A. SNYDER.

Bridge.

No. 227,068. Patented April 27, 1880.

Fig:2.

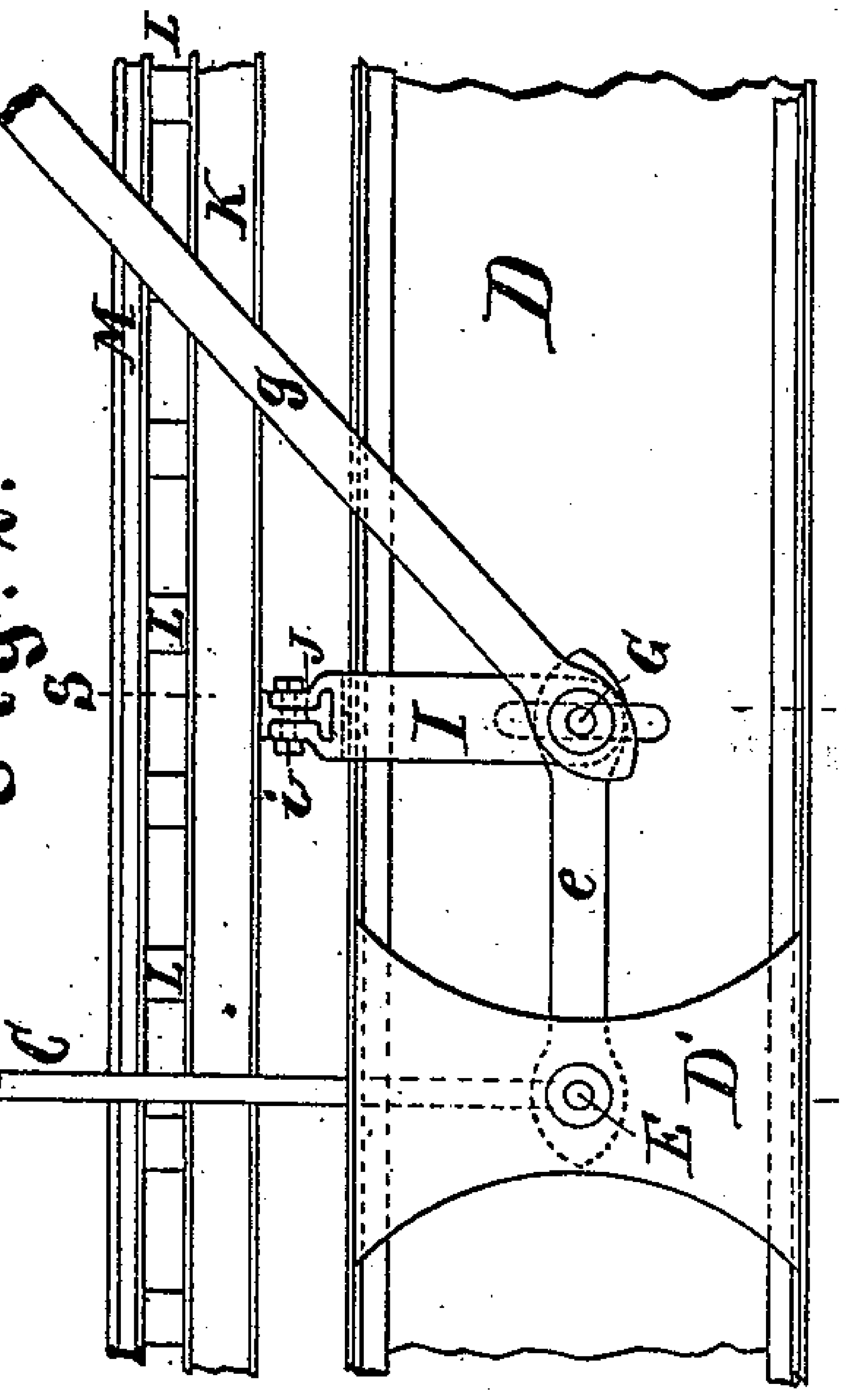


Fig:4.

