of the front edges of each of said attachment plates abutting against the back edge of one of the said side plates, the other end of each of said attachment plates abutting against the back edge of the other of said side plates, the pull of the cable against each of said attachment plates being transmitted to said side plates; and means by which the pull of the cable on said side plates is transmitted to members secured to fixed anchorage of said bridge, the back edge of each of said attachment plates being curved in an arc struck from an axis located on the line formed by the intersection of the planes of said side plates.

4. An attachment means for taking the pull of a cable of a suspension bridge, said cable consisting of separate wires, each having a head secured to the end of said wire, said head being of

larger diameter than the wire, each of said heads being distinct and separate from each of the other heads, comprising: attachment plates, each of which has a plurality of grooves, each groove being of such size that a wire can lie therein but a head cannot pass therethrough so that the pull of each wire is transmitted by the head of said wire to the back of said attachment plate; two side plates, one of the ends of the front edges of each of said attachment plates abutting against the back edge of one of the said side plates, the other end of each of said attachment plates abutting against the back edge of the other of said side plates, the pull of the cable against each of said attachment plates being transmitted to said side plates; and means by which the pull of the cable on said side plates is transmitted to members secured to fixed anchorage of said bridge, the back edge of each of said side plates being curved in an arc struck from an axis located on the line formed by the intersection of the planes of the top and bottom surfaces of said attachment plates, the back edge of each of said attachment plates being curved in an arc struck from an axis located on the line formed by the intersection of the planes of said side plates.

LOUIS H. SHOEMAKER.

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Certificate of Correction

Patent No. 2,429,332.

October 21, 1947.

LOUIS H. SHOEMAKER

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Column 3, line 16, for "preferably" read *probably*; line 38, strike out "or 22"; line 74, after "edge" insert the numeral 9; column 4, line 36, for "strans" read *strands*; column 6, line 9, for "on of" read *one of*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of January, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.