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Amesbury-Newburyport Chain Bridge 1810-1909

by

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Amesbury Carriage Museum
Amesbury, MA

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Newburyport Chain Bridge 1810-1909

Private Collection

Bridges and Other Local Technology

The surprisingly profound nature of early Industrialization Around Amesbury

Modest river geography merged with regional seaport wealth to leave Amesbury with small enough physical features as to be manageable using early technology, yet sufficiently large and well funded to support significant early industrial development. The Powow River, with 75-feet total drop, provided ample power to spark continuous growth from the 1600s into notable textile milling by the early 1800s. Amesbury technology and technologists resided on the direct path to initial fulfillment of American industrial textile manufacture. On the other hand, that convenient scale implied that 19th century Amesbury would soon be far surpassed by larger mill complexes along the mighty Merrimack, and that the town's seminal accomplishments would largely be forgotten, even in town.

The immensely more powerful Merrimack River was so large and wide that it was daunting to the capability and finances of early mill entrepreneurs. Yet, the same Merrimac was simultaneously small enough to be within reach of early adventurous bridge designers. Deer Island, in the river between Amesbury and Newburyport, was an ideal location for bridging the Merrimac, and indeed hosted its first crossing. Local bridges constituted America's earliest advances in such technology, but suffered the same limitation as did local textile milling. In the overall scale of things, the Merrimack was sufficiently small that bridge technology quickly advanced more spectacularly on larger streams, notably the Schuylkill River adjacent to Fairmount Water Works, then just outside of Philadelphia. Even Newburyport's Timothy Palmer built a bridge over the Schuylkill. Except for longevity and popular romantic views of the chain bridge, local bridge pioneering has largely been forgotten, even in town.

Timothy Palmer's Wood Truss Bridges at Deer Island, 1792

From: *Structure* (Magazine), Dr. Frank Griggs, June, 2013

Period drawing, *Structure* magazine. Note at lower right, group net fishing from shore

This view looks downstream (east) to wood truss bridges on both sides of Deer Island. Timothy Palmer was a Newburyport architect and house-wright who had never previously built a bridge. These were the first long-span trusses in America, the right one being replaced by the chain bridge in 1810 to improve navigation. The left span was 140 feet, the right was 160 feet, then the longest bridge in the country. Piers are believed to have been stone-filled wood cribs, which Palmer used on later bridges. Arched beams were hewn from bent trees so that the grain would follow the desired curves, further supported from below by angled struts to the piers. For this and later bridges, Palmer was termed "the Nestor of American bridge builders".

Timothy Palmer's Wood Arch Bridge at Deer Island. Ca. 1870

Palmer built this bridge in 1792, then covered and shingled it in 1808. Here, looking from the Amesbury side toward Spofford house on the island. The bridge was replaced in 1883 by an iron truss bridge, having a swing section, right beside the wood bridge on the near side. The current bridge keeper's house resides on the Deer Island (far) pier of this wood bridge.