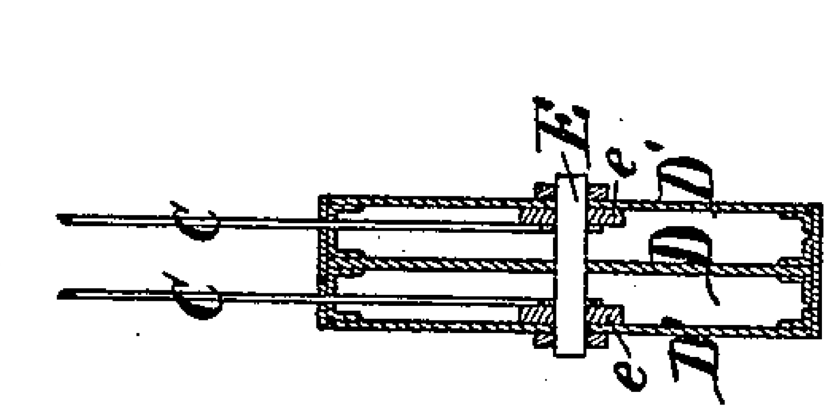


Fig:3.

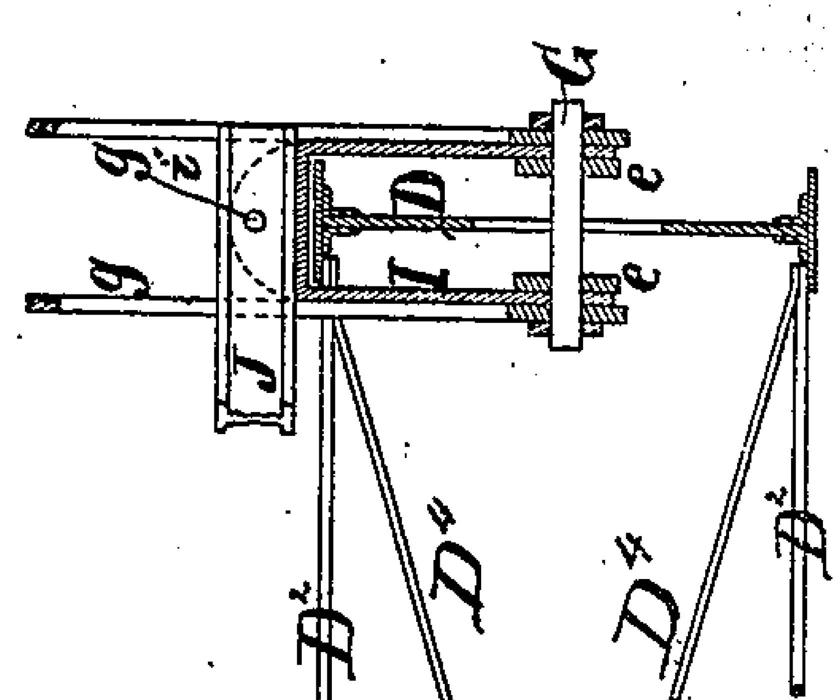
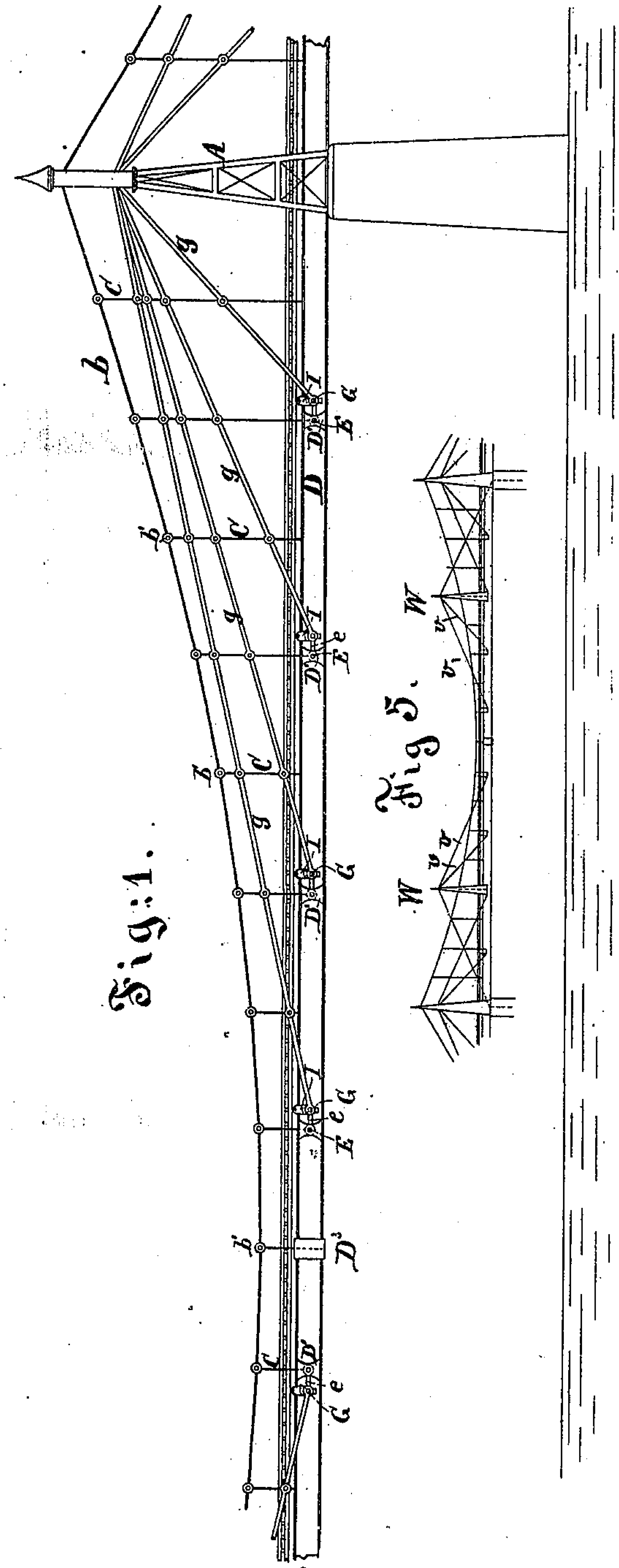


