Bardwell's Ferry Bridge
Spanning the Deerfield River on Bardwell's Ferry Road
Shelburne/Conway
Franklin County
Massachusetts

HAER No. MA-98

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PHOTOGRAPHS
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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Department of the Interior
Washington, DC 20013-7127

HISTORIC AMERICAN ENGINEERING RECORD

BARDWELL'S FERRY BRIDGE
HAER No. MA-98

Location:	Spanning the Deerfield River on Bardwell's Ferry Road, approximately three-and-a-half miles south of the intersection of State Highway 2, between the towns of Shelburne and Conway, Franklin County, Massachusetts UTM: Shelburne Falls, Mass., Quad. 18/690620/4713870
Date of Construction:	1882
Structural Type:	Wrought-iron lenticular through truss bridge
Engineer:	Unknown; design based on 1878 patent by William O. Douglas
Fabricator/ Builder:	Corrugated Metal Company, East Berlin, Connecticut
Owner:	Towns of Shelburne and Conway, Massachusetts
Use:	Rural vehicular and pedestrian bridge
Significance:	The Bardwell's Ferry Bridge is an excellent, virtually unaltered, example of William Douglas's 1878 patent for a wrought-iron lenticular truss bridge. It is one of approximately fifty lenticular truss bridges to survive nationally, and one of only ten known surviving lenticular truss bridges in Massachusetts (eight of which are under Massachusetts Department of Public Works purview). It is thought to be the longest single lenticular span in the state. The bridge is nationally significant as one of the longest and oldest surviving lenticular truss spans in the United States. The bridge's fabricator, the Corrugated Metal Company, became the Berlin Iron Bridge Company in 1883, and went on to become one of the leading bridge-building companies in New England in the late-nineteenth century.
Project Information:	Documentation of the Bardwell's Ferry Bridge is part of the Massachusetts Historic Bridge Recording Project, conducted during the summer of 1990 under the co-sponsorship of HABS/HAER and the Massachusetts Department of Public Works, in cooperation with the Massachusetts Historical Commission. Lola Bennett, HAER Historian, August 1990

Description

The Bardwell's Ferry Bridge is a 198-foot, pin-connected, wrought-iron lenticular through truss. The design of the thirteen-panel truss follows William O. Douglas's 1878 patent quite closely. The upper chord, a polygonal curve in elevation, is a built-up member, comprised of two 12" plates, one 18" plate and four angles, connected on the underside with tie plates. The lower chord, also a polygonal curve in elevation, is comprised of two pairs of 1"x3" eyebars. The upper chord and lower chord are connected by verticals, comprised of two pairs of 3"x2" angles, connected with lacing and tie plates. The verticals are connected to the top chord and bottom chords, by means of a pin at either end. The floor beams, tapered, built-up members of a plate and four angles, hang from the verticals by means of 1¼" square bars, which loop over the pins through the lower chord and pass through the flanges of the floor beams and are secured underneath with a plate and nuts. Timber stringers, 4"x12", run between the floor beams, and support the 15'-wide plank deck. Lower lateral bracing consists of rods, approximately 1" in diameter, with turnbuckles at the ends, crossing between panel points. Upper lateral bracing consists of the same type of rods, crossing between panel points; transverse struts, comprised of four angles with lacing, at panel points U3, U5, U8, and U10; and transverse sway bracing, in the vertical plane above the struts. Diagonal bracing, between the vertical members, consists of 1" diameter rods with loop-welded eyes and turnbuckles. A longitudinal tie rod, approximately 1" in diameter, runs the length of each truss through the center panel points, flaring up to the top chord in the second panels from the end. A longitudinal sway bracing member, comprised of two pairs of 3"x2" angles connected with webbing, runs the length of each truss below the level of the lower chord, between the end posts, and is riveted to the floor beams. The open lattice end posts, aligned vertically at the junction of the upper and lower chords of each truss, are 12" plates, built up with two 2½"x2½" angles, connected with lattice and tie plates.[1] The top of each post is boxed-in around the connection, and covered with a decorative, cast-iron cap. The portals are defined by the endposts, with a latticed transverse strut running between them. The builder's plates, which were fastened directly above each portal, are no longer in place. The southwest end of the bridge is fixed to the granite pier by means of a plate and bolts, while the northeast end rests on a nest of rollers on the abutment. At the southwest end of the bridge, is a 32-foot steel girder approach span, with steel floor beams and stringers, and a wood plank deck.(See Figure 1, HAER drawings, and photographs.)

Bardwell's Ferry

The place known as "Bardwell's Ferry" is located in the southernmost section of the town of Shelburne on the Deerfield River, which is the boundary between Shelburne and Conway, Massachusetts. Bardwell's Ferry operated for close to eighty-five years during the eighteenth and nineteenth centuries, and had such an impact on the history of the area, that even today the place is referred to as Bardwell's Ferry, and the road leading to it is known as Bardwell's Ferry Road.

According to his descendants, Gideon Bardwell settled in the southern

part of Shelburne, near the Deerfield River, around 1778, and shortly thereafter, he began operating a ferry across the river at that place. The first written evidence of this is a town record from 1784, which mentions "Gideon Bardwell's Ferry."[2] Later records, maps, and histories refer to the southern part of Shelburne as "Bardwell's Ferry," and to Gideon Bardwell as "the ferryman."(See Figures 2-4.) As time went on, the operation of the ferry passed on to Gideon's son Joel, and later to his grandson Orsamus O. Bardwell.[3](See Figure 5.) Orsamus, who is said to have "entered largely into local improvements," was "the first to project, and afterward was mainly instrumental in procuring, [a] bridge across the river near this point."[4]

The need for a bridge at Bardwell's Ferry became evident shortly after the Troy & Greenfield Railroad was chartered in 1848. Their plan was to lay tracks from Greenfield (about nine miles east of Bardwell's Ferry) through the Deerfield River Valley to North Adams, and eventually to Troy, New York. In June of 1855, the engineers surveyed Orsamus Bardwell's land, and shortly thereafter, the railroad company purchased land on his river bank sufficiently wide enough for a single track.[5] On June 25, 1860, the Greenfield newspaper reported: "The contractors on the railroad commenced grading on the 16th at Bardwell's Ferry."[6]

By the summer of 1867, work on the railroad was progressing rapidly, a railroad bridge had been framed across the Deerfield River near Bardwell's Ferry, and tracks had been laid to a point about six miles west of Greenfield.[7] The full impact that this railroad would have on the people of the local communities could not yet be measured, but the newspaper hinted at the potential economic boom that lay ahead:

> Not less than fifteen towns lying on each side of [the railroad] between Greenfield and Adams, will find it the most ready and accessible outlet for their present business, and through it will receive an impetus to business and development which in the future will make it, not only the most important part of Franklin county, but will make Franklin county one of the most important counties in wealth and influence in Massachusetts.[8]

Bardwell's Ferry Bridge

At about that time, Orsamus Bardwell and others petitioned the county commissioners to upgrade the road leading to the river crossing. In their petition, they set forth that the road was out of repair and unsafe for public travel and that this danger was greatly increased by the building of the railroad, which was going to increase vehicular traffic in the area of Bardwell's Ferry, and thus necessitated a change in the road, and the construction of a bridge across the river.[9] After due consideration, the county commissioners ordered the road to be changed, and a bridge to be constructed between the towns of Shelburne and Conway. The matter was to be brought up at the August town meeting in Shelburne, and was stated in the warrant, as follows:

> Article 2--To see if the town will choose a committee to superintend the building of a bridge across Deerfield River in

> connection with the town of Conway and a road from O.O. Bardwell's to said bridge as ordered by the County Commissioners.[10]

The town voted that the selectmen be the committee, and authorized them to "raise on the credit of the town Three Thousand Dollars to defray the expense of building the said Road and Bridge."[11] On November 6, 1867, the towns of Shelburne and Conway contracted with Hartwell & Sprague of Northampton,

> "to construct, erect and complete, in a thorough and workmanlike manner, a substantial Bridge of the "Howe pattern," so called, across Deerfield River, at a point indicated by said County Commissioners in their said orders to the towns of Shelburne and Conway--said Bridge to be built of good straight-edged spruce timber, except as hereinafter specified ... And said Bridge is to be fully completed and finished on or before the first day of July A.D. 1868.[12]

A few years later, the bridge needed tightening, but Conway refused to help keep the bridge in repair. The main cause of the problem was a boundary line dispute, wherein the bridge was actually located in Shelburne, the south side of the Deerfield River being the boundary between the two towns. Shelburne argued that the majority of the people using the bridge were residents of Conway, as the railroad station was on the Shelburne side of the river, but to no avail. Finally, after much bickering, on November 7, 1873, the town of Shelburne petitioned the state legislature for a change in the boundary line.(See Appendix A.) In February of the following year, the town recinded the petition, and requested instead that Conway simply be forced to pay their share for maintenance of the bridge. The Legislature granted this request by an act approved April 28, 1875, which read:

> The towns of Conway and Shelburne shall jointly maintain and keep in repair the bridge across the Deerfield River near Bardwell's Ferry, with its abutments, and be jointly liable for all penalties and damages for any neglect in keeping the same safe and convenient for travel.[13](See Appendix B.)