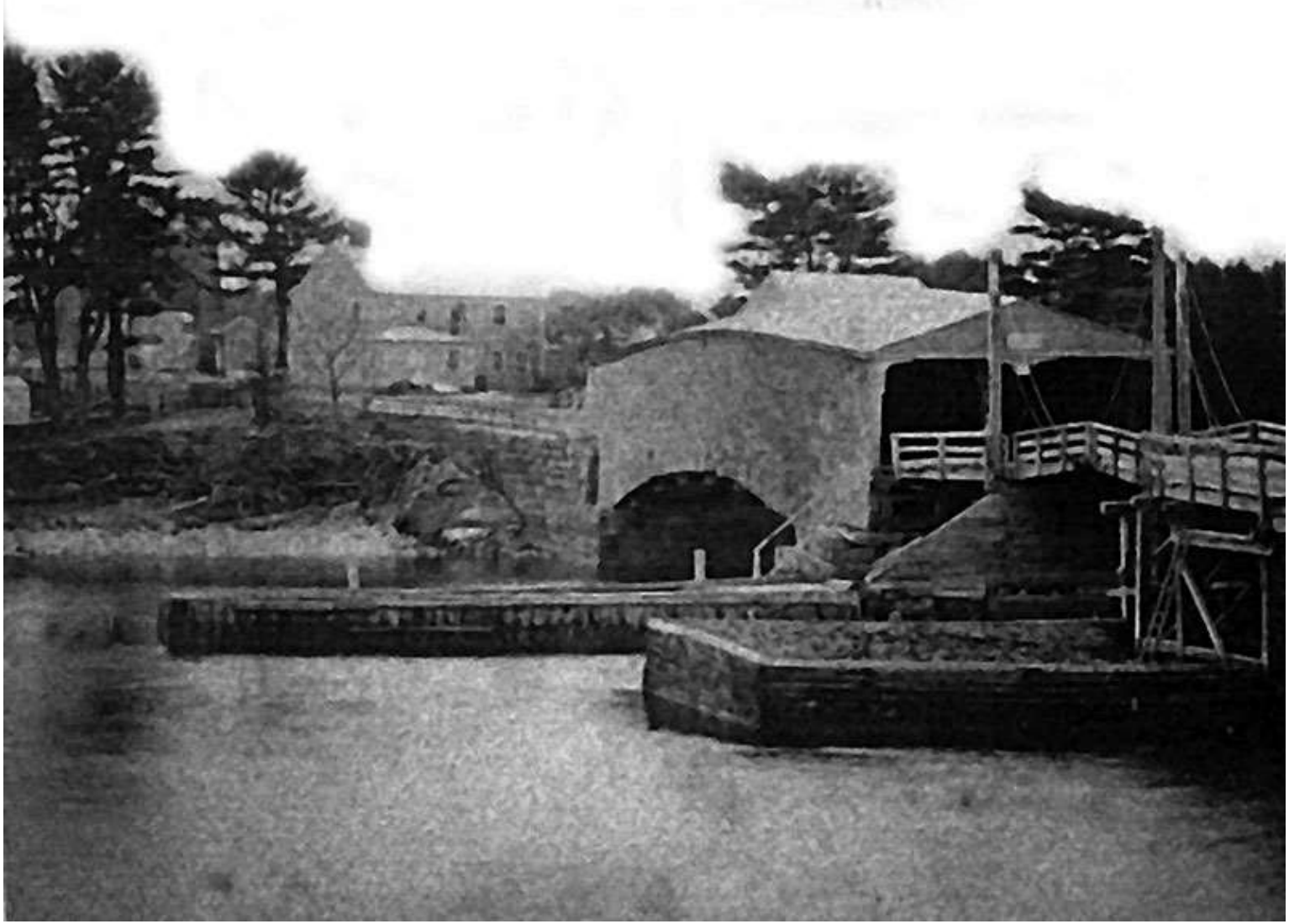


Photo from: *Structure* (Magazine), Dr. Frank Griggs, June, 2013

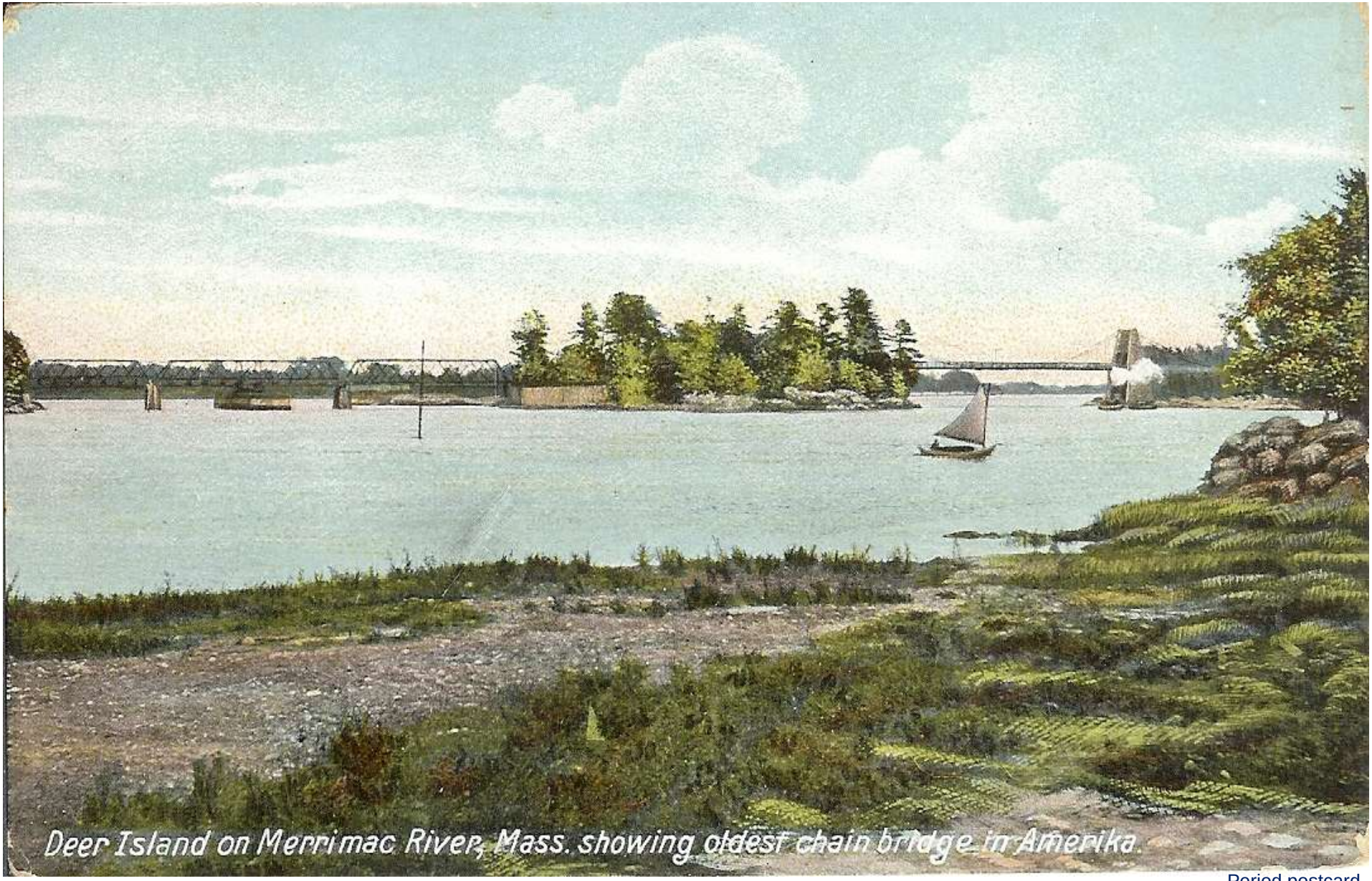
Vista from Above the Old Newburyport Water Works, ca. 1880

Period postcard

Looking downstream (east) with chain bridge is right of Deer Island, on the Newburyport side. Left of the island is Timothy Palmer's covered wood arch bridge, which connects to the lift bridge on the Amesbury side

Shore Vista of New Iron Truss Swing Bridge, ca. 1890

New iron truss bridge left of island, with center span rotating atop a center support pier. The chain bridge on right of island.



Period postcard

Detailed Photo, Similar to View on Previous Page, ca. 1895

with electric trolley on the chain bridge

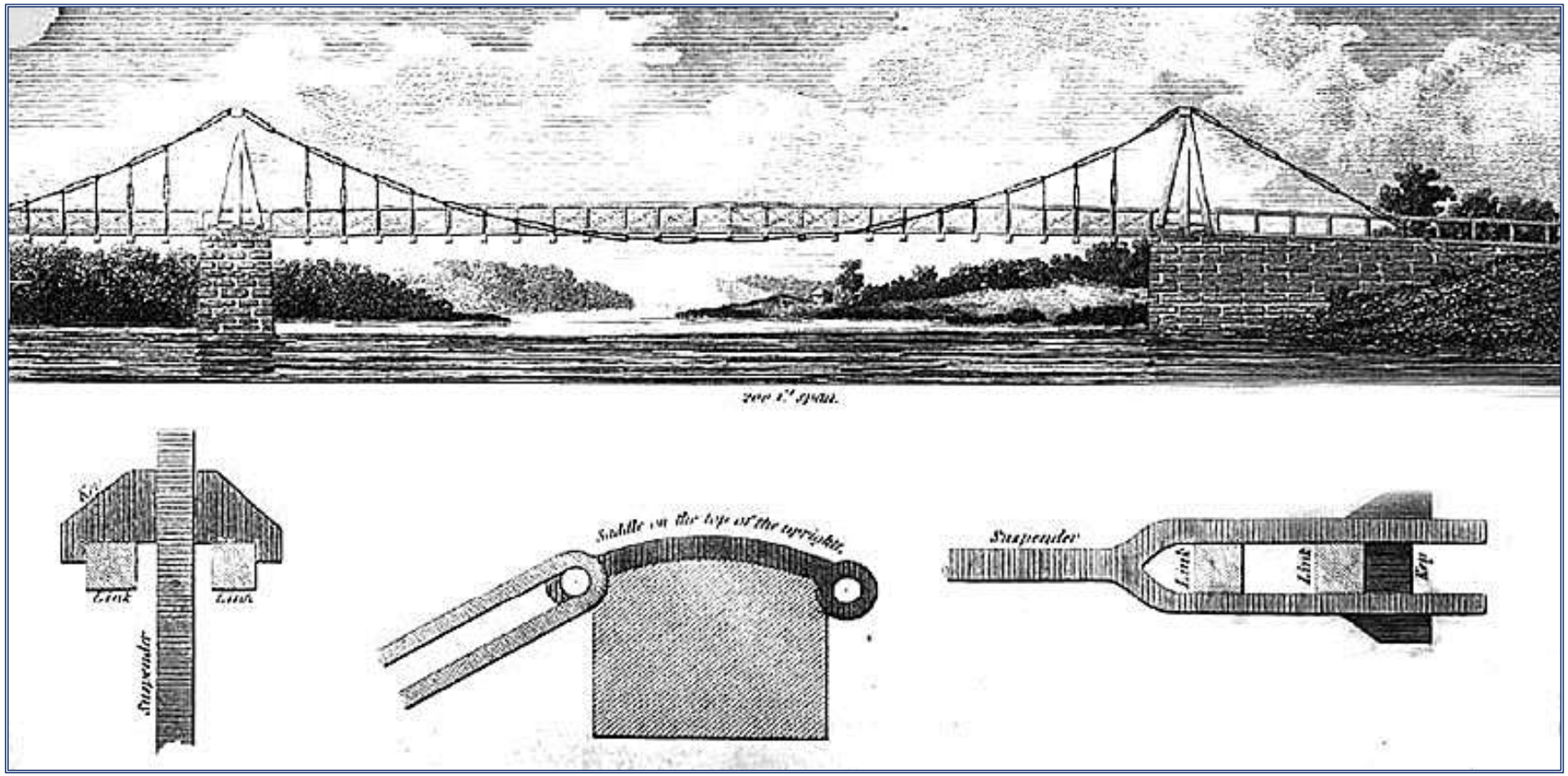
Public domain image courtesy of Wikipedia

Above, watercolor by Frank Thurlo, 1837-1913

Below, double-width foldout postcard, ca. 1890

James Finley Bridge System, Patented 1808

The chain bridge was built on James Finley's design. Earlier suspension bridges had roadbeds (decks) either resting on tightly stretched chains beneath, or built of rigid plank sections that were connected end-to-end as a chain of platforms. Both types were supported from overhead catenary chains, via vertical hanger chains or rods, and both were highly flexible and unfriendly to heavy traffic. Finley's main feature was a single deck, made as rigid as possible from end-to-end, including stiffening from side railings. Stiffness was limited by relative inability of wood structures to carry tensile forces, so that the concept was only fully realized in iron construction, but the stiffened deck suspension bridge was the basis for 200 years of record breaking spans. Below shows a very similar Finley bridge built in 1809 at the Fairmount Water Works, near Philadelphia, having two 153-foot catenary spans end-to-end (as with the Oakland Bay bridge), the first to do so.