Fig:1.

Fig 5.



WITNESSES:

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UNITED STATES PATENT OFFICE.

ANTES SNYDER, OF JOHNSTOWN, PENNSYLVANIA.

BRIDGE.

SPECIFICATION forming part of Letters Patent No. 227,068, dated April 27, 1880.

Application filed August 15, 1879.

To all whom it may concern:

Be it known that I, ANTES SNYDER, of Johnstown, Cambria county, in the State of Pennsylvania, have invented certain new and useful Improvements relating to Railway and other Bridges, of which the following is a specification.

Suspension-bridges are deficient in the quality of stiffness.

There is a style of bridge designated as the "cantalever bridge," which is, for obvious reasons, very stiff, but the great obliquity at which the forces act renders it necessary in this cantalever style of bridge to employ large amounts of material relatively to the load to be carried.

I have devised and worked out means for combining the two systems of bridge, so that the stiffness of the cantalever system will be realized in supporting the live weight, and the economy of the suspension-bridge system will be realized in supporting a large part of the dead weight, and at the same time have the two systems work harmoniously together in the same bridge under all variations of temperature and load. The moving train, with the rails on which it runs, and a small portion of the bridge structure, is supported upon the cantalever principle, while the weight of the great part of the bridge structure and of the oblique ties or stays is supported by connections to one or more cables stretched on each side of the bridge.

