No. 691,982. Patented Jan. 28, 1902.

N. H. STURGIS.

SUSPENSION BRIDGE.

(Application filed Dec. 27, 1900.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.

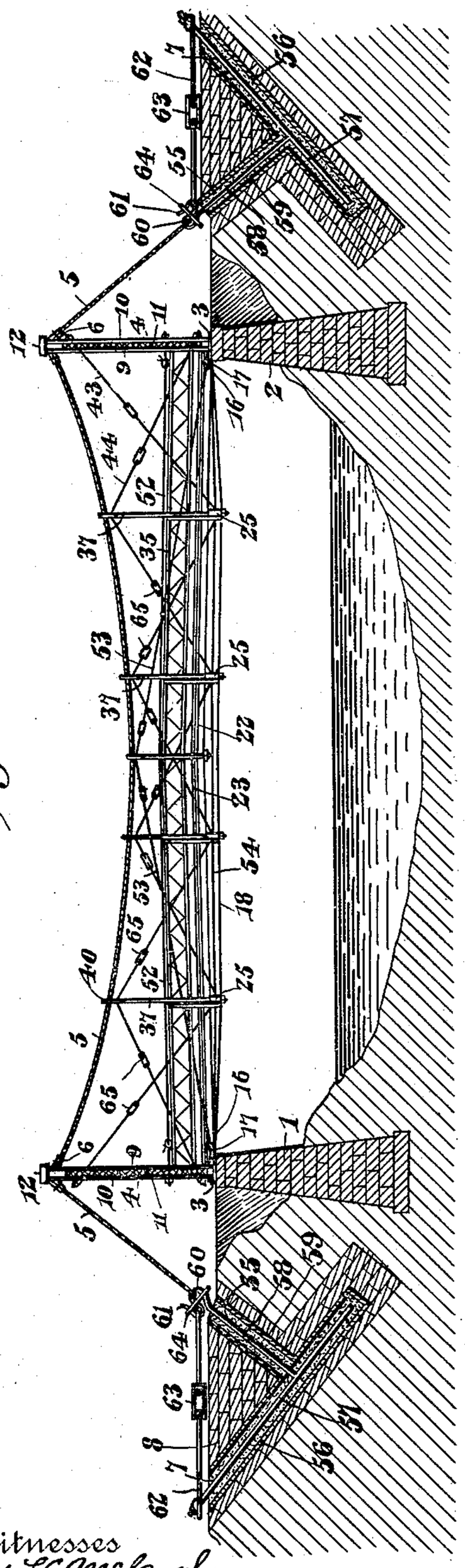
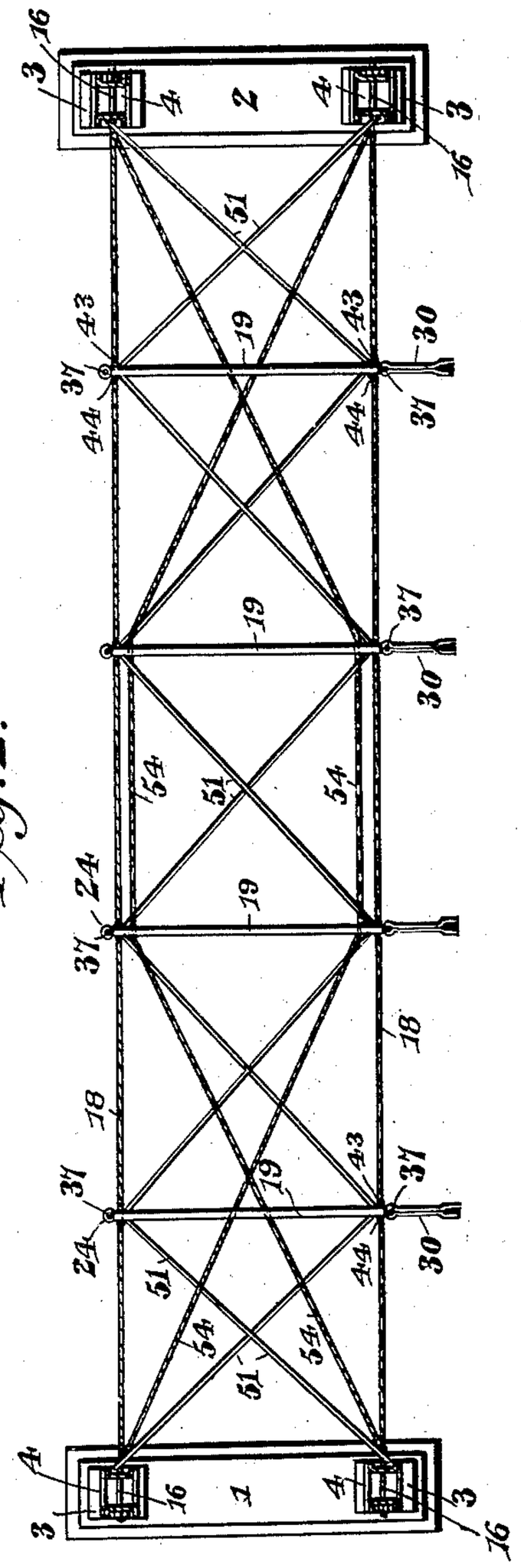


Fig. 2.