Engraving from *The Port Folio* (magazine) June, 1810

James Finley Bridge System

From: *History of Bridge Engineering*, Henry G. Tyrrell, by the author, Chicago 1911, pgs. 204-207

272. The first suspension bridge in England (1741) crossed a chasm 60 feet deep and the river Tees near the High Force, two miles from Middleton. It was 70 feet long, 2 feet wide, and the floor lay directly on the cables, with a railing on each side. It was used chiefly by miners, and fell in 1802, killing one or two people, but was replaced by a similar one known as Wynch bridge, which was standing in 1908. Suspensions were used in America before any other kind of iron bridge, the first scientific ones of the modern type, with horizontal suspended floor, appearing at the beginning of the nineteenth century, though rude ones like that at Caucasus may have preceded them. James Jordan secured an American patent in 1796 on a "suspension bridge," but it was really a bow-string truss with a suspended floor. Those previous to 1810 were chiefly the work of **James Finley,** a native of Fayette county, Pennsylvania, whose first bridge in 1801 over Jacob's Creek on the turnpike between Uniontown and Greensburg, had a span of 70 feet, though he is said to have made experiments with, or models of, smaller ones three or four years before. As the Greensburg bridge was a success, many others were made like it, and the type became the most approved form in the first half of the nineteenth century. The **Greensburg bridge** had two iron chains, one on each side, with links of the proper length to suit the distance between the suspended floor joist. The chains had a sag of 10 feet, or one-seventh of the span, and passed over masonry towers with the same angle of inclination on each side, being bolted to four large anchor stones on shore. The suspended wood floor was 12½ feet wide without any stiffening trusses, the whole costing when finished about $600. Eight similar ones are said to have been erected the same year, and about forty more prior to 1808, when patents were granted to Mr. Finley on his designs. He made the floors in one solid slab for the sake of lateral stiffness, and used long joists to spread the floor loads over several suspenders. Previous to 1808 he erected one over the Potomac at Washington with a span of 130 feet and a 15-foot roadway supported by two chains of 1¼-inch wrought iron bars; another over Brandywine Creek at Wilmington, Del., with a span of 145 feet and a floor 30 feet wide; two at Brownsville, Pa., with spans of 120 feet; and one at Cumberland, Md., with a span of 130 feet. The one at Wilmington over the Potomac was washed out by a freshet about 1840 and was replaced by a wooden bridge.

273. One of Finley's earliest bridges, 306 feet long, was erected in 1809 over the Schuylkill river at **Fairmount,** Philadelphia, on the site occupied by the Colossus twenty years later. A description says that it was "aided by an intermediate pier," and it is represented in an old illustration with two spans of 153 feet each, being the first appearance of a suspension bridge with more than one span. The cables were made of long iron links from which the floor was hung with rods. It collapsed in 1811 under a drove of crowding cattle, but was replaced by another suspension, which fell January 17, 1816, under a weight of snow and ice. The third bridge opened in June, 1816, had a single span of 408 feet, and a passage way of only 18 inches, and was the work of White and Hazard, who owned and operated a wire mill near by, the cables being made of six ⅜-inch wires. It was notable

James Finley Bridge System

From: *History of Bridge Engineering*, Henry G. Tyrrell, by the author, Chicago 1911, pg. 204-207

for being the first wire suspension bridge in any country, all those in Europe having a later date. The wood floor was without stiffening trusses, and the bridge was safe for only eight persons at one time, and is said to have cost the small sum of $125. A toll of one cent was levied on each passenger. It fell in 1816 under a load of snow and ice soon after its erection, and was replaced by the Colossus, a wooden bridge designed by Wernwag, and opened in December, 1817.

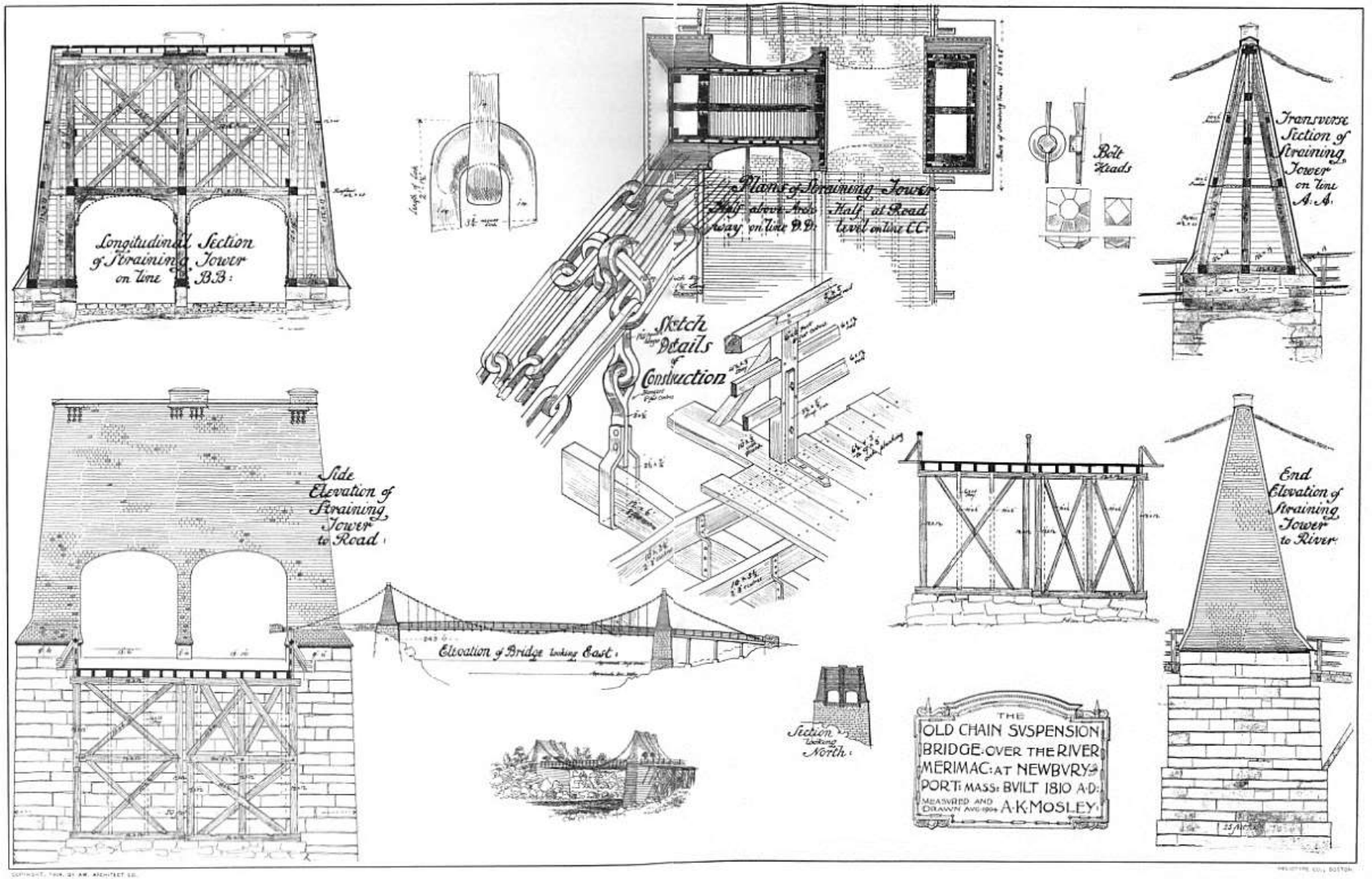
274. One of Mr. Finley's most notable suspension bridges crossed one channel of the **Merrimac river** at Deer Island, three miles above **Newburyport,** Mass. It replaced Timothy Palmer's old wooden one of 1792, and was built under the direction of John Templeton in 1810, with a span of 244 feet between tower centers. The two roads were 15 feet wide, each having two sets of cables containing three chains in each, or a total of twelve chains for both roadways. The links were one inch square and 27 inches long, making a total area of six square inches in each chain, and floor supports were 7 feet apart. The anchorages are 100 feet from the towers and the shore end of cables are not loaded, being supported on timber frames 47 feet wide and 37 feet high above the floor, sheathed over and shingled, and standing on masonry abutments. One chain broke in 1827 under a load of four oxen and a horse, but it was repaired. It was sold to Essex county in 1868 for $30,000, and in the following year the woodwork was wholly rebuilt. It was again strengthened in 1900 by adding two new wire cables to one of the roadways, making the bridge strong enough for a line of electric cars, the work being done without interfering with travel on the other roadway. It has no stiffening trusses, and although the first chain bridge in New England, it still remains. Another suspension bridge with several spans was erected at Newburyport in 1826, and is described later. Mr. Finley designed two bridges crossing the Lehigh river, one at Northampton, Pa., in 1811, and another at Allentown, in 1815. The Northampton bridge had a total length of 475 feet and three towers supporting two intermediate and two end spans with double roadways and two 6-foot walks, and was the second suspension bridge with more than two towers. The Allentown bridge had two spans of 230 feet, with cables of iron bars carrying a roadway 30 feet wide. It was damaged by fire in 1828 and carried away by a flood soon afterwards. Another old bridge at Island Park, near Easton, Pa., has two spans resting on a pier in the river and a floor following the sag of the cables.