The following is a description of what I consider the best means of carrying out the invention.

The accompanying drawings form a part of this specification.

Figure 1 is a side elevation, showing a little more than half of a span between the two supporting-towers. Fig. 2 is a corresponding elevation of a portion on a larger scale. Fig. 3 is a cross-section on the line S S in Fig. 2. Fig. 4 is a cross-section on the line T T in Fig. 2. Fig. 5 shows a modification.

Similar letters of reference indicate corresponding parts in all the figures.

Referring to Fig. 1, A is a tower, represented as a skeleton of iron resting on a pier, which may be supposed to be a little out from the bank of the river. A cable, *b*, extends from anchorages at each end (not represented) and is suspended across the river from saddles on the tops of towers A. It may be a cable formed of wires; but I have represented it as formed of link-rods, the knuckles or points of connection being marked *b'*. Light suspension-rods *c* depend from these pins or joints *b'*. These parts constitute the suspension-bridge part of my structure.

The principal portion of the substantial bridge-work below may be formed by stout longitudinal iron beams D, of double-T, sometimes called "I" section, adapted to endure a severe strain in the direction of their length, and connected together at top and bottom by cross-ties D^2, and stiffened by inclined braces D^4. These beams may be rolled complete, or may be made up by riveting, as preferred. At the points D' additional upright pieces are applied at the side, making it at those points a box-girder, as indicated in Fig. 4. A stout pin, E, extends horizontally through D at each of these points. The vertical suspension-rods C, depending from the cables *b*, connect to the pins E in the manner shown in Fig. 4. Any number of intermediate suspension-rods C that may be found desirable may be used. The form and size of this part D of the bridge must be varied according to the amount of compression to which it is subjected, and so that the strain may be resisted in the most economical manner. These beams D of the bridge, where they rest on the piers and abutments or anchorage, rest on rollers, so as to allow for expansion and contraction.

At the anchorages or ends I make the top surfaces of the plates on which these rollers rest horizontal or parallel to the base of D for enough length to admit of the full amount of expansion of the beam D.

I have shown the longitudinal beam D as made in two separate lengths, each extending out from the pier or abutment on the side of the river, and meeting at the center, with a suitable splice-piece, D^3, which, under some circumstances, may be preferable; but generally I prefer making D in one continuous girder from end to end.

Short horizontal links *e* connect each pin E, on each side of the beam D, to the corresponding ends of a pin, G, which extends through a sufficient slot in the beam D, in which it is free to move vertically, and carries the one end of each of the links *e* along with it, while the other ends of said links move with D and the suspension system. This pin G is not connected in any way with the cable *b*, but is connected at each end by diagonal tie-rods or stays *g* to a saddle (not shown) supported on rollers on the tower A, which is a different and independent saddle from the one connected to the cable *b*. The first link of the diagonal rod or stay *g*, at the end connected to pin G, is free to move vertically with G. At the other end, where it is connected to the next link or links, forming the tie or stay, it is supported by a suspension-rod, C, and moves with the suspension system. These stays *g* are connected at convenient intervals—generally at the connecting-pins of the links forming the stays—to the suspension-rods C, depending from *b*. The lengths of these links may be so arranged that the same rods which connect to D will serve for holding *g*, or separate rods may be used. Where these stays *g* come above *b* they can be supported by slight struts, so that the cable *b* not only serves to carry the stays *g* and beam D, but also to keep the stays *g* in proper line and prevent sagging.

From the saddle in tower A any number of like stays found desirable may extend toward the abutment or anchorage, and be connected with D by rigid pins, (not shown,) as in ordinary cantalever bridges.