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(No Model.) 3 Sheets—Sheet 2.

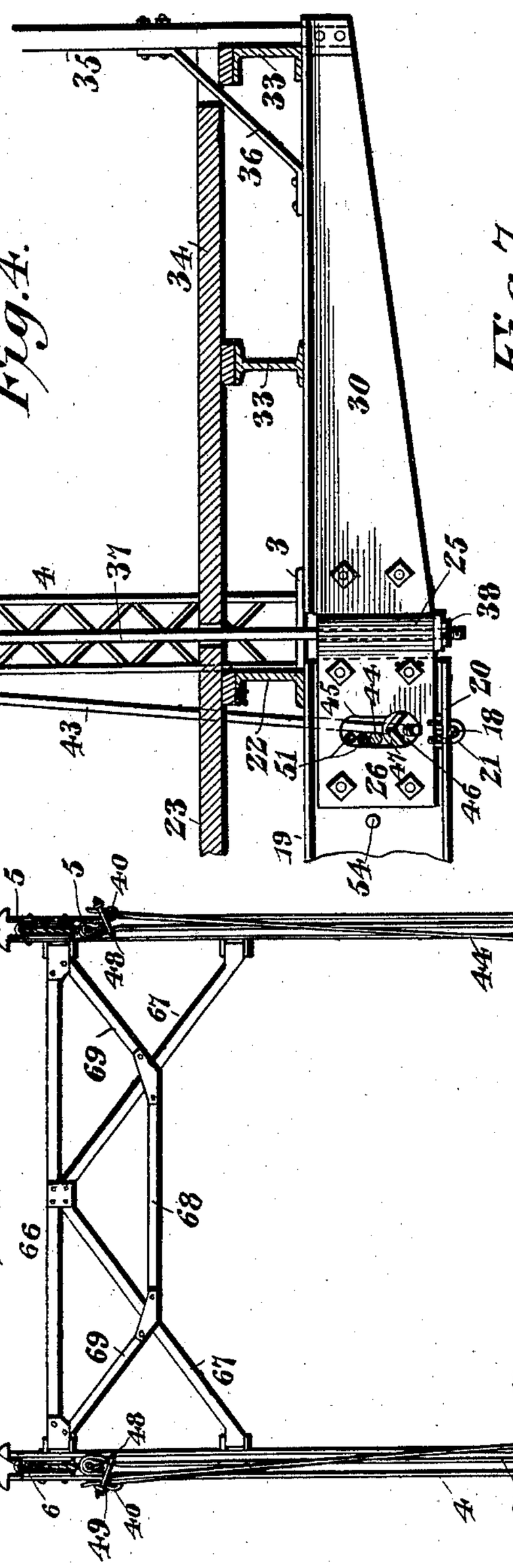

Fig. 4.