Tyrrell's John Templeton (left), builder of the chain bridge, is generally recognized as John Templeman, found on the 1909 bronze plaque at the bridge, and in the source below, as well as others. He was a Finley licensee from Georgetown, Maryland, who had just previously built the Finley design bridge at Philadelphia's Fairmount water works.

Transitions in Engineering, Tom F. Peters, 1987, Birkhauser Verlag, pgs. 28-32

Scaled Drawings of Chain Bridge Construction, by A. K. Mosley

From: *American Architecture,* Boston, October 29, 1904, pg. 39



A. K. Mosley is unrelated to Frederick S. Moseley of Moseley Woods & Maudslay Park. The former was seemingly an architect interested in historic structures, doing similar sketches in 1939 for Lebanon, NH shaker village

ILLUSTRATIONS

[Contributors of drawings are requested to send also plans and a full and adequate description of the buildings, including a statement of cost.]

DETAILS OF THE OLD CHAIN BRIDGE, NEWBURYPORT TO AMESBURY, MASS. MEASURED AND DRAWN BY MR. A. K. MOSLEY.

THIS drawing illustrates an old type of bridge—claimed locally, in fact, to be the oldest chain suspension bridge in America, being built, or rather rebuilt, about 1810. The structure is certainly one of the most picturesque and quaint that I have seen or heard of, and its general principles might well be reproduced for some present-day bridges, where economy of outlay is a primary consideration and the traffic of an ordinary character.

The bridge is approached through both straining towers by two separate archways, and actually forms two separate and distinct carriage-ways, with about a foot's space separating them—one now being devoted to electric traction and the other to ordinary traffic. What the original object was I cannot suggest, but it is a feature which meets modern requirements. However that may be, if the floor of the bridge had been built in one block instead of two, it would have added greatly to the stiffness and rigidity of the carriage-ways, and would largely obviate the oscillation which would be unnoticed at the time it was built—but the exigencies of modern traffic and street railway cars evidently caused the carriage-way down stream to be much reinforced with additional cables and timbering—the little turrets on the top of the straining towers being the only evidence of this so far as my drawing is concerned—the up-stream carriage-way remaining untouched.

The bases of straining towers are 50x25 feet at water-level, and the span between about 230 feet. Granite is used up to a couple of feet above road-level—with dry open joints. Above this level oak is used for the main timbers of the straining towers, with fir rafters and finished with shingles.

The chains are of inch-square iron links, two-foot centres, three chains to each side of each carriage-way.

The drawing illustrates the method of hanging up the weight of carriage-way from the chains and various other interesting details of construction.

A. K. M.

Deer Island End of Bridge, ca. 1880s

A flexible wood deck would sag & twist under weight. To allow 2 lanes of traffic, the bridge was really 2 independent bridges, having 15-foot wide roadways, about 1 foot apart. Towers were A-frames of hewn timber beams, spaced 244 feet between centers, sheathed in planks and then shingled over. There were 4 chain sets, 2 per bridge, each set having 3 chains. Remnants of the shingled road sign at far left still remain.

This postcard and research from Greg Colling highlights Newburyport photographer William C. Thompson (1839-1917). He had an Opera House Studio in Amesbury from 1869 to 1893, and the Globe Studio in Newburyport.

Period postcard by W. C. Thompson

Steamer *Merrimac* Approaching Bridge from Upstream, ca. 1895

prior to 1900 addition of support cables, frame at mid-span carries electric trolley wires

Period postcard

Carriages Entering & Leaving Newburyport End, ca. 1905

Two rectangular structures atop right-side of bridge carry steel wire catenary cables, added in 1900 as extra support for heavy electric trolleys of the Northeastern Street Railway.

