HISTORIC AMERICAN ENGINEERING RECORD

SPRINGFIELD-DES ARC BRIDGE

HAER No. AR-32

LOCATION:	Spanning the North Branch of Cadron Creek, on County Road 222 (Old Springfield-Des Arc Road), Springfield vicinity, Conway-Faulkner County Line, Arkansas. UTM: 15/544360/3900960 Quad: Springfield, Arkansas
DATE OF CONSTRUCTION:	1871-74
ENGINEER:	Zenas King, Cleveland, Ohio.
FABRICATOR:	King Bridge Manufactory and Iron Works, Iola, Kansas.
BUILDER:	George B. Preston, Conway County, Arkansas.
PRESENT OWNER:	Faulkner County, Arkansas
PRESENT USE:	Vehicular Bridge (Will be closed to vehicles and become a pedestrian bridge in 1989.)
SIGNIFICANCE:	The Springfield-Des Arc Bridge is the oldest remaining highway bridge in Arkansas, as well as the only remaining iron bowstring arch bridge in the state. The bridge is an unaltered example of an iron tubular arch bridge design, patented by Zenas King in 1866. King is a significant nineteenth-century bridge builder, credited with being the first to develop a practical system for mass producing bowstring arch bridges.
HISTORIAN:	Lola Bennett
DESCRIPTION:	Corinne Smith
	Arkansas Historic Bridge Recording Project, 1988

The oldest of only two remaining nineteenth century bridges in Arkansas, the Springfield-Des Arc Bridge is also the last iron bowstring arch bridge in the state, an unaltered example of an iron tubular arch design patented by Zenas King in 1861 and 1866. King is a significant nineteenth-century bridge builder, credited with being the first to develop a practical system for mass-producing bowstring arch bridges. By 1884, his Ohio-based bridge company was the largest highway bridgeworks in the United States. The Springfield-Des Arc Bridge is one of a very few known bridges manufactured by the King Iron Bridge Manufactory and Iron Works of Iola, Kansas, a short-lived branch of the Ohio firm.

The Springfield-Des Arc Bridge was nominated to the National Register of Historic Places in 1988.

EARLY HISTORY OF SPRINGFIELD, ARKANSAS

The town of Springfield, Arkansas, was settled in 1839 and incorporated in 1858. It was an important trade center and the county seat of Conway County from 1850 to 1873. The town developed around two major roads, one oriented north-south, the other oriented east-west. The east-west route, known as the Springfield-Des Arc Road, was used to transport merchandise to Springfield from the steamboat landing at Des Arc. During the Civil War, the Military improved the Springfield-Des Arc Road, and it was used by both Union and Confederate troops.(1)

EARLY CROSSINGS AT NORTH CADRON CREEK

For many years, a ferry crossing was maintained across North Cadron Creek. One of the last ferry operators there was C.A. Simmons. In 1869, he petitioned the county court for a renewal of his ferry operator's licence, and was granted the privilege of charging the following rates on his ferry(2):

Six-horse team	$1.00
Four-horse team	75 cents
Two-horse team	50 cents
Two-horse spring carriage	75 cents
One-horse spring carriage	40 cents
One-ox cart	20 cents
Two-ox cart	40 cents
One man and horse	15 cents
Footman	5 cents
Stock per head	5 cents
Sheep per head	3 cents

Following the Civil War, Arkansas experienced a great increase in population, and consequently, an increased demand for improved roads and river crossings. Apparently, Conway County attempted to bridge at least two major streams before 1870, but had limited success.(3)

COUNTY COURT PROCEEDINGS

In 1871, the citizens of Conway County petitioned the county court for two bridges, one across Cadron Creek on the Des Arc Road, and the other across Point Remove Creek on the Fort Smith Road. The October 1871 court record stated:

> Whereas frequent petitions are coming before the County Court for aid in building bridges across Cadron Creek and Point Remove Creek; and whereas bridges of wood have heretofore proven insufficient in strength and durability for those streams; therefore be

> it ordered by the Court that for the purpose of more effectually bridging those streams Judge A.B. Gaylor, Dr. J.A. Westerfield, and A.D. Thomas be and are hereby appointed Bridge Commissioners and vested with full authority to contract with the most reliable company of wrought-iron bridge manufacturers for two wrought-iron bridges...(4)

At that same session, the court contracted with J.A. Allen for the construction of stone piers for both bridges. On November 8, the contract for the two bridges was awarded to the King Wrought Iron Bridge Company of Iola, Kansas.(5)

CONSTRUCTION OF THE SPRINGFIELD-DES ARC BRIDGE

Construction began almost immediately on the stone abutments for the bridge. The stones were obtained from a quarry about two miles northwest of the bridge site(6), and cut by Alfred Cook, a Springfield stone mason.(7) A team of oxen hauled the stones to the site, where the contractor, James Allen, put them into place.(8)

The bridge itself was fabricated at the Iola, Kansas branch of the King Bridge and Iron Works, and shipped to Lewisburg, Arkansas, for future delivery to the construction site twenty miles north.(9) However, due to a number of political factors, the project was stymied for nearly two years.