In these drawings I have represented a railway-bridge. M represents the rails, resting on cross-ties L. These ties, in turn, rest upon longitudinal girders or trusses K, of such spans as may be found the most economical for each bridge. These trusses or girders K are supported by cross-girders J. These cross-girders or trusses J rest at each end on yokes I, which have proper recesses for the reception of the ends of J, which are held in place by stout pins *i* passing through I and J. The cross-girder J may have its base resting on the bottom of the recess in I, which bottom is convex, so that any deflection of J from a vertical plane may not cause a tilting of I and unequal distribution of the weight on the links *e* and *g* on each side of D. This yoke or saddle I extends down on each side of D, but does not touch or rest upon D. It rests on each end of the pin G, and is free to move vertically with G. These longitudinal girders K are securely fastened at their ends to the cross-girders J, and are properly braced to each other and to J and the yoke I. This part of my bridge, M L J K I, does not form part of either the flexible or rigid systems. They are intermediate parts, which I call "the bridge-bed," and their office is to take up the moving or live load and concentrate it at the points of support G, so as not to allow any of it to rest upon D, so that the strain on the pins G is that resulting from the moving or live load and the dead weight of the bridge-bed or intermediate parts required to concentrate the live load at the points G. This strain is a vertical downward one, and is decomposed into two strains—one a horizontal strain, passing through the link *e* and pin E to D, and through it from the center toward the anchorage, the other inclined to the horizon and passing through the diagonal ties or stays *g* to the saddle in tower A. This latter strain is here again resolved into a vertical downward strain, passing down through the tower to the pin, and a diagonal strain, passing through the back-stays.

While my system of constructing bridges may be made applicable to bridges of any number of spans, long or short, I consider that its advantages and economies are more fully realized where the structure is one consisting of a long central span and short side spans, and where the peculiarities of my bridge are applied to the center span, leaving the load to be carried over the end spans by independent trusses or other ordinary means.

The peculiarities of my bridge can be applied to the end spans also, with suitable modifications of the general arrangement of the cable and saddles, but I do not think with as satisfactory results as by the method I have described. Various other modifications of detail may be made.

While I prefer the pin G to extend through D and connect the horizontal links *e g* and the two sides of I, as shown, yet such arrangement is not necessary. Two pins, G, may be used, one on each side of D and connecting *e* with *g*, and each supporting one side of I.

Bridges intended for both railways and highways may have the two road-beds side by side, or the track may be suspended from the pins G and hang below D, while the highway passes above D and rests upon the same pins G; or they may change places, the two in each case being suitably braced and bound together so as to have sufficient stiffness.

Another modification is shown in Fig. 5, in which light additional towers W are supported on each side of the bridge on one or two yokes, I, and pins G, which, with their links *e* and stays *g*, are suitably strengthened to bear the additional strain. I have shown them as supported on one connection only of such yoke with its stay. The tops of these posts or intermediate towers W being well braced together transversely of the bridge by rods, are made the points of attachment for a series of diagonal ties or stays, *v v v*, similar in all respects to those already described, and attached to the beam D, cable *b*, and bridge-bed in the same way. The tops of W are also the points of attachment of a shore-stay extending to and connected with a stout pin extending through D over the pier-masonry of the tower A. From this pin strong anchor-chains extend down into the pier and are suitably secured therein; or these secondary towers and stays may be omitted and the vacant space between the principal cantilevers—*i. e.*, between the points of connection of the outermost stays with the beams D—be spanned by an ordinary truss resting at each end on yokes I or pins G; but I much prefer the former arrangement.

I have not deemed it necessary to represent the saddles or the connections therefrom to the anchorages.

I wish it to be distinctly understood that either of the following might be adapted, by proper arrangement, so as to be used with my invention: First, the cable may depend from the same saddles as the oblique ties and be connected to the same anchorage as the oblique ties and longitudinal girder, or to an independent anchorage; second, it may depend from independent saddles, and the land ends may be connected to the same anchorage as the diagonal ties or stays and longitudinal girder, or to an independent anchorage; third, the cable and stays may connect at the tower with the same or independent saddles, and the shore ends terminate in the same or different anchorages, independent of the longitudinal beam or girder.

