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FOR MISS. COUNTY SURVEY LADY WHO WILL BE ARRIVING SOMETIME IN AUGUST OR SEPT.

8/2/60

HARPERS FERRY BRIDGES

By: Charlotte Judd Fairbairn, 1960

Harpers Ferry: While not really a bridge, this ferry furnished early transportation to the Maryland side of the Potomac. When Robert Harper arrived in 1747, a primitive ferry was in operation with a single boat poled across the river by the first settler, Peter Stevens, and an Indian named Gutterman Tom. On June 4th, 1766, Robert Harper was appointed to keep the ferry over the River Potowmack at the Falls of the Shenandoah, together with 3 hands for the service of same. On Dec. 11th, 1789, seven years after Harper's death, the Virginia Legislature passed an Act for Establishing Ferries and for Erecting a Toll Bridge. The ferry keeper at Harpers Ferry was authorized by this act to collect from every wagon, chariot or other 4-wheel carriage and the driver thereof 1 shilling; for every cart, sixpence; for every head of cattle, 1 penny; for every sheep, hog or goat, 1/2 penny. From Harper's to his land in Maryland the charge was 5 cents for every man and the same for a horse. A similar ferry was established to the Virginia shore.

Wager Bridge: On October 22, 1824, Masonic Charity Lodge #111 officiated at the corner-stone laying ceremony for the first bridge at Harpers Ferry. Harper's heirs, the Wager family, owned the bridge extrances, and built the bridge, from which they collected tolls. In 1829, the Virginia Literary Magazine announced this handsome wooden bridge was in use and "another is to be begun at once across the Shenandoah". A plat and photographs showing the Wager Bridge are on file at Harpers Ferry National Monument.

Wernwag Bridge: On December 1st, 1834, the B&O Railroad reached the Maryland Shore across the river from Harpers Ferry, and an enthusiastic reception ceremony took place. A bridge across the Potomac to Harpers Ferry was begun in the fall of 1835. Bridge plans were designed chiefly by Lewis Wernwag, a bridge-builder who lived on the Island of Virginius at Harpers Ferry. By January, 1837, the structure was sufficiently completed to allow passage of a locomotive. In April of 1837, the Virginia Legislature bestirred themselves to pass an act authorizing the transfer of travel from the old Wager Bridge to the new B&O structure. Unfortunately the contractor for the masonry of this bridge, Charles Wilson, seems to have allowed faulty masonry to pass inspection. The 11th annual Report of the B&O in the fall of 1837 reported the masonry defective, and reconstruction of the principal foundations was advised by the chief engineer. These defective piers were redesigned and rebuilt by William Lester. In the B&O 11th annual Report, Benjamin Latrobe, Chief Engineer, reporting this structural work, advised that the wooden superstructure was sound except for a minor fracture, which was repaired. By 1838, repairs were completed, and the line was in operation, the railroad cars being drawn over the bridge by horses, then continuing over the Winchester and Potomac tracks.

In 1839, the Virginia Legislature passed a law requiring the railroad to run westward to Cumberland, necessitating a "Y" on the Harpers Ferry end of the bridge. The right hand arm of the "Y" carried the train on an abrupt rightangle curve to a trestle between the Armory buildings and the Potomac. Property at the bridge entrance was purchased from the Wagers and in November bids were received for construction of the road. In June of 1842, the Virginia Free Press announced the main stem open as far as Hancock, Md., and in November of the same year the line had reached Cumberland.

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After two years of successful operation, in September of 1844, one span of the bridge, about 120 feet in length, fell under a single tender and engine, which was hurled to the river below. Surprisingly, damage was slight and no lives were lost. The accident was attributed to decayed timbers. In restoring the arch, B&O officials ordered the weather-boarding opened at intervals for regular inspection. Cost of repairs totalled $7,594.40. The following spring (March 1845) the same span again gave way, catapulting 10 cars from a train of 27 into the river. The engine Gladiator and nine house cars had passed over the weak span and were saved, but a gondola loaded with iron and ten cars of coal were thrown into the river. Miraculously there was no loss of life. The arch was again restored, at a cost of $6,000. Pictures and detailed descriptions of the Wernwag Bridge are available at Harpers Ferry National Monument.

Bollman Bridge: In 1851 an iron span designed by Bollman was erected from the Harpers Ferry shore, at a cost of $6,743.49. By June 1st this span was completed and was regarded as a remarkable structure. A single suspension truss of wrought iron, 124 feet in clear span, it replaced the original timber span of the Winchester and Potomac Railroad. The new structure was tested on June 1st by running 3 locomotives and their tenders on it, a total of 137 tons of weight, more than a ton for each foot of bridge. At the time of John Brown's raid and the outbreak of the Civil War, the single iron span still joined the old covered wooden bridge with the Harpers Ferry side of the Potomac. At the Maryland entrance to the covered wooden portion Brown's party captured the night watchman of the bridge, and, after crossing the bridge, stopped a train on its way to Maryland. On June 14, 1861, at 4 a.m., the Bollman span was blown up by order of General Johnston as his troops left Harpers Ferry. Torches set the wooden bridge blazing, and a large locomotive too heavy to transport on the road to Winchester was thrown into the river. The Shenandoah Bridge, Armory buildings and Hall Rifle Works were also left in flames.

Civil War Bridges: From March 14-18, 1862, a military suspension bridge was rapidly thrown across the Potomac on iron cables with a wooden platform. It was a short-lived structure, washed out by the flooded Potomac on April 22, despite heavy weighting with loaded coal cars. On the 28th, the intrepid engineers began an 800 ft. trestle across the Potomac, only to have it washed out by another flood on June 7th. Two days later they were back at work on a third trestle, completed on June 16th. Measured iron spans were ordered from Mount Clare, sent to the Ferry and set up, gradually replacing wooden spans. It was in use only a month when on September 24, 1862, Jackson again ordered the bridge destroyed behind his troops. Patiently the B&O again set to work, fabricating new iron spans at Mount Clare, and completed the new bridge by April of 1863. Two weeks after completion it was threatened by heavy floods, but was saved by weighted coal cars. On July 5th, 1863 the new bridge was burned by the U. S. Army as a military precaution. The iron spans were refloored, and opened to traffic August 1st. The following April, two principal spans were washed out by heavy floods. Other spans were saved by means of steel cables, rushed from Baltimore to strengthen the existing structure. On May 16th, 1864, the pontoon bridge in use during repairs to the main bridge broke in flood, piled against the bridge and demolished several spans. Harpers Ferry's main artery was a complete shambles. But only five days later, an emergency trestling bridge was opened to traffic. Wendell Bollman's design for the completed bridge was put into execution and the Bollman bridge remained unchanged until 1893.

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Modern Bridges: Today the bridges at Harpers Ferry present a pleasing study in the history of transportation. Abutments of the old covered wooden Wernwag bridge are still visible. To their right from Maryland Heights one sees the Winchester and Potomac freight bridge built between 1893 and 1896, when the tunnel was cut through the Maryland Heights. On the right of this bridge is the new modern bridge and route of the B&O streamliners, completed on June 1st, 1931. Across the greater Potomac to one's left is the new highway bridge, dedicated in 1947, and beyond the confluence at the Ferry Point, a second new highway bridge crosses the Shenandoah. The latter bridge was dedicated in 1949.

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MORNING HERALD
Hagerstown, Maryland
May 19, 1970

Foot Bridge Across River Studied

Plans are in the works for a foot-bridge across the Potomac River connecting Harper's Ferry and Maryland Heights.

The plans are "very preliminary" right now, said Benjamin Davis, superintendent of Harper's Ferry National Monument, but he hopes they will be ready for the 1972-73 fiscal year.

The bridge would be built across the old Baltimore and Ohio Railroad piers which were in use in John Brown's time.

The piers are controlled by the Maryland state government because they are in the Potomac River, Davis noted. He said Spencer P. Ellis, director of the Maryland Department of Forests and Parks, and State Senators George E. Snyder and Goodloe Byron are trying to work out a method by which the state-controlled piers can be used in the federal project.

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THE FIRST RAILROAD BRIDGE AT HARPERS FERRY

Harpers Ferry National Historical Park

Prepared by:

D. E. Stinson
March 10, 1970

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TABLE OF CONTENTS

PAGE NO.

PART I - The Early Years - 1835-1843..... 1

PART II - The Pre-War Years - 1844-1860..... 14

PART III - The Civil War - 1861-1865..... 26

PART IV - The Final Years - 1866-1936..... 50

APPENDICES

A - Pier Specifications..... 54

B - Bridge Repairs of 1837..... 55

C - Accident Report of 1844 (Portion)..... 57

D - Bollman's Pamphlet (1852)..... 59

E - Summary of Bridge History..... 66

BIBLIOGRAPHY..... 67

NOTES..... 69

ILLUSTRATIONS - A section of 28 illustrations follows page 77.

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INTRODUCTION

This report is intended to be a history of the first railroad bridge at Harpers Ferry. It is not an engineering document and an effort has been made to keep highly technical data from impeding the flow of the narrative. The diagrams are not scale drawings and are included only to clarify points in the text. All source materials used are available at Harpers Ferry National Historical Park.

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PART I

THE EARLY YEARS

1835-1843

On December 1, 1834 the Baltimore & Ohio Railroad established its railhead at Sandy Hook, Maryland. The ceremony was marked by the arrival of a train pulled by the engine Arabian and crowded with distinguished visitors. [1] Across the Potomac River lay the thriving industrial community of Harpers Ferry.

The only link between Harpers Ferry and the railhead was a "handsome double wooden highway bridge, 750 feet from one abutment to the other." [2] This was the Wager Bridge - totally adequate for wagons and pedestrians but useless for the passage of a railroad. If the B & O wanted to cross the Potomac, as indeed it did, it would have to build its own bridge. And so designers and engineers went to work to produce a structure which, unknown to them, was to serve in one form or another for 99 long years.

Meanwhile, the Winchester & Potomac Railroad had been laying track from Winchester with a target date of March, 1836, for reaching the Potomac at Harpers Ferry. A bridge linking the lines would establish full rail connections between the rich Shenandoah Valley and the markets of Baltimore. This would serve

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as a temporary justification for the bridge until the main line could be built to Hancock, Cumberland and beyond. The bridge plans were completed by the late summer of 1835 and the construction bids were let in September. [3] (See Appendix A for Pier Specifications).

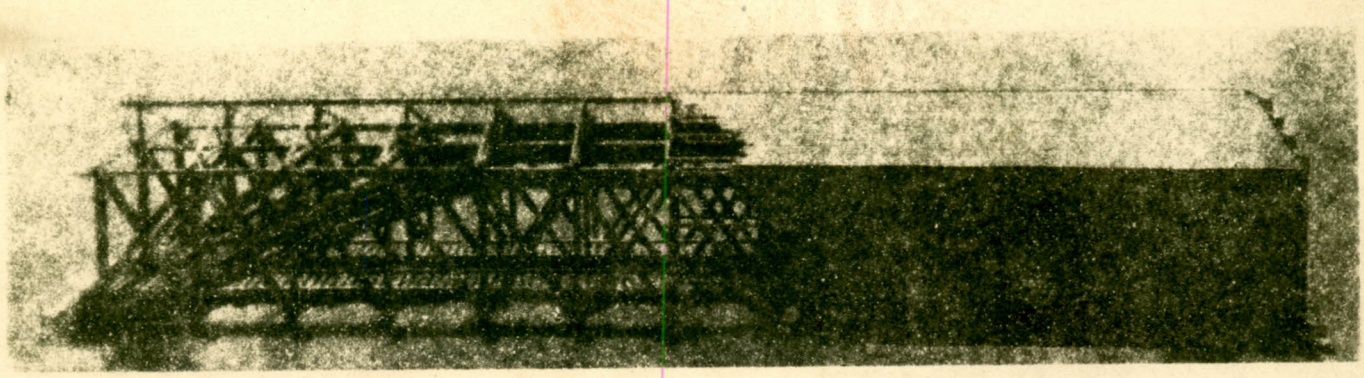
The Harpers Ferry railroad bridge was designed principally by Benjamin H. Latrobe who was to become the railroad's Engineer of Location and Construction in 1836. Latrobe was in his late 20's and the son of the noted architect and engineer of the same name. Latrobe had already made a name for himself in 1832 when he designed and constructed the bridges on the B & O's Washington Branch. The most famous of these, the Thomas Aqueduct near Laurel, Maryland, was originally scoffed at as "Latrobe's Folly" yet it remained in service for over a century. [4] But the short Thomas Aqueduct was built of stone - not wood as the bridge at Harpers Ferry would be.

