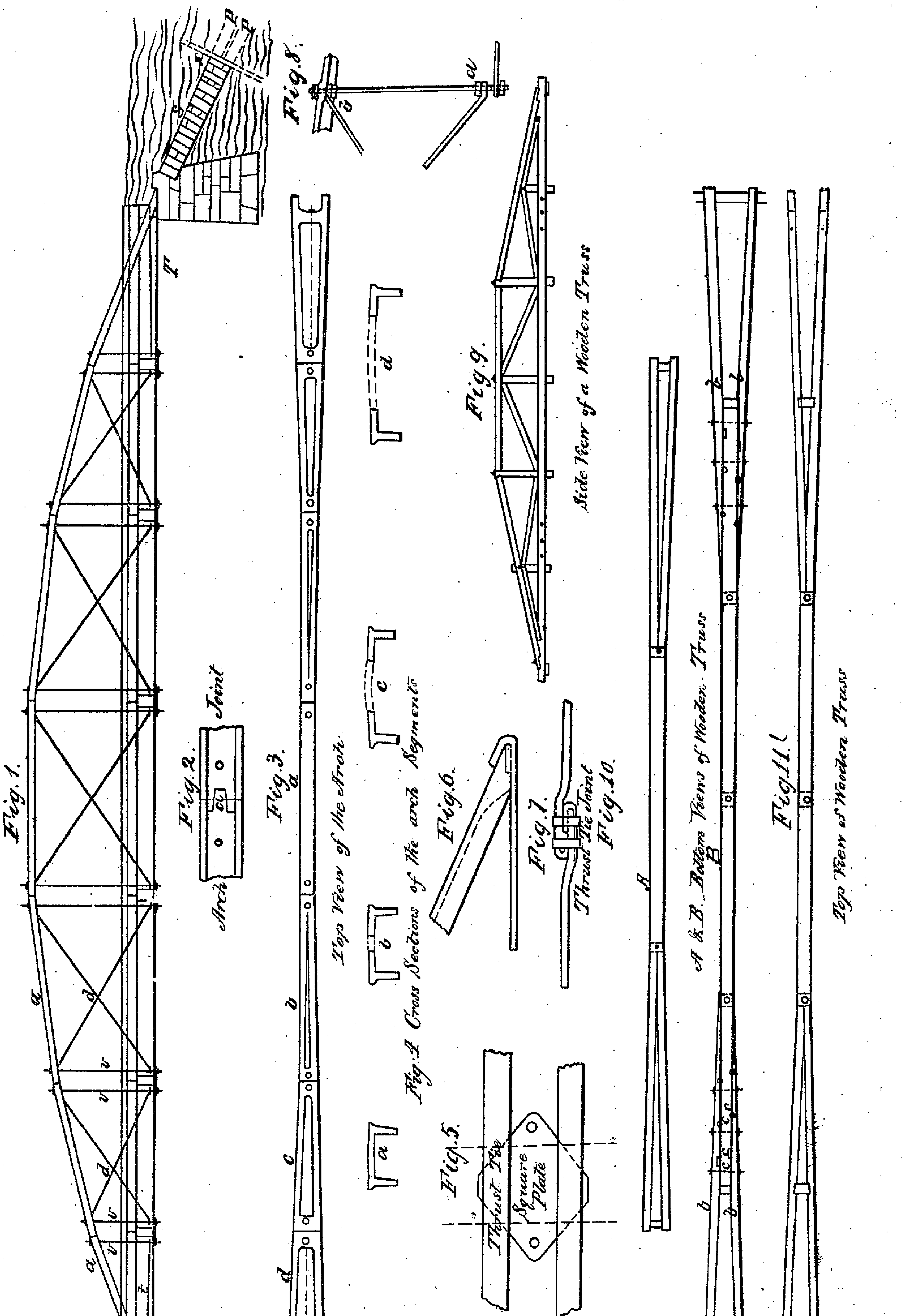
S. Whipple.
Bridge.

No. 2064 Patented Apl. 24. 1841.



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CONSTRUCTION OF IRON-TRUSS BRIDGES.

Specification of Letters Patent No. 2,064, dated April 24, 1841.

To all whom it may concern:

Be it known that I, SQUIRE WHIPPLE, of the city of Utica, county of Oneida, and State of New York, have invented a new and useful Improvement in the Construction of a Bridge by me called an "Iron-Truss Bridge," which contains principles also advantageously applicable in the construction of wooden truss bridges, and that the following is a full and exact description thereof, reference being had to the accompanying drawings.