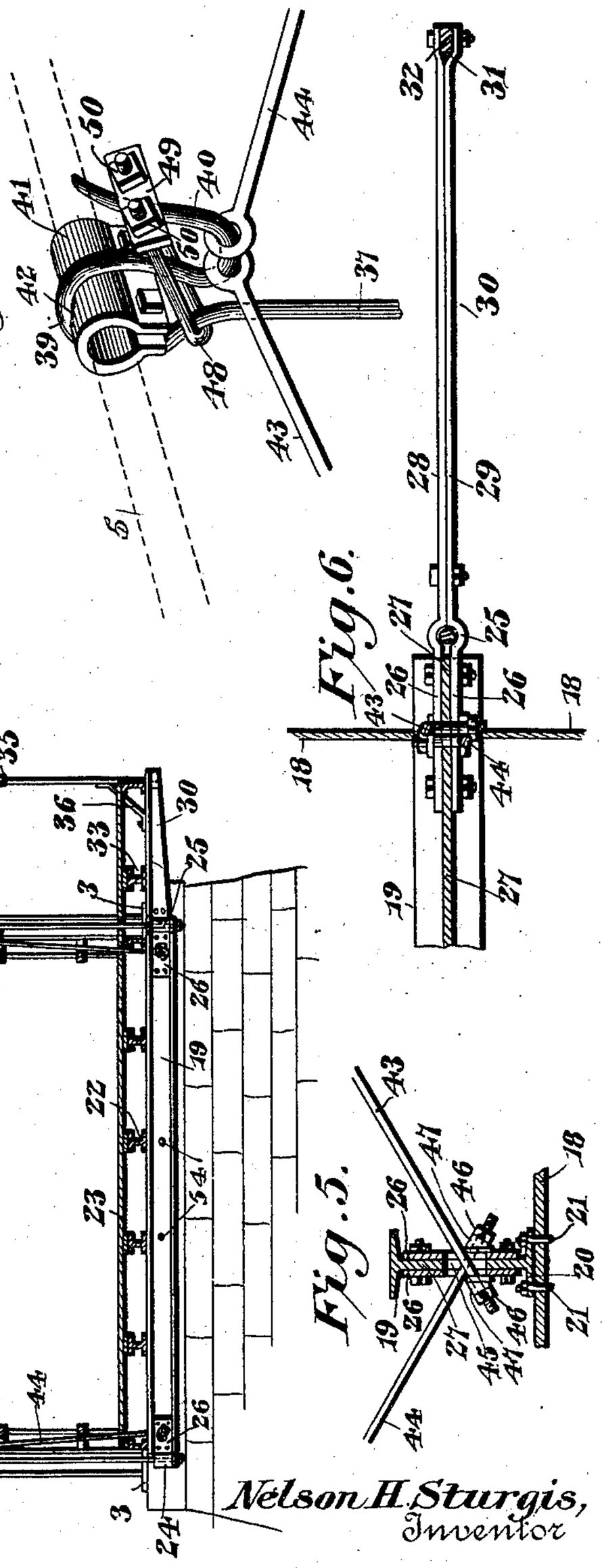

Fig. 7.

Fig. 6.

Fig. 5.

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(No Model.) 3 Sheets—Sheet 3.

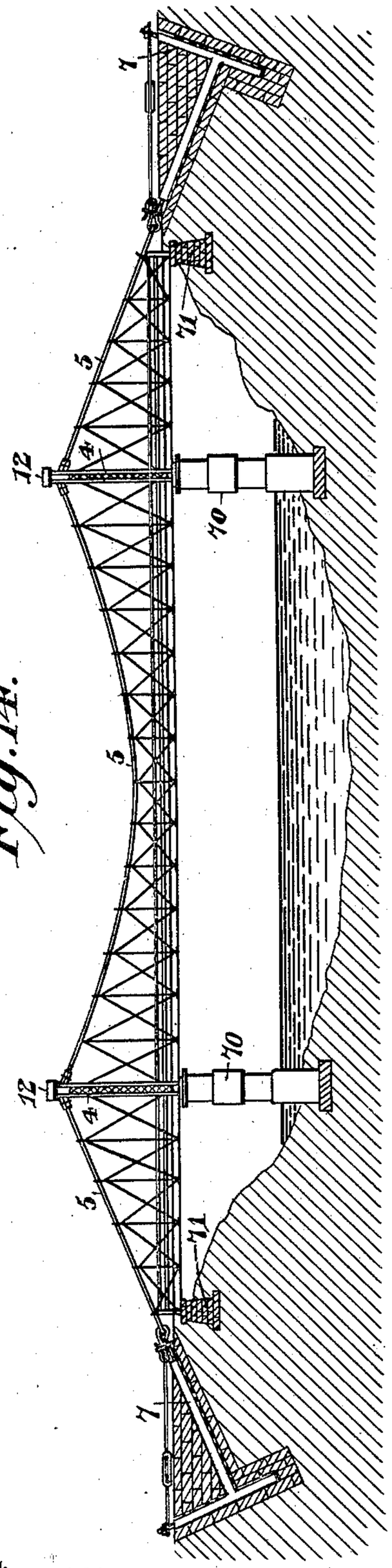

Fig. 14.

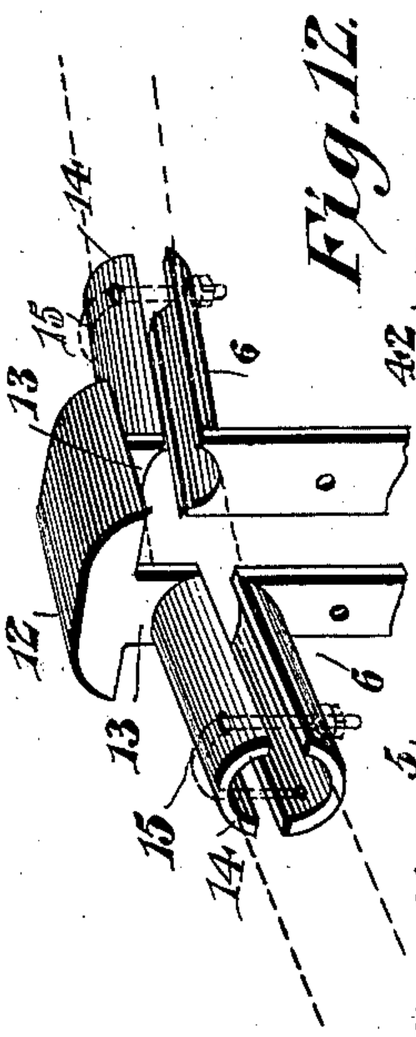

Fig. 10.