Period postcard

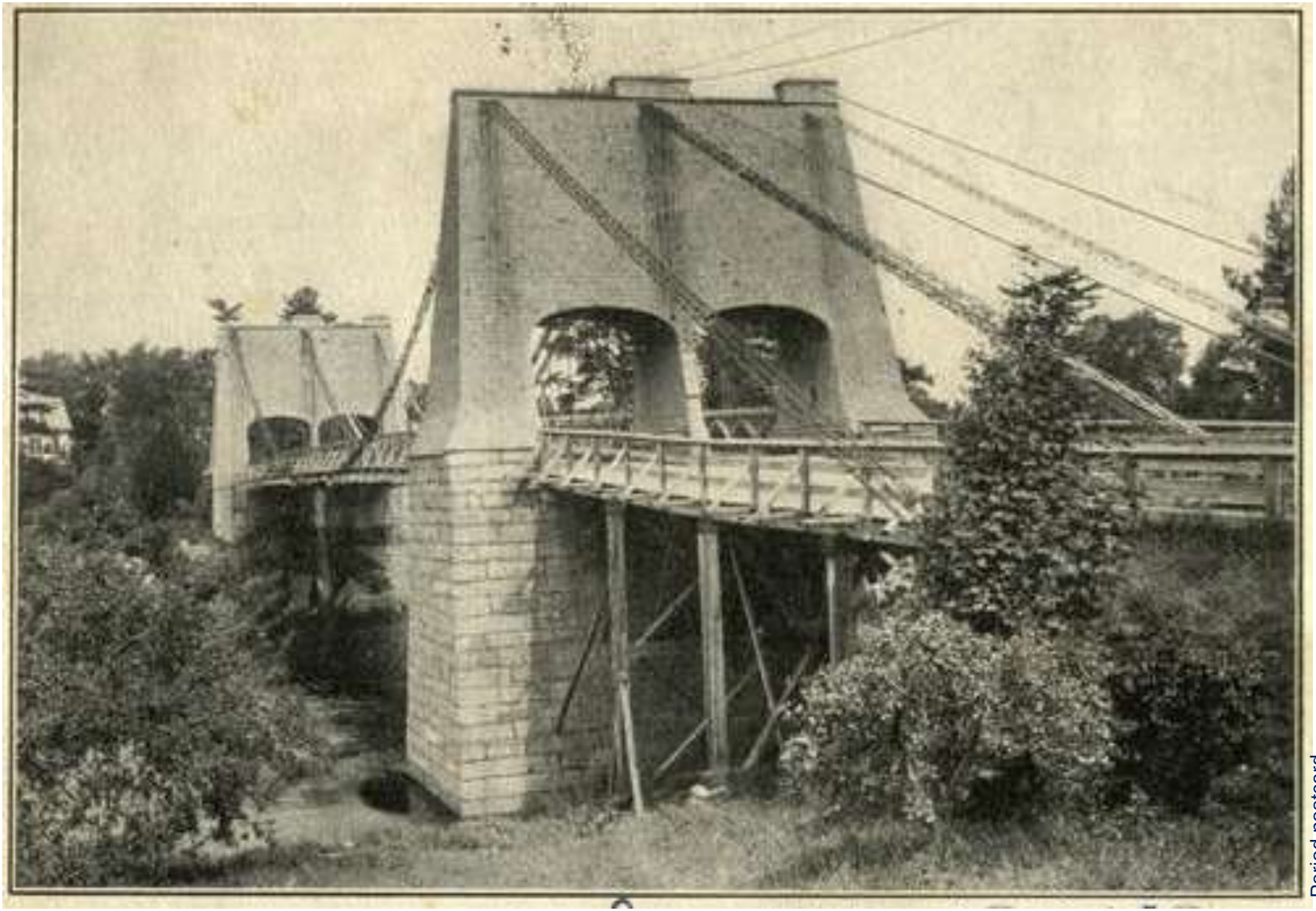
View from Moseley Woods Area Shore, ca. 1905

View of deck and railing structure, showing the relatively thin deck. At far side, the bottom of the deck now has a continuous longitudinal stiffener, certainly of iron or steel, to support trolleys. It generally appears that original deck hangers were rods, although one chain is clearly visible. Also visible are deck hangers extending from the new wire catenary cables supporting the trolley bridge.

No-known-restriction image courtesy of LoC

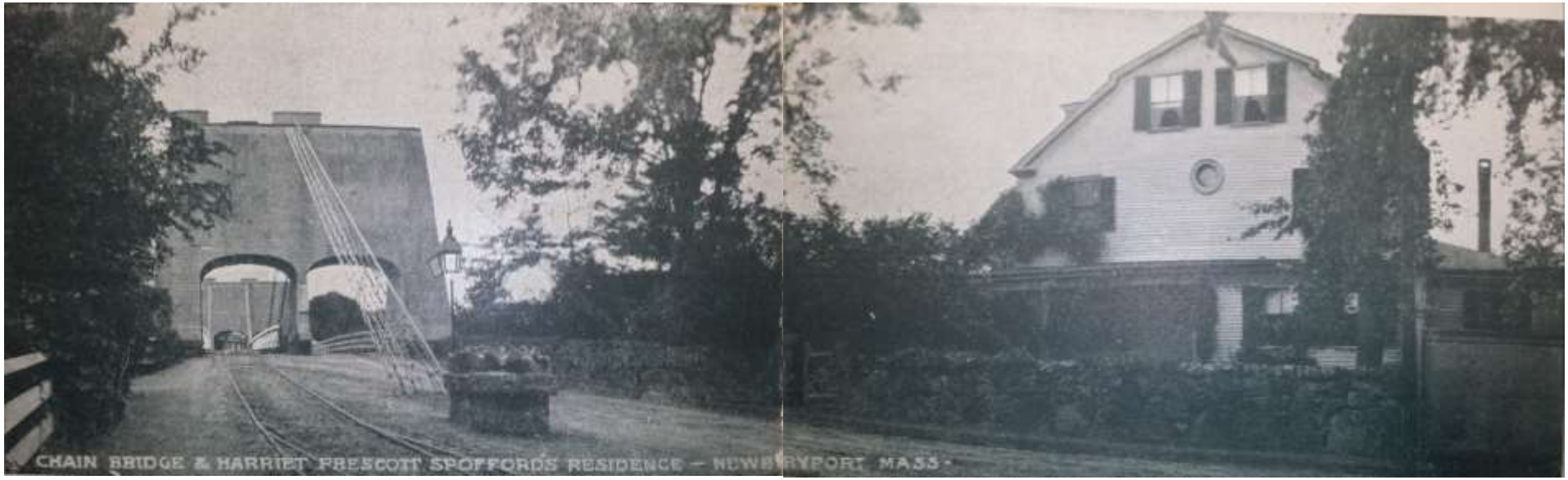
View from Moseley Woods Area Shore, ca. 1905

The wide solid deck leading out to the pier is not suspended from chains, but is supported by wood structure from the ground beneath and from the bridge pier. Unloaded chains above thus stretch out straight, rather than having a characteristic catenary curve.



Period postcard

The Continued Life of Chain Bridges



Above, double-width foldout postcard, ca. 1905

While Newburyport's bridge used traditional style links, large chain bridges of the British "eye-bar" type (right) were built in America & elsewhere trough the 1920s. Long iron-plate bars were pinned through "eyes" at each end, frequently with multiple plates side-by-side. A latent fault arose from period inability to calculate large local stresses around areas of these eyes, compounded by more rapid corrosion that occurs in high-stress regions.

A spectacular collapse occurred in 1967 with such a bridge over the Ohio River at Gallipolis, Ohio, while it was holding evening rush-hour traffic. Some other large such bridges were subsequently dismantled.

Brunel's 1864 Clifton chain bridge, Bristol, England

Replacing Newburyport's Chain Bridge

The chain bridge was replaced in 1909 with a modern equivalent suspension span, resting on the original stone piers. Whereas the Newburyport approach had formerly been a wood deck supported from the ground underneath, stone retaining walls were built out on each side to meet the sides of the pier. The enclosed space was filled solid, so that the approaching street was then on firm ground out to the pier.