Latrobe designed all the B & O's principal timber bridges as far west as Cumberland;

> These were good, solid structures of composite construction, in which a certain amount of cast iron was used in joints and wrought iron for certain tension members. They were . . . not only grossly overdesigned but of decidedly difficult fabrication and construction. [5]

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DIAGRAM: LATROBIAN TRUSS



The truss in this diagram, although of a 1838 bridge over the Patapsco River at Elysville, is probably similar to that in the Harpers Ferry bridge. The following extract (Vogel, 85) provides technical data on the design;

> What is interesting about the Latrobian timber trusses, however, is the effect they appear to have had upon Bollman's subsequent work in the design of his own truss. This effect is evidenced by the marked analogy between the primary structural elements of the two types. The Latrobe truss at Elysville was only partially a truss, inasmuch as the greater part of the load was not carried from panel to panel, finally to appear at the abutments as a pure vertical reaction, but was carried from each panel (except the four at the center) directly to the bearing points at the piers by heavy diagonal struts, after the fashion of the famous 18th-century Swiss trusses of the Grubenmanns. It was a legitimate structural device, and the simplest means of extending the capacity of a spanning system. However, it was defective in that the struts applied considerable horizontal thrust to the abutments, requiring heavier masonry than would otherwise have been necessary.
>
> It is quite likely that Latrobe did not have absolute confidence in the various pure truss systems already patented by Town, Long and others, and preferred for such strategic service a structure in which the panel members acted more or less independently of one another. It will be seen that, similarly, the individual panel loads in Bollman's truss were carried to the ends of the frame by members acting independently of one another.

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The contracts for the bridge were in 2 sections - Charles Wilson for the pier and abutment masonry and Lewis Wernwag for the wooden superstructure. [6] The 65 year old Wernwag was the most renowned wooden bridge builder in the United States and by the oddest of coincidences was living on Virginius Island at Harpers Ferry. Following a distinguished career in the Philadelphia area, in 1824 Wernwag came to Harpers Ferry under contract with the Wager family to build the covered bridge over the Potomac. In December of that year he purchased a parcel of land on Virginius Island and erected a sawmill. [7] Having completed the bridge, Wernwag stayed on at Harpers Ferry although his profession took him to many parts of the country. The new bridge at Harpers Ferry would be the old man's last.

Although the bridge design was by Latrobe it may be well to comment on one of Wernwag's principles which it is probable was used in the bridge.

> . . . Wernwag . . . sawed all the timbers through the heart, so as to detect unsound wood, and to reduce the greatest width of a stick to six inches; the iron collars introduced between the various parts of the rib were to allow a free circulation of air, and thus prevent decay. If greater strength were required the number, but not the dimensions of the sticks, was increased. 8

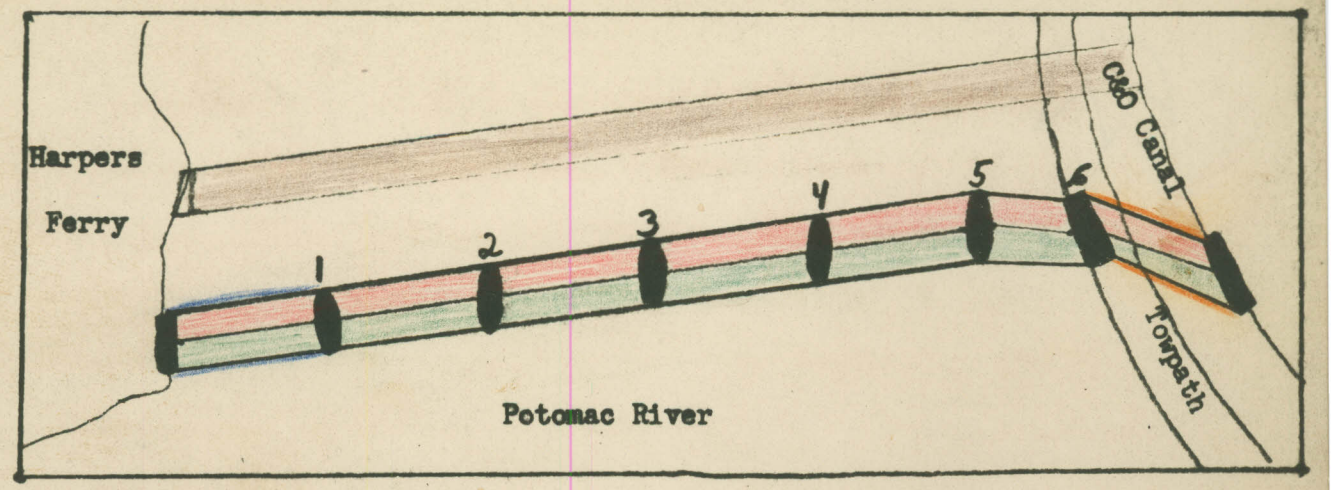
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By the summer of 1836 the masonry on the piers and abutment was completed. Work on the wooden superstructure continued on into the fall and winter, [9] marked in October by the drowning of a blacksmith named Odey who "was engaged . . . in putting some irons to the timbers" of the bridge. [10] By January 1837 the structure was completed to the extent that, as the press announced, "locomotives and their trains have passed over it." [11] (A diagram on the following page shows the bridge as originally built. See also Photograph #2).

The completion of the bridge was a giant step forward for the railroad but it also marked the beginning of a trying year for both the company and its new structure. The former was hit by the Panic of 1837 then sweeping the country. The latter, as discovered in April by alarmed engineers, was in apparent danger of collapse. The masonry work on the piers was so defective as to require the reconstruction of the prinicpal foundations. Latrobe, now Engineer of Location and Construction, was faced with the task of making the necessary repairs while keeping the bridge in use. Understandably, his first move was to find a new masonry contractor to replace Wilson whose inferior work had caused the problem. The contractor this time was William Lester. Lewis Wernwag continued as contractor for the superstructure.

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DIAGRAM: THE ORIGINAL BRIDGE 1837-1840



KEY:
- Brown - Approximate Location of Wager Bridge
- Green - Railroad Portion of New Bridge
- Red - Highway Portion of New Bridge
- Shaded Areas - Those with numbers are piers. Those without numbers are abutments. (Numbers referred to throughout text but not reproduced on other diagrams)
- Blue (outline) - Known as Winchester Span (between west abutment and Pier #1)
- Orange (outline) - Known as Canal Span (between east abutment and Pier #6)

LENGTH OF BRIDGE: Overall - 830'

Winchester Span	- 124'
#2 Span (between piers 1-2)	- 126.6'
#3 Span (between piers 2-3)	- 126.6'
#4 Span (between piers 3-4)	- 127'
#5 Span (between piers 4-5)	- 126.9'
#6 Span (between piers 5-6)	- 76'
Canal Span	- 122.6'

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Latrobe's report of the 1837-38 repairs did not go into detail as to exactly what the bridge deficiencies were. It may be inferred, however, that weakness in the pier foundations caused a settling which, by chain reaction, damaged the upper portion of the piers and, in turn, the wooden superstructure.

The repair work went on through the summer of 1837 while trains cautiously made their way over the bridge. By fall the foundation work was completed. During the same time the span over the C & O Canal was weatherboarded and roofed. (See Photograph #2). The project was halted for the winter and then completed in the following year. Roofing and weatherboarding the entire structure, although planned for 1838, was indefinitely postponed.[12] (See Appendix B for Latrobe's report on repairs).

In 1838 a 24 year old Baltimore carpenter named Wendel Bollman arrived in Harpers Ferry. He had worked for the B & O in his teens both as a laborer and later on the survey crew. Since that time he had become a journeyman carpenter with jobs as far away as Mississippi. In 1837 Bollman returned to Baltimore and set up his own business, a contract of which had brought him to Harpers Ferry to build a house. Here he was approached by the

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B & O and hired to assist in the bridge repairs. The association with Latrobe and Wernwag was to have marked influence on this creative young man.[13]

The problem of continuing the main-stem to Hancock was also active in 1837-38. To accomplish the next leg of its westward movement the railroad had two alternatives for moving out of the Harpers Ferry bottleneck;

1. It could go through the U. S. Armory property.
2. It could continue down the W & P for about 6 miles and then turn north.

The second alternative was rejected out of hand by the W & P. This refusal caused the B & O to pursue the first alternative which was less attractive for the following reasons;

1. An agreement would have to be made with the U. S. for passing through part of the Armory grounds.
2. The Wager Bridge would have to be purchased and demolished.
3. It would be necessary to run the main-stem branch off the bridge in mid-stream.

Foot and vehicular traffic had been transferred from the Wager Bridge to the new one by an act of the Virginia Legislature in

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April, 1837.[14] In November, 1838 an agreement with the United States was reached concerning Reason #1 above and in December, 1839 the railroad purchased the Wager Bridge with the stipulation that it be demolished in time for the new construction.[15]

The new plans made 1839 the last year the bridge functioned in its original straight and uncovered state. A traveller passing over by train in November of that year recorded;

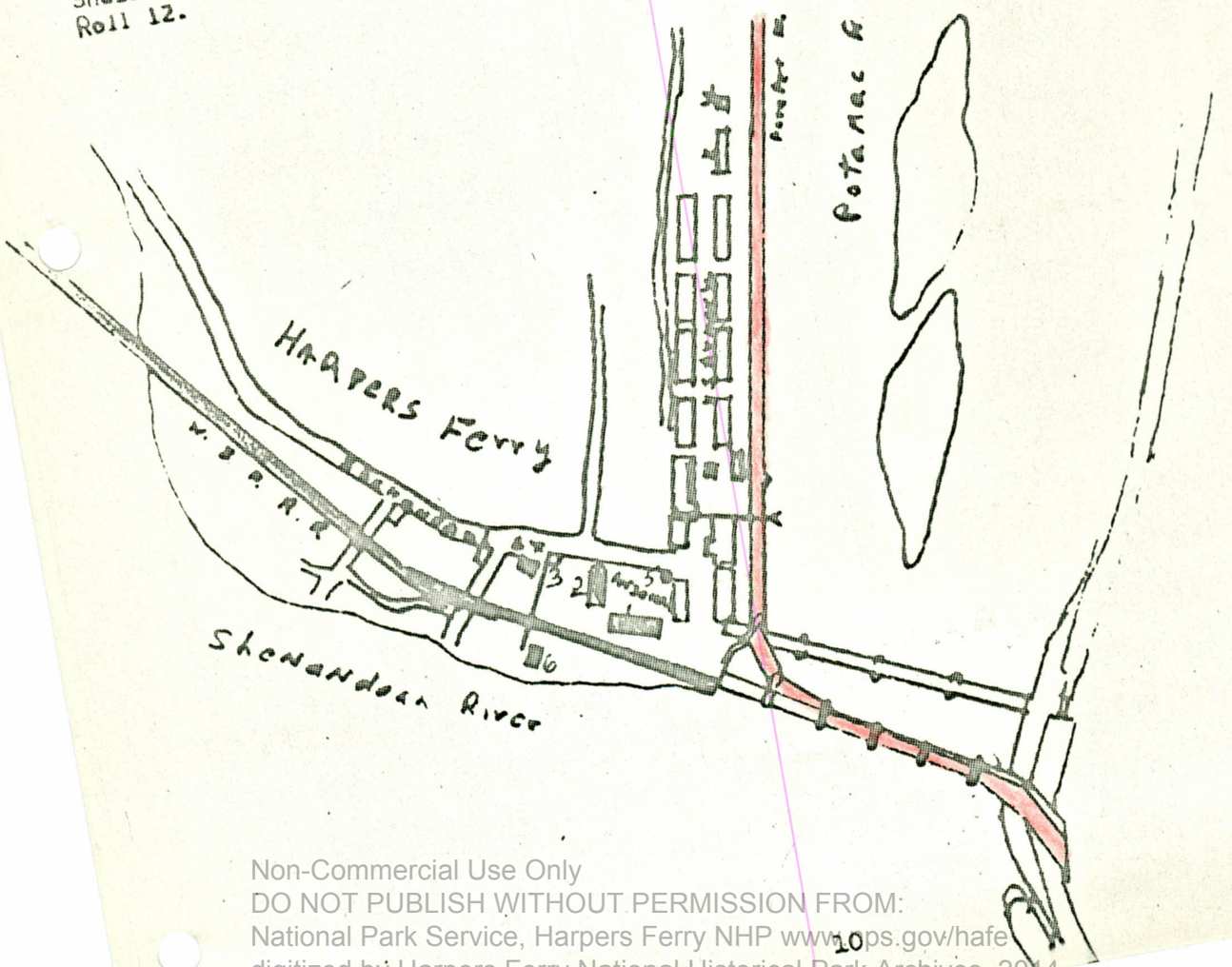
> The cars are drawn across the bridge over the Potomac by horses, and as there is no roof over the bridge and the cars move slowly across, here the traveller becomes enraptured with the beauty and grandeur of the scenery.[16]

The construction of the new span or Y, begun in 1840, was again a Latrobe-Wernwag project. The map on the following page shows the general plan, which is described as follows;

> The route . . . leaves the railroad viaduct at or near second pier from the Virginia shore and turns to the right up the Potomac until it acquires a direction parallel . . . to the new river wall . . . on the river side of the northern row of work shops belonging to the musket armory.[17]

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MAP Showing the Routes for the
BALTIMORE AND OHIO RAIL ROAD Along
the Public Grounds upon the Potomac
River at & Above Harpers Ferry
upon which the Company have applied
to Government for Permission to Locate
and construct their road.
Scale 400 ft to an inch.
Benj. H. Latrobe, Engineer of Location
& Construction, Balt. & Ohio Rail Road.
(1837-38)
Baltimore & Ohio R.R. Archives
Real Estate Dept.
Case 5
Shelf 24
Roll 12.