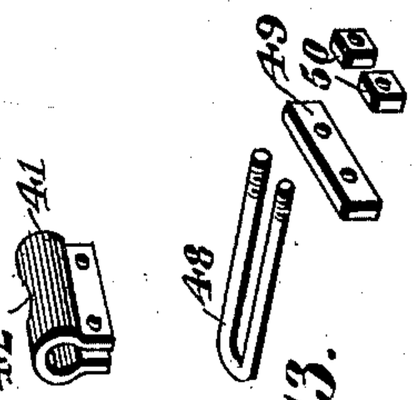

Fig. 12.

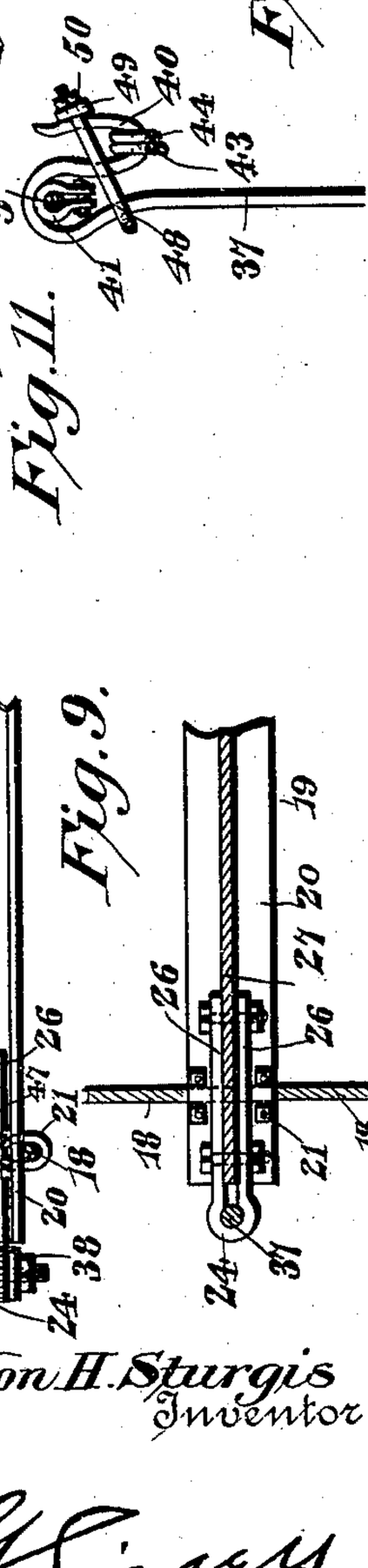

Fig. 11.

Fig. 13.

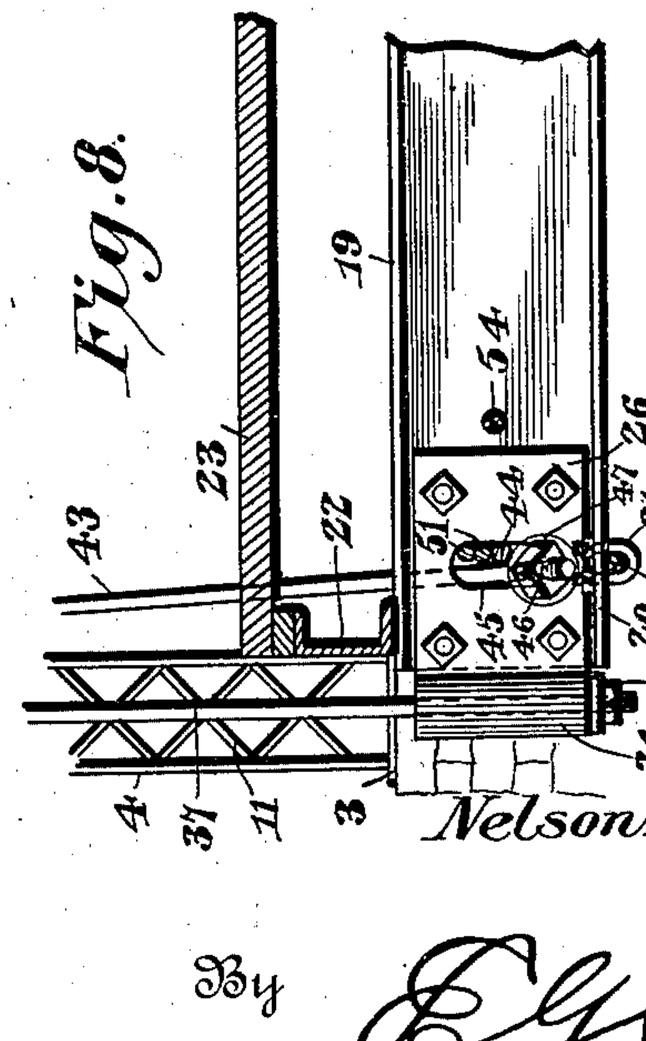

Fig. 8.