This bridge consists of a floor of plank and timber similar to an ordinary bridge floor, sustained by two or more trusses of iron. See drawings Figure 1. Each truss consists of an arch *a*, *a*, of cast iron extending the whole length of the span, one or more thrust ties T, T, extending along through or near to the chord of the arch, and connected with the extremities thereof, to sustain the thrust and prevent the spreading of the arch; vertical rods *v*, *v*, &c., of wrought iron which serve both as ties and posts between the arch alone, and the floor and thrust ties, (or the horizontal plates hereafter described) below; diagonal ties *d*, *d*, &c. of wrought iron, or braces of cast iron, in pairs crossing one another between the vertical rods and between the arch and the thrust ties, except under the end segments, letter *t*, of the arch where only one tie or brace, Figs. 1, and 3, is used extending horizontally from the end of the arch to the foot of the first vertical rod from the end, Fig. 5; horizontal plates, nearly square in form, and placed diagonally forming a support for the floor beams and thrust ties, and affording points of attachment for the vertical and diagonal pieces. These are the essential parts of the truss, and I proceed to a more particular description of each and the manner of forming and connecting them.

The arch is formed in sections or segments, Fig. 3, of from ten to twelve feet or any suitable length. The middle segment letter *a*, Figs. 3, and 4, may be in the form of an inverted trough, with its width for arches from 60 to 80 feet about the top part of the span of the arch, the depth about half of the width and the thickness of metal about one-tenth of the width, size, form and proportions to be varied according to circumstances or the taste and views of the engineer. The segment letter *b*, Figs. 3, and 4, next the middle is to be made of the same form and size, but separated vertically and longitudinally in the center, the parts thus formed, remaining together at the end toward the middle, but diverging slightly toward the other end, where they are connected by a cross bar *e*, Fig. 3, forming the whole into a solid piece with a slit or opening in the middle extending to within ten or twelve inches of the wider end, and running to a point toward the other. The next segment, letter *c*, Figs. 3, and 4, is formed and separated in the same way, only having the openings in the middle wider and more divergent toward the end of the arch, the narrower end being of the same width and matching with the wider end of the preceding. The remaining segments to be formed and adapted to the preceding in the same manner last described, but increasing in width and divergence to the end of the arch, where the width may be about three times as great as at the middle, with the same area in the cross section except at the cross bars connecting the two halves of the segments, Fig. 4. These cross bars should have greater thickness than the other parts of the segments and be cast with holes six or eight inches from the ends of the segments for the vertical rods to pass through or in case a single vertical rod is used at each joint, the hole should be formed immediately at the joint by a semicircular notch in each of the two contiguous ends.

At the joints of the arch the segments *a*, Fig. 2, should be furnished with projections or extensions from their ends lapping past the joint and interlocking in such a manner as to keep the ends in place, and if necessary, small bolts may be passed through these lapping portions to strengthen the joints. To give the diagonal ties a more uniform obliquity, the segments may be made shorter toward the ends of the arch.

It will readily be seen from the manner of forming and connecting the segments, that the top of the arch, Fig. 3, will present the appearance of two horizontal arches touching one-another in the middle and curving equally therefrom in opposite directions to the ends. This form being given it to produce stiffness and sustain it against lateral flexure.

The thrust ties are two to each truss, one under each side of the arch, though any different number of arrangement may be adopted. They may be composed of flat bars of a manageable length placed horizontally and connected together by locking and banding, in the manner of which Fig. 7 of the drawings presents an edge view or any other suitable manner. The connection with the toes or extremities of the arch may be in the manner represented in Fig. 6. Or the ties may be in the form of chains consisting of a number of long links formed of round bars and connected by clevises and pins, the end links embracing the toes or extremities of the arch and being kept in place by a notch or shoulder at or near the end of the arch.

The size of the thrust tie will depend upon the length of the arch. The weight it is to be subjected to and the rise of the arch above the thrust tie.

When the rise of the arch above the thrust tie is from one tenth to one eighth of the length of the span, thrust ties having an aggregate cross section of about one square inch for each hundred square feet of bridge floor will be about a suitable size in ordinary cases.

The vertical rods may be made of round iron, and in all cases should have an aggregate strength sufficient to sustain the floor and any additional weight that may come thereon, and when the wrought iron diagonal tie is used, the vertical rods should have a larger size to give them stiffness as posts. They are two at each joint (though one only may be used) at from 12 to 16 inches distance from one another to admit the floor beams between. These rods have a screw and two nuts at each end, Fig. 8. Previous to putting them into the structure, one nut is screwed onto each end *a* and *b*, Fig. 8, to a distance of six or eight inches from the end toward the middle of the rod. The upper end is then passed through a loop or eye formed on the upper end of the diagonal tie, Fig. 8, then through the hole in the arch segment and secured by a screw nut on the top. The lower end is passed through a loop on the lower end of that diagonal tie which is opposite to the one attached as aforesaid to upper end of the same vertical rod. Then passing down through the lower or square plate, is secured by a nut below. The uppermost of the two lower nuts *a*, Fig. 8, serves to regulate the tension of the diagonal tie and prevent its sliding up, while the lowermost nut *b*, Fig. 8, at the upper end answers a similar purpose, preventing the vertical rod from being thrust up through the loop of the diagonal tie and the hole in the segment of the arch.