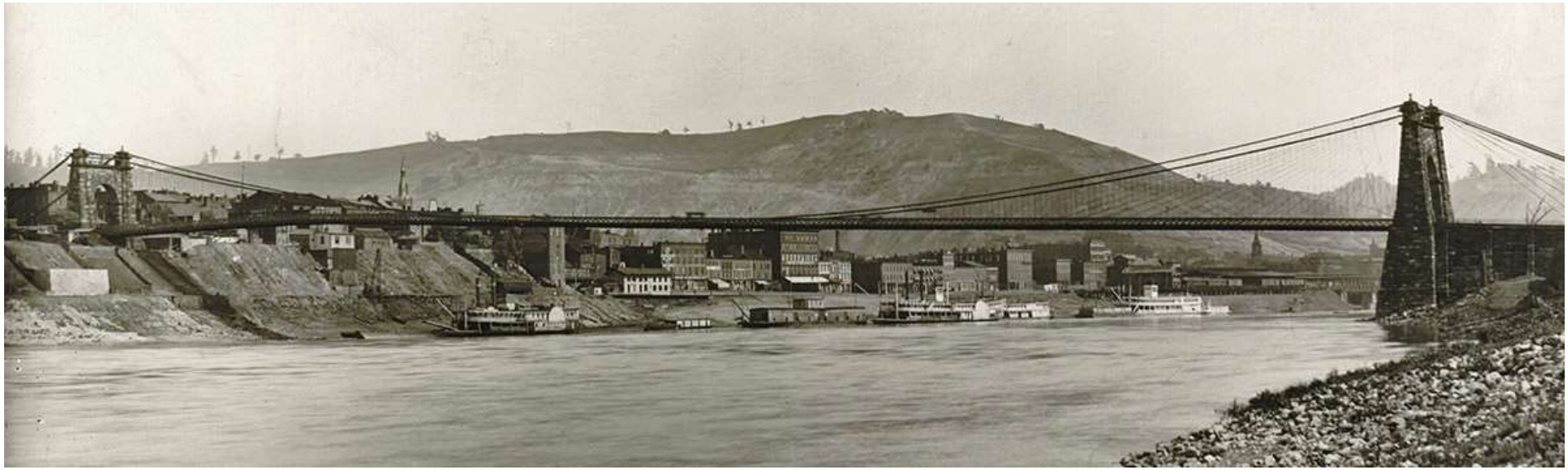
Beyond that, the new structure had modern versions of the three main suspension bridge elements: towers, deck, and catenary suspension.

Architectural concrete had been employed around Boston since the 1850s, offering an economical option for these relative small towers. Similarly, iron truss decks had been used on suspension bridges since the 1840s. Newburyport's new "zig-zag" truss structure and rigid lateral beams underneath can be seen at right, the truss being approx. 7 feet deep (vertically) to create a rigid beam. That rigidity allowed the previous paired independent spans to be replaced by a single bridge of full width, so that the new towers have a single wide opening. A single wide version of the original flexible deck would have suffered excessive droop and "ribbon" twisting that would have been extreme in the instance of heavy carriages on opposite corners of the bridge, in their respective right lanes.

Period postcard

Wire Cable Suspension Bridges

Wire cable suspension bridge by Charles Ellet over the Ohio river at Wheeling, West Virginia. Steam powered river boats can be seen along the shore.



Found at HistoricWheelingWikispace.com

It was noted above, in the Tyrrell bridge history, that an early Finley chain bridge had existed 1809-1811 adjacent to the Fairmont Water Works in Philadelphia. That was replaced by a wooden arch bridge, similar to the Timothy Palmer bridges once at Deer Island. However, the Fairmont span was, at 340 feet, one of the longest wood arches ever made, aided by iron rods, and the longest single span in America at the time. After that burned, in 1838, it was replaced by a 340-foot wire cable suspension bridge designed and built by Charles Ellet in 1841. That was the first permanent wire cable bridge in America, lasting until 1875.

With that experience, Ellet completed a second example in 1849 across the Ohio River at Wheeling, West Virginia. At 1010 feet, this was the then longest bridge in the world, and it still stands there today. Ellet's bridge has a substantial iron truss deck, although it seems quite slender in proportion to its length. Being as it was designed in the carriage era, it now has a 2-ton vehicle limit. By 1850, wire cable bridges were the primary design type for long spans.

Wire Cables & Deep Trusses in Modern Suspension Bridges

John A. Roebling, America's first producer of wire cable, had competed for the Fairmont project. He had an early history of building wire cable bridges, eventually landing a railroad suspension bridge contract at Niagara Falls.

The Niagara contract had originally been awarded to Charles Ellet, who completed a temporary cable bridge in 1848. Roebling stepped in after Ellet departed that project in 1851, amid payment disputes. Well aware of flexibility issues around suspension decks, Roebling designed a very (vertically) deep iron truss that carried the railroad on top, and a carriage & pedestrian roadway inside the truss on its bottom deck (top right). This constituted an immense & very rigid box girder, hung by two cables on each side. Although trains were limited to 6 mph, the span was successful from 1855 to 1897, when heavier trains required a new steel arch bridge.

Roebling's next project was a large suspension bridge at Cincinnati, still existing adjacent to Riverfront Stadium. At 1057 feet, it was the world's longest span when opened in 1866. The decks are again very deep, stiff trusses. Seen at bottom right, the ice scene is appropriate, as this is where poor Eliza crossed the river on ice floes. Harriett Beecher Stowe lived in Cincinnati, while her brother was a prominent preacher in Brooklyn, where Roebling completed his next bridge in 1886. A late design change to the Brooklyn bridge was to deepen deck trusses by an additional 6 feet.

Worldpress.com, courtesy of the Niagara Falls (NY) public library

courtesy of www.roeblingbridge.org

New Bridge, with Single Openings and Wire Cables, ca. 1910

Version 1, with concrete towers, steel truss deck, and wire cables, still with trolley tracks on the downstream side. (The trolley barn was the brick building still at 506 Merrimac St., Newburyport, later a Coca Cola bottling plant.) Note gap in railing, in front of trolley.

Period postcard

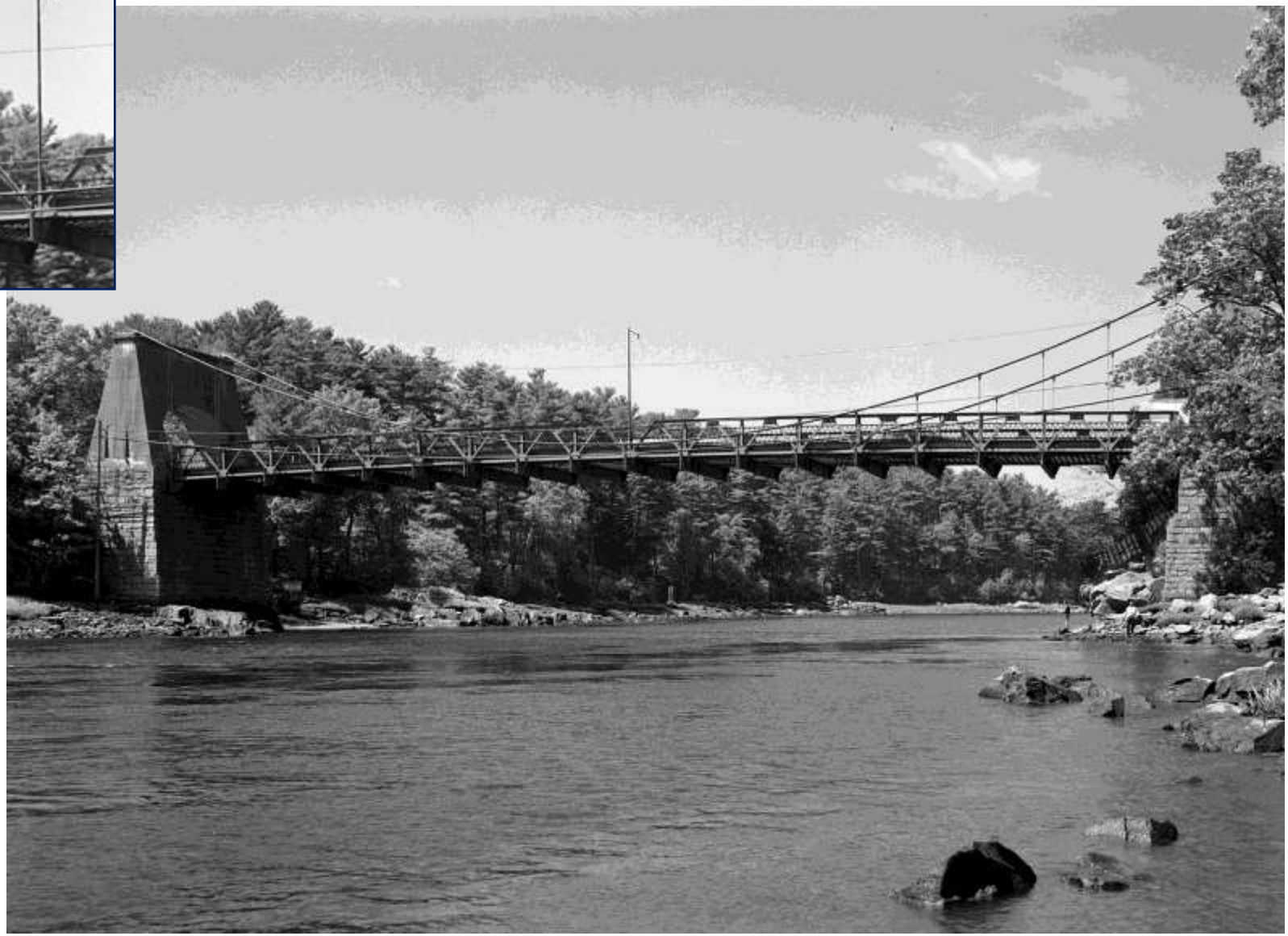
New Chain Bridge, Version 1, Having Hinged Deck, ca. 1910