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(This route is colored red on the preceding map). For a westbound train, the switch would begin immediately upon crossing Pier #2, ease across the highway portion, so as to be ready for the more pronounced curve at Pier #1 where the tracks would actually begin crossing the new span. To accomplish this, several feet had to be added to the upstream end of Pier #1. (This highway section continued on the straight portion of the Y which was known as the "Winchester Span"). The new span was 130.6 feet in length from Pier #1 to the abutment. It would appear that the Wager Bridge abutment, probably with some improvements, was used for the new span. [18]

The exact date that the "Y" was completed is difficult to pinpoint. However, on June 1, 1842, the entire line was open to Hancock. [19] In December of the same year a special train made the 170 mile run from Washington to Cumberland in 5 hours and 50 minutes.

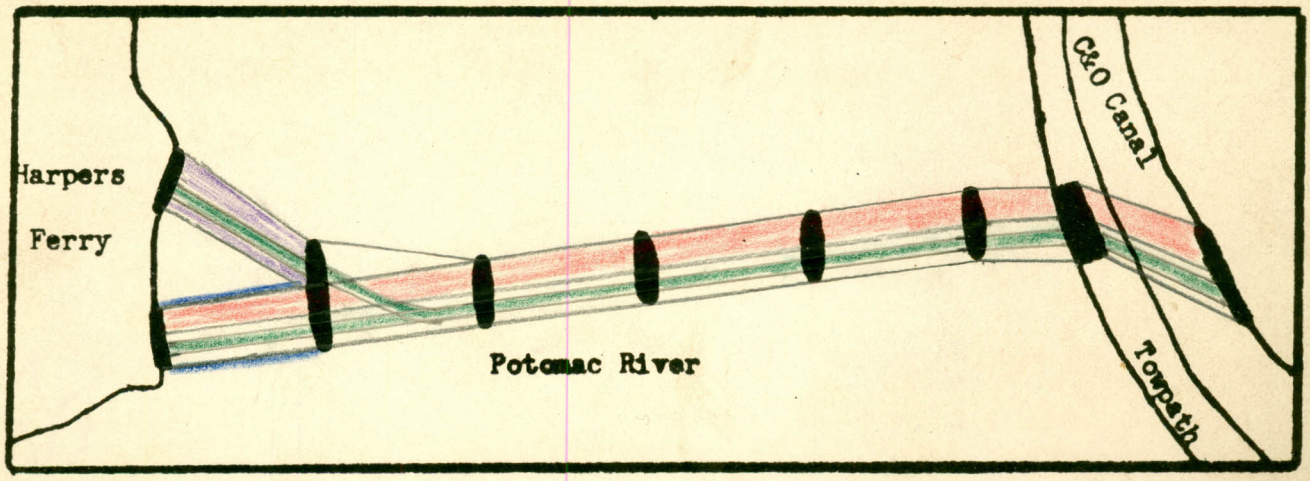
During this project, the entire bridge including the Y was weatherboarded and covered with a tin roof to protect the wood from the elements. [20]

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The B & O had indeed made a significant leap forward in the years 1840-42 and the Harpers Ferry Y was a vital link in the chain. Yet its great haste was not accomplished without a certain amount of substitutes of quantity for quality. This was particularly true of the wooden bridges along the line, including the Harpers Ferry Y. In these cases it was impossible to secure the proper timber in sufficient quantity and rather than hold up progress an inferior type was used in a good part of the new construction. This bow to expediency was to have near disastrous results a short while later. [21]

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DIAGRAM: CONSTRUCTION OF THE Y - 1842



This diagram illustrates the layout of the bridge after the addition on the Y as described on page 11. The green line shows the single railroad track. Note that the track crossed the highway section (red) on the #2 Span. (This span is often referred to as the "Wide" Span). The covering on this, and the new span (purple) was higher than that of the rest of the bridge, and it is probable that the superstructure (at least on the #2 Span) was as well. The entire structure was wooden until 1851 when the Winchester Span (blue outline) was reconstructed on the Bollman principal.

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PART II

THE PRE-WAR YEARS

1844-1860

On September 4, 1844 eight locomotives pulling both passenger and freight trains passed over the Harpers Ferry bridge. That night 3 more freights crossed. Nothing out of the ordinary occurred - it was just a routine day, typical of many that had gone by since the contruction of the Y. The next day began the same way with an engine, its tender, and a 4 man crew steaming out onto the bridge. Then, suddenly, the curved span between Piers 1 and 2 gave way, plunging the equipment and men into the river below.[1] In spite of the catastrophic potential the President of the B & O was able to report that;

> . . . Providentially, no life was lost, and but slight injury sustained by any of the men who were carried down in the fall; nor was the Engine materially damaged . . .[2]

Passenger travel was restored in a few hours and the freights were moving within a week. The investigation of the accident took somewhat longer, (The report is included as Appendix C) and may be summarized in a few words;

1. The accident was caused by the rot of several timbers making an important part of the framing of the arch.

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2. The rot was caused by a leak in the tin roof.

3. The rot was not discovered because the weather-boarding made a minute inspection impossible.

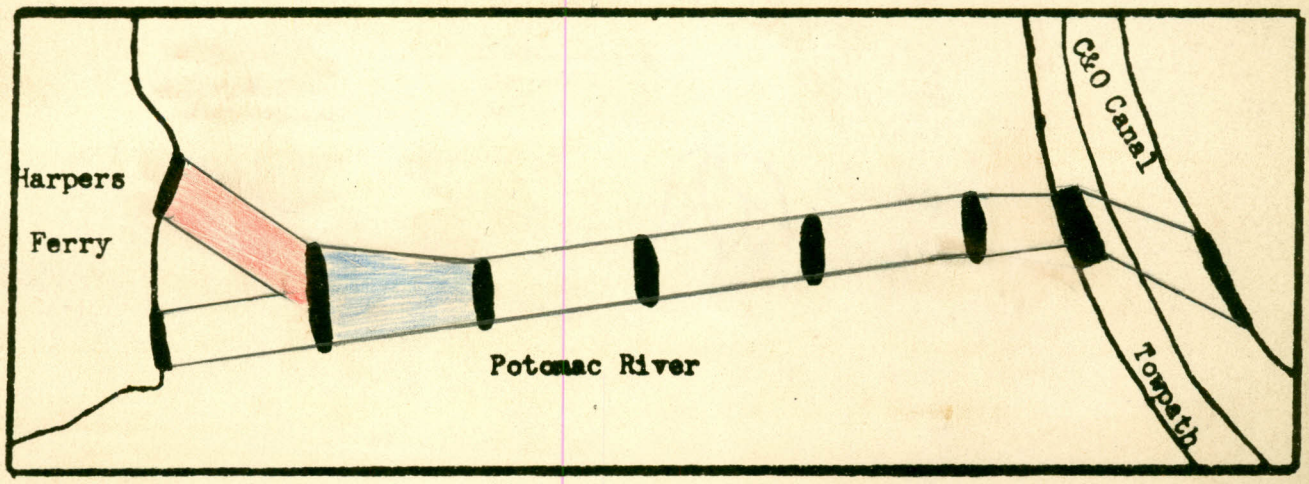
While reconstruction of the fallen arch went on the company pulled the weatherboarding from all its wooden bridge and examined the timbers before replacing it.[3] No other trouble was observed, but more was coming.

On the afternoon of March 18, 1845, a scarce 6 months after the accident, the engine Gladiator - one of the newest and best on the line, moved out on an east-bound run. The Gladiator was hauling a 20 car train which included 9 freight cars, 1 gondola loaded with iron, and 10 coal cars. The train was no sooner fully on the bridge than the span closest to the river bank gave way. Fortunately, the engineer heard the crash and by giving steam was able to reach the safety of the next span with about half of his train. The 10 coal cars and the gondola fell into the river carrying with them the conductor and an unidentified man and boy. Once again no life was lost.[4] (See diagram on following page).

The official reaction to the second accident was described in the restrained words of the B & O President;

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DIAGRAM: ACCIDENTS OF 1844-45



The span between Piers 1 and 2 (blue) collapsed on September 5, 1844. Repair on this span was still in progress when, on March 18, 1845, the main-line span (red) collapsed.

It appears that after the first accident temporary supports were put under the (red) span while the (blue) span was being reconstructed. This was done to compensate for the loss of the counter-thrust. The supports were washed out in a sudden flood and apparently had not been replaced when the second accident occurred.

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> The recurrence of such an accident, as will be readily supposed, created the most lively anxiety in the minds of the board, both as to the durability of the bridges along the entire route, and the principle upon which they were constructed. [5]

Yet in spite of the "lively anxiety" and the resultant investigation the causes of the accident were remarkably similar to those of the previous year. Once again, it seems, parts of the timbers were rotting away unobserved. Other contributing causes cited included defective workmanship and the fact that repair work was going on at the time of the accident. Temporary timber supports had been put under the arch while the previously fallen arch was being reconstructed. This was done to help bear the burden while the arch was "deprived of the counter-thrust of the adjacent span." [6] Why heavy trains were allowed to use the bridge was not gone into.

Although nothing really new was learned, the railroad for the first time, admitted that there had been too much speed in the construction of the Y;

> It will be remembered that it was necessary to hasten the finishing of the bridges along the route, in order to avoid delay in the opening of the road to Cumberland; and, the difficulty which attended the procuring of the proper description of timber in sufficient quantities . . . [7]

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This time repair and replacement of defective timber parts was on an extensive scale. In addition, a new covering system was devised whereby the timbers would be protected while thorough and frequent inspections were made. The cover, like the previous, consisted of weatherboard siding and a tin roof but it was apparently arranged in a different manner on the superstructure.[8] By the fall of 1847, a year and a half after the second accident, the railroad felt safe to report the bridge "as durable as if built of stone or iron." At any rate, the repairs were so extensive that only the Winchester Span was not considered "new."[9]

Also, in 1847, night trains began running through the bridge. Apparently up until this time only freights were allowed on the structure during the hours of dark. This required a night-watchman because it was the "only bridge with gates upon the line and upon which tolls are collected."[10]

It was obvious to forward-looking engineers that the time was coming when wooden bridges would have to be phased out along the railroad lines. Not only were they hazardous, as evidenced by the two Harpers Ferry accidents, but they were economically unsound due to the necessity of frequent replacements. This had

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been strongly impressed upon Latrobe during the 1840-1850 decade and experiments in more permanent structures were being conducted by his Master of Road - Wendel Bollman - the same young man who had hired on during the repairs of 1838 (See Page 7). [11]

In 1850 the railroad began plans for a thorough overhaul of the Winchester Span, the only portion of the bridge not recently refurbished. During the year Bollman built two bridges on the Washington Branch employing his ideas on iron spans. Both were considered successful. Latrobe then gave Bollman approval for constructing the Winchester Span in iron. [12]

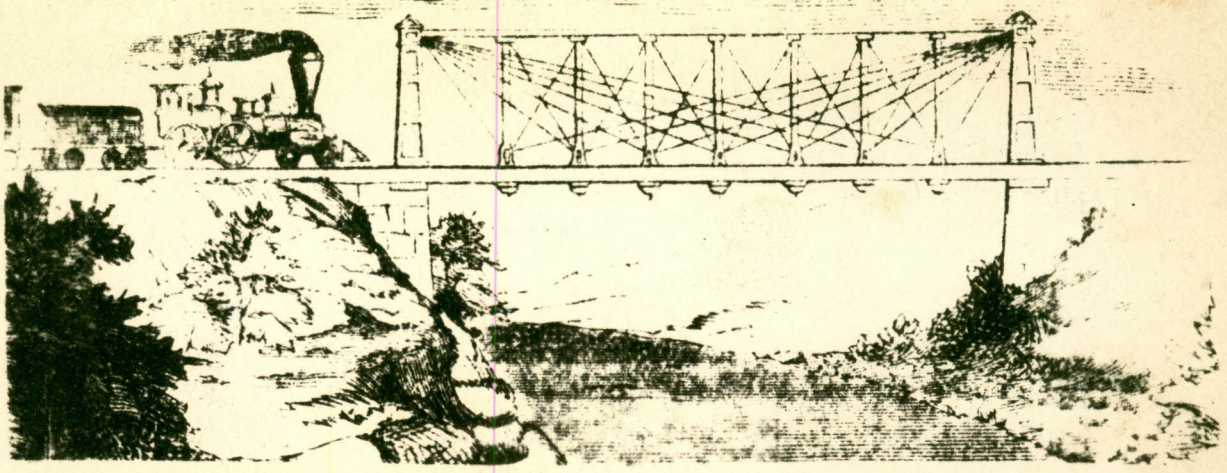
Bollman worked on the span in 1851 and by September the President of the Railroad reported;