Just a few years after the maintenance matter was resolved, however, on January 27, 1882, the bridge was blown off its abutments in a storm. The newspaper reported: "The wind did considerable damage here (Conway) Friday morning. Mr. Dole, who went out with the morning mail, was obliged to come back because the bridge had blown down at the ferry."[14] The following month, at separate town meetings, Shelburne and Conway both voted to rebuild the Bardwell's Ferry Bridge. In Shelburne at least, "many favor(ed) the construction of an iron bridge."[15]

On March 9, 1882, the selectmen of Shelburne and Conway contracted with the Corrugated Metal Company of East Berlin, Connecticut, "to build, paint, and make complete, and have ready for use, by the 20th day of May 1882, ... a Wrought Iron Parabolic Truss Bridge."(See Appendix C.) This bridge was to be 198 feet long, with a 16-foot roadway. The contract price was $7000, shared equally by the two towns.[16] On April 15 the towns of Shelburne and Conway

contracted with George G. Merrill, a stone mason from Shelburne,

> to make, erect, build and finish in a good and workman-like manner and according to his best skill, the abutment and pier of stone for the bridge at Bardwell's over Deerfield River.[17] (See Appendix C.)

On May 27 Engineering News reported, "The Corrugated Metal Co., of (East) Berlin, Ct., have now on hand ... 1 span, 198 ft., for Conway, Mass."[18] Two days later, the Greenfield paper stated that at Bardwell's Ferry, "The new iron bridge has arrived, but has not yet been taken from the cars."[19] The contractors set to work immediately, and the bridge was completed within a few weeks. On July 17 the newspaper carried this item: "The Bardwell's Ferry bridge is completed and proves to be a fine looking structure."[20]

The Corrugated Metal Company

The lenticular (lens-shaped) truss is unique among truss forms of its day, in that it combined many of the advantages of arch, cable and truss systems into a single structure. When the Corrugated Metal Company began building trusses in the late 1870s, the lenticular form had already been known for a number of years. Lenticular trusses had been built in France, England and Germany in the 1840s and 50s. Patents for bridges of the lenticular form had been granted in the United States to Edwin Stanley in 1851 and to Horace Hervey and Robert Osborne in 1855.[21]

Considering these early bridges and patents, historians have considered it somewhat odd that in 1878 the United States Patent Office issued a patent to William O. Douglas of Binghamton, New York, for "an elliptical bridge-truss."(See Appendix D.) It is not known where Douglas received the inspiration for his patent, but bridge historian Victor Darnell has suggested that he may have designed it without any knowledge of precedents.[22] In any case, it was Douglas's patent that launched the Corrugated Metal Company into a very profitable bridge-building career.

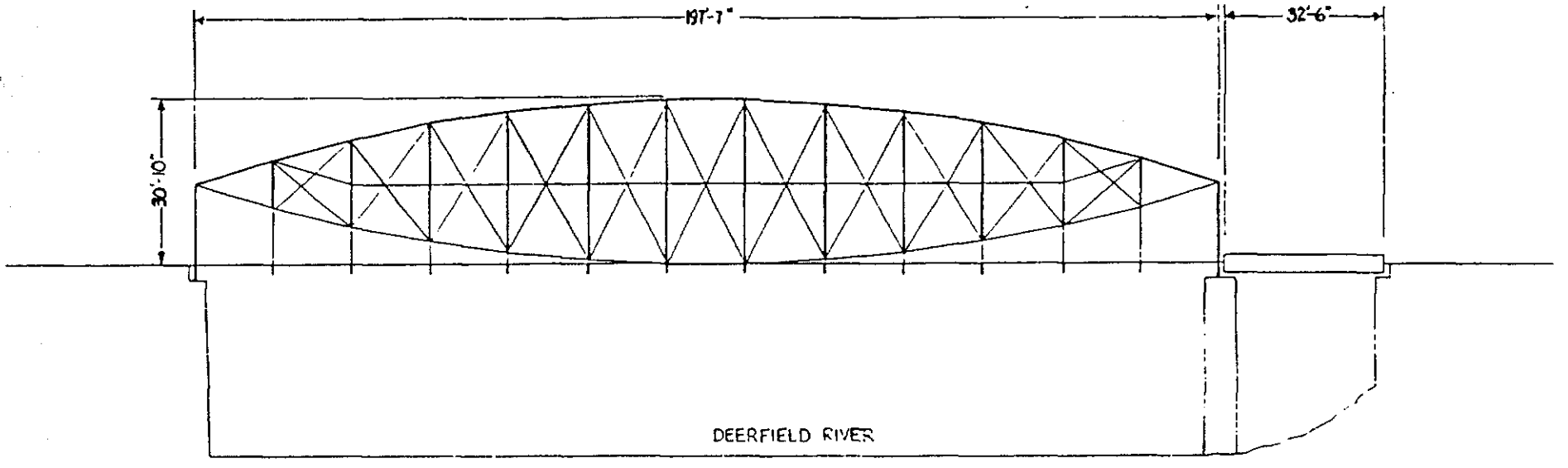
The Corrugated Metal Company was actually a descendent of the Berlin tinware industry that began in the 1740s. The business progressed to the manufacture of metalworking machinery, and from there to other forms of metal fabricating. In 1868 an East Berlin company by the name of Roys & Wilcox, manufacturers of tinner's tools and machinery, transferred part of their land to the American Corrugated Iron Company, which Roys had organized. Three years later, the property was again transferred, and the Metallic Corrugated Shingle Company was incorporated. In 1873 the concern became The Corrugated Metal Company, manufacturers of corrugated iron and roof trusses for buildings.

In 1877 the company was on the verge of bankruptcy when S.C. Wilcox became president. That same year, Douglas also became associated with the company as Treasurer and Executive Manager. Under Wilcox, the company obtained the exclusive rights to Douglas's patent.[23] As evidenced by the company's early advertisements, the first lenticular bridges were apparently rather crude structures.(See Figure 6.) Under the expertise of the company's chief engineer, Charles M. Jarvis, however, the lenticular design was

perfected by changing the shape of the chords so that the pins were placed at points of true parabolas.[24] This change, dramatically illustrated in later advertisements, was the turning point for the company, and their business began to grow rapidly.(See Figure 7.) On March 13, 1883, the name was again changed, this time to The Berlin Iron Bridge Company. By the mid 1890s, the company had built more than 600 lenticular spans in the Northeast, about fifty of which have survived to the present.[25]

The company built other types of bridges as well, but the lenticular spans were popular and the company used the design to compete with other bridge building companies. Eventually, however, after ten years of intensive bridge-building, the company began to shift its emphasis to metal-frame factory and mill buildings. In 1900, finding itself unable to compete with large fabricating firms outside of New England, the Berlin Iron Bridge Company, merged with twenty-three other firms to form the American Bridge Company.[26]

According to the Massachusetts Historic Bridge Inventory, prepared by the Massachusetts Department of Public Works, the Bardwell's Ferry Bridge is one of only eight remaining lenticular trusses in the state.[27] Built in 1882, the Bardwell's Ferry Bridge is a very early, and virtually unaltered, example of this now rare bridge type. At 198' long, it is also one of the longest lenticular spans surviving in the United States. The Bardwell's Ferry Bridge is also an interesting example of a lenticular truss, because of a number of unusual details: open endposts, four-bar lower chord, and web verticals that pass outside of the chords at the panel points.