CONSTRUCTION DELAYS

In January 1872, J.W. Smith and S.S. Bedinger, owners of a bridge one-and-a-half miles from the Point Remove bridge site, brought a grievance against the county bridge commissioners, claiming that the new bridge was unnecessary, on a road seldom traveled, and located adjacent to property owned by one of the bridge commissioners, A.D. Thomas. Upon investigation, the court found that "contracts were made . . . with no restrictions as to the cost of erecting said bridges . . . thereby leaving the county at the mercy of the commissioners and the bridge company."(10) The court, therefore, cancelled the contract for the Point Remove Bridge and ordered a review of the Springfield-Des Arc Bridge. As a result of these proceedings, A.D. Thomas resigned from the bridge commission, and Judge Gaylor lost his bid for re-election.(11)

Although the Springfield-Des Arc Bridge was found to be a necessary improvement, its construction was further delayed by the formation of Faulkner County in April 1873. Part of Conway County broke off to form part of the new county, and Cadron Creek became the new county boundary. Since half of the Springfield-Des Arc Bridge site was in the new county, Conway County filed a lawsuit against Faulkner County for half the cost of the bridge.(12) To further complicate the situation, the Conway County seat moved from Springfield to Lewisburg that same year.

The matter of the Springfield-Des Arc Bridge was not resolved until January 1874, when the Conway County Court appointed Thomas J. Durham as the new bridge commissioner, and authorized funding for the project. The court chose George B. Preston, "to erect said bridge upon the terms of the original contract heretofore made with the amendment to said contract that the bridge be received by the Bridge Commissioners at its present sight (sic) now situated north of Lewisburgh."(13) The bridge was completed in July at a cost of $12,857.(14) On July 21, 1874, Thomas Durham, special bridge commissioner, reported to the county court:

> I hereby certify that the Iron Bridge on North Cadron near Springfield is now completed and erected upon the abutments in full compliance with the contract made by Conway County with Charles C. Reid, Jr., and attorney for George B. Preston, and that said Bridge, ironwork

> and woodwork is completed and finished as fully contemplated by the terms of said contract.(15)

RECENT HISTORY OF THE SPRINGFIELD-DES ARC BRIDGE

The Springfield-Des Arc Bridge, now well over a century old, has been threatened by numerous hazards over the years, not the least of which were three major floods in 1882, 1927 and 1982. The Arkansas Gazette described the 1882 flood this way:

> At Pinnacle the water rose within 5 feet of the spring on the bluff; the foundation of the bath-house was completely submerged, and the water was fully 15 feet higher than was ever known before. . . . On the Mallet farm, water covered large old apple trees, where it was never seen before. At the iron bridge it was more than a mile wide, and deep enough to sweep over the floor of the bridge.(16)

On one occasion, a heavy log truck fell through the floor of the bridge. Another time, the bridge floor burned--some people suspected arson. Most recently, a bulldozer went through the floor of the bridge.(17) Several times, the bridge has been condemned as a danger, but for lack of a more convenient crossing, it has remained in use.

In 1983, realizing the significance of the bridge, the Conway Chamber of Commerce and the Faulkner County Historical Society began a campaign to preserve the structure, one result of which was a nomination to the National Register of Historic Places. The bridge is scheduled to be replaced in 1989 by a concrete span a short distance upstream. The old bridge will be restored, vehicle barriers erected, and a park developed at the surrounding site.(18)

KING BRIDGE AND IRON WORKS

Zenas King was born in Vermont in 1818. Five years later, he moved with his family to upstate New York, where he grew up on the family farm. He left the farm in 1840 and went to Milan, Ohio, where he held a number of successive positions, as a carpenter, a clothing merchant, and a salesman.(19) King's first experience with bridge building occurred in 1858, when he became an agent for the Moseley Bridge Company in Cincinnati, Ohio. The company's owner, Thomas W.H. Moseley, was the inventor of the first practical tubular arch bridge in America made from wrought iron boiler plate.(20) In a relatively short time, King began to experiment with a tubular bowstring design of his own. Moseley moved to Boston about 1860, and King went to Cleveland, where he established a bridge and boiler works.