Fig. 9.

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UNITED STATES PATENT OFFICE.

NELSON H. STURGIS, OF GUTHRIE, OKLAHOMA TERRITORY.

SUSPENSION-BRIDGE.

SPECIFICATION forming part of Letters Patent No. 691,982, dated January 28, 1902.

Application filed December 27, 1900. Serial No. 41,251. (No model.)

To all whom it may concern:

Be it known that I, NELSON H. STURGIS, a citizen of the United States, residing at Guthrie, in the county of Logan and Territory of Oklahoma, have invented a new and useful Suspension-Bridge, of which the following is a specification.

My present invention relates to improvements in suspension-bridges; and the object in view is to improve the construction of parts in order that the entire structure may be assembled with ease and facility.

More particularly the object of the invention is to improve and simplify the construction illustrated in my Letters Patent of the United States No. 629,935.

With these ends in view the invention consists in providing a novel form of arch, more convenient and effective anchoring devices for sustaining the shore ends of the cables, simple means for sustaining the needle-beams and floor structure, simple and efficient means for positioning the hanger-rods upon the main cables, for securing the lower ends of said hanger-rods to the needle-beams, for connecting and sustaining both the vertical and diagonal trusses, and for equipping the bridge structure with wind-braces, and, further, the invention consists in equipping the bridge with a lateral extension at one side to produce a causeway for foot-passengers.

To the accomplishment of these several ends and others which will more fully appear hereinafter, my invention consists in the novel combination of elements and in the construction and arrangement of parts, which will be more fully described, illustrated in the accompanying drawings, and embraced within the scope of the appended claims.

In said drawings, Figure 1 is a sectional elevation of one form of my bridge and its foundations. Fig. 2 is a plan view, on a somewhat-enlarged scale, illustrating the arrangement of the needle-beams and the horizontal diagonals or trusses connecting the beams to each other and to the arch-posts. Fig. 3 is a transverse sectional view of the bridge on a somewhat-enlarged scale. Fig. 4 is a detail sectional view illustrating the construction and arrangement of the needle-beam extensions and of the manner of connecting the hanger-rods and vertical diagonals or trusses to the needle-beams. Fig. 5 is a transverse section through one of the I-beams adjacent to one end thereof and illustrating the manner of connection of the beam extension to the beam and the way in which the diagonals are secured to the beams. Fig. 6 is a detail sectional view in a plane at right angles to the line of section in Fig. 5 and illustrating the arrangement of the needle-beam, needle-beam extension, rail-standards, and diagonals. Fig. 7 is a detail perspective view of the upper end of one of the hanger-rods and its connected parts. Fig. 8 is an enlarged detail view of the end of a needle-beam opposite the extension. Fig. 9 is a detail view similar to Fig. 6, but illustrating that end of the needle-beam shown in Fig. 8. Fig. 10 is a detail perspective view of one of the post-caps. Fig. 11 is a sectional elevation of the subject-matter of Fig. 7. Fig. 12 is a detail perspective view of one of hanger-bar saddles. Fig. 13 is a detail view of the disorganized elements of one of the hanger-bar clips, and Fig. 14 is a view of a modified form of bridge.

Referring to the numerals of reference employed to designate corresponding parts throughout each of the several views, 1 and 2 indicate the usual shore abutments or foundations, which are preferably, although not necessarily, constructed of masonry on opposite sides of the stream or chasm and designed for the support of the opposite ends of the bridge. Secured upon the foundations in any suitable manner are the foot-plates 3 of the arch-columns 4. As usual, two of these columns are mounted upon each foundation, and the corresponding columns of each pair are intended for the support of the main suspension-cables 5, which pass over the grooved metallic cable-rests 6 and have their opposite ends sustained by anchors 7, sustained by anchor-abutments 8, constructed of masonry at opposite sides and below the surface of the approaches of the bridge. The arch columns or posts 4 may be constructed in any desired manner, but are preferably composed, respectively, of a pair of parallel flanged side plates 9 and 10, connected by intermediate lattice-work or trussing 11, the plates being disposed vertically, as shown, and transverse to the bridge. The main cables, supported by the rests 6, which are of the angular form

