## Historic Structures

Newburyport Bridge

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This is the first in a series of articles on the historic bridges of the United States. It will include those bridges the writer believes were the most significant structures since 1793 built in wood, iron and steel. Up to then, most bridges built in the country were wooden pile and stringer bridges built in much the sàme manner as Caesar ${ }^{\circ}$ did when crossing the Rhine centuries before. It remained for Timothy Palmer, a local architect and house wright, to build the first long span truss bridge in the country across the Merrimack River in Massachusetts.
In 1790, Newburyport was a major port city, ranking $13^{\text {th }}$ in population in the country, and was homeport to a large number of ships, brigantines, schooners and sloops. Several rope ferries crossed the Merrimack River in the area. The tolls from the ferries made them very attractive sources of revenue for their operators. Even though tides, seasons, and weather could make the journey across the river dangerous at times, ferries had met the needs of the traveling public. In 1791, a group of local leaders proposed a bridge across the river at a point just upstream from the town where an island split the river into two channels. A formal petition was submitted to the Massachusetts legislature on June 1, 1791 asking for a charter to build the bridge. The petition stated "That a bridge across Merrimack River from a place called the Pines in Newbury in the county of Essex to Deer Island, so called, and from the said Island to Salisbury in said County would in the opinion of your petitioners very greatly subserve the public interest and convenience by affording a safe, prompt and agreeable conveyance to carriages, teams and travelers at all seasons of the year, and at all times of tide, whereas great dangers are incurred and great delays often suffered by the present mode of passing in Boats."
The act of incorporation was approved by the legislature on February 24, 1792 and was signed by Governor John Hancock with the signature identical to his Declaration of Independence signature 16 years earlier. The tolls were in part,

- For each foot passenger two thirds of a penny.
- For each horse and rider two pence.
- For each horse and chaise chair and Sulkey seven pence.
The bridge itself was described as follows: And be it further enacted by the authority aforesaid that the said bridge shall be at least thirty feet wide; that between Newbury \& Deer Island there be an arch one hundred and sixty feet wide; that between Deer Island and Salisbury there be an arch one hundred \& forty feet wide, a convenient draw or passage way for the passing and repassing of vessels at all times fifty feet wide with well constructed substantial and convenient piers on each side of the bridge \& adjoining said draw sufficient for vessels to lie at securely; and also another arch fifty feet in width; and that the crown of the arch between Newbury and Deer Island be at the least forty feet high, and that each of the abutments thereof be twenty eight feet six inches high in the clear above common high water mark..
By early April, the Directors evidently had many proposals consisting of drawings, models, and extensive descriptions of bridge styles. With a new, or enhanced, plan in hand, they decided that the original legislation was not acceptable and submitted proposed changes to the legislature. The revised act was passed on June 22, 1792, modifying the restrictions and limitations of the first act as regards height above high water mark, braces, etc. The legislature required that the bridge not impact negatively navigation on the river, and therefore set minimum vertical clearances and clear waterway distances between abutments and piers. The change evidently came about after Timothy Palmer was selected as chief engineer of the bridge. For this bridge and others, he has been called "the Nestor of American Bridge Builders."
The revised act stated in part,
Sect. 3 And be it further enacted by the authority aforesaid, That the crown of the arch to be erected between Newbury and Deer Island may not be less than thirty-six feet high, and that each of the abutments


Salisbury Truss then covered, post 1808, with lift span looking south at Deer Island.
thereof may not be less than twenty-four feet and a half high, above common high water mark; and that braces or shores may be placed from the abutments of the said arch, at four feet and an half from common high water mark, to pass $u p$ to the said arch, at not more than forty-eight feet distance, from the top of the said abutments; any thing in the said Act to the contrary notwithstanding.