ELEVATION
(LOOKING EAST)

BARDWELL'S FERRY BRIDGE
SPANNING DEERFIELD RIVER, ON BARDWELL'S FERRY ROAD
SHELBURNE/CONWAY, MASSACHUSETTS

MEASURED AND DRAWN BY LOLA BENNETT AND PAUL MORETTI, AUGUST 1990.

Figure 1. Elevation of Bardwell's Ferry Bridge.

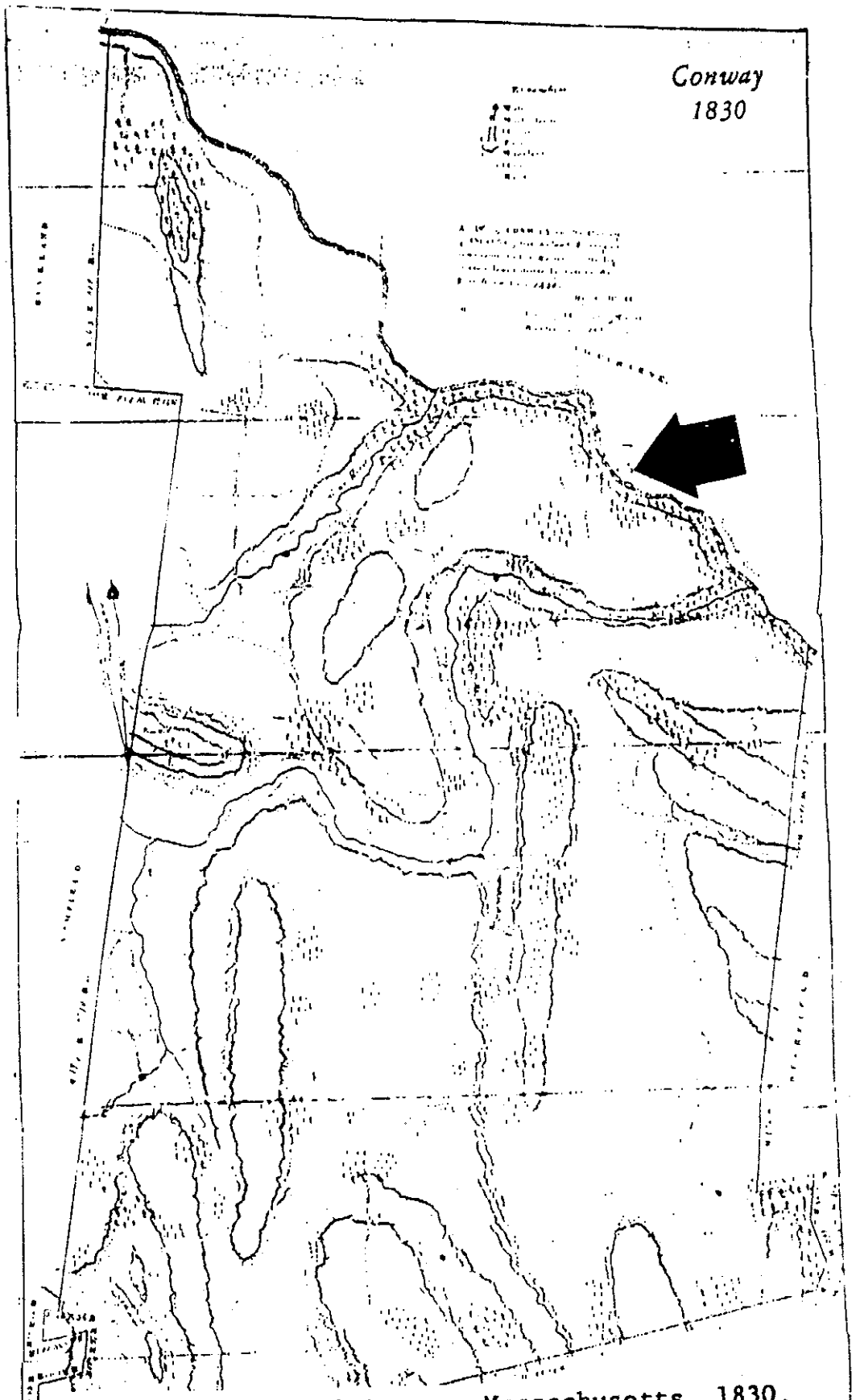


Figure 2. Map of Conway, Massachusetts, 1830, with arrow showing location of Bardwell's Ferry.

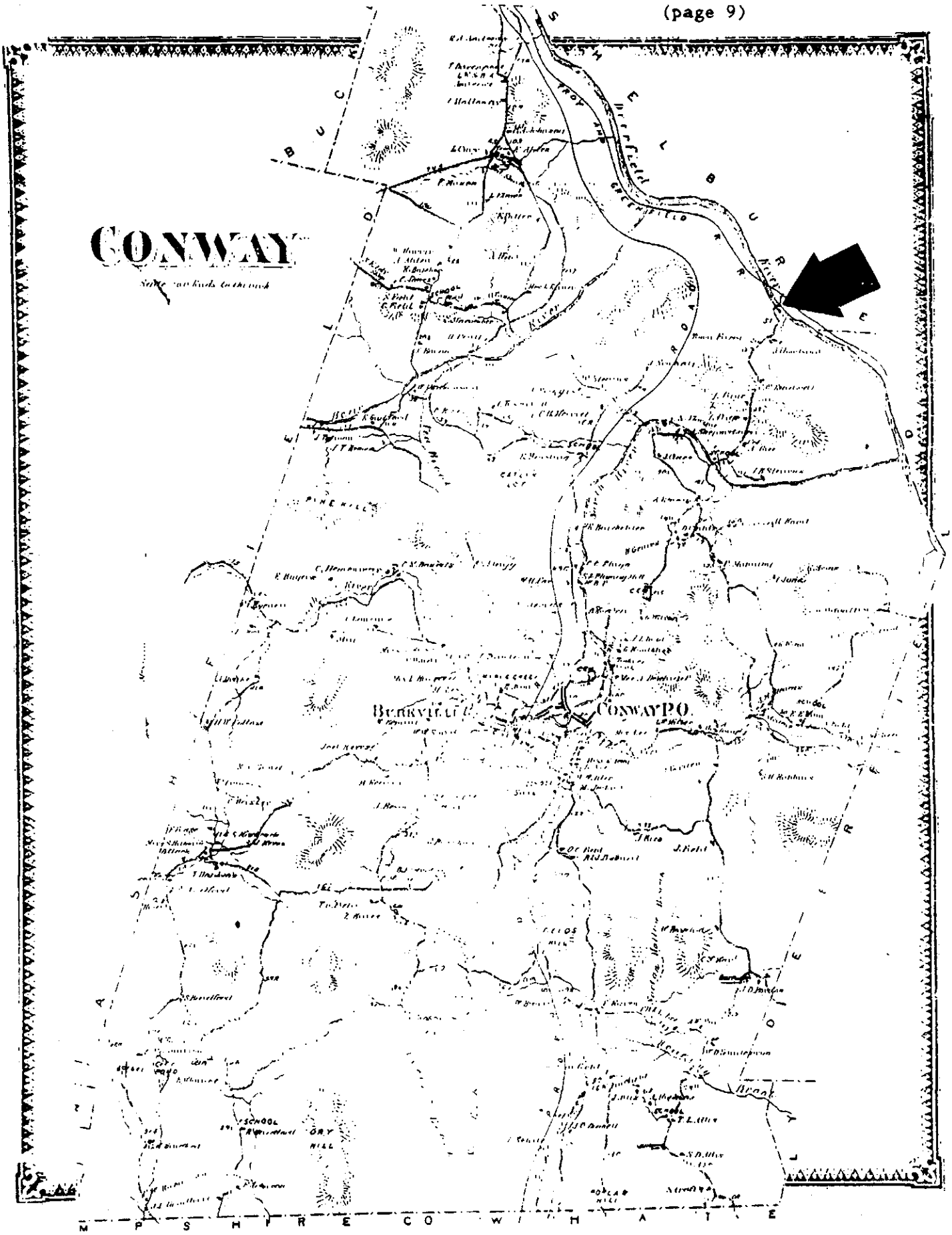


Figure 3. Map of Conway, Massachusetts, F.W. Beers, 1870, with arrow showing location of Bardwell's Ferry.