shown and have their base-flanges bolted at the upper extremities of the column-plates, are covered by post-caps 12, resting upon the upper ends of the posts. Each of these post-caps is provided with a pair of drop-flanges 13, from which extend laterally the longitudinally-inclined and transversely-curved cap extensions 14, corresponding in general dimensions to the grooved cable-rests 6 and clamped upon the cable at opposite sides of the post by means of substantially U-shaped clips 15, passed through coincident openings in the rests and extensions and secured below the former by nuts, as shown. Each of the columns is pierced adjacent to its lower end—that is to say, immediately above the abutment—by a hook-bolt 16, suitably retained. The hooks of these bolts have their throats closed by clips 17, and between the hooks located at opposite ends of the bridge are strung the parallel supporting-cables 18, which serve to aid in the support of the bridge structure. Above these cables are a series of transverse needle-beams 19, each of which has its base-flange 20 perforated for the reception of clips 21, straddling the supporting-cables 18 and securing said cables to the needle-beams. The needle-beams supported by the cables 18 and otherwise additionally retained in a manner to be described serve to support the longitudinal floor-stringers 22, which in turn support the floor 23. At the opposite ends of each needle-beam 19 are located vertical hanger-rod sockets 24 and 25, the socket 24 being formed in the doubled end of a plate whose ends 26 are bolted or otherwise secured upon the opposite side faces of the vertical web 27. The other hanger-rod socket 25 at the end of the needle-beam opposite the socket 24 instead of being formed by bending a single plate upon itself is formed between the laterally-offset portions of a pair of plates 28 and 29, having their inner ends bolted against the opposite sides of the web 27 and bolted together beyond the socket 25 to form what may be termed a "needle-beam extension" 30, the outer ends of the plates 28 and 29 being separated sufficiently to form a standard-socket 31 for the reception of a railing-standard 32. In this manner each needle-beam is provided at each end with a vertically-disposed hanger-rod socket and beyond one end with an extension. These extensions, disposed in series, as shown more clearly in Fig. 2, constitute the supports for the stringers 33, supporting the flooring 34, to form a footway located beyond one side of the main bridge structure and protected by a hand-railing 35, carried by the standards 32, which latter, as we have seen, are supported at the outer ends of the extensions 30. The rigidity of the railing may be additionally secured by disposing one of the stringers 33 directly against the standards 32 and by additionally bracing said standards by means of inclined braces 36, bolted at their opposite ends to the extensions 30 and to the standards above the floor 34, as shown more clearly in Fig. 4 of the drawings.

The suspension of the floor structure from the main cables is effected by means of a series of hanger-rods 37. The lower ends of these rods are passed through the sockets 24 and 25 and are secured by nuts 38, while their upper ends are curved to form loops 39 for the reception of the main cables 5 and are upwardly recurved at a point below the cables to form upwardly-opening truss-supporting hooks 40. In order to prevent the hanger-rods from slipping along the cables by reason of the inclination of the latter, I provide each hanger-rod with what may be termed a "saddle" 41, which is a somewhat-elongated split collar, clamped upon the cable and provided with a recess or depression 42, within which the upper portion of the loop 39 rests, as shown more clearly in Fig. 7. The truss-supporting hooks 40 are each designed for the reception of the contiguous looped ends of a pair of oppositely-inclined trusses, diagonals, or truss-rods 43 and 44, disposed, as illustrated in Fig. 1 of the drawings, to present their lower ends to the outer extremities of certain of the needle-beams—that is to say, those beams located at opposite sides of the beam to which the hanger under consideration is attached. For the purpose of facilitating the connection of these truss-rods with the needle-beams the latter are provided, adjacent to their outer ends, with vertical slots 45, through which the contiguous lower ends of a pair of trusses are passed in opposite directions, as illustrated in Fig. 5, and are secured by means of nuts 46, screwed upon the lower ends of the truss-rods and bearing against angle-washers 47, seated against the opposite faces of the socket-plates, which are obviously also pierced by the slots 45. Thus it will appear that each needle-beam is supported by the supporting-cables and by two hanger-rods and is further sustained by its connection at each end with a pair of oppositely-extending truss-rods connected at their upper ends to the truss-supporting hooks 40. The shape of the loop 39 is maintained and the escape of the truss-rods 43 and 44 from the hook 40 is prevented by means of what may be termed a "hanger-rod clip" 48, straddling the loop and hook and having its ends passed through a clip-plate 49 and drawn up by nuts 50. (See Fig. 7.) The needle-beams are further retained in spaced relation by diagonal floor-trusses or tie-rods 51, extending between the opposite ends of the adjacent needle-beams and having their threaded extremities passed through the slots 45 of said beams and secured like the trusses 43 and 44 by means of nuts and angle-washers. The bridge structure proper is completed by the provision of railing-cables 52, extending between the columns at a proper height, and by wind-braces 53, extending between the lower ends of the columns or arch-posts at each side

of the bridge and suspended at the center of the bridge in the truss-supporting hooks of the center hanger-rod, and, if desired, the wind-braces 54 may be incorporated in the floor structure, as illustrated in Fig. 2.