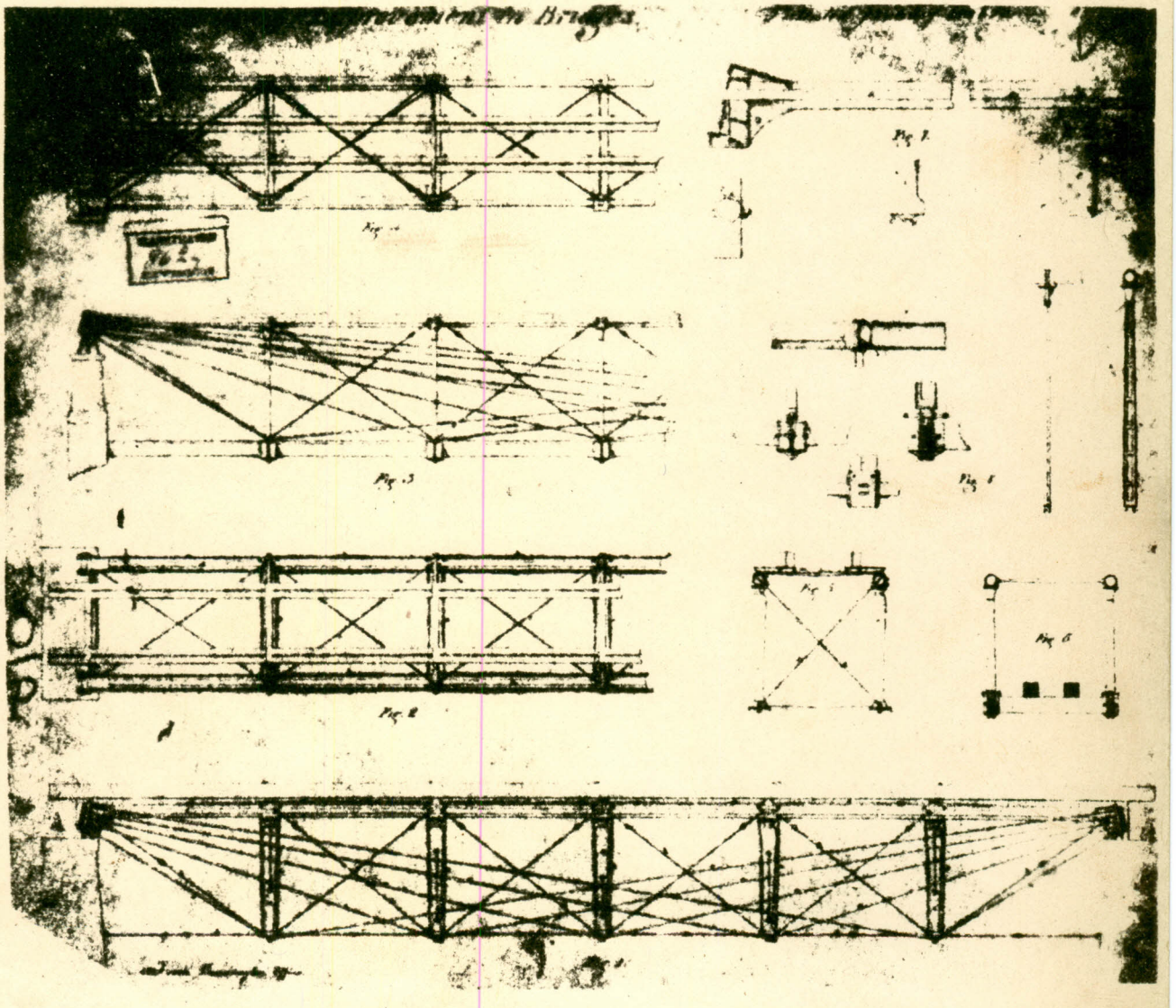
> That part of the Bridge at Harpers Ferry, known as the "Winchester Span", has been so far completed as to be brought into full use, and has cost $6,743,49. It is a very substantial Iron structure, from which most permanent service may be expected. [13]

The components of the bridge were fabricated at the B & O's Mount Clare shops and shipped to Harpers Ferry where Bollman supervised the construction. It consisted of three parallel lines of trussing with granite towers, (See plans on following pages) and was described by its creator as a "suspension and trussed bridge." [14]

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From Bollman advertisement of 1855. The Winchester Span had granite towers and 7 vertical struts similar to the bridge shown.





Copy of Bollman's original patent drawings.

(These and other technical drawings of the Bollman principal are available in Park Library).

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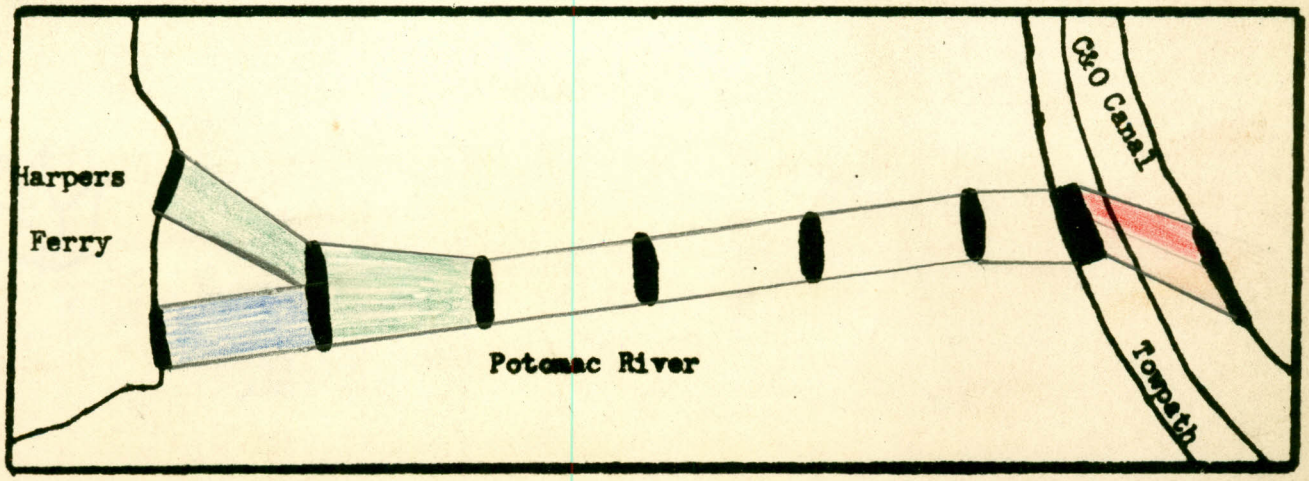
In 1852 Bollman patented the truss and also published a leaflet on the subject which was widely read.[15] (Reproduced as Appendix D). On June 1 the new span was tested under the direction of the Superintendent of the B & O. He described the test as follows;

> Three first class tonnage engines with three tenders, were first carefully weighed, and then run upon the bridge, at the same time nearly covering its whole length, and weighing in the aggregate 273,550 lbs., or 136,775 (2,000 lbs.) tons net, being over a ton for each foot in length of the bridge.
>
> This burden was tried at about eight miles per hour, and the deflections, according to gauges properly set and reliable in their action, were at Centre Post - 1 3/8", and at the first post from abutment 9-16 of an inch.[16]

Bollman's work was so successful that as the decade wore on the Chief Engineer continued to recommend that the entire bridge be redone in iron. In both 1857 and 1858 he suggested that all the necessary parts be gradually prepared so as to be on hand when replacement was necessary.[17] Apparently no action was taken and from 1851 to 1861 the bridge situation was as shown on the diagram on the following page and in Photographs 4 - 8.

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DIAGRAM: THE FIRST BOLLMAN SPAN 1851-1860



In 1851 the Winchester Span (blue) was reconstructed on the Bollman principal. Being of iron, it was not necessary to cover it.

The remaining part of the bridge was covered except possibly the highway portion of the Canal Span (red). This is suggested by a close study of Photographs #4, 7 and 8.

The covering over the curved spans (green) was of different design than the straight sections. Photographs #5, 6 and 8 show it to be considerably higher and with a flat rather than a peaked roof. (See caption of Photograph #5 for further comments on difference of coverings).

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In the late fall of 1859 the Harpers Ferry bridge played a role in one of the stirring events in American History. On Sunday night of October 16, William Williams the bridge watchman was seized by a party of armed men near the Maryland side. He was conducted to the Armory Engine House and thus became the first of over 40 prisoners taken by the Abolitionist John Brown in his abortive raid. Brown left his son Oliver and Dangerfield Newby to guard the bridge.

At about midnight Patrick Higgins, another watchman, was captured by the bridge guards as he came across from his Sandy Hook home to relieve Williams. Oliver Brown attempted to take Higgins to the Engine House but near the Virginia side (probably on the Y span) the watchman suddenly turned and floored young Brown with his fist. Higgins then ran for his life to Fouke's Hotel and made it although being fired on. He later stated that Brown and Newby had probably stumbled over some cross pieces on the bridge while firing.

A short while later the east-bound train arrived at Harpers Ferry and was halted by the Abolitionists. While the train was stopped, Heyward Shepherd, a free Negro who worked as a baggage

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man at the depot approached the bridge to see why the train had stopped. He was ordered to halt by the bridge guards but elected to run instead. Shepherd was not as fortunate as Higgins and he received a shot in the back from which he died the next day.

For reasons still debated Brown decided to allow the east-bound train to continue. Conductor William Phelps, not without reason, feared that the bridge might have been undermined by the invaders. He refused to leave until daylight and even then insisted that old Brown walk with him across the bridge in front of the train. Brown did so, and soon the train was speeding eastward to alert Washington of the insurrection.

The bridge was vital to Brown's plans for two reasons. It was the only link between himself and the main party with the small contingent he had left on the Maryland side. The function of the latter was to forward supplies from the Kennedy farm-hideout. Perhaps more important, the bridge was the line of retreat to the north which could be used should things go wrong at Harpers Ferry.

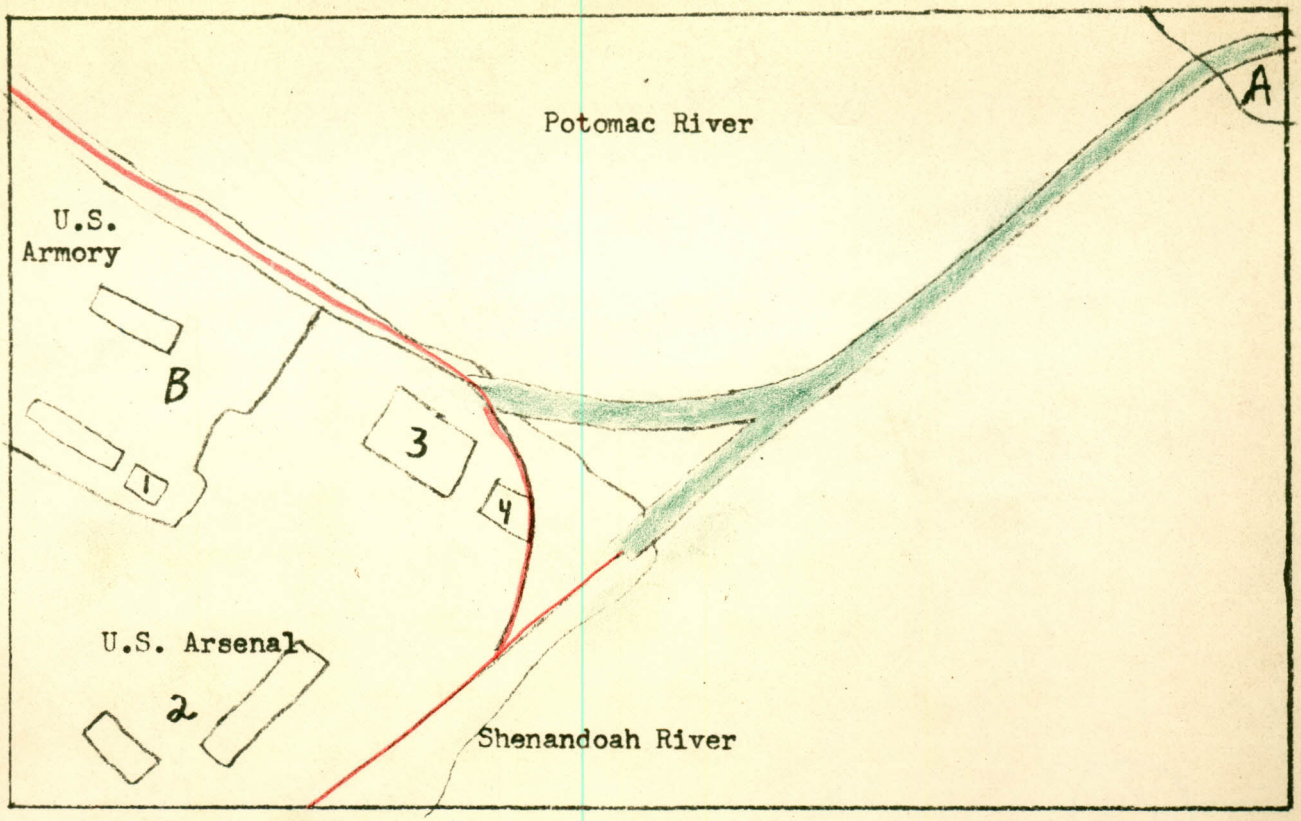
From Brown's point of view things began going wrong at noon Monday. At about that hour the Jefferson Guards, a militia

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company from Charles Town, stormed the bridge from the Maryland side and put the Abolitionist sentries to flight. The escape valve had now been closed. Later in the day a raider who had been captured was carried out to some point on the bridge, shot, and his body dropped into the river below. The last part the bridge played in the affair came later that night when U. S. Marines detrained at Sandy Hook and marched over it. The next morning Brown and the surviving members of his band were captured. [18] (See diagram on following page).