Although King hoped to establish his business on the basis of marketing an innovative bowstring arch bridge, it was more likely his introduction of mass-produced wrought iron bridge parts that eventually led his company to become one of the leading bridge companies in the United States during the second half of the nineteenth century.(21)

In 1870 King established a branch of his bridgeworks in Iola, Kansas. About a year later, the branch moved to Topeka, claiming that they needed better transportation facilities.(22) Fragmentary documentation, however, indicates that the company branch went bankrupt.(23) The Springfield-Des Arc Bridge was probably one of a very few bridges manufactured by the Iola plant. Despite the failure of the Iola branch, the Cleveland firm thrived throughout the next few decades. King's use of standardized parts allowed his company to manufacture large quantities of bridges, and agents and subsidiary companies allowed King to distribute his bridges over a large geographical area.(24) Although King died in 1892, the firm continued into the twentieth century.(25)

ZENAS KING'S PATENT

The rapid growth of highway and railroad systems in the second half of the nineteenth century "fostered bridges which were efficient in their use of materials and labor."(26) The bowstring was considered a very efficient design because of its high carrying capacity and use of a relatively small amount of iron.(27)

King's bowstring arch bridge design incorporated a tubular arch, which increased in size toward the crown of the arch, where the strain would be greatest. (See patent in appendix.) A uniform section would be wasteful of materials. The first two times King and his assistant, Peter Frees, applied for a patent, they were refused on the grounds that the concepts were not new, because Charles DeBergue, an Englishman, had patented a similar design in 1848.(28) Eventually, in 1861, King and Frees received their patent, after showing that their design incorporated continuous wrought iron plate in the top chord, as opposed to DeBergue's short cast iron sections.(29) King received a second patent in 1866, for an "improvement" to his original design, which in effect reversed the configuration of the first design. This time, the tubular section of the top chord increased at the ends of the arch, and got smaller at the crown. The following year, he revised the patent again, eliminating the varied section of the arch.(30) The Springfield-Des Arc Bridge follows the design of the 1866 patent reissue, with the tubular chord of the arch getting larger at either end.

DESCRIPTION

The Springfield-Des Arc Bridge is a cast- and wrought-iron, single-span, bowstring arch through truss. Its span length is 146', and timber stringer approaches on either end give an overall length of 188'. The overall width is 19'4", and the roadway is 11'6" wide. The bridge has built-up members, punched eyebars with pinned connections, wrought-iron tension members, cast-iron connections, and stone abutments. Zenas King's innovation in metal bridge construction was the pre-fabrication of metal parts and cast-iron connections that could be used on many different bridges. The stock number for each cast-iron part was inscribed in the mold, thus labeling the finished part for field assembly.

The top chord is constructed with two channel sections riveted to two wrought-iron boiler plates to form a tubular section. The channels are oriented to form recesses on the top and bottom surfaces of the chord. The four main elements of the chord are spliced in different locations to eliminate weak joints in the arch. This bridge span length approaches the limit for a bowstring arch, so the compression forces in the top chord near the abutments are greater than normal. To strengthen the arch at the ends, the cross-sectional area of the top chord is increased in two ways: first, an additional channel bar is rivetted to the center of the arch tube and runs from each end up to the middle of the fourth panel; secondly, the depth of the chord is increased gradually from the crown of the arch down toward the abutments by increasing the width of the boiler plates from 8½" to 11½". Each end of the arch sits in a cast iron bearing shoe that rests on the top of dry-laid stone abutments; the north bearing shoes are on steel plates that rest on the abutments.

The bearing shoe connects the arch to the bottom tension chord. The bottom chords are double, rectangular punched eyebars, wrought from large rods. The rod, still present at the ends, is threaded where the bottom chord screws into the bearing shoe. The 30-inch-long eyebars are connected by cast-iron pins.

Fifteen vertical, wrought-iron cruciform posts extend through the top chord and are fastened with nuts and cast-iron skewbacks from mold #151 of King's ironworks shop. Cast-iron joint blocks and clamps on the bottom chord connect the vertical posts to the chord, the crossed counters in each panel, wrought-iron floor beams, and the wrought-iron rods bracing the floor. The wrought-iron counters are 1'and 1¼" in the first four panels from each end where the member forces are greater, and 7/8" in the other panels. The counters extend through the top chord and are fastened with cast iron skewbacks and nuts. The two larger rods use skewback #35, and the thinner rod uses skewback #53. One vertical post and five counters (two in one panel) are missing. Two posts are bent, probably from being hit by vehicles, and most of the counters are very loose. The 5/8" rods bracing the floor span two panels in both diagonal directions, and are attached at each panel point. Most of these rods are missing on the south half of the bridge.

