2 Sheets--Sheet 1.

J. B. EADS.

Iron Bridges.

No. 142,380. Patented September 2, 1873.

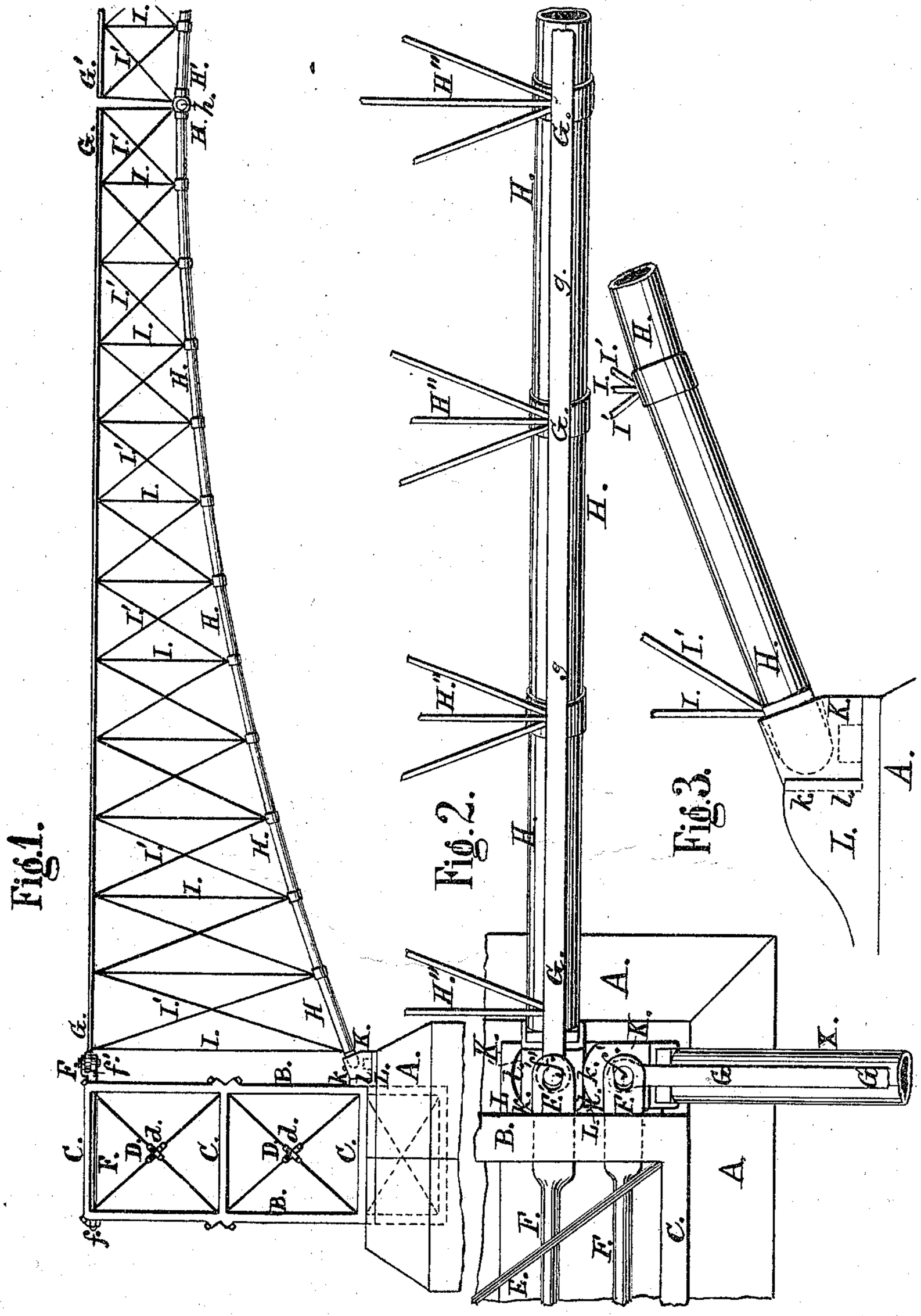

Fig. 1.

Fig. 2.

Fig. 3.

ATTEST:

Jas. L. Ewin

Walter Allen

INVENTOR:

James B. Eads

By Knight Bros

Attys.

2 Sheets--Sheet 2.

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Fig.5.

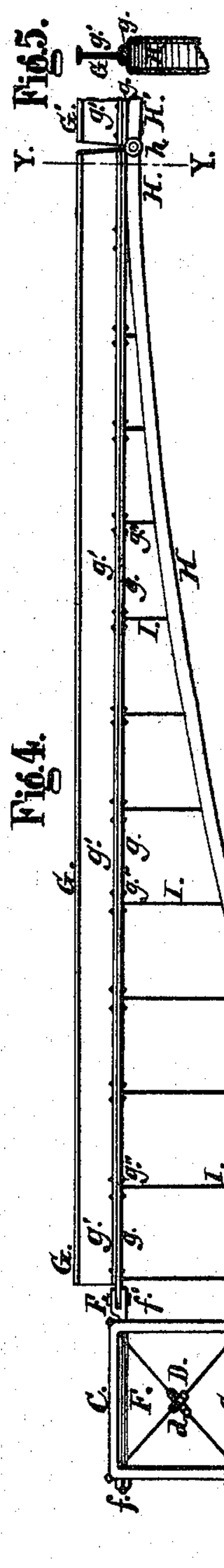

Fig.4.