We have now seen in what manner the bridge proper is constructed; but it remains to be described in what manner the cable-anchors 7 are constructed and retained in the cable-abutments 8. These abutments, as heretofore stated, are constructed of masonry in any approved manner, built around a metallic anchor-casing 55. The casing 55 comprises a tube 56, disposed substantially at right angles to that portion of the cable extending between the anchor and the adjacent column and open at its upper end only. Within this tube is disposed a straight anchor-rod 57, projecting beyond the open end of the tube and provided at a point intermediate of its ends with a laterally-disposed anchor-stem 58, inclosed within a tubular extension 59 of the tube 56 and extending beyond the open upper end of said extension. The upper or outer end of the stem 58 is curved to form a loop 60 for engagement with the end of a cable and is recurved to form a hook 61 for engagement with one end of a tie-rod 62, connected at its opposite end to the upper end of the anchor-rod 57 and provided at a point intermediate of its length with a turnbuckle 63. The loop 60 and the hook 61 are preferably closed by a clip 64, mounted in a manner similar to the hanger-rod clips 48. Thus the anchors are embedded within the anchor-abutments, but are inclosed within casings which prevent injury to the anchors and are preferably filled with Portland or other hydraulic cement to absolutely preclude the rusting of the anchors, and thereby greatly increase their continued efficiency. It should be noted, further, that by the peculiar construction of these anchors the cables exert their strains directly upon the anchor-bars in a direction transverse thereto, but are additionally secured by the tie-rods 62, disposed at an angle to the cable and connected to the outer end of the anchor-stem and to the projecting upper extremity of the anchor-rod, the tie-rod and stem constituting what is, in effect, a metallic loop encircling the major portion of the anchor-abutment.

In constructing a bridge in the manner described I contemplate the employment of either cables or rods in forming the various trusses and inner braces, and where rods are utilized, as illustrated in the drawings, they are preferably provided with turnbuckles 65, by means of which their tension may be regulated.

The specific manner in which the portals of the bridge are constructed is susceptible of wide variation; but, as illustrated in Fig. 3 of the drawings, I prefer to connect the upper ends of each pair of posts 4 by means of a head-beam 66, from the center of which diverge downwardly a pair of diagonal braces 67, secured at their lower ends to the posts and rigidly retained by a horizontal brace 68, bolted at its opposite ends to the braces 67, which are further braced by supplemental inclined braces 69, disposed between the opposite ends of the head-beam 66 and the contiguous ends of the horizontal brace 68.

In Fig. 14 of the drawings I have illustrated a slightly-different form of my bridge, the variation consisting in constructing the main abutments 70 in sectional tubular form and in providing supplemental abutments 71, which support the extreme ends of the floor structure.

In order that the relative functions of various parts of the bridge structure and the special utility underlying their employment may be better understood, it may be stated that the main cables, supported by the columns and anchored at their ends, are designed, as usual, to constitute the primary supports of the needle-beams and the floor structure mounted thereon. In bridges of this character, however, there is more or less tendency of the floor structure to sag and vibrate when subjected to a moving weight—as, for instance, heavily-loaded teams crossing the bridge. Furthermore, there is more or less tendency, particularly where the bridge is of great length, to swing—that is to say, the floor structure, suspended, as it is, is apt to vibrate laterally, for instance, when the bridge is subjected to the action of a violent wind-storm. In order to overcome these tendencies, the floor-cables are provided, and said cables constitute not only a supplemental support for the bridge proper, but tend to resist the lateral vibration thereof under abnormal conditions. It is apprehended that under some circumstances one or the other of the floor-cables might become broken or deranged, and in order to prevent the bridge from collapsing under such circumstances the hanger-rods suspended from the main cables are connected directly to the needle-beams in the manner described. For the purpose of preventing any possible movement of the individual needle-beams in the event of their detachment from the floor-stringers diagonal trusses extend from the upper end of each hanger and are attached at their lower ends to the adjacent needle-beams, through which the rods pass in the manner described, in order that any strain upon the hanger-rod incident to the tendency of the needle-beam to move will be exerted as nearly as possible in the longitudinal direction of the trusses, and for a similar reason the other set of diagonal trusses are employed in order to insure the maintenance of the needle-beams in parallelism, each of the recited elements being provided in view of some contemplated movement of the bridge structure and being especially adapted to resist the same.

From the foregoing it will be observed that I have produced a simple, durable, and effi-

cient suspension-bridge embodying a novel arrangement of parts which is well adapted to effect the accomplishment of the various objects stated; but while the present embodiment of the invention is believed at this time to be preferable I desire to be understood as reserving to myself the right to effect such changes, modifications, and variations thereof as may be comprehended within the scope of the protection prayed.

What I claim is—

1. In a suspension-bridge, the combination with the columns and anchored main cables, of hanger-rods fast to the main cables, needle-beams connected to and supported by the hanger-rods, floor-cables located below the needle-beams and connected at their opposite ends to the columns, and a floor structure carried by the needle-beams.

2. In a suspension-bridge, the combination with the columns and anchored main cables, of needle-beams, hanger-rods connecting the needle-beams and main cables, side trusses extending diagonally between the upper ends of the hanger-rods and the ends of the needle-beams, floor-cables supported at their opposite ends by the columns and connected to the needle-beams, and a floor structure carried by the needle-beams.