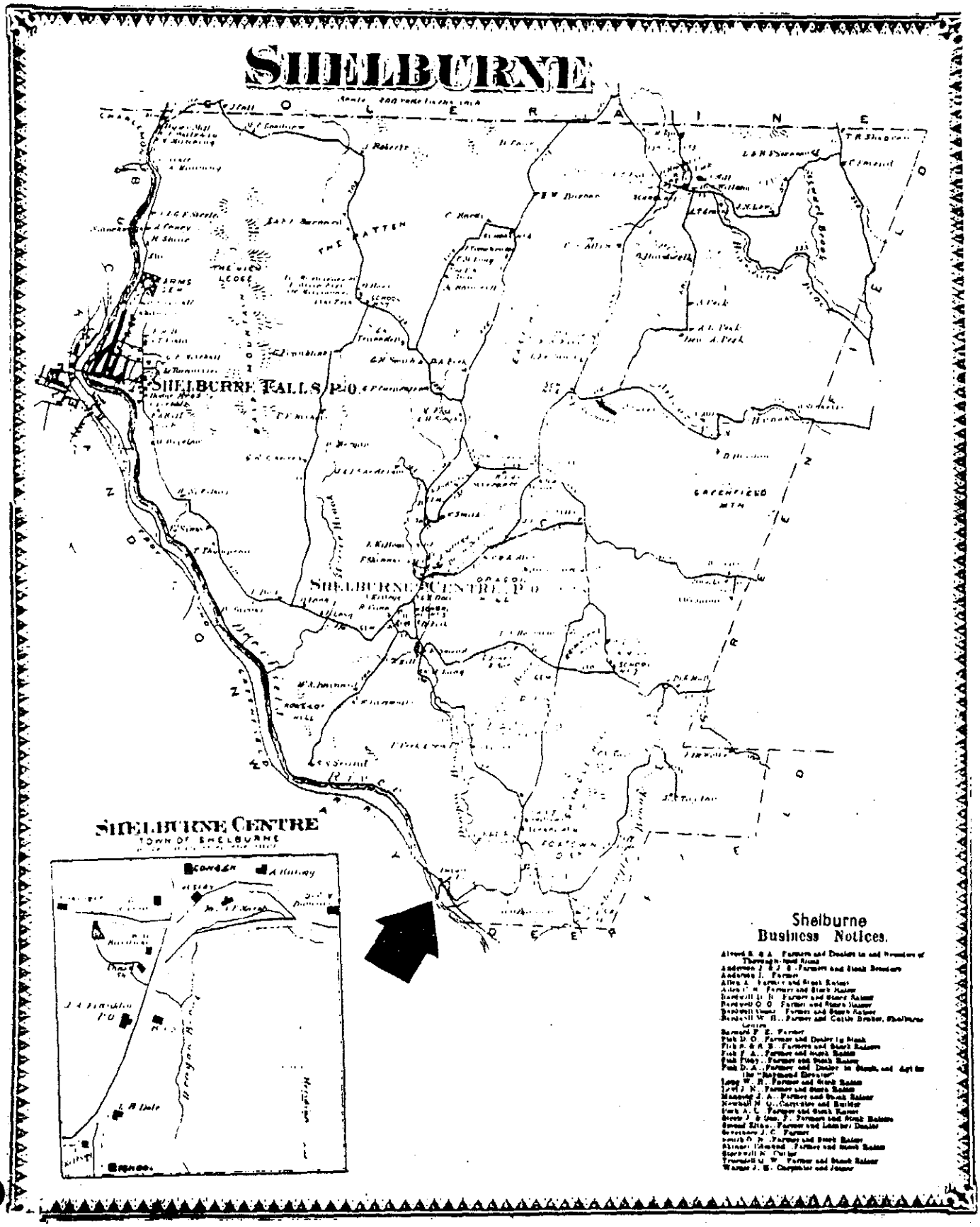


Figure 4. Map of Shelburne, Massachusetts, F.W. Beers, 1870, with arrow showing location of Bardwell's Ferry.

Figure 5. Portrait of Orsamus O. Bardwell (Everts, 1879).

Figure 6. Advertisement for Corrugated Metal Company, c.1878.

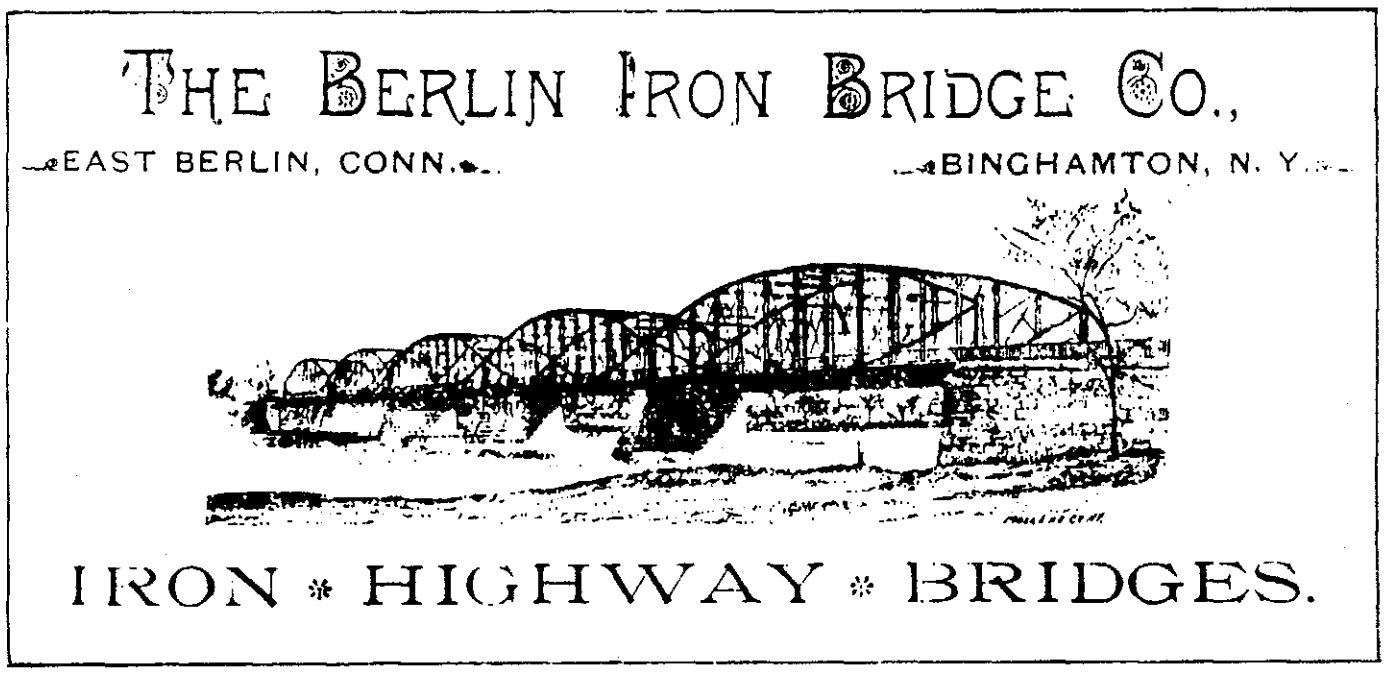


Figure 7. Advertisement for Berlin Iron Bridge Company, c.1886.

To the Honorable Senate and the House of Representatives of the Commonwealth of Massachusetts.

Respectfully represent the undersigned citizens of Shelburne in the County of Franklin and Commonwealth aforesaid That the Deerfield River forms a natural boundary line between the towns of Conway and Shelburne for a long distance in said County to wit the Southerly boundary of Shelburne and the Northerly boundary of Conway, but that by a special act of the Legislature approved Feby 19, 1781, the South Bank of said River was made the dividing line between said towns. That for years the only communication between said towns across this line was by a Ferry Boat or by fording the River. That recently since the construction of the Troy and Greenfield Rail Road a Depot has been built in Shelburne on the Northerly Bank of said River and near to the same. That thereafter a Bridge was constructed over said River near to the said Depot principally for the benefit of the inhabitants of Conway, & necessary for them as affording their only near and convenient connection with said Rail Road. That the farms of the inhabitants along this line are partly in Conway and partly in Shelburne to wit the land which they own lying between the South Bank of the River and the middle or thread of the stream or River is in Shelburne while the balance is in Conway. That the expense of maintaining the ferry was always borne by the towns in equal shares but the expense of supporting the Bridge falls entirely upon the town of Shelburne.