The two systems, rigid and flexible, work harmoniously together, neither interfering with the action of the other, under all variations of the moving load or temperature. Each system bears its own portion of the load without affecting the other, under all variations of load and temperature. All the variable strains are borne by the rigid system, which is best adapted to bear such strains, while the constant strains are borne by the flexible system, to which class of strains it is best adapted. The only variable strains are those produced by the moving or live load, which can be accurately calculated and properly provided for. The two systems adjust themselves to all variations of temperature without affecting each other, so that there are no strains produced by variations of temperature, a quality not possessed by any other bridge and of great importance.

The flexible system and all supported by it, (except the diagonal stays,) not being subjected to the concussions of the moving load, will be longer lived and less liable to fracture or displacement. The structure being free of all uncertain strains, and only subject to those produced by the moving load and dead weight, which strains I am able to calculate exactly and provide for properly, is a safer and better structure than any other. The failure of one member does not necessarily involve the destruction of the bridge. The bridge can be erected and repaired without false works.

I claim as my invention—

1. The beam D, resting on a suspension-member and the separate bridge, floor-pieces K, serving to carry the moving load, in combination with each other, and with the inclined ties *g*, bolt G, and short links *e*, and bolt E, to allow the beam D to be held up by independent means, and to allow the floor K to rise and sink to a limited extent without carrying the beam D, as herein specified.

2. The suspension-cable *b* and ties C, depending therefrom, in combination with each other and with the beam or compression-member D, separate floor-pieces K, inclined ties *g*, bolt G, short links *e*, and bolt E, all arranged, as shown, to allow the parts *b* C to support the beam, while the ties *g g* support the floor and its live load, as herein specified.

3. The horizontal links *e*, in combination with two sets of bridge parts—namely, stiff and flexible systems—so that the stiff and flexible bridges, or parts corresponding thereto, shall each be capable of independent vertical motion without interfering, as herein specified.

4. In a compound bridge composed of a rigid and a flexible system united for joint operation, as shown, the longitudinal beams or cords D, formed with openings, as described, loosely surrounding the bolts G, in combination with such bolts and with the links *e* and *g*, bolts E, and transverse pieces J, the latter resting on the yokes I, as herein specified.

5. The girders K, cross-girders J, and yokes I, arranged, as shown, to receive the moving load, and concentrate it upon the points G, in combination with the beam D, bolts G E, and links *e*, and with the inclined ties *g*, and suspension - cable *b*, and suspending - rods C, as herein specified.

6. In a compound bridge having both a rigid and a flexible system combined, as shown, the one to bear the dead and the other the live weight, the beam D, formed as shown, with a flange at the top and bottom, and with additional side pieces, D′, at the points where the links *e* engage with the cross-bolts G, as herein specified.

7. In combination with the horizontal girder D, inclined stays *g*, and links *e*, the cable *b* and suspension-rods C, by which a large portion of the dead weight of one system is carried by the other system, substantially as shown and described.

8. The main or horizontal girder D, as described, in combination with the pins G, links *e*, stays *g*, pins E, and suitable bearing-piece I, substantially as and for the purposes described.

9. The longitudinal girders K, on which rests the live load, the cross - girders J and yoke I, or their equivalents, in combination with the pin G, links *e*, stays *g*, pin E, and main girder D, with or without slots, substantially as shown and described.

10. In combination with the tower A, main girder D, inclined ties *g*, links *e*, and the longitudinal girder K, cross-girder J, and yoke I, communicating the live or moving load to the stays *g* and link *e* at the points G, as specified, of the cable *b*, and suspension-rods C, supporting the dead weight of the rigid system, substantially as and for the purposes specified.

In testimony whereof I have hereunto set my hand, this 8th day of August, 1879, in the presence of two subscribing witnesses.

ANTES SNYDER.

Witnesses:
R. B. EVANS,
LIZZIE M. EVANS.