When the cast iron brace is used instead of the wrought iron diagonal tie, the vertical rod is never subjected to a thrust or negative force and may be of smaller size and furnished only with a bolt head at one end and a screw-nut at the other, like an ordinary bolt. Otherwise, there may be one or more posts of cast or wrought iron used in conjunction with the wrought iron diagonal ties, in which case the vertical rods may be made smaller, or dispensed with entirely, the diagonal ties being enlarged so as to be adequate to sustain the whole weight.

The mode of connecting the diagonal ties with the other parts has been explained in speaking of the vertical rods, and it is only necessary to add that they may be of round iron from one to one and a half inches in diameter according to circumstances. It may also be proper to add that in case a single vertical rod be used at each joint of the arch, two diagonal ties are connected with each end thereof by loops in the manner above described, viz, one descending obliquely to the right and left from the upper end, and ascending obliquely to the right and left from the lower end of the vertical rod.

The square horizontal plates, Fig. 5, may be of wrought iron from fourteen to sixteen inches square and from $\frac{3}{4}$ to 1 inch thick placed diagonally under the floor beams with two opposite angles projecting on opposite sides of the beam, and pierced for the vertical rods to pass through. The remaining angles, Fig. 5, projecting under the thrust ties, and being turned up at the points to support the sag of the ties and prevent them from spreading. These last mentioned angles may be elongated if necessary toward the ends of the arch, where the tie bars are farther asunder.

The thrust ties may be dispensed with and the thrust of the arch be supported by the abutments and piers upon which the bridge rests. The other parts of the truss being the same, or nearly so, as when the thrust ties are used. In such cases the abutments may be strengthened by a slope wall or frame work of timber *s*, Fig. 1, on the back side, extending into the earth so as to form nearly a continuation of the arch of the truss, and if necessary piles *r*, *r*, Fig. 1, may be driven obliquely into the earth in continuation of the curve, or sheet piling *x*, Fig. 1, driven toward the center of the arch, to support the foot of said slope wall or frame work.

In bridges of a long span where the arch rises high above the floor of the bridge, the diagonal ties may not extend quite down to the floor but terminate at their lower extremities in another arch between the floor and the principal, or cast iron arch, being here connected and steadied by light ties of wrought iron, forming the intermediate arch as aforesaid.

The application of the expansion or divergence of the parts of the arch, or main braces of wooden truss bridges may be effected in the following manner. If the span be so short that the timbers to sustain the thrust of the arch may be conveniently obtained of the whole length, these timbers A, Fig. 10, may be split with a pitsaw for about one third of their length from each end, and the ends sprung and braced apart, more or less, according to the length and the proposed degree of divergence to be given to the braces. Then the braces (or arch segments) running up from the ends of the truss, must be two at each end, corresponding in thickness horizontally with the halves of the split timbers below, to which said braces are adapted and secured at the end of the truss. Or the lower timbers may be split for their whole length, and the two halves fixed apart to a distance equal to the proposed divergence of the braces above.

In case the span be greater than is convenient (B, Fig. 10,) to procure the string timbers or thrust ties, these may be formed of a timber *a*, B, Fig. 10, in the middle of about two thirds the length of the truss, upon which may be lapped or spliced other timbers, *b*, *b*, *b*, *b*, B, Fig. 10, one on each side (horizontally) of both ends of the same vertical but less horizontal thickness, extending to the ends of the truss. These later timbers being so chamfered as slanted upon the part lapping onto the other timber, as to give them the required divergence at their opposite ends. These lap joints may be secured by iron bolts passing through horizontally with iron straps if necessary, and further strengthened by pieces of wood or metal (*c*, *c*, and *c*., B, Fig. 10,) driven or fitted vertically into corresponding notches or mortises in the contiguous or splicing surfaces of the timbers. The truss is then to be completed Fig. 11, with double braces, and otherwise like the ordinary truss.

It is obvious that with arrangement, truss bridges will be more secure from the lateral deflection of their trusses and consequently may be used with safety of a greater span than when no such precaution is taken to prevent lateral flexure. Or a wooden arch may be formed in sections or segments, diverging toward the ends (of the arch) in a manner similar to that of the cast iron arch above described secured by braces and thrust formed by the continued splicing of timbers, or having the thrust sustained by abutments and piers.

Now what I claim as my invention in the above described improvement, and desire to secure by Letters Patent, is—

1. The method of sustaining the flooring of bridges by iron trusses containing cast-iron arches formed in sections or segments, in combination with diagonal ties or braces, to sustain the form of the arch against the effects of unequal pressure, (with or without vertical posts or rods,) and wrought iron arch strings or thrust ties to sustain the thrust and prevent the spreading of the arch, in case the abutments and piers be not relied on for the purpose.

2. Also, the divergence or horizontal expansion of the arch from the middle portion to the ends thereof, in wooden trusses or arches as well as in those composed of iron.

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Witnesses:
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