The deck has 2 rigid sections, hinged at mid-span. The flexing arched deck would thus slightly lengthen & contract. End supports are hinged to allow this motion. In a 2010-2012 overhaul, the top railing was modified into a continuous rigid structure, by removing rivets and bolting in reinforcing plates, creating Version 2 with a single rigid deck.

Period postcard

The New Bridge, Looking Upriver from Deer Island Shore, 1990

Still Version 1, see inset. Modifications to form the current continuous deck truss occurred during the ca. 2008 modernization.



Historic American Engineering Record (HAER), summer 1990

Newburyport's Other Chain Bridge

281. In 1826-27, when Mr. Telford was completing the two suspension bridges at Bangor and Conway, a notable one of several spans was started under the direction of Thomas Haven, at **Newburyport, Mass.** (Fig. 104), crossing the Merrimac river betwen Newburyport and Salisbury, below Carr Island. It had three river and two shore spans supported on four piers and two abutments. At the Newburyport end was a small double leaf bascule draw span separate from the rest of the bridge, but as the main river was about 1,000 feet wide, the spans must have been 150 to 200 feet in length. The cables were wrought iron links with four groups of three in each, supported on timber towers 31 feet high standing on log cribs filled with stone.

From: *History of Bridge Engineering*, Henry G. Tyrrell, by the author, Chicago 1911, pgs. 211-213

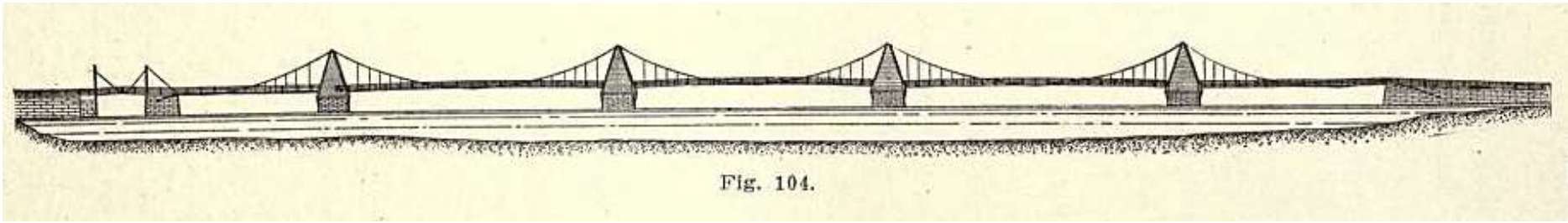
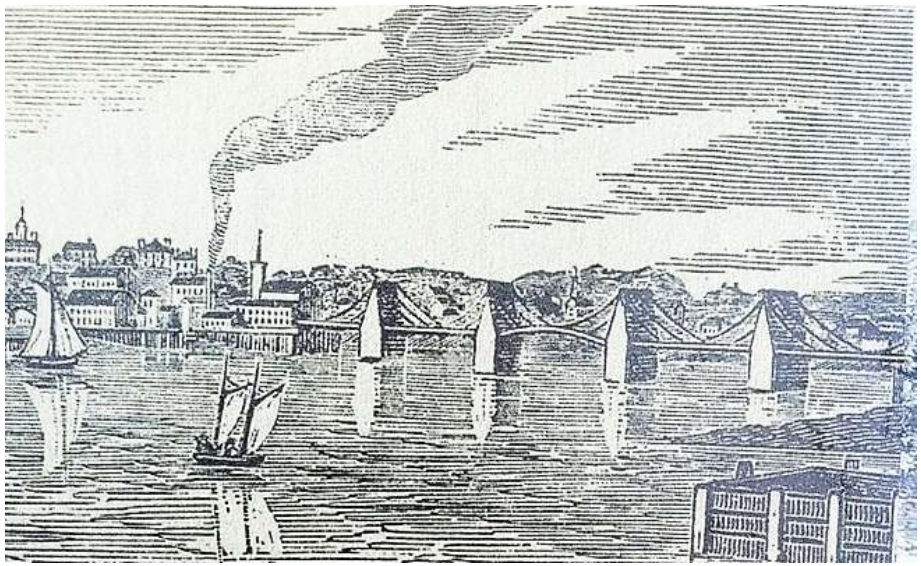


Fig. 104.

Right, an early engraved depiction of the downtown Newburyport multi-span chain bridge. Tyrrell, above, describes this as having four groups of three chains, seemingly copied from the successful Finley bridge at Deer Island. It had perhaps been noted that chain bridges of lesser mechanical integrity had a history of short lifespans. This suggests that the Newburyport bridge also had 2 independent side-by-side spans.

Tyrrell does not state how long this bridge survived, (print at right dated 1848) but it apparently, and unfortunately, did not last into the photography era.



1848 print

Newburyport's Other Existing Unusual Bridge, the 2 in 1

The next bridge downriver from the chain bridge is the railroad swing bridge located adjacent to Rt. 1. In the same way that heavier trains eventually limited the life of Roebling's Niagara suspension bridge, they threatened the viability of the railroad truss bridge at downtown Newburyport.

The solution was to construct around the outside, and across through the middle, of the original bridge a second box girder bridge, seen above as the brighter red structure having parallel top & bottom beams. Within are the slightly darker original trusses having thick heavy "zig-zag" girders. The two can clearly be discerned from the river. The result is two bridges, one inside the other, supporting the rail bed in parallel.