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DIAGRAM: JOHN BROWN RAID 1859



John Brown and his men crossed the bridge from the Maryland side (A) and seized the U. S. Armory. Brown established his headquarters in the Armory Engine House (1) and it was there that he was captured. Other points mentioned in the text are the B & O Depot (4) and the Wager House (3) from which the raider William Thompson was removed to be killed on the bridge.

It is readily seen that once Brown lost control of the railroad bridge his chances of escape to Maryland were negligble.

(Off-bridge railroad track is shown in red).

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PART III

THE CIVIL WAR

1861-1865

On April 12, 1861 Civil War began at Fort Sumter, South Carolina. On the 17th Virginia passed the Ordinance of Secession. The next day, upon learning of the advance of Virginia Militia, Lieut. Roger Jones, U. S. Army, set fire to the armory and arsenal with its 15,000 stand of arms and retired across the railroad bridge. The town was then occupied by the Virginia Militia and was to remain in Confederate hands for two months. [1]

Events in other quarters having come to pass, in mid-June the Confederate command determined to withdraw from Harpers Ferry. Before retiring it was decided to leave nothing of value to the enemy and this of course included the B & O Bridge. At 6:30 on the morning of June 14 Confederate demolition squadsfired the bridge. A resident of the town described the scene; (See Photograph #9).

> From the first, preparations had been made for the destruction of the railroad bridge under the superintendence of competent engineers and, early in the morning . . . the town was alarmed at hearing a loud explosion and seeing the debris of the destroyed bridge flying high in the air. [2]

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Another witness stated;

> The whole structure seemed to ignite at once and was soon consumed, the incombustible parts, iron rails and metal roofing, falling into the water, the quantity of half-burned timber and there forming a dam the whole way over that one might cross upon. [3]

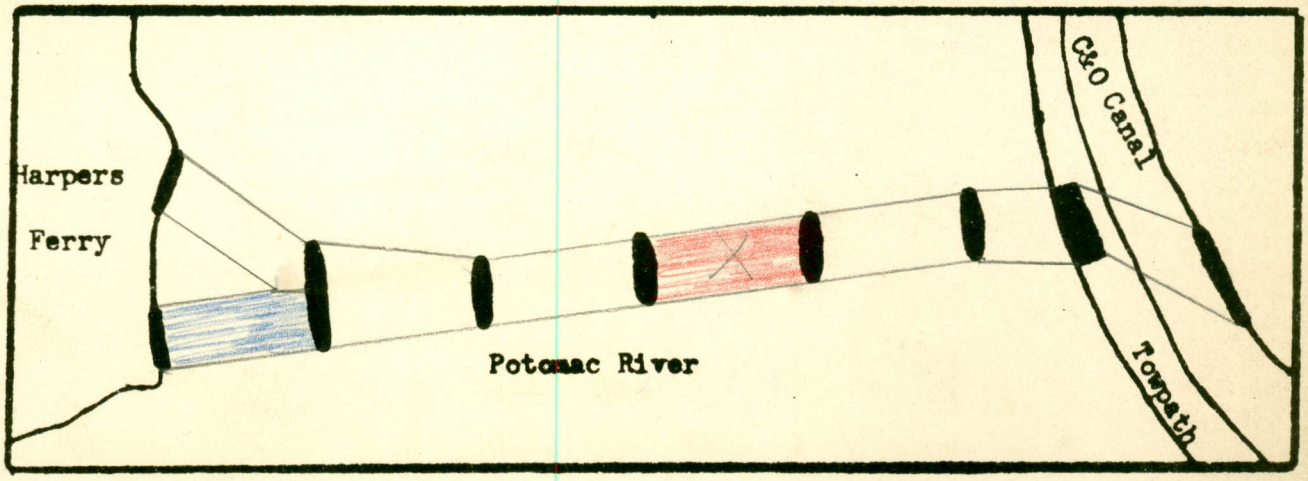
The Confederate Army moved out toward Winchester the same day. Through an oversight the Hall's Rifle Works on Virginius Island had been neglected by the demolition parties so on June 20 a small force returned to complete the job. While in the area Engine No. 165 was pushed off the destroyed bridge into the river. (See Photograph #10). They also burned the wooden parts of the Bollman or Winchester Span. [4] (See diagram on the following page).

In August an attempt was made to construct a bridge across the piers but high water deterred progress. On the 19th work was stopped due to withdrawal of Federal forces from the vicinity. On September 29 a flood carried away all the trestling except two trestles near the Maryland shore. This was the only attempt at reconstruction made in 1861. [5]

Early 1862 found stirrings in Federal troops in western Maryland. The division of Major General Nathaniel Banks, a detached

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DIAGRAM: SITUATION JUNE, 1861 - SPRING, 1862



During this period only the Bollmanized Winchester Span (blue) was intact, the rest of the bridge having been destroyed by Confederate forces on June 14, 1861. (See Photographs #9, 11 and 12). In Photograph #9 an explosion is seen on Span #4 (red).

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component of the Army of the Potomac, received orders to cross the river at Harpers Ferry and move into the Valley. On February 26 military engineers constructed a pontoon bridge immediately upstream from the ruined railroad bridge. By sundown Bank's Division, some 15,000 strong, was across the river on (See Photograph #12) the first leg of what was to become the ill-fated Valley Campaign.[6]

On the heels of the Army came a B & O bridge building crew under W. C. Quincy which arrived at Harpers Ferry on March 4. Quincy found Harpers Ferry in shambles with complete repairs necessary not only for the bridge but the Armory trestling as well. B & O records reported the work as follows;

> Owing to the great depth of water and the swiftness of the current, it was found impossible to raise the trestles in the Potomac River . . . Large cables were stretched across the river . . . Frequent efforts were made by lashing boats to the cables and to the masonry, to raise trestles in the river. On the 5th, one was placed in position, but in consequence of the excessive cold, the ropes becoming stiffened by ice the force was . . . sent . . . to the arsenal yard . . . On the 9th, the forces were put upon four of the river spans, but their most energetic efforts were unequal to the power of the elements. On the 10th, heavy rain all

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> day, but trestling in river progressed. From the rain . . . the river continued too full and the current too swift, to accomplish much on the 11th . . . [7]

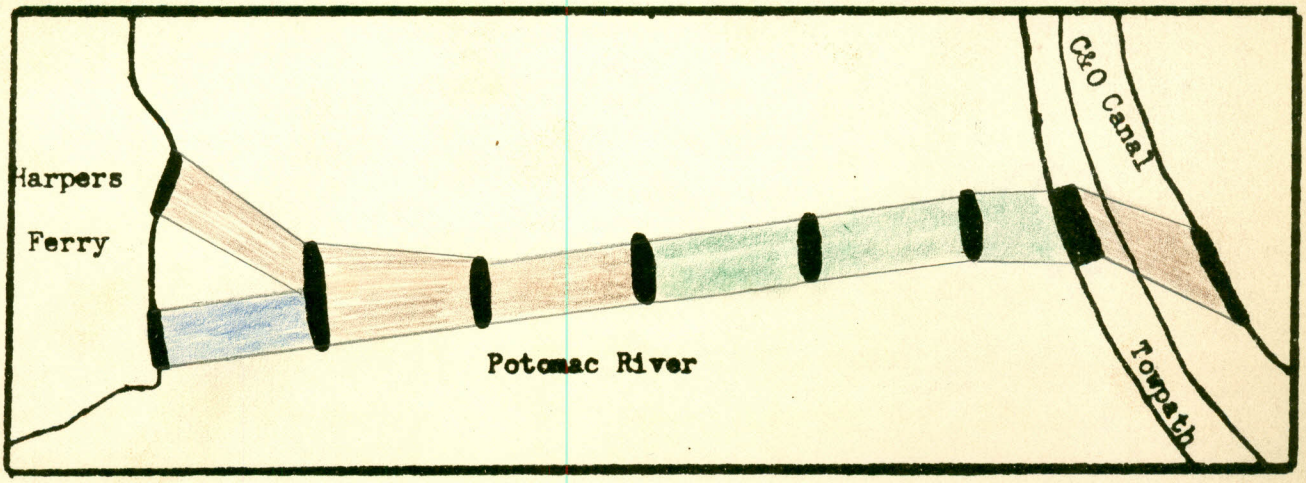
Quincy's crew returned to full work on the 12th and through strenuous efforts completed the bridge on the 18th. That night "the first locomotive, for nine months, went over into Harpers Ferry." [8]

On March 29 Colonel Dixon S. Miles, of whom more will be heard later, was posted to command of the Railroad Brigade with headquarters at Harpers Ferry. Miles' assignment was to protect the B & O from Baltimore to the western limits of the Department of the Potomac. [9]

Seven inches of snow fell on April 9 and by the 13th the Potomac was so high that loaded coal cars were stood on the new bridge to weight it down. This expedient worked until 11:30 on the morning of the 22nd when the three spans closest to the Maryland shore were swept out and 14 of the coal cars went into the river. Other spans went at 3:15 and 7:45 along with 22 more coal cars. (See Diagram on following page).

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DIAGRAM: FLOODS OF SPRING, 1862



In March of 1862 the bridge was reconstructed and was complete by the 18th. This bridge was wooden, except for the Bollmanized Winchester Span (blue) which remained from the pre-war bridge, and uncovered.

On the morning of April 22 the three eastern river spans (green) were destroyed by flood in spite of loaded coal cars used to weight them down. That night the other spans (brown) also gave way.

The bridge was repaired and in service by May 4.

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By the 28th the river had subsided to where repairs could again begin. Within a week, by May 4, the bridge was again in operation and 400 loaded cars passed over it the same day.[10] For several weeks things were fairly routine at Harpers Ferry. Then, on May 25 the Confederates struck Bank's army at Winchester. Reports indicated the Federals were in flight toward the Potomac with Jackson in full cry. Banks crossed the river safely at Williamsport on the morning of the 26th. The Confederates were expected to move on Harpers Ferry and the local commander hastily ordered the railroad bridge planked so that heavy equipment could be moved across. On the night of the 27th some troops and equipment were sent over to Maryland Heights. A participant in the movement recalled;

> . . . the single track of the railroad bridge was floored with rough plank, forming a passage-way, without hand-rails or parapets, a thousand feet long, forty feet above the river, and about seven or eight feet wide. The infantry marched two abreast; the cavalry, dismounted, led their horses in single file; the artillery was pushed over by hand. Several horses got frightened and leaped over into the water; one, falling upon a railroad engine which lay overthrown in the stream, was instantly killed. Strange to say, the others, striking deep water, swam ashore and were saved . . .

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But in spite of wild rumors Jackson did not make an attempt on Harpers Ferry and by June 1 the scare was over. [12]

No sooner had the Confederate threat ended than nature again stepped in. The Potomac was rising so rapidly that a special crew was sent to Harpers Ferry to save the bridge. The crew arrived on June 4, just in time to see all but the Y span carried away by the flood. Three days later the final span went.