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UNITED STATES PATENT OFFICE

JAMES B. EADS, OF ST. LOUIS, MISSOURI.

IMPROVEMENT IN IRON BRIDGES.

Specification forming part of Letters Patent No. **142,380**, dated September 2, 1873; application filed April 16, 1873.

To all whom it may concern:

Be it known that I, JAMES B. EADS, of the city and county of St. Louis and State of Missouri, have invented a certain Improvement in Bridges, of which the following is a specification:

The first part of my improvement consists in facilitating the erection of arch-bridges by connecting the bridge-ribs, in half-span lengths, to the abutments by hinge-joints, so as to enable each half-rib to be constructed, where means of support can be found, (upon the river-bank, for instance,) and then swung around into position, and each then joined at the middle to its corresponding half-rib by a central pivot, or, if desired, by a rigid connection.

The second part of my improvement consists in the general construction of the bridge, which has two or more arched ribs from abutment to abutment, each rib having a lower member or arch jointed at the center, and combined with an upper member or girder disconnected at the center, so as to form two independent girders, to preserve the form of the arch when unequally loaded, and, at the same time, avoid the strain which would occur in a continuous girder placed over the entire arch, by the rising and falling of the arch at the middle, when expanded or contracted by changes of temperature.

The third part of my invention consists in providing the part of the abutment or pier, to which the bridge is directly connected, with adjustable stay-braces, hinge-rods, or both, so as to control the position of the upper hinge of the half-rib, and, by that means, the elevation of the outer end of said half-ribs, when brought in contact at the center of the span, and thus to facilitate the joining of them together at that point by the raising or lowering of the free end of the rib to proper position.

The fourth part of my improvement consists in the manner of constructing the lower hinges of the ribs, the ends of the arch being jointed to the abutments in such manner as to allow the half-rib to be swung around into position.

The fifth part of my improvement relates to a manner of constructing such bridges by forming each half-rib, at first, of an arched member and single chord—the arched member and said chord being directly connected at the center pivot, and connected at other parts only by vertical struts, excepting such temporary diagonal bracing as may be needed to maintain the form of each half-arch until the half-span girders shall have been put in place. The chord need only be of sufficient strength to sustain the weight of the rib thus formed, and to support the necessary men and appliances to join it to its fellow at the center; after which the other parts of the structure can be safely placed on it by equally distributing the weights until the girders or vertical bracing is completed. In this manner the weight of parts to be swung into position will be found very light compared with the total weight of the complete structure, and the need of false works will be entirely avoided in raising the structure over the stream. After two such incipient half-ribs have been swung into position and secured to their fellows from the other abutment, and the proper lateral connections and braces have been put on to secure them together, an additional member, in form of a girder, is added to each half-rib, so as to preserve the form of the arches without the use of diagonal or spandrel bracing between the arch and girders.

In the drawings, Figure 1 is a side view of one-half of a bridge, showing the jointed connection to the other half and the hinge-connections. Fig. 2 is a top view of portions of two ribs, exhibiting the process of construction. Fig. 3 is a side view of the turn-block of the lower hinge, with part of the arch. Fig. 4 is a side elevation of a part of a bridge having the same general construction, but whose arched member is held in form by two distinct girders, as hereinafter described, connected to the arch by simple vertical struts, the ends of the lower chords having direct connection with the arch at the pivot. Fig. 5 is a transverse section of the girder and arch at Y Y. The voussoirs or sections forming the arch should be straight between the joints or points

where the vertical struts take hold of the arch.