3. In a suspension-bridge, the combination with columns and anchored main cables, of floor-cables supported exclusively by the columns, needle-beams supported by the floor-cables, vertical hanger-rods depending from the main cable and connected to the needle-beams, diagonal trusses extending between the ends of the needle-beams and the upper ends of the hanger-rods, and diagonal trusses adjustably connected at their opposite ends to the opposite ends of adjacent needle-beams.

4. In a suspension-bridge, the combination with columns and anchored main cables, of floor-cables connected at their opposite ends to the bases of the columns, needle-beams supported at their opposite ends by the floor-cables, hanger-rods connected to the needle-beams and to the main cable, trusses connected to said needle-beams and to the upper ends of the hanger-rods, and side cables connected at their opposite ends to the columns at points above the floor-cables.

5. In a suspension-bridge, the combination with columns and main cables passing over said columns and anchored beyond the opposite ends of the bridge, of hook-bolts passed through the columns adjacent to their bases, floor-cables connected to their opposite ends to said hook-bolts, other hook-bolts passed through the columns above the floor-cables, side cables connected at their opposite ends to said last-named hook-bolts, needle-beams supported by the floor-cables, hanger-rods connected to the main cables and to the ends of the needle-beams, diagonal trusses connecting the opposite ends of adjacent needle-beams, and other diagonal trusses connecting the needle-beams to the upper ends of hanger-rods located at opposite sides thereof.

6. In a suspension-bridge, the combination with columns provided with cap-pieces, of cable-rests extending in opposite directions from said columns, and suspension-cables anchored at their opposite ends and passed between the rests and cap-pieces.

7. In a suspension-bridge, the combination with columns provided with grooved cable-rests, of anchored suspension-cables passed over the rests, caps supported at the upper ends of the columns and provided with extensions disposed above the rests, and means for connecting the cap extensions and rests to clamp the cable therebetween.

8. In a suspension-bridge, the combination with the columns and anchor-abutments, of anchor-casings located within the anchor-abutments, anchors within said casings and projecting therefrom, and suspension-cables connected to said anchors above the abutments and passing over the columns.

9. In a suspension-bridge, the combination with columns and anchor-abutments, of an anchor detained by each anchor-abutment and comprising an anchor rod and stem extending laterally therefrom, and suspension-cables passed over the columns and connected to the stems of the anchors.

10. In a suspension-bridge, the combination with columns, cables and anchor-abutments, of anchors each comprising an anchor-rod provided with a laterally-disposed stem connected to a cable, and a tie-rod extending between the upper ends of the anchor rod and stem.

11. In a suspension-bridge, the combination with columns, cables and anchor-abutments, of anchor-casings within the abutments, anchors within said casings and comprising, respectively, an anchor-rod, a laterally-disposed anchor-stem connected to the anchor-rod at a point intermediate of its ends, the upper ends of the stem and rod being extended beyond the casing, and an adjustable rod connected at its opposite ends to the upper ends of the stem and anchor-rod, respectively.

12. An anchor for bridges comprising an anchor rod and stem, a casing inclosing said anchor, and a protective filling, as for instance, hydraulic cement inclosing the anchor and stem within the casing.

13. In a suspension-bridge, the combination with a cable, of a saddle-clamp carried thereby and provided with a depression, and a hanger-rod engaging said depression.

14. In a suspension-bridge, the combination with columns, cables, hanger-rods, needle-beams and flooring, of hanger-rod sockets disposed at the opposite ends of the needle-beams for the reception of the hanger-rods, and needle-beam extensions disposed beyond said sockets.

15. In a suspension-bridge, the combination with supporting means, of needle-beams pro-

vided with the needle-beam extensions and with hanger-rod sockets disposed intermediate of the beams and extensions.

16. The combination with a needle-beam, of a needle-beam extension formed with a hanger-rod socket and secured to the end of the needle-beam.

17. In a bridge, the combination with suspension-cables, hanger-rods pendent therefrom, and needle-beams carried by the hanger-rods, of diagonal trusses supported by and extending from the upper ends of the hanger-rods and passed laterally through the needle-beams.

18. In a suspension-bridge, the combination with cables, and needle-beams provided with terminal vertically-disposed hanger-rod sockets, of hanger-rods engaging the sockets and secured at their upper ends to the cables, diagonal braces passed laterally through the opposite ends of adjacent needle-beams, and other diagonal braces likewise passed transversely through the needle-beams and secured at their upper ends to the upper extremities of the hanger-rods.

19. A needle-beam provided with an extension, said extension being composed of a pair of connected plates offset to form a socket and secured to the opposite sides of the needle-beam.

20. A needle-beam provided with an extension formed at one end with a hanger-rod socket and at its opposite end with a socket designed for the reception of a railing-standard.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

NELSON H. STURGIS.

Witnesses:
JNO. DEVEREUX,
F. H. MCGUIRE.