As soon as the waters receded - on June 9 - the bridge crew began their monumental task again. Working in feverish haste the bridge was again able to pass trains by the 15th. [13]

Meanwhile, the B & O had naturally become discouraged with the frequent problem at the Harpers Ferry bridge. Early in July it was determined to "risk" an iron bridge. Work was begun on the 24th under the personal supervision of Wendel Bollman. [14] Within a month 2 spans of the "magnificent bridge" were completed and work began on a third. Other crews removed the wrecked coal cars that had been in the river since April. [15]

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But events to the south were moving even faster than the bridge crews. In the last days of August the Federal army was routed at Manassas and hurled into the defences of Washington. Between Harpers Ferry and the Capitol was Lee's victorious Army of Northern Virginia, preparing for its first invasion of the north. On September 5 its advanced elements crossed the Potomac below Point of Rocks and the Maryland Campaign had begun. [16]

Rather than go into the maneuverings of the armies, suffice it to say that by September 13 Colonel Miles at Harpers Ferry found his garrison under close seige and on the morning of the 15th he surrendered the post and 12,520 men. [17] From that time until the 19th when Federal troops returned the town was in Confederate hands. As might be expected, demolition squads were hard at work. The report from the Federal reconnaissance commander who entered on the night of the 19th stated "everything is destroyed." [18] The offical B & O report was somewhat more detailed;

> The iron spans Nos. 3 and 4, also Winchester iron span, blown up, and laying in confused masses in the river. The trestling in other spans all destroyed . . . Engine No. 30 burned, and hanging in trestlework at west end of bridge . . . [19]

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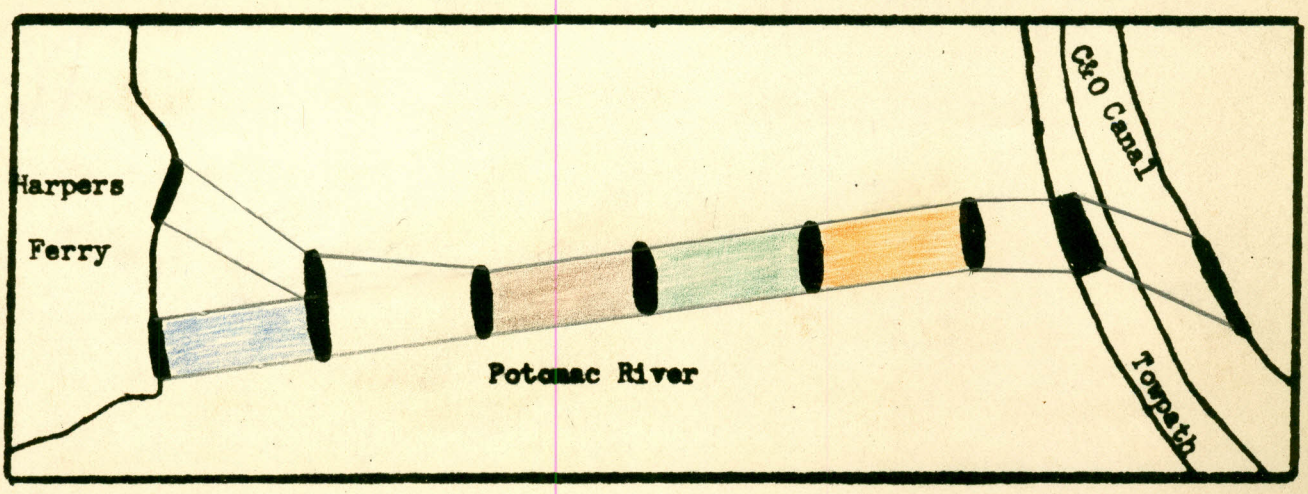
There was also a report, unconfirmed but probable, that the Confederates had made 5 unsuccessful attempts to blow up the bridge piers.[20] (See Diagram on following page).

The bridge crews went to work on the 24th and by October 8 a temporary bridge with support trestles was completed. The next day they began salvaging the iron spans from the river, a job that was extremely difficult because many of the rods "had to be disconnected while under water."[21] Meanwhile, the B & O management was giving serious thought as to just how much should be expended on a bridge in such a vulnerable location. On the last day of the month President Garrett send the following telegram to General McClellan;

> Our engineer advises us that he has again restored the masonry for the erection of an iron span . . . You are aware of the large losses heretofore, and of the heavy cost of the proposed iron structure. The advantage of this central span, in case of freshets sweeping out trestles, you, doubtless, appreciate. Do you think the prospects of permanent military protection at the point are sufficiently favorable to justify us in again incurring this large expenditure? Your advice will oblige us.[22]

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DIAGRAM: DESTRUCTION OF SEPTEMBER, 1862



During the summer of 1862 an attempt was made to completely Bollmanize the bridge. The first new iron span (green) and the second (brown) were completed in August and work was beginning on the third (orange) when, in September, the Maryland Campaign opened. (See Photograph #13). Harpers Ferry was occupied by Confederate forces for the period September 15-19. During this period the new iron spans and the old Winchester Span (blue) were blown up and the rest of the structure burned.

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McClellan promptly gave his assurances that the bridge would be properly protected as long as he had control of the area. He concluded that this would "justify you in the erection of an iron span as part of the bridge at Harper's Ferry." [23]

Apparently on the strength of McClellan's telegram, Garrett permitted the work to begin. During November the temporary structure on Span #5 was replaced with the salvaged Bollman iron. During the winter months the railroad's Mount Clare shops fabricated new iron sections and on February 14, 1863 Span #6 was completed in iron, but work was halted on Span #4 due to extreme cold. [24]

Late in February disaster threatened the non-iron spans. The Potomac was so high that on the 28th loaded cars were put on the temporary spans. The next day the cars were removed to allow six trains to pass. During the passage;

> . . . one trestle leg . . . loosened from the force of the current, and the wind blowing with such power until dark that men could not stand upon the trestling to repair it, trains following were further delayed until 9 P.M. [25]

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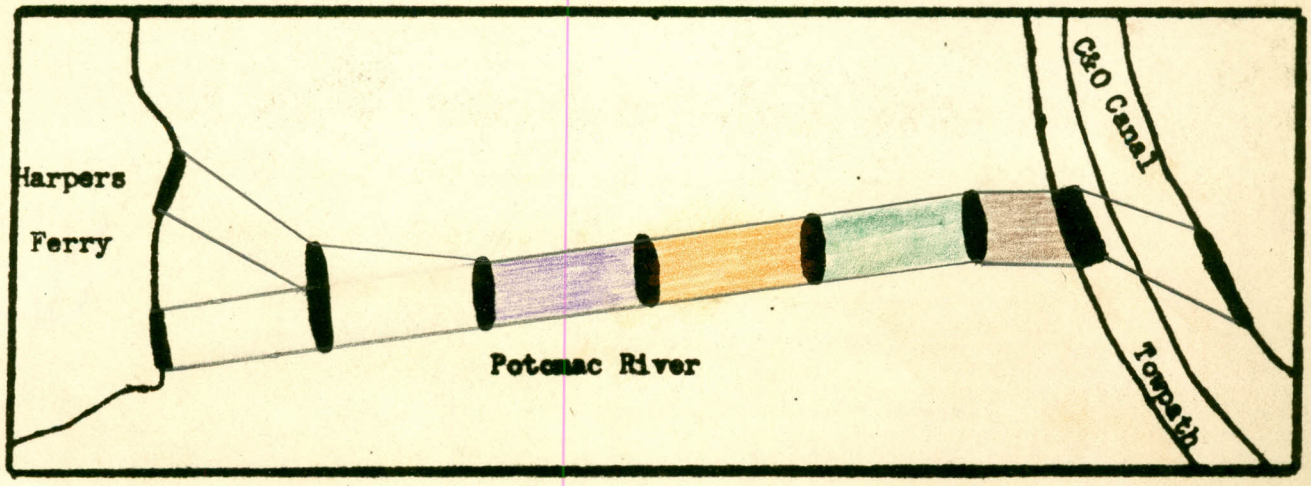
On March 10 the water rose again and the loaded cars were moved out on the trestling for a day. During each of these brief delays the pontoon bridge was used for the transfer of baggage and passengers. Finally on the 11th work was resumed on Span #4 and it was completed on the 18th.

The month of April saw the completion of Span #3 between the 13th and 22nd. Thus by that date the four wide spans of the bridge had been Bollmanized. Late in April a drifting flat-boat lodged against the trestle support of one of the temporary spans but this caused no damage. [26] (See Diagram on following page).

In the summer of 1863 the Gettysburg Campaign developed but although Harpers Ferry was evacuated for a few days no damage was done to the bridge. On July 5, however, with Lee's army still north of the Potomac, Federal troops burned the wooden span over the C & O Canal and all the woodwork on the iron spans. This was done so as not to have the bridge available should the Confederates retire through Harpers Ferry. [27] But Lee recrossed the river at Falling Waters, far upstream, on July 14. Repairing the damage began on the 18th and completed on the 20th in spite of the roads and the bridge itself being jammed with Federal troops. [28]

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DIAGRAM: BOLLMAN SPANS CONSTRUCTED NOVEMBER 1862-APRIL 1863



Following the Maryland Campaign work was again initiated to reconstruct the bridge on the Bollman principal. The iron spans were completed as follows:

#5 (Green) - November, 1862
#6 (Brown) - February, 1863
#4 (Orange) - March, 1863
#3 (Purple) - April, 1863

These spans survived the war and remained a part of the Post-War Bridge.

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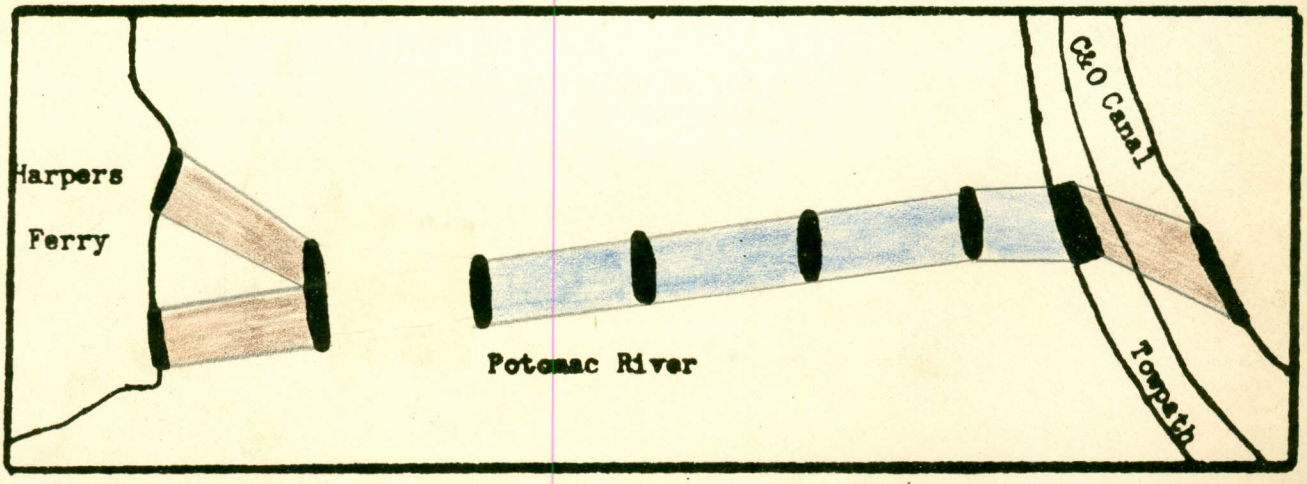
Things were relatively quiet in Harpers Ferry until the middle of December when the Potomac rose to its greatest height in 3 years. Loaded cars were placed on the trestle on the 18th but were removed on the 20th. The scare was over for the moment but it was only an omen of things to come. Early in April of the next year, 1864, the tributaries of the Potomac swelled and by the morning of the 10th it was apparent that trouble was on the way.

The Potomac rose rapidly during the day and heavy drift was running. The usual remedy - loaded coal cars - was employed, but at about midnight the wide span gave way carrying 12 cars down. At the time this incident occurred a great number of Federal troops were enroute for the Capitol via the railroad. With the span gone and the river too turbulent for boats Harpers Ferry had suddenly become a bottleneck. In view of the emergency a special effort was made to bridge the gap - an effort which developed into a unique feat. As the railroad later reported; (See Diagram on following page).

> Wire cables were ordered from Baltimore by special train, which reached its destination at 9 A.M. on the 12th. Previous to its arrival a small line, with weight attached, had been thrown

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DIAGRAM: TEMPORARY CABLE BRIDGE APRIL, 1864



The temporary span between Piers #1 and 2, 126 feet in length, was destroyed by floods on April 10, 1864. The usual emergency method of transporting passengers and freight by boat was impractical because of the raging waters. Instead, a cable suspension bridge was constructed across the chasm (Pages 40-42) on the 12th and used to transfer troops, baggage and ammunition. By the 18th the cable bridge had been replaced by another temporary span and the railroad was again operative.

In this diagram the span of the Cable Bridge is left blank, the temporary spans are shown in brown and the Bollman spans are blue.