A is a portion of the bridge-pier or abutment. The upper part of the abutment has posts B, cross-beams C, and cross-braces D E. The side stay-braces D are made adjustable in length, so as to enable the adjustment of the upper part of the abutment, or tower, in respect to its verticality. Screw-swivels *d* are shown as the means employed to lengthen and shorten the stay-braces, but any known mechanical equivalent may be used—for instance, their ends may be screw-threaded outside the frame B C to receive nuts, by which the length may be adjusted. The anchorage of the tower in the abutment, which also furnishes brace-work to resist the thrust of the arch, is shown in dotted lines in Figs. 1 and 4. F are screw-rods, carrying at their rear ends nuts *f*, and at their front ends forming parts of the hinges *f'*, by which the chord G is connected to the tower or frame B C. The girder G, Fig. 1, may be of any desired construction, each rib of the span having two such girders, G G', disconnected at the center, and each connected to its proper half-arch, substantially as shown, by struts I and braces I'. The girders G G', in Figs. 4 and 5, are made in two parts—one chord, *g*, connected by struts I to the arch, and the other, *g'*, connected to *g* by bolts or rivets, so as to admit of being added after the rest of the bridge has been fixed in position. The center end of the chord *g* is secured directly to the arch at the pivot without the interposition of any strut. The girders G G', in this modification, may have any form of construction that will impart the necessary rigidity, as in this case the girders G G' are depended on to preserve the form of the arch, vertical struts only and no diagonal or other braces being needed between the girders and the arch. The two ends H H' of the arch in each rib are connected together by a hinge-joint, *h*, at the center, or by any means that will allow the rise and fall of the arch at the center without undue strain to the material of the arch by such rise and fall. The ends of the arches H H' are set into metallic blocks K, whose ends, *k*, are rounded to fit recesses *l* in the skew-backs L. The blocks K may have sockets at the bottom to receive pivot-pins, shown by dotted lines. The ends of the arch may have vertical pivot motion in the blocks K, but if the depth of the arch is inconsiderable pivoting the ends at the abutments to admit of vertical motion will not be necessary.

In the construction of this bridge a rib on each side of each abutment would be built, the ribs being constructed in such position (see X, Fig. 2,) that the bank of the river or other foundation may be used to support the half-rib until self-supporting on the hinges *f'* and *k l*. When one rib on each side of each opposite abutment is completed they may be swung around into position parallel with each other and connected at the center by the joint *h*, or equivalent means, and the proper lateral and other bracings and connections to each other can then be completed. In the same manner additional ribs may be formed on each side of these, swung into position, and then connected by horizontal ties and braces H'' to the middle pair. This method of procedure may be carried on until the bridge is made of the requisite strength by the addition of a sufficient number of ribs.

If, when a half-rib is swung into position, the free end should be either too high or too low the necessary adjustment may be made by means of the rods F or the adjustable stay-braces D. In small bridges vertical struts may be stayed on the lower pivots and braced to each other transversely and stayed by strong back-stays, just as the masts of boom-derricks are held in position, and the top of each strut would in this case form the upper hinge, by which to swing the rib into position. These struts could remain afterward to receive the ends of the arch-girders and the girders forming the approach to the bridge. After completion of the bridge, if the girders be of metal, it will be necessary that the upper pivot *f'* be arranged to permit the extension and contraction of the girder resulting from changes of temperature. This may be done by elongating the pivot-eyes, (see Fig. 2,) or by allowing some free movement to the hinge-rods F in that direction, or by dispensing, after erection, with the upper hinge.

The method of swinging the half-ribs around into position, and joining them at the center, admits of being used in construction of any kind of arches.

The improvement in the construction of bridges consists in combining two half-girders with an arched rib, and is based upon the fact that a continuous girder when supported in the middle has twice the stiffness of two independent girders of half the length and of the same section.

A continuous girder, however, when used to stiffen a metallic arch or suspension bridge loses the advantage it possesses by virtue of its central support, in proportion as the supporting point rises and falls in a different ratio from the end supports of the girder. Strains are then created in its chords due to the bending of the girder from end to end, which increase in intensity in proportion to the rise or fall of the center of the arch (resulting from temperature.)

If the arch be jointed at the middle and the girder be separated at the same point it is evident these strains cannot occur. Now, it is equally evident that if the half-girder be loaded to its maximum capacity it cannot deflect under the load without bending the other half-girder upward, just as though it were continuous. The deflection of the loaded half-girder

will tend to bend or straighten the part of the arch beneath it, and this cannot be done without transferring the compressive strains induced in it throughout its entire length, and producing an effort in the unloaded half of the arch to rise, which will create an upward force against the unloaded half-girder, and thus its stiffness is brought to the support of its loaded neighbor exactly as it would be if the two half-girders formed one continuous whole.

The girders may be made of any suitable material, but they should be made to resist bending in both upward and downward directions. In moderate spans wooden girders may be advantageously used on iron arches.

Where a sufficient rise to the arch cannot otherwise be given, the arch may rise to the top chord of the girders, or even above them. In this case the arch would still be held in form by vertical connections from each joint in its length to the girders. The girders, if properly attached, will be found competent to preserve the form of the arches under unequal loading equally well whether they be above or below the arches. The construction, however, will be much simpler when the girders are above, as shown in Fig. 4.

I do not confine myself to the form of hinges shown, as the same may be considerably modified according to circumstances.

I claim as my invention—

1. The combination of bridge-piers, abutments, towers, or vertical struts with half spans or ribs of a bridge and hinge or pivoted connections to connect the same together, for the purpose of facilitating the construction of the bridge by enabling the half-ribs to be swung around in detail and joined to corresponding half-ribs forming the other half of the span, substantially in the manner set forth.

2. The combination of two independent half-span girders with an arch pivoted at the center for the purpose of preserving the form of the arch when unequally loaded.

JAS. B. EADS.

Witnesses:

SAML. KNIGHT,

ROBERT BURNS.