The Massachusettgn Magazine, May 1793, reported, "..Sthis bridge was built, under the prospect of advantages much less encouraging, than any which have been granted by the legislature to undertakings of a similar kind..." What made Palmer, who, although an accomplished millwright and house wright, had never built a bridge, think that he could design and build a bridge over 1,030 feet long, with one span of 160 feet, over water that
averaged 34 feet deep? His bridge, most likely based upon a $16^{\text {th }}$ century Palladio design, would have the longest span of any in the country at the time.
A genius has been defined as someone who sees what everyone has seen but thinks what no one has thought. This phrase applies to Timothy Palmer, who began his bridge building career with this bridge. Early illustrations of the longest span show it with 10 panels of approximately 16 feet with a panel height equal to the panel length yielding compression diagonals on approximately a 45-degree angle.
Palmer used what has been called by some a trussed or braced arch as his supporting system with the deck resting on the lower chord. How the truss/arch worked depended greatly on how the members were connected at the upper and lower chord and the stiffness of the lower chord. If the lower chords were very stiff, the structure would act more like a braced arch if they were built into the abutments that prevented longitudinal movement of the ends of the members. If the lower Chords were less stiff, and not anchored to the abutment, the whole structure would act more like a highly cambered truss with radial tension posts and compression diagonals. It is believed that the latter case was true.
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The foundations for the superstructure were probably stone filled wooden cribs that were Palmer's standard foundation, sometimes with wooden piling and sometimes without. In the language of the day, they were called "huge log piers which extended far below the water line to a firm foundation of either stone, hardpan or gravel."
To build the arched lower and upper chords, he used what Theodore Cooper in his fine 1889 paper on railroad bridges called "crooked pieces of timber, so that the fibre might run in the direction of the curves." Palmer ordered trees with a natural bend in them to match the curvature of his chords. Some of these timbers, in his later bridges, were $16 \times 18$ inches in cross section and up to 50 feet long. As seen in the engraving of the bridge, he used struts off the piers extending out several panel points to help support his trusses as permitted by the modified Act of the Legislature.
His spans, piers, and abutment lengths working from the northerly shore (the Salisbury shore) were 124 feet, 50 feet, 45 feet, 60 feet, 50 feet, a 40 -foot draw structure, 50 feet, his arch of 113 feet, and 60 feet to the northerly shore of the island. The bridge then ran from the island 93 feet, his truss of 160 feet, and 185 feet on piers and deck beams to the Newburyport shore.
Shortly after the opening of the bridge in 1793, The Massachusetts Magazine wrote, "The two large arches, one of which is superior to anything on the continent, were both invented by Mr. Timothy Palmer, an ingenious house wright of Newburyport, and appear to unite elegance, strength and firmness beyond the sanguine expectation." In the book Olde Newbury, the author states, "The principles upon which it was constructed were novel and hitherto untested; but the beauty and strength of the structure, when completed, demonstrated their practical value and utility."
The bridge opened in December 1793, but the official opening ceremony was on July 4, 1794. What we know about some of the early wooden bridges in the country came from travelers who wrote about what they had seen on their trips around the country. Timothy Dwight, President of Yale University, wrote about the EssexMerrimack Bridge (he also wrote that the bridge was painted a brilliant white):

Between Salisbury and Newbury the Merrimack is crossed on Essex Bridge...It consists of two divisions, separated by an island at a small distance from the southern shore. The division between the island and this shore consists principally of an


Templeman Chaiñ Bridge 1810-1909.
arch, whose chord is one hundred and sixty feet, and whose vertex is forty feet about the high water mark...the whole length of Essex Bridge is one thousand and thirty feet, and its breadth thirtyfour. I have already mentioned that $M r$. Timothy Palmer. of Newburyport, was the inventor of arched bridges in this country. As Mr. Palmer was educated to house building only and had never seen a structure of this nature, he certainly deserves not a little credit for the invention... The workmanship of the Essex Bridge is a handsome exhibition of neatness and strength."
Another description by John Drayton, who saw the bridge shortly after it opened, gives a little better description of the long span as follows:

Two or three miles beyond Newburyport is a beautiful wooden bridge of one arch, thrown across the Merrimac River, whose length is one hundred and sixty feet; and whose height is forty feet above the level of high water. For beauty and strength, it has certainly no equal in America, and I doubt whether as a wooden bridge there be any to compare with it elsewhere. The strength of the bridge is much encreased above the common mode in use by pieces of timber placed upon it and shouldered into each other. They run upon the bridge in three lines, parallel with the length of the bridge and with each other, so as to make two distinct passageways for carriages. These braces are some feet in height, and are connected on the top by cross pieces affording sufficient room for carriages to pass underneath without
inconvenience. It is said that the upper work has as great a tendency to support the weight of the bridge as the sleepers upon which it is built...
Palmer, in a letter to Richard Peters in Philadelphia dated July 11, 1808, wrote, "Last summer, I rebuilt one of the Arches, the span of which is 113 feet and is on the same principle with your Bridge. With much persuasion, I obtained liberty to cover it. There were many doubts in the minds of the Stockholders as to its stability against strong winds." This covered span survived until 1882. In the same letter, Palmer informed Peters that on "the $17^{\text {th }}$ of June last there came on one of the most tremendous gales of wind ever known in this country...The reason of my being thus particular in this reason is Essex-Merrimack bridge stands nearly in the centre of the direction of this tempest; and stood like Mount Atlas amid the warring elements."
In 1810, John Templeman, using a variation of James Finley's chain suspension bridge patent, built a chain suspension bridge to replace Palmer's 160 -foot truss. This span had been, in the words of the boatmen, a "menace to navigation." By going with a 244 -foot suspension span as contrasted to a 160 -foot truss with abutments extending greatly into the river, it was possible to widen the southerly passage around Deer Island.
This bridge, even though suffering a partial collapse in 1827, survived until 1909 when a look alike bridge was built in the same location. This bridge, recently restored in 2003, still serves local traffic across the Merrimack River. It is the oldest continually occupied, long span, bridge crossing ( 220 years) in the country dating from 1793.-