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> across the opening, by means of which larger lines increasing in size, were passed and repassed, until a five inch cable was secured, upon which the ropes were taken over, and at 5 P.M. on the same day, all passengers from delayed trains were passed safely over a suspension bridge. The mails and baggage were also thus transferred. Regiments of troops then passed over. Several car loads of ammunition were also transferred . . . [29]

On the 14th the crews managed to lash boats to the piers and began work on the trestling. By the next morning the Winchester track portion was finished and trains moved over. The temporary suspension bridge was removed during the 15th and work began on trestling the curved portion of the span. Work was stopped all the next day because of rising water. It resumed on the 17th and was completed by the 18th, a piece of work marred only by the drowning of a carpenter foreman named John McLaughlin who fell into the raging waters. His death was the first incurred on bridge construction at Harpers Ferry since that of the blacksmith Odey 28 years before. [30]

April of 1864 had been a bad month but the Potomac was not finished for the year. On May 15 a great rise was noted on the upper portion of the river and by the next day the river was

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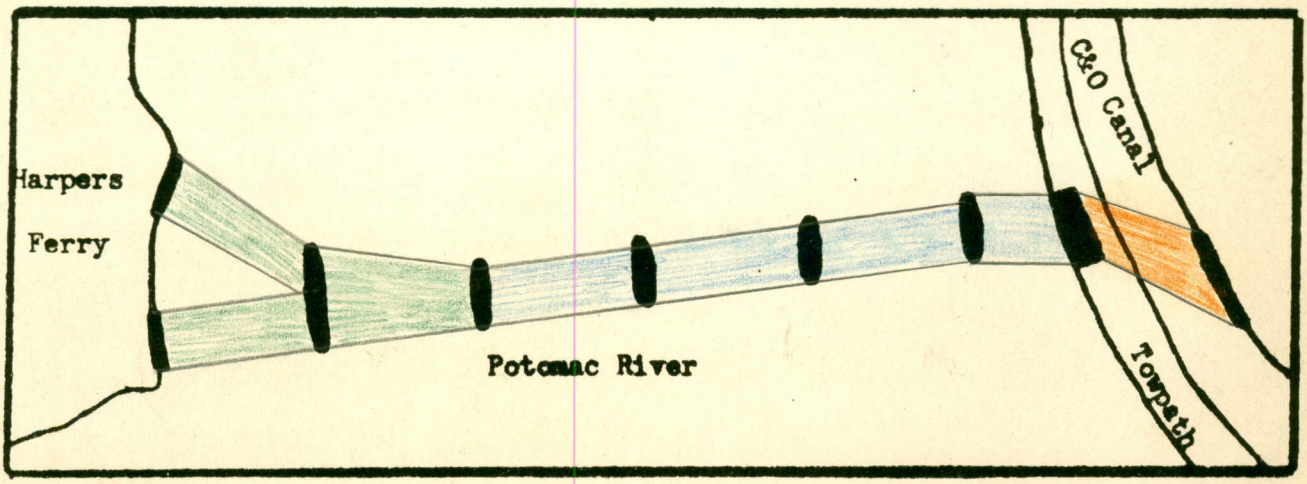
higher at Harpers Ferry than it had been in April. This time the pontoon bridge gave way and went crashing into the trestling. By nightfall all three spans on the Virginia side were wrecked and 16 coal cars were in the river. The waters began to recede on the 18th and repairs were started early the next day. By the 21st another fast job had been completed. [31]

Late in June Early's Confederate forces swept down the Valley toward Harpers Ferry on what was to be the third and last invasion of Maryland. The main body crossed the Potomac between Shepherdstown and Williamsport but the Federal commander at the Ferry, with Miles' fate in mind, withdrew to Maryland Heights on July 4. As a precaution he pulled the pontoon bridge and destroyed the temporary spans (the same as had been washed out by the flood earlier). Two days later a Confederate detachment "destroyed the canal span, and all the wood connected with the iron spans of the main bridge." [32] On the 8th Federal troops reoccupied Harpers Ferry. (See Diagram on following page).

Early's operations had destroyed much of the B & O's track and bridge east of Harpers Ferry so it was not until July 18 that work was begun on the bridge. By the 21st, although repairs

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DIAGRAM: DESTRUCTION DURING EARLY RAID JULY 1864



In early July, Federal troops evacuated Harpers Ferry and destroyed the western temporary wooden spans (green). Confederate troops then burned the wooden Canal Span (orange). The Bollman spans (blue) remained intact although all wooden parts were burned by the Confederates.

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were not completed, it was possible to pass a train over. Four days later the Confederates threatened Martinsburg and the Federal command ordered "one span of the . . . trestling to be disconnected, so that trains could not cross." [33] When the danger passed on the 29th the trestling was repaired. Later in the summer the cars that had fallen during the flood were salvaged.

The fall and early winter of 1864 were uneventful as far as the bridge was concerned. Then in December heavy ice flows appeared on the Potomac and on January 12 the ice gorged at the Harpers Ferry trestling. An extra truss was hastily put in and no damage was done.

Late in February drift and ice threatened the bridge again. Loaded cars were placed on the curved spans but trains continued to run over the Winchester Span. On March 4 loaded cars were placed on that span as well. This tied up traffic for one day but on the 6th 38 trains passed over safely. Again on the 18th the same situation developed and subsided. [34]

April, 1865, was a month of momentous events. Lee's army surrendered on the 9th and President Lincoln was assassinated 5 days later. The war was virtually over but there was still action ahead for the bridge. [35]

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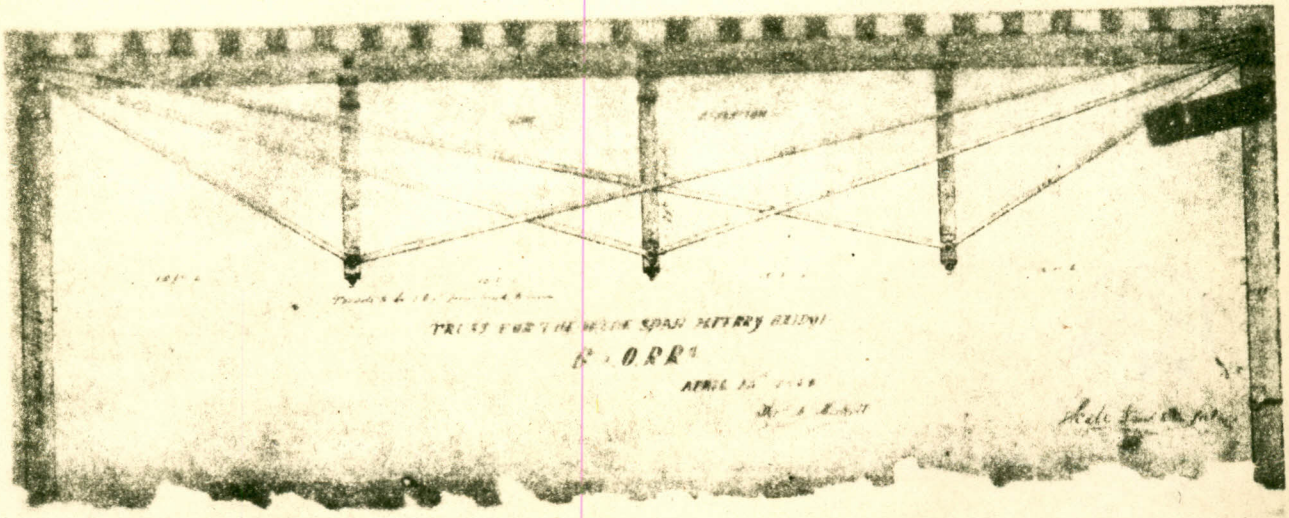
On May 12 and again on the 21st cars were placed on the wooden spans. The next day high waters carried off all of the wooden spans and 14 cars. On the 24th the straight track was repaired and in service by the 25th. Two days later the curved spans were replaced. Later on in the summer the "Virginia abutment . . . was rebuilt with granite laid in cement. No. 1 Pier partly in same manner." [36] (See Diagram on following page).

Looking back over the four hectic years the B & O had reason to be pleased with the work of its bridge building crews. Walter C. Quincy had been in charge of all bridges east of Cumberland and it was through his organizational abilities that the Harpers Ferry bridge had been so promptly repaired on each occasion. On the local level, the town chronicler gave the following tribute;

> . . . Thomas N. Heskett . . . every time superintended its construction, assisted by Milton and Oliver Kemp, his foremen, and it is very creditable to these gentlemen that, notwithstanding the many disadvantages under which they labored, and the hurry with which they were obliged to perform the work of reconstruction, no accident occurred to any of the thousands of railroad and wagon trains that passed over it during these years, which could be traced to any defect in the bridge itself, or the track laid on it.

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DIAGRAM: BOLLMAN DECK TRUSS



This drawing is of a Bollman deck truss of the type used to support the temporary trestling during the war. Each section was 12 feet 6 inches wide and constructed of wood and iron. One such truss is visible on the Canal Span in Photograph #16.

The following statement is from the drawing caption (Vogel, 81);

> Simple beam of 50-foot span with three independent trussing systems. Bollman's use of the method of support led to the development of his bridge truss. This drawing is of a temporary span used after the timber bridge at Harpers Ferry was destroyed during the Civil War.

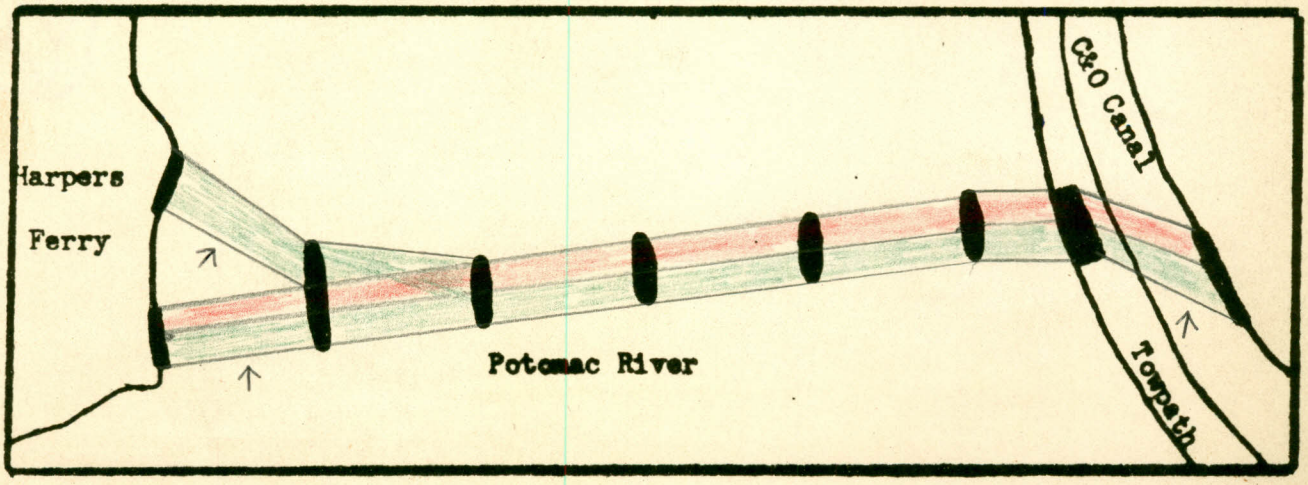
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In summing up the story of the bridge during the Civil War the chart below may be of use. The bridge, or portions of it, were destroyed 9 times during the 4 years of war - and on all occasions but the first, was promptly repaired and put in service.

	MONTH-YEAR	DESTRUCTIVE AGENT	CARS LOST
1	June -1861	CS Army	
2	April-1862	Flood	36
3	June -1862	Flood	
4	Sept.-1862	CS Army	
5	July -1863	US Army	
6	April-1864	Flood	12
7	May -1864	Flood	16
8	July -1864	US + CS Armies	
9	May -1865	Flood	14

See Diagram on following page.

DIAGRAM: THE POST-WAR BRIDGE 1870-1894



Following extensive masonry repairs, between 1868 and 1870 the remaining war-time temporary spans (arrows) were replaced by Bollman iron.

The bridge layout (railroad-green, highway-red) was the same as in the pre-war days. The major difference was that it was now uncovered iron instead of covered wood. (See Photographs #18-23).