Your petitioners therefore pray for an Act of the Legislature changing the boundary line between said towns to the thread of the stream, or for an act obliging the said town of Conway to contribute their due proportion for the maintenance of support of said Bridge.

November 7th, 1873,

Amasa Bardwell) Selectmen
Joel Thayer) of
G. G. Merrill) Shelburne

John A. Andrews) Road Com-
Geo. P. Carpenter) missioners

and 123 others.

APPENDIX A: 1873 petition for boundary change between Shelburne and Conway.

sales of old estate, to be added to sinking fund.

this act, whatever premium may be received from the sale thereof, beyond the cost of preparing and negotiating the same, and so much of the proceeds of the sales of the old hospital estate in Worcester as may be necessary for the redemption of said scrip, and also of all the scrip secured by the sinking fund created by the provisions of chapter three hundred and ninety-one of the acts of the year eighteen hundred and seventy-four, shall be added to and constitute a part of the sinking fund aforesaid. And said fund shall be applicable to the redemption of all said scrip at maturity. Any balance of the proceeds of sales of the old hospital estate not required for the sinking fund as herein provided, shall be paid over and delivered to the treasurer of the Commonwealth who shall keep a separate account of the same.

SECTION 4. This act shall take effect upon its passage.

Approved April 28, 1875.

[1876, 226.]

Chap. 162 AN ACT concerning the maintenance of the Bridge near Bardwell's Ferry.

Be it enacted, &c., as follows:

Towns, jointly, to keep bridge in repair.

SECTION 1. The towns of Conway and Shelburne shall jointly maintain and keep in repair the bridge across the Deerfield River near Bardwell's Ferry, with its abutments, and be jointly liable for all penalties and damages for any neglect in keeping the same safe and convenient for travel.

SECTION 2. This act shall take effect upon its passage.

Approved April 28, 1875.

Chap. 164 AN ACT to incorporate the Suffolk Brewing Company.

Be it enacted, &c., as follows:

Corporators.

SECTION 1. James M. Smith, James Walsh, Charles F. Donnelly and Philip O'Donnell, their associates and successors are made a corporation by the name of the Suffolk Brewing Company for the purpose of malting and brewing ale and porter, with the powers and privileges and subject to the duties, restrictions and liabilities contained in the general laws which now are, or hereafter may be, in force and applicable to such corporations, and especially subject to the laws which now are or hereafter may be in force in regard to intoxicating liquors.

Name and purpose.

Powers and duties.

Capital stock.

SECTION 2. The capital stock of said corporation shall not exceed three hundred thousand dollars.

SECTION 3. This act shall take effect upon its passage.

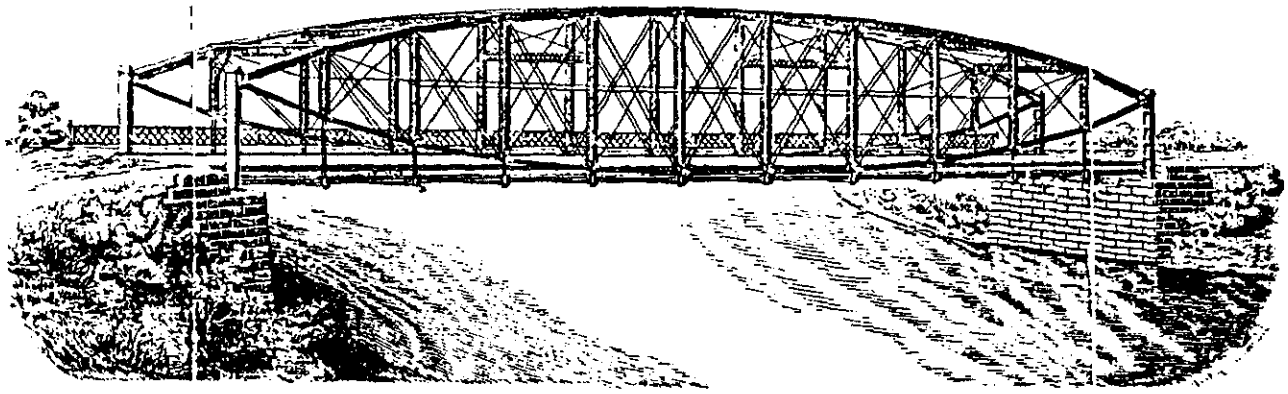
Approved April 29, 1875.

APPENDIX B: Act for maintaining the bridge at Bardwell's Ferry.

CORRUGATED METAL COMPANY,

BRIDGE BUILDERS,

OFFICE AND WORKS, - - - - - - - - - - EAST BERLIN, CONN.



HIGH TRUSS BRIDGE.

Patented April 16, 1878, and pending.

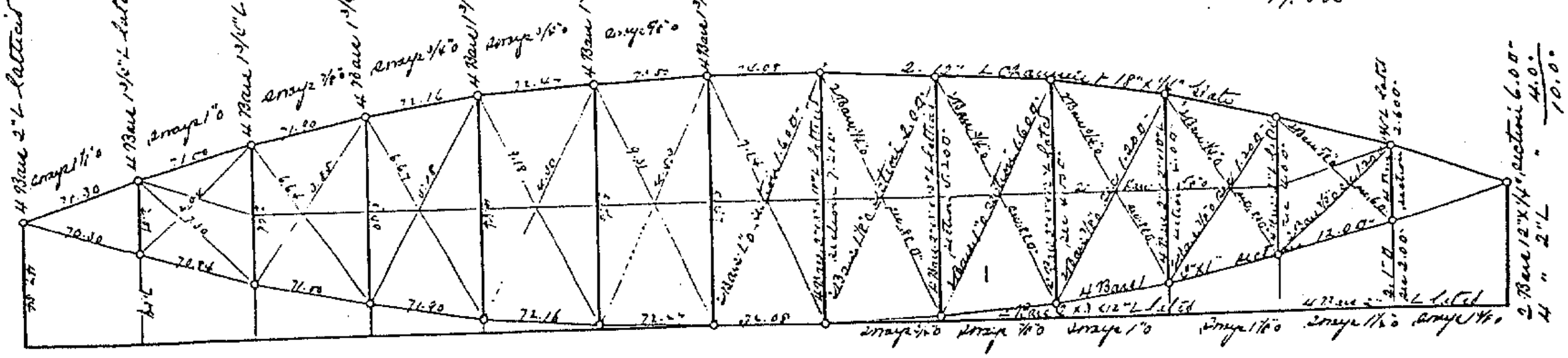
APPENDIX C: Contract for Bardwell's Ferry Bridge.

STRAIN AND SECTION SHEET.

Corrugated Metal Company,—Iron Builders,

EAST BERLIN, CONN.

Section Top Chord (2. Bars 12" x 3/8" sec 9.00"
1 " 18" x 1/4" " 4.5"
4 " 2" x 1/4" L " 4.0
17.500"



Length of Span 197.17 feet on centers.
Height of Truss 30 feet on centers.
13 Panels each 15.17 feet on centers.
Iron strained in tension 6¼ tons per square inch.
" " in compression 5 tons per square inch
reduced by Gordon's Formula.

Rolling load, 65 pounds per square foot of roadway.
" 00 " " " footwalks.
" 1040 " per lineal foot of Bridge.
" 520 " " " Truss.
Bridge weight, 832 pounds per lineal foot of Bridge.
" 416 " " " Truss.

Red lines denote Tension.
Black lines denote Compression.
Strains given in tons of 2000 pounds.

Copy

This Contract, Made this Ninth day of March A. D. 1882, by and between THE CORRUGATED METAL COMPANY, of East Berlin, State of Connecticut, party of the first part, and The Selectmen & Com. of the Towns of Conway & Shelburne Mass of .... County of Franklin and State of Massachusetts party of the second part,

Witnesseth, That the said party of the first part contracts and agrees to and with the party of the second part, to build, paint, and make complete, and have ready for use, by the 20th day of May 1882 for the party of the second part, a

WROUGHT IRON PARABOLIC TRUSS BRIDGE,

as per drawings and specifications herewith attached, over the stream called Deerfield River at Bardwells Ferry ~~........~~ between the Towns of ~~........~~ Conway & Shelburne County of Franklin and State of Mass according to the following specifications, viz.:

Extreme length of Bridge,	about 196	feet.
Space between the face of abutments or water way,	192	feet.
Roadway, floor,	16	feet.
Sidewalk,	None	feet.

The roadway joists to be 3 inches thick, 12 inches wide, and of good sound Chestnut lumber.

~~The~~ sidewalk joists to be ...... inches thick, ... inches wide, and of good sound ...... lumber.

The roadway floor of good sound Chestnut plank, 3 inches thick, and laid Squarewise

~~The~~ sidewalk floor of good sound ...... plank, ... inches thick, and laid ......

All the materials for said Bridge, except the abutments and piers, are to be furnished by the party of the first part, and are to be of good and suitable quality, and the work is to be done in a thorough, workmanlike manner. And the party of the second part contracts and agrees to furnish ready for the superstructure, the abutments and piers for the said Bridge, ~~at right angles to the center line of Bridge~~, by the 10th day of May A. D. 1882, and to pay the party of the first part the sum of

Seven Thousand Dollars $7000.00

for the said Bridge, as follows, viz.: One-half on the day of delivery of the iron material of said Bridge at the place of erection, and the remaining one-half on the completion of the said Bridge. And the party of the second part further agrees to let the party of the first part have free use of the old Bridge at or near the aforesaid place, for the putting up of trestle work, and for other purposes, as may be for convenience in erecting said Iron Bridge. And the party of the first part are not to be held responsible for unavoidable delays in railroads, or the elements, or circumstances beyond their control.

Amasa Bardwell
Elbridge Adams } Selectmen of Shelburne
Ebenezer [illegible]

Chs Parsons Jr
Franklin Pease } Selectmen of Conway
Henry W. Hopkins

Corrugated Metal Co
John Lorme
agent

Patented April 16, 1878, and pending.

Corrugated Metal Company,

IRON BUILDERS,

EAST BERLIN, CONN.

Specifications for a Wrought-Iron Truss Bridge.

LOCATED

Across the Deerfield River at Bardwells Ferry

General Dimensions. Extreme length, 198 feet. Number of Spans, 1. Clear length of each Span 192' 196' feet. Bridge to have 1 roadway 16 feet wide in the clear, and 0 walk each 0 feet wide in the clear. Trusses to be 30 feet high and to consist of 13 panels.

IRON WORK.

Top Chord. The top chord shall be constructed of two 12 inch channel bars and top plate 18" inches wide, united by 7/8 inch rivets 6 inch pitch, and on the bottom by 6 inch by 1/4 inch bars placed from 3 feet to 4 feet apart with two 7/8 inch rivets in each end. Chord to be re-enforced and accurately drilled at each panel point for pin holes.

Lower Chord. The Lower Chord shall be composed of 4 chord bars 3" X 1" made from refined iron connected at each panel point ~~and at each post~~ by 3 inch pins, which latter shall be turned to exact size to fit drilled pin hole in enlarged head of chord bars. At ends the pins shall be 4" in diameter

End Post. The End Post shall be composed of two 12 inch channel bars united on the face side by ~~lattice~~ bars inches wide at the top, spreading to inches wide at the bottom, and united to same by 1/2 inch rivets 6 inch pitch: the opposite flanges of channels shall be united by 4 inch by 1/4 inch strips, same as top chord. The bed plate shall be 3/4 inch thick, securely riveted to end post by wrought iron angle brackets.

Web Posts. The Web Posts shall be made of one rolled I beam at each panel point or 4 L's latticed re-enforced and accurately drilled at each end for pin holes. The post shall be held at the center by 1 wrought iron round tie-rod passing through the web of ~~each beam~~, and secured to same with jam nuts on each side.

#1 = 4 Bars 1 1/4" L latticed #2 = 4 Bars 2" L latticed #3 = 4 Bars 2"x3" L latticed #4 = 4 Bars 2"x3" L latticed #5 = 4 Bars 2"x3" L latticed #6 = 4 Bars 2"x3" L latticed

Main Diagonal Ties. The Main Diagonal Tie in each panel shall be formed of 2 bars of round iron having pin connections with top and bottom chords and sleeve-nut adjustment. All screw ends shall be enlarged that bar under the thread shall be 1-16 inch larger than in the body.

2 panels 2 Bars 7/8"0 3 panels 2 Bars 7/8"0 4th panel 2 Bars 7/8"0 5th panel 2 Bars 1"0 6th panel 2 Bars 1 1/8"0 7th panel 2 Bars 1"0

Counter Ties. There shall be ~~two~~ counter-ties in each panel formed of round iron with sleeve-nut adjustment and enlarged screw ends, same as main ties.

2 panels 2 Bars 7/8"0 all of the panels 2 Bars 3/4"0

Overhead Bracing. The Bracing over the floor shall be high enough to leave a clear headway of 13 feet, and constructed of 4 Bars 1¼"L latticed at each panel of upper chord. At portals 4 Bars 2"L latced mid Knee Braces.

Overhead Laterals. The Overhead Lateral Rods shall be made of 1/8 inch to 7/8 inch round iron, placed two in each panel, and united direct to top chord pins: they shall be provided with sleeve-nut adjustment.

Floor Beams. There shall be a Wrought Iron Floor Beam at each panel point, fastened direct to lower chord pins with wrought iron stirrups of same capacity as beams. The Beam shall be made of plate 24" to 12"x¼" mid 4 Bars 2"x3"x15#L's rivited to the flanges and 1¾"& 2"L Row stiffeners rivited to the mid ale by ⅞" rivets

Lower Laterals. The Lower Laterals shall be made of 1⅜ inch to ⅜ inch round iron, placed two in each panel, secured to floor beams by angle iron clips, and adjusted by means of thread and nut at each end.

Floor Line Chord. The Floor Line Chord shall be composed of 4 L's laced securely fastened to end post and held at each panel point by floor suspenders passing through it.

~~Sidewalk~~ Railing. The ~~Sidewalk~~ Railing shall be made of 2 lines of 3/4"ø Iron upon each side of Bridge.

General. All Iron work shall be neatly and accurately fitted up in a thorough and workmanlike manner. It shall be painted two coats of metallic paint and boiled linseed oil; one before it leaves the works of the Company, and a second coat after erected in place. All joints and compressive members shall be planed or dressed to form a perfect bearing. All rivets shall be driven hot. The form and number of parts of bridge may be changed from sizes herein specified without reducing section.

WOOD WORK.

The Floor Joist shall be of good, sound Chestnut lumber 12 inches deep and 3 inches wide, placed 2 feet apart.

Floor Plank to be of good, sound Chestnut lumber 3 inches thick and 6 to 12 inches wide, and laid square across. The ends to be secured by 3 by 6 inch wheel guard

~~Sidewalk~~ Joist to be by inches, placed feet apart. Sidewalk Plank to be inches thick.

Upon each end of Bridge attached to the Overhead Brace, will shall be placed an ornamental Cast Iron name plate giving the names of the Selectmen of the Town of Shelburne Falls & County & names of Builders.

CORRUGATED METAL CO.

Contract [illegible] Made this [illegible] day of April in the year Eighteen hundred and Eighty [illegible] by and between [illegible] of [illegible] in the County of Franklin party of the first part, and the [illegible] for Shelburne and the [illegible] Conway all in said Franklin County party of the second part.

The said party of the first part [illegible] [illegible] at Bardwell's Ferry [illegible] [illegible] [illegible] according to plans and specifications [illegible] [illegible] 1882 [illegible]

The party of the second part [illegible] [illegible] according to the said specifications [illegible] [illegible] dollars [illegible] by the Town of Shelburne and one half by said Town of Conway —

In witness whereof the said parties hereto have set their hands and seals the day and year first above written.

[illegible] — [illegible]

[illegible]
Selectmen
of Conway

[illegible] Bardwell
for the Selectmen of Shelburne

UNITED STATES PATENT OFFICE.

WILLIAM O. DOUGLAS, OF BINGHAMTON, NEW YORK.

IMPROVEMENT IN TRUSS-BRIDGES.

Specification forming part of Letters Patent No. 202,126, dated April 16, 1878; application filed March 28, 1878.

To all whom it may concern:

Be it known that I, WILLIAM O. DOUGLAS, of Binghamton, in the county of Broome and State of New York, have invented certain new and useful Improvements in Truss-Bridges; and I do hereby declare the following to be a full and exact description of the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a side elevation of a through-bridge; Fig. 2, a side elevation of a deck-bridge; Fig. 3, a side elevation of a swing-bridge; Fig. 4, a side elevation of a bridge with the roadway through the center of the truss; and Fig. 5 is a floor plan of the bridge, all constructed in accordance with my invention.

Similar letters of reference in the accompanying drawings denote the same parts.

My invention has for its object to improve the construction and efficiency of truss-bridges by combining as far as possible the maximum of strength with the minimum of cost; and to this end it consists, first, in the combination of parts forming an elliptical truss; and, secondly, in the construction of bridges with such trusses as I will now proceed to describe.

The truss, which constitutes the first part of my invention, is shown in the accompanying drawings composed of a compressive chord, B, and an extension-chord, C, firmly secured together at their ends A, with the struts E and diagonals or tension-rods D between them. The truss thus constructed is shown in Figs. 1, 2, and 3 in hipped form, and in Fig. 4 of parabolic form; but the general form is that of an ellipse or parabolic figure, which may be modified to suit circumstances or the taste of the constructer.

In Figs. 1, 2, 3, and 4 the thrust of the top chord B is resisted by the pull of the lower chord C; but in the form shown in Fig. 3 this is reversed when the span is open; then the pull is upon the upper chord, which resists the thrust of the lower chord.

The diagonals D are preferably arranged in pairs, although this is not absolutely essential, and are connected to the top chord B by pins S, passing laterally through them and the chord, while the lower ends are held in saddle-plates *m* at the points of their connection with the lower chord C at the foot of the struts. At the center of the bridge, where the diagonals cross each other, both their upper and lower ends are fastened to the respective chords by pins S, as shown in Figs. 1 and 3; or the trusses may be, and preferably are for long spans, connected by pins throughout, after the well-known details of the Pratt truss, as now usually employed.

The struts E and diagonals D bind the truss together, and transfer the strains toward the farthest point of support from them, while the chords B C transfer the greatest strain from the same point to the nearest point of support or abutment.

G is the floor-girder to support the roadway, having transverse joist, and either extends to the abutments below the chord C, as in Fig. 1, or above the chord B, as in Fig. 2, or through the center between the two chords B C, as in Fig. 4, or below the lower chord C, but unsupported by the abutments, as in Fig. 3.

In Figs. 1 and 3 the part G and the roadway are supported by rods F F, which run through the chords B C and the member G, and through or alongside the struts E, being secured by nuts at the top of the truss and beneath the part G. In long spans the tie-rod F does not run through to the top chord B, but is secured to the chord C at each panel-joint, as by a pin, a saddle-plate, thread and nut, or bolt-head.

In Fig. 2 the tie-rods are similarly connected at the top to the part G, and at their lower ends to the chord C; but in Fig. 4 their ends are held in the two chords and pass through the part G at about their centers.

In a bridge constructed as shown in Fig. 1, the member G serves to prevent the truss from moving bodily endwise, being attached along the center thereof to the chord C and to the bridge-seat. It also acts as part of the sway-brace system shown in Fig. 5, being subject to but little tensile and compressive strain, and forming no part of the supporting power of the truss. As a beam it carries the floor-joist between the tension-rods F, but is lighter in section when the floor-beams supporting longitudinal joist rest upon it at or near the rods F. For carrying joist upon it between such rods, it may be re-enforced by a T-bar, I,

APPENDIX D. William Douglas' Patent, 1878.

(shown in Figs. 1, 2, 3, 4,) or otherwise increased in vertical diameter sufficiently to perform the office of a beam to carry transverse joist, as shown at right hand of Fig. 5.

In Figs. 1 and 3, H H are end posts which support the trusses when the roadway is along the bottom. They may be dispensed with when the floor-line is along the top of the truss or through the center, as shown in Figs. 2 and 4. In Fig. 4 the floor-line is unconnected with the truss at the ends.

Fig. 5 shows the different arrangement of the floor-joist and planking—the right-hand half having transverse joist and longitudinal planking, and the left-hand half having longitudinal joist and cross planking. This figure also shows the connections between the girders G and the trusses to form a bridge.

The strains are as follows: The members B, E, and H are compressive, and the members C, D, and F are tensile, excepting in the form shown in Fig. 3 for an open span, in which case the chord B is tensile and the chord C compressive, as previously stated. The strains upon the girder G and T-bar I are slightly compressive and tensile and transverse, accordingly as the joists are placed longitudinally or transversely with the truss.

All the tensile members may be made of any convenient form—round, square, or flat—and all compressive members must be constructed with a proper ratio of diameter to the length, in order to properly resist compressive strain. The trusses or bridge may be constructed of iron or wood, or both.

I claim as my invention—

1. An elliptical bridge-truss consisting of the chords B C, united at their ends, with the struts E and diagonals D between them, substantially as described, for the purpose specified.

2. In combination with the elliptical truss, constructed as described, the suspension or tension rods F and floor-girders G, substantially as described, for the purpose specified.

3. In combination with the elliptical truss, constructed as described, the suspension or tension rods F, floor-girders G, and end posts H, substantially as described, for the purpose specified.

4. The combination of two or more elliptical trusses, constructed as herein described, with the floor girders and joists, and the necessary flooring to form a through, deck, or swing bridge, substantially as described.

WILLIAM O. DOUGLAS.

Witnesses:
A. J. INLOES,
FRED. W. SMITH.

3 Sheets—Sheet 1.

W. O. DOUGLAS.
Truss-Bridge.

No. 202,526. Patented April 16, 1878.

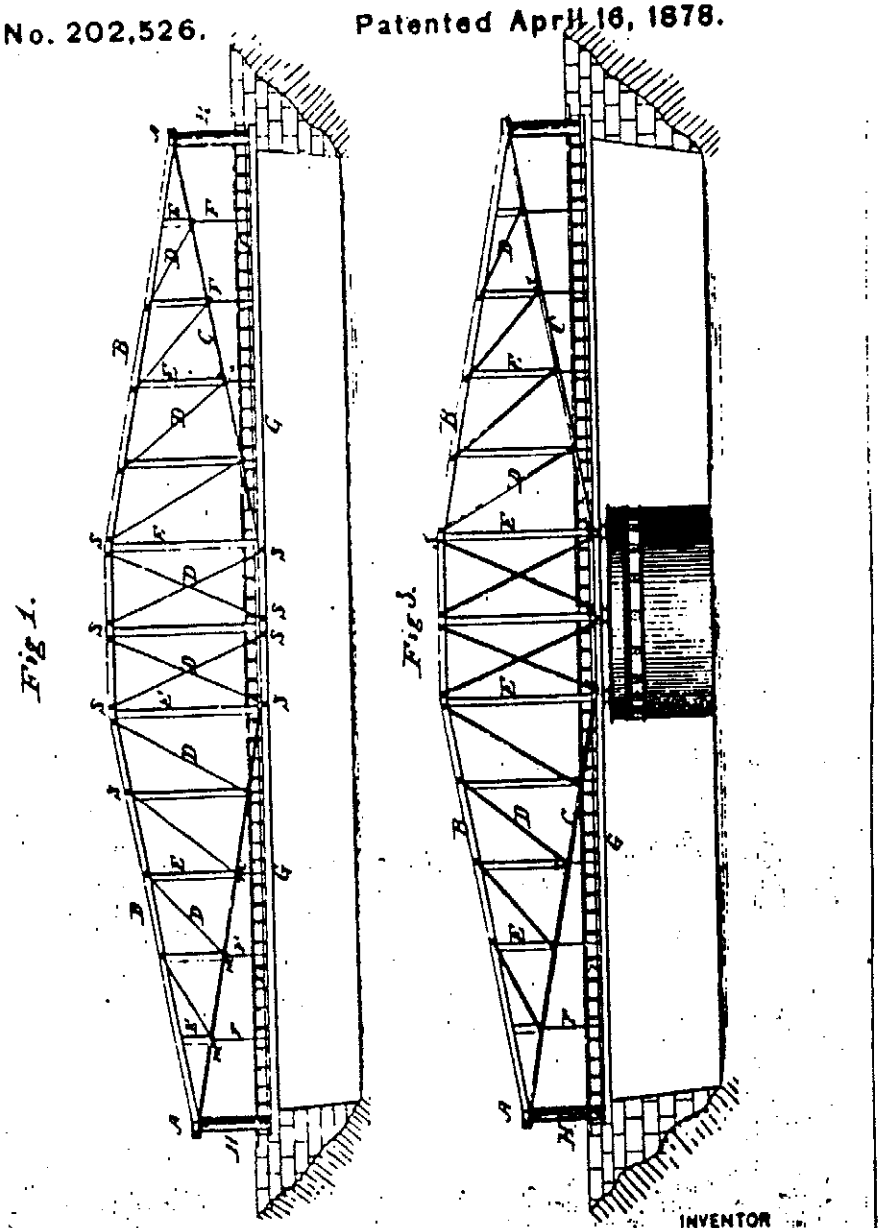


Fig. 1.

Fig. 2.

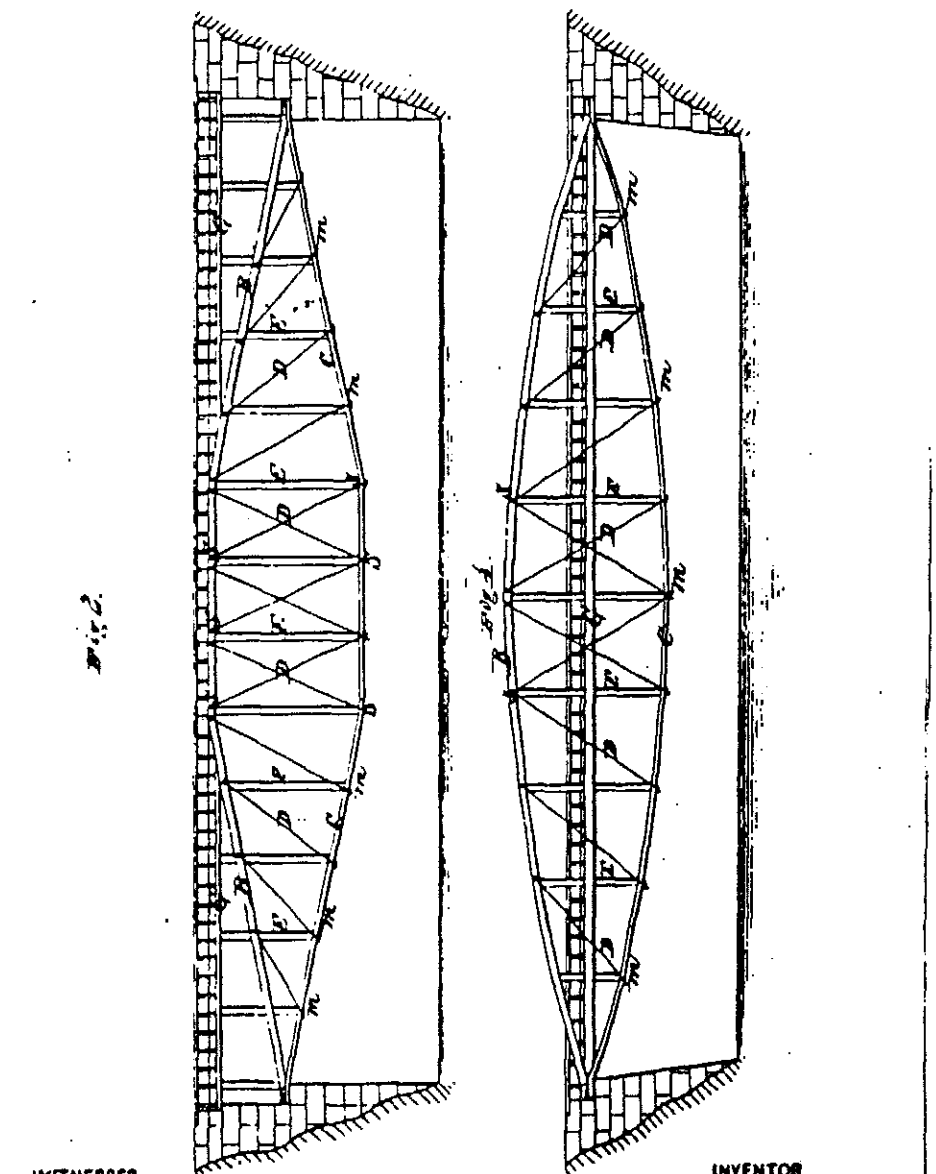
WITNESSES

INVENTOR

3 Sheets—Sheet 2

W. O. DOUGLAS.
Truss-Bridge.

No. 202,526. Patented April 16, 1878.



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Wm. Blackstock Jr.

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By Munn & Co
His ATTORNEYS.

3 Sheets—Sheet 3.

W. O. DOUGLAS.
Truss-Bridge.

No. 202,526. Patented April 16, 1878.

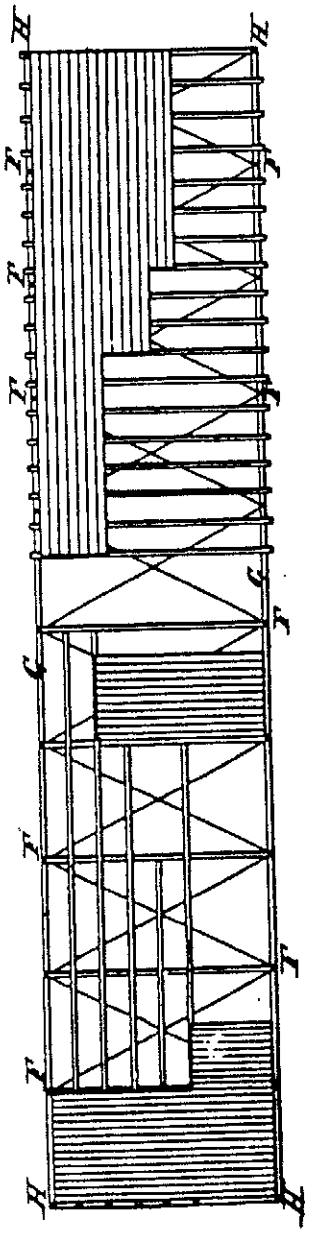

Fig 3.

WITNESSED
Jany King
Wm Slingerland Jr.

INVENTOR
Wm O. Douglas
By Hill Peloubet
his ATTORNEYS.

ENDNOTES

1. Noted bridge historian Victor Darnell feels that these endposts may be unique, as he has not seen others like them elsewhere. The majority of Berlin Iron Bridge Company lenticular bridges featured solid endposts.

2. Shelburne Town Records, Book 1, 1784.

3. Louis H. Everts, History of the Connecticut Valley in Massachusetts, vol. 2 (Philadelphia, 1879), p.654.

4. Ibid.

5. Leila Stone Bardwell, Bardwell's Ferry Lives Again (Shelburne, Massachusetts, 1959), p.11.

6. Cazette and Courier, Greenfield, Massachusetts, June 25, 1860.

7. Ibid, July 8, 1867.

8. Ibid, July 22, 1867.

9. Shelburne Town Records, Book 3, 1867.

10. Ibid.

11. Ibid.

12. Contract for Bardwell's Ferry Bridge, 1867. (Copy on file at the Town Clerk's Office, Shelburne, Massachusetts.)

13. Acts of Massachusetts, 1875, p.1034.

14. Cazette and Courier, January 30, 1882.

15. Shelburne Town Records, Book 3, 1882, p.479.

16. Contract for Bardwell's Ferry Bridge, 1882.

17. Contract for Bardwell's Ferry Bridge Abutments, 1882.

18. Engineering News, May 27, 1882, p.176.

19. Gazette and Courier, May 29, 1882.

20. Ibid, July 17, 1882.

21. Victor Darnell, "Lenticular Bridges From East Berlin, Connecticut," The Journal of the Society for Industrial Archeology, vol. 5, no. 1, 1979, p.19.

22. Ibid.

23. Ibid, p.24.

24. Engineering News-Record, May 10, 1928, pp.748-749.

25. Darnell, pp.31-32.

26. Darnell, A Directory of American Bridge Building Companies, 1840-1900 (Washington, DC, 1984), pp.85-86.

27. The 1990 Massachusetts Historic Bridge Recording Project documented three other lenticular truss bridges: Aiken Street Bridge at Lowell (HAER No. MA-106), Tuttle Bridge at Lee (HAER No. MA-105), and Blackinton Bridge at North Adams (HAER No. MA-109).

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