The lateral stability of the bridge is maintained by the floor rods, five outriggers, and six top struts. The outriggers, cruciform in section, extend from the outside of the top chord to the ends of channel-section floor beams, a distance 4'6" perpendicular to the bottom chord. The outriggers, folded into a flat section at the top, are bolted to the top chord, and held by nuts in a ring rivetted to the end of the floor beam. These braces and beams are located at the fourth, sixth, eighth, tenth, and twelfth verticals. The metal beams and intermediate wooden beams rest on the bottom chord and support the 3-inch-thick wooden plank deck. The present wooden members have replaced the original wood beams and deck. Three metal I-beam sections have been used in the first three panels at the south end of the bridge to reinforce the floor system. The six top strut posts, cruciform in section, form five panels of top lateral bracing. The middle panel is 11 inches wide, and the other four are 13'6" wide on the average. Each pair of strut posts is connected by 1¼-inch wrought-iron rods. Two pairs of strut posts, and all but two rods, are missing.

The parts of the bridge were pre-fabricated at the bridge company according to King's design. In the field, the construction workers were required to rivet the top chord together and to punch the holes in the top chord for posts and diagonals to pass through. The placement of holes and members were based on King's drawings. Apparently, an error was made in placing the first vertical on the west arch. The first panel should be 9'6" long, but the measurement was off by one foot. The rest of the panels on the west arch are spaced correctly. This places the verticals from one arch to the other off by one foot, creating a visual skew in the bridge, and also skewing the floor beams and all members connected to the verticals.

ENDNOTES

1. Guy Murphy, "The Springfield-Des Arc Bridge," Faulkner County Facts and Fiddlings, Fall/Winter 1987 (Conway, Arkansas: Faulkner County Historical Society), pp.1-2.

2. Conway County Court Records, 1869, Book A, pp.83-84.

3. Court Records, October 1871.

4. ibid.

5. Court Records, November 8, 1871.

6. Murphy, p.4.

7. ibid.

8. ibid.

9. Court Records, January 26, 1874.

10. Court Records, January 1872.

11. Michael Swanda, National Register Nomination: Springfield Bridge, (Little Rock: Arkansas Historic Preservation Program, 1988.)

12. Court Records, April 1873.

13. Court Records, January 26, 1874.

14. Court Records, July 1874.

15. Court Records, July 21, 1874.

16. Arkansas Gazette, May 23, 1882 (Little Rock).

17. Murphy, p.5.

18. "Counties team up to preserve bridge," Arkansas Gazette, (September 1987).

19. David A. Simmons, "Zenas King: A Bridge Builder of National Proportions," report on file (Columbus: Ohio Historical Society, 1986), pp.1-2.

20. ibid., p.2.

21. ibid., p.1.

22. Larry Jochims (Kansas State Historical Society) Letter to Michael Swanda (Arkansas Historic Preservation Program), March 25, 1988.

23. ibid.

24. Simmons, p.9.

25. ibid., p.19.

26. ibid., p.3.

27. ibid.

28. ibid., p.4.

29. ibid.

30. Zenas King, Patent No. 33384, October 1, 1861; Patent reissue No. 2707, July 30, 1867 (U.S. Department of Commerce, Office of Patents and Trademarks).

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"Bridge No. 13045," Arkansas Highway and Transportation Department file. Little Rock, Arkansas.

Conway County Court Records, 1869-1874 (Books A-H). Conway County Courthouse, Morrilton, Arkansas.

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McClurkan, Burney B. "Arkansas' Historic Bridge Inventory, Evaluation Procedures, and Preservation Plan," report on file. Arkansas Highway and Transportation Department, Little Rock, 1987.

Murphy, Guy W. "The Springfield-Des Arc Bridge," Faulkner Facts and Fiddlings, Fall/Winter 1987. Faulkner County Historical Society, Conway, Arkansas.

Simmons, David A. "Zenas King: A Bridge Builder of National Proportions," report on file. Ohio Historical Society, Columbus, 1986.

Swanda, Michael. National Register Nomination: Springfield Bridge. Arkansas Historic Preservation Program, Little Rock, 1988.

UNITED STATES PATENT OFFICE.

ZENUS KING, OF MILAN, AND PETER M. FREES, OF CINCINNATI, OHIO.

IMPROVEMENT IN TRUSSED BEAMS FOR BRIDGES, &c.

Specification forming part of Letters Patent No. 33,384, dated October 1, 1861.

To all whom it may concern:

Be it known that we, ZENUS KING, of Milan, in the county of Erie and State of Ohio, and PETER M. FREES, of Cincinnati, in the county of Hamilton and State of Ohio, have invented a new and useful Improvement in Iron Bridges; and we do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings and the letters of reference marked thereon, making part of this specification.

Our invention relates to that class of bridges which have tubular iron arches, and in which the roadway is supported by a tie-beam attached to each end or foot of the arch, and connected to the arch by radial rods passing at various points from one to the other.

Our invention consists in the construction of these arches, which we make with a gradually-increasing sectional area from each foot toward the center or crown of the arch, so as to make the arch proportionately more resistant to deflection at all the points where an increase of deflection would naturally take place, and, vice versa, diminishing the sectional area of the arch as the deflection would naturally decrease from the ends receiving more directly (from their contiguity) the vertical support of the abutments, when a weight of any kind passed over the bridge, thus making each section equally strong in proportion to the deflection which it has to resist, and thereby insuring an extremely stable structure. This increase in the sectional area of the arch is generally confined to its vertical dimensions and does not ordinarily include its width or lateral measurement. All structures of this kind are really stronger and more capable of enduring the wear and tear or resisting any accident to which they are liable when they are equally rigid and equally flexible at all points in proportion to the amount of resistance which each point has to exert to the work or weight which tends to injure or destroy it, and this desideratum is fully attained by this method of constructing bridges.

The object of our invention is to make a bridge of the same strength with less metal than is now employed by distributing the metal in proportion to the strain it has to bear, and thus lightening the bridge, or to make a much stronger bridge by employing the same amount of metal now employed. These are of course great advantages.

In the drawings, Figure 1 is a side elevation of the whole bridge, and Fig. 2 is a cross-section taken through the line x x' in Fig. 1.

The same letters of reference indicate similar parts in each.

A is the arch, extending from pier to pier and resting on each pier in a suitable and proper bearing, as at B. This arch is constructed of two side and parallel plates C, which are connected together by an upper and lower plate I, running the whole length of the arch and having their edges turned at right angles in order to allow of their being riveted to the side plates, and so forming a hollow arched girder. Between these two plates I a stay-plate I' is placed and riveted to the side plates C to give rigidity and strength to the structure. These angles and rivets are seen at a, Fig. 2. As will be seen in Fig. 1, the arch gradually increases in sectional area vertically from the point A'—one foot of the arch—to the point x—the center or crown of the arch—and gradually diminishes in sectional area vertically from the point x to the other foot of the arch A''. Each foot of the arch rests in a suitable step G, to which the tie-beam E is also secured by stirrups H, whose ends are threaded and pass through holes in the back of the step on each side of the arch, where they are secured by nuts c. This tie-beam is constructed of two parallel plates or bars connected by eyes, or in any other suitable way.

Connected to the tie-beam by pins F are one series of radial rods D, which pass upward to the arch above them, where they are secured in the following way: In the upper and lower plates I, which connect the side plates horizontally, and in the central stay plate a hole or aperture is cut large enough to admit of the radial rod D passing through it, and on the upper end of the radial rod a screw-thread is cut. Fitting in the recess formed by the top plate I and its junction with C by means of the portion turned up at right angles to it, to be riveted to C, is a cast-iron washer or plate J, whose under side is channeled by grooves b to admit of any rain passing through over the top of the arch to the ground which would otherwise lodge on the top and tend to rust the bridge, and thus cause premature decay. Through this passes also the end of the radial rod D and on it the nut K, which secures the rod in its place, rests. By having the nut rest on this plate the strain of the radial rod is distributed equally over all parts of the arch which naturally belong to it. A nut L is also screwed around the rod D up to the lower horizontal plate I to prevent any vibration of the rod, and thereby prevents the rod wearing out the holes through which it passes, and thus becoming loose.

We have described our improvement as applied to tubular arches having a rectilinear cross-section. It is, however, equally applicable to tubular wrought-iron arches made in other forms.

Having thus described our improvement in the construction of tubular metallic bridges, what we claim as new, and desire to secure by Letters Patent, is—

The peculiar formation or configuration of the arch A, the same being made to increase gradually in its vertical and lateral dimensions from the ends A′ A″ of the arch to its center or crown, in the manner as described, for the purposes set forth.

Z. KING.
P. M. FREES.

Witnesses:
WM. CLOUGH,
CHARLES L. FISHER.

Frees & King.

Truss Bridge.

No. 2,380.
33,384.

Patented Oct. 1, 1861.

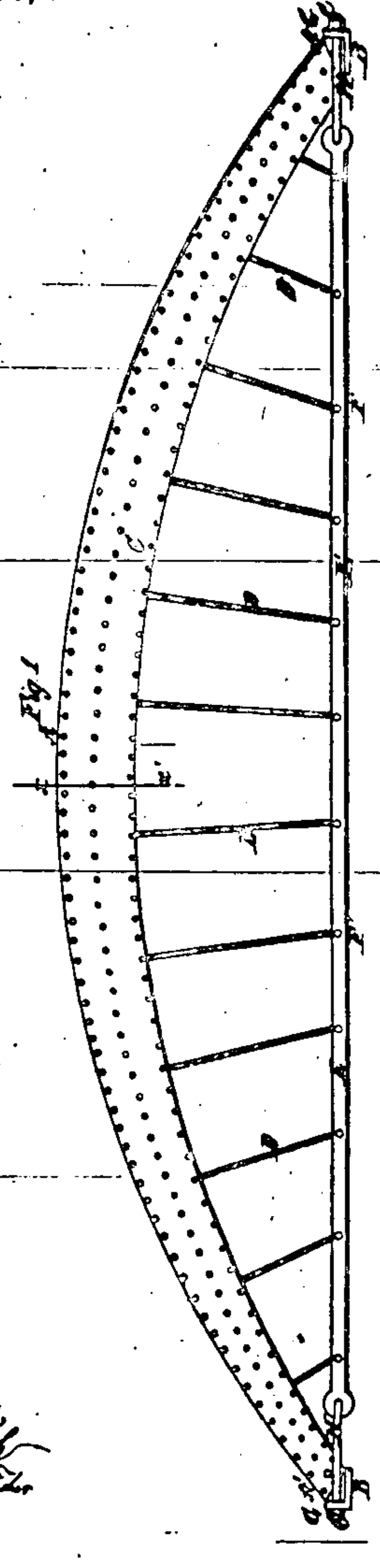


Fig. 1

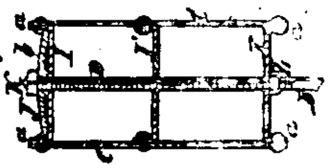


Fig. 2

Witnesses,
W. Clough
Charles [illegible]

Inventors
J. King
P. W. Frees

UNITED STATES PATENT OFFICE.

ZENAS KING, OF CLEVELAND, OHIO, FOR HIMSELF, AND ASSIGNEE OF P. M. FREES.

IMPROVEMENT IN BRIDGES.

Specification forming part of Letters Patent No. 2,380, dated October 1, 1861; reissue No. 2,767, dated July 30, 1867.

To all whom it may concern:

Be it known that I, ZENAS KING, of Cleveland, Cuyahoga county, Ohio, have, in connection with P. M. FREES, formerly of Cincinnati, Ohio, and assignor to said KING, invented certain Improvements in Bridges; and I do hereby declare that the following is a full and exact description thereof, reference being had to the accompanying drawings and to the letters of reference marked thereon.

This invention relates to that class of bridges which have tubular iron arches, and in which the roadway is supported by a tie-beam attached to each end or foot of the arch, and connected to said arch by iron rods passing at various points from one to the other.

These arches are constructed with a gradually-increasing sectional area from each foot toward the center or crown of the arch, so as to make the arch proportionally more resistant to deflection at all the points where an increase of deflection would naturally take place, and vice versa, diminishing the sectional area of the arch, as the deflection would naturally decrease from the ends receiving more directly, from their contiguity, the vertical support of the abutments when a weight of any kind passed over the bridge, thus making each section equally strong in proportion to the deflection which it has to resist, and thereby insuring an extremely stable structure. This increase in the sectional area of the arch is generally confined to its vertical dimensions, and does not ordinarily include its width or lateral measurement.

This improvement also relates to the channel-irons or stay-plates, so constructed and arranged in relation to an arch that the said plates form a vertical and lateral support to the bridge, the said plates being constructed with a flange or rim on one or both sides, so as to have two or more, and conforming to the spring or sweep of the arch; and, in addition, the said plates, by means of the flanges, admit of side or top plates being so secured to them that a continuity in the structure of the bridge is attained. The said plates may be so formed or bent as to be either placed on the side, top, bottom, or other parts of the arch, of any form, and without regard to the outer or inner lines of the arch being parallel.

The object of this invention is to make a bridge of the same strength with less metal than is ordinarily used, by distributing the metal in proportion to the strain it has to bear, and thus lightening the bridge; or to make a much stronger bridge, by employing the same amount of metal now employed. The importance of these advantages need not be enumerated, as they are well understood.

In the drawings, Figure 1 is a side elevation of the whole bridge. Fig. 2 is a cross-section taken through the line *x x'* in Fig. 1.

The same letters of reference indicate similar parts in each.

A is the arch, extending from pier to pier, and resting on each pier in a suitable and proper bearing, as at B. This arch is constructed of two side plates, C, which are connected together by an upper and lower plate or plates, I, running the whole length of the arch, and having their edges turned at right angles, forming a flange or rim, *a*, in order to allow of their being riveted to the side plates, and so forming a hollow arched girder or chord. Between these two plates I a stay-plate, I', of like character, is placed and riveted to the side plates C, to give rigidity and strength to the structure. These angles and rivets are seen at *a'*, Fig. 2. The angles or rims *a* may be formed on each side of the plates opposite to each other, so as to be I-shaped, making rims on each side, which would admit of additional riveting and strength to the structure. The stay-plates or channel-irons I' may be so combined in the structure as to take the place of the side plates C, in which case plates would be secured to the rims or angles of the stay-plates, so as to form the outer and inner line of the arch. As will be seen in Fig. 1, the arch gradually increases in sectional area, vertically from the point A', one foot of the arch, to the point X, the center or crown of the arch, and gradually diminishes in sectional area, vertically from the point X to the other foot of the arch A''. Each foot of the arch rests in a suitable step, G, to which the tie-beam E is also secured by stirraps H, which ends are threaded, and pass through holes in the back of the step on each side of the arch, where they are secured by nuts c. This tie-beam is constructed of two parallel plates or bars, connected by eyes or in any other suitable way. Connected to the tie-beam, by pins F, are series of iron rods, D, which pass upward to the arch above them, where they are secured in the following way: In the upper and lower plates I, which connect the side plates horizontally, and in the central stay-plate, a hole or aperture is cut large enough to admit of the radial arm D passing through it, and on the upper end of the radial rod a screw-thread is cut. Fitting in the recess formed by the top plate I and its junction with C, by means of the portion turned up at right angles to it, to be riveted to C, is a cast-iron washer or plate, J, whose under side is channeled by grooves b, to admit of any rain passing through over the top of the arch to the ground, which would otherwise lodge on the top, and tend to rust the bridge, and thus cause premature decay. Through this means, also, the end of the radial rod D, and on it the nut K, which secures the rod in its place, rests. By having the nut rest on this plate, the strain of the radial rod is distributed equally over all parts of the arch, which naturally belongs to it. A nut, L, is also screwed around the rod D, up to the lower horizontal plate I, to prevent any vibration of the rod, and thereby prevents the rod wearing out the holes through which it passes, and thus becoming loose.

Having described the improvement as applied to tubular arches having a rectilinear cross-section, it is, however, applicable to tubular wrought-iron arches made in other forms or structures.

Having thus described the improvement in the construction of tubular metallic bridges, what is claimed as new, and desired to be secured by Letters Patent, is—

1. The construction and arrangement of the arch when the same increases gradually in its vertical and lateral dimensions from the ends A′ A″ of the arch to its center or crown, substantially as and for the purpose set forth.

2. The construction and arrangement of the arched or curved stay-plates or channel-irons in combination with arched bridges, for the purpose specified.

ZENAS KING.

Witnesses:

W. H. BURRIDGE,

E. E. WAITE.

Frees & King.
Truss Bridge.

No. 2,707. Reissued Jul. 30, 1867.

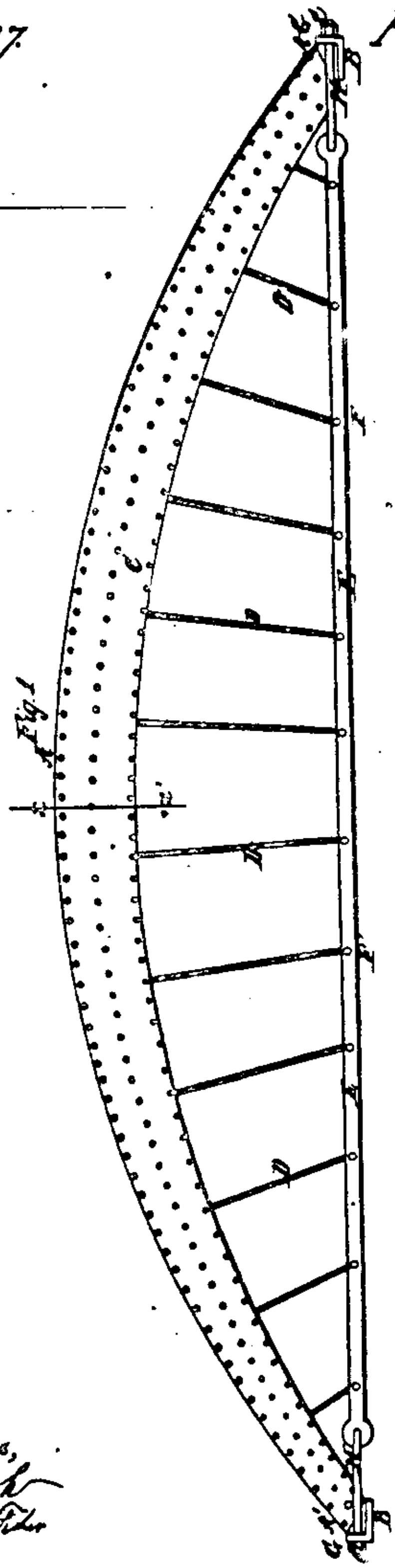


Fig. 1

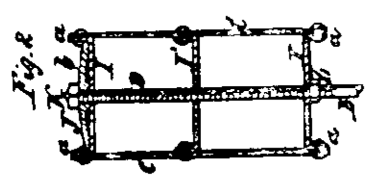
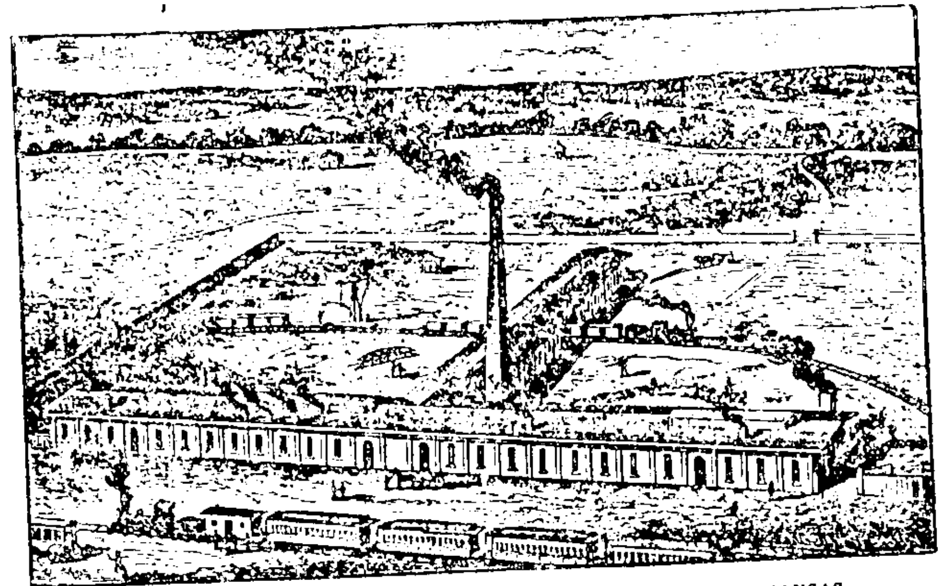


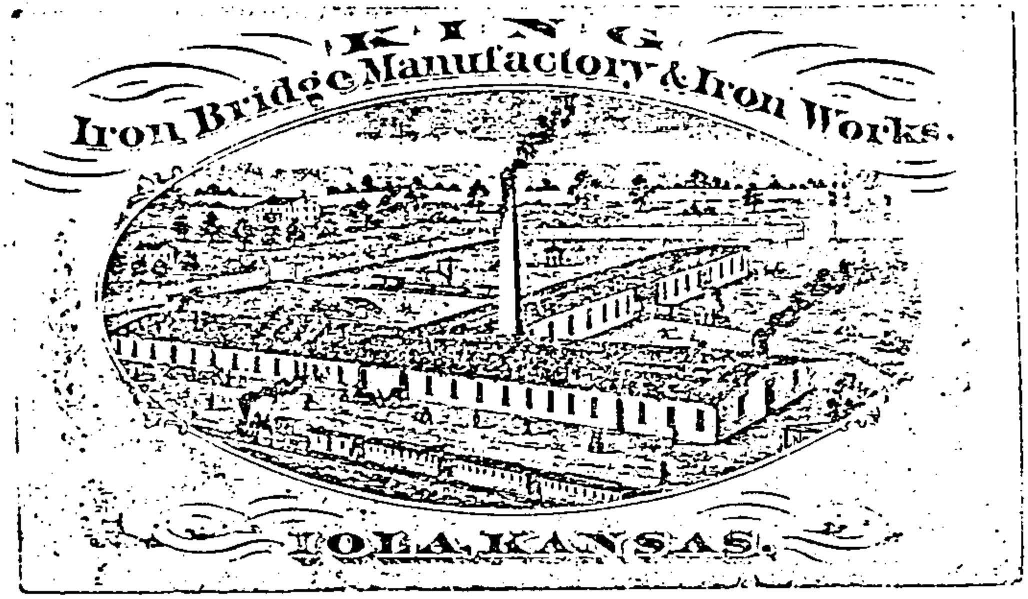
Fig. 2

Witnesses,
Wm Clough
Charles L. Fisher

Inventors
G. King
P. M. Frees



KING IRON BRIDGE MANUFACTORY AND IRON WORKS, IOLA, KANSAS.



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