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PART IV

THE FINAL YEARS

1866-1936

With the coming of peace, plans were made for permanent improvements on the bridge. The first step began in 1866 with a thorough overhaul of the stone masonry substructure. [1] Between 1868 and 1870 the temporary wooden spans were redone in iron so that by the latter year the entire bridge was Bollmanized. [2] For over 20 years it carried the main line in a dependable and uneventful manner. Then modernization approached;

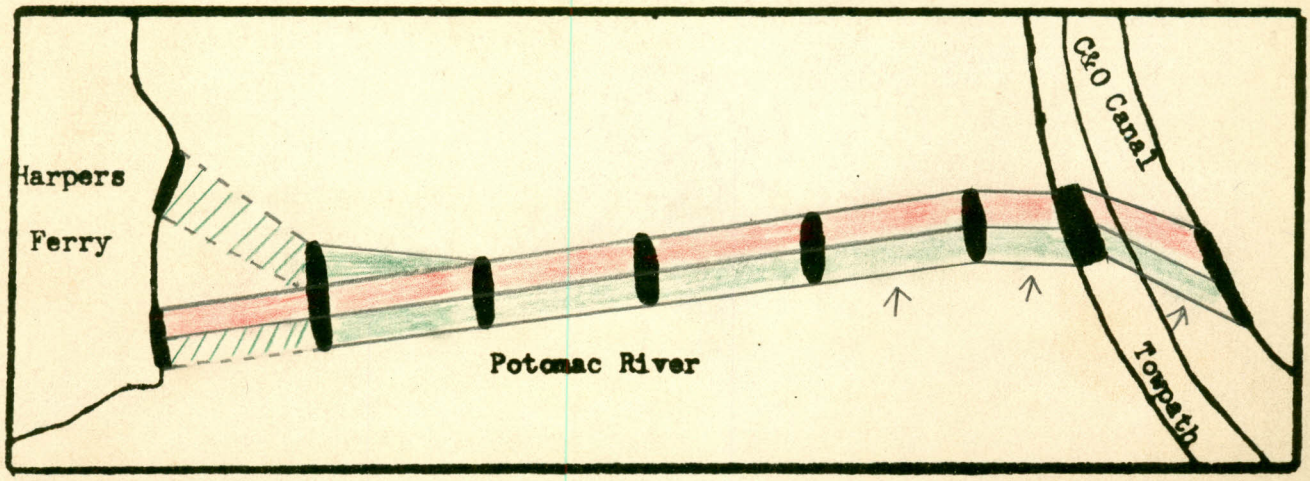
> In the summer of 1892 they /the B & O/ commenced the cutting on a tunnel of over eight hundred feet in length through the spur of the Maryland Heights that projects over the old track near the railroad bridge. They also commenced at the same time the erection of stone piers to support a new bridge a little northwest of the old one . . . The principal object of this change was to straighten the road and avoid the dangerous curves at the old bridge . . . [3]

See Diagram on the following page.

On April 12, 1894 the new structure was completed and the old bridge was relegated to highway use only. The Y span was eliminated. (See Photograph #24). [4]

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DIAGRAM: THE BRIDGE AS A HIGHWAY 1894-1936



Drastic changes took place in the bridge when a new structure was completed in 1894. On two spans (green striped) the railroad portion was completely removed. On the remainder of the bridge the track portion (green) was abandoned. This is clearly shown in Photograph #24 made in 1896.

The highway portion (red) remained in service, except for interruption in 1924. In that year 3 of the old Bollman spans (arrows) were destroyed by flood and replaced with new superstructures. (See Photographs #25, 26 and 27). The bridge then continued as a highway until completely destroyed by flood in 1936.

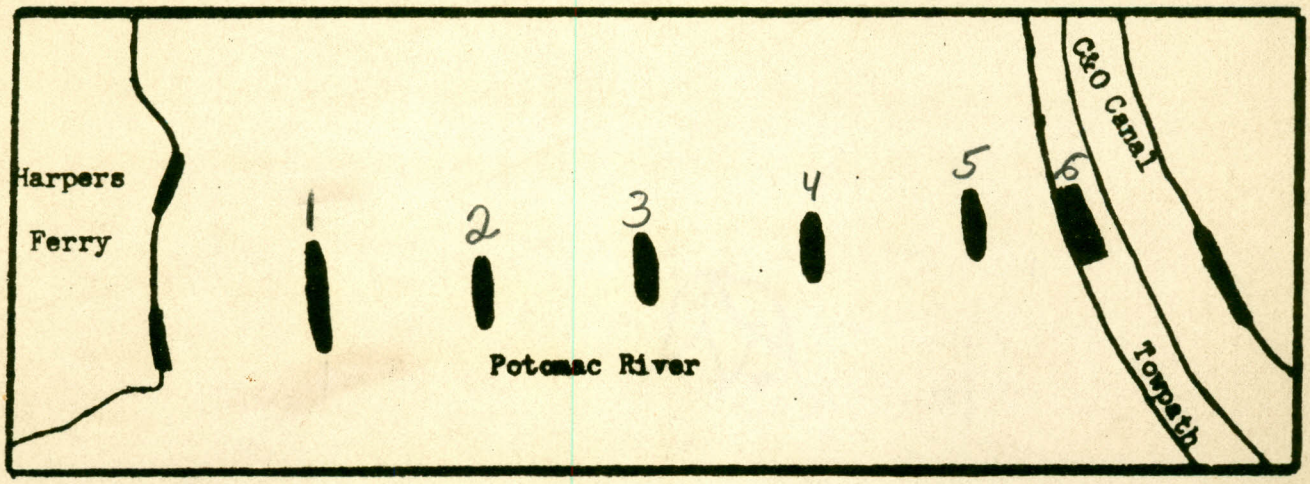
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In 1924 flood waters destroyed the spans closest to the Maryland shore. These were replaced by a new design so that the bridge took on a half-Bollman-half-modern appearance. (See Photographs #26 and 27). The bridge continued in service for another decade, during which still a third bridge was built to carry the main line.[5]

Finally, in March of 1936, almost a full century since it was originally built, the old bridge was carried away by floods. This time even some of the piers were wrecked (See Photograph #28) and there would be no repairs.[6] Today the piers remain substantially as they did when the flood of 1936 destroyed the bridge. See Diagram on following page.

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DIAGRAM: CONDITIONS OF PIERS - 1970



Pier #	Condition
1	Good
2	Good
3	Rubble
4	Rubble
5	Good
6	Good

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APPENDIX A

PIER SPECIFICATIONS

Proposals will be received by the subscriber at Harpers Ferry, on Saturday the 19th of this month, for the construction of the Masonry of the Viaduct, to be built across the Potomac River at that place. The masonry will consist of one abutment and seven piers. The face of the abutments and piers will be of ranged rustic masonry extending inwards an average of at least two feet from the exterior - the filling of six of the piers and the backing of the abutments to be of the best rubble masonry, and the whole laid in the best mortar. The foundations of six of the piers will be formed in the bed of the river by throwing in large stones and compactly fitting the interslices between them with smaller stone. The foundation will be raised from the bottom of the river to within two feet of the surface of low water, at which level the ranged work will commence. One of the piers will stand upon the tow path of the Chesapeake and Ohio Canal, will be built hollow and filled with dry rubble stone and earth. The foundation of this pier will be of ranged work laid in water cement, and the lower course will rest on puddling clay about two feet in depth. The thickness of the walls of the solid part of this pier will be six feet. The six piers in the river will be ten feet thick at bottom and eight feet at top, twenty-five feet high and fifty feet long, with their ends, both up and down stream, of a curved form, resembling the gothic arch. The Abutments will be built against and united to the wall between the canal and rail road. It is believed that the water, in which the piers will be founded, will in no case exceed seven feet in depth at the low stage of the river, and for most of the piers will not be more than four to five feet deep; and that the bed of the river at the site of the bridge, is entirely of rock.

(From Virginia Free Press, September 10, 1835)

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APPENDIX B

BRIDGE REPAIRS OF 1837

The third work carried on under my supervision, has been the completion and repair of the Harper's Ferry Viaduct, and some walling and rail laying appurtenant thereto. The history of this important structure, and the causes of the imperfections which it has exhibited, are well known to you, and need not be more than alluded to. The weakness of the stone piers, built previous to my appointment as superintendent of the work, exhibited itself as soon thereafter as the superstructure was placed upon them. The causes of, and most appropriate remedy for their defects having undergone a thorough investigation and consideration, a plan of securing the foundations and repairing the upper portions of the piers was matured, and its execution committed to my charge. A contract was accordingly entered into, under the sanction of the board, with Lewis Wernwag and William Lester; the foundation work and trusselling of the arches being assigned to the former, while the re-building of the defective parts of the piers was allotted to the latter. Both these parts of the work were proceeding with satisfactory speed; the trussels were framed ready for use, the foundation masonry was well advanced, and the dressed stone for the repairs of the piers was in process of speedy preparation. The viaduct in the mean time, however, appearing to endure with less apparent injury than had been looked for, the action of the travel upon it, which had never been suspended, though cautiously conducted, and the season having arrived during which freshets in the rivers at the immediate confluence of which the bridge was situated, might be expected, and the occurrence of which would have endangered the superstructure while depending on the trussels for support, -- the board, at their meeting on October 4th, determined to postpone until the ensuing spring the proposed repairs of the upper parts of the defective piers, proceeding, however, with the stone work for the security of their foundations, which work was completed about the middle of this month, in the most satisfactory manner, and places the foundations of the piers, it is believed, beyond the reach of future injury by the operations of the currents of the rivers. The wooden superstructure of the bridge has justified the confidence entertained, in the excellence of its principle of construction, the only weakness which it has exhibited, being shown by three of the timbers supporting a part of the flooring, which cracked during the passage of one of the trains. The recurrence of such a fracture, caused by an accidental imperfection in one of the timbers which failed, will be effectually prevented by the proposed immediate introduction of an additional timber between each of those upon which the floor and

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tracks depend for their support. The eastern arch of the viaduct, which spans the Chesapeake and Ohio Canal, is now weatherboarded and roofed. The weatherboarding of the remaining arches of the viaduct, has been of necessity postponed, until the repairs of its masonry were accomplished, and will suffer now only an additional delay of three or four months, at a season when wood suffers the least from exposure to the weather.

(From B & O Report, 1837)

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APPENDIX C

ACCIDENT REPORT OF 1844 (PORTION)

The Board regret that, in the present report, they are called to record an accident to the bridge over the Potomac river at Harper's Ferry, by which one of the arches of that structure has been destroyed.

The arch gave way under the weight of a single Engine and tender, after sustaining the entire work of the road for nearly two and a half years, and, only the day previous, eight heavy trains of passengers and burthen, without the slightest indication of defect or weakness in any part.

Providentially, no life was lost, and but slight injury sustained by any of the men who were carried down in the fall; nor was the Engine materially damaged.

A delay of a few hours only was occasioned in the passenger travel, and the interruption in the tonnage transportation was less than a week.

The remaining six arches of the bridge, even those contiguous to that which fell, have received no injury from the fall.

A thorough investigation into all the particulars of the accident, has satisfied the Board that it was occasioned by the decay of several pieces of timber, comprising an important part of the framing of the arch.

This part of the superstructure in order to protect it as far as practicable from the weather, had been closely covered by weather boarding and roofing, which rendered it inaccessible to the ordinary inspection constantly made of these structures; and the timber having been in use for two years only, there was no reason to suspect any unsoundness.

No settlement of the frame had previously taken place inconsistent with the soundness and safety of the structure, and it had borne, only the evening previous, the usual trials of its strength: indeed the final fracture took place in a part of the frame so situated, and so surrounded and kept in place, as that there could be no sensible yielding without a total giving away. The decay, therefore, most probably proceeding from an unperceived leak in

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the tin roof and the spreading of the water between the several pieces of timber composing the straining beam, had been progressing silently and unsuspected, until the strength of the remaining sound wood became insufficient to withstand the strain to which it was subjected.

This accident, it is believed, does not authorise any suspicion of an inherent defect in the principle of construction of this, or any other bridge employed on the line of the road. In the opinion of the skilful Engineers, by whom the plan of the bridges was adopted, it is a combination of the most excellent and approved forms of superstructure known to the science of engineering: the principal features being modeled after those of the celebrated bridge over the Rhine at Schaffhausen, which, previously to its destruction by fire, was considered one of the most admirable specimens of the art in the world. The heavy trade of the rail road, and of numerous droves of cattle on that part of it common to the public, which the ruined arch had withstood for more than two years, and the greater evidence of strength offered by some other bridges precisely the same in principle on other parts of the line, for upwards of five years, also inspire great confidence in the plan of these structures; which, from the lesson now learned, may be rendered even more secure in the future.

Immediately after the occurrence of the accident, the weather boarding was removed from all the other structures upon the line of the road, and a minute investigation made into the state and condition of all their parts.

Every precaution will be immediately taken to give additional strength and security to these structures; and nothing will be omitted to prevent a recurrence of an accident.

The Board have already determined upon a plan of reconstructing the arch at Harper's Ferry, which will not only ensure more adequate protection of the timber from the effects of the weather, but, at the same time, expose all parts of the structure to a daily and minute investigation of their condition.

The entire loss occasioned by the accident, and the sum required to restore the arch to a condition of even greater strength and security, is estimated not to exceed $7,594.40, being $8,932.92 less than the surplus revenue of the year just ended.

(From B & O Report, 1844)

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IRON SUSPENSION AND TRUSSED BRIDGE

AS CONSTRUCTED FOR THE

Baltimore and Ohio Rail Road Company

AT HARPER'S FERRY,

AND ON THE WASHINGTON BRANCH OF THIS ROAD.

DESIGNED AND PATENTED BY

WENDEL BOLLMAN.

BALTIMORE:
PRINTED BY JOHN MURPHY & CO.
No. 178 MARKET STREET.
1852.

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DESCRIPTION OF THE BRIDGE AS BUILT AT HARPER'S FERRY.

The span of Iron Suspension and Trussed Bridge, erected at Harper's Ferry, is 124 feet between abutments. The length of cast iron in stretcher 128 feet. The weight of cast iron in the R. R. truss, 65,137 lbs.; of wrought iron 33,527 lbs.; making a total weight of cast and wrought iron, 98,664 lbs.

From examination of the drawings it will be found that, the wrought iron would require little workmanship; the rods