Additional Photos

Horse Trolley at Deer Island End of Bridge, ca 1890

Period postcard

View Looking Downriver from Moseley Woods Shore, ca. 1890

Period postcard

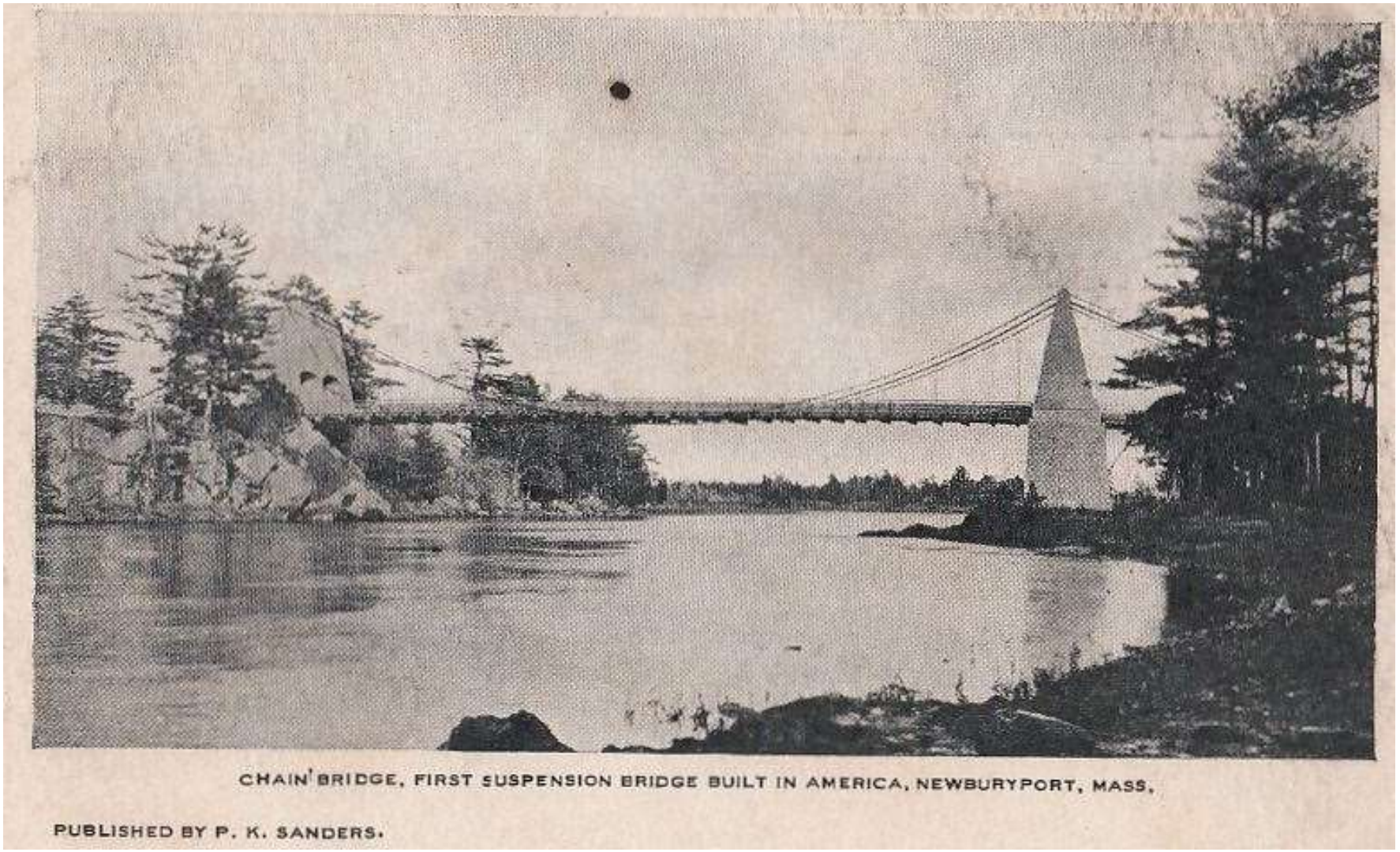
View Looking Across to Deer Island, ca. 1890

Period postcard

Winter View Looking Across to Deer Island, ca. 1890

Period postcard

View Looking Downriver from Moseley Woods Shore, ca. 1890



Period postcard

View Looking Upstream from Newburyport Shore, ca. 1895

looking over to Deer Island, with trolley-wire frame at mid-span

Newburyport End of Bridge, ca 1895

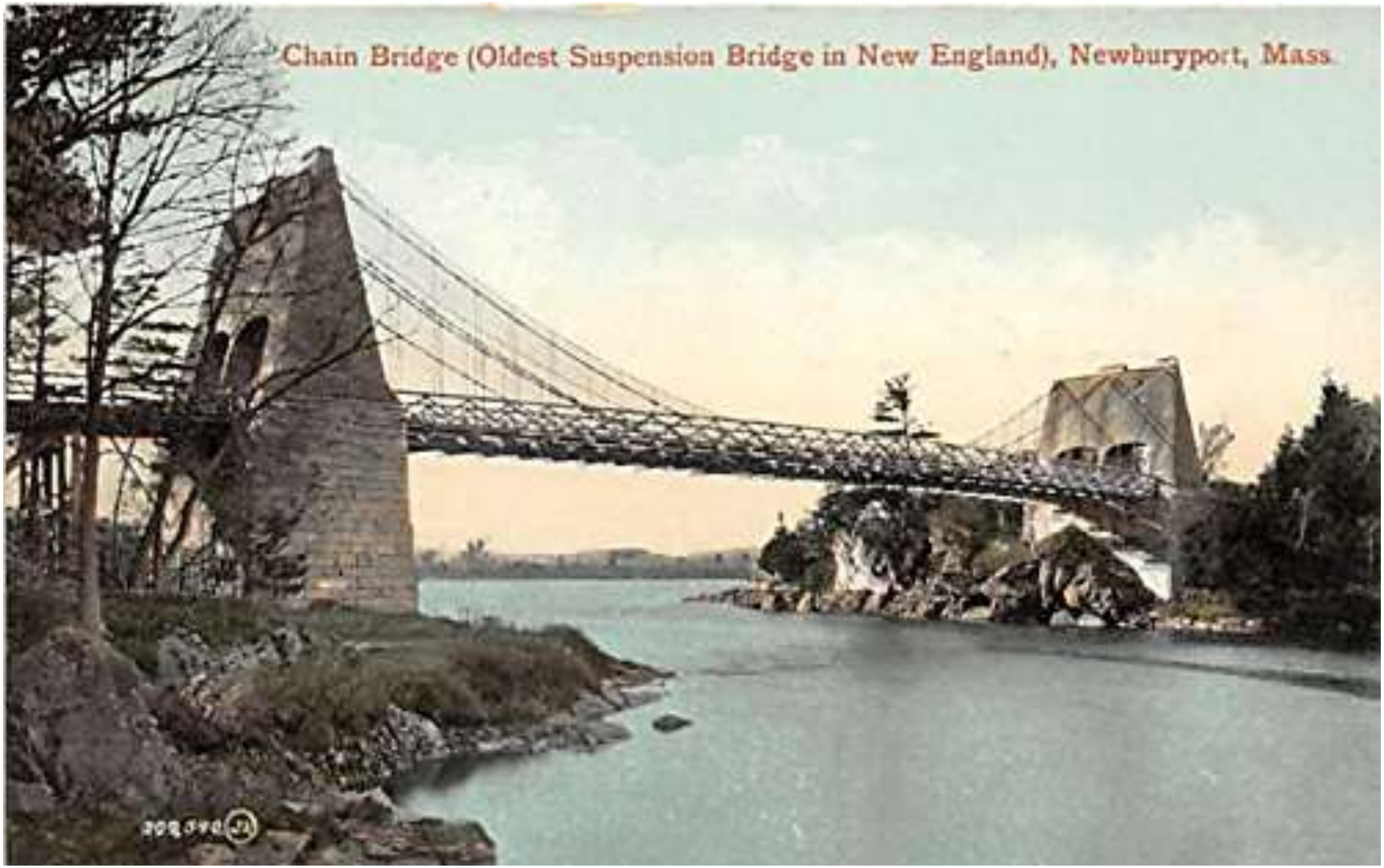
trolley-wire frame can be seen at mid-span

Period postcard

Steamer *Merrimac* Approaching Bridge from Upstream, ca. 1905

Period postcard

View Looking Upstream Toward Deer Island, ca. 1905



Period postcard

View from Moseley Woods Area Shore, ca. 1905

Period postcard

The *Gundalow* Sailing at Portsmouth, New Hampshire

Shallow draft (4 feet) gundalows mainly ran with the tides, carrying cargo in major local rivers. Lateen sail rigs added power, and could be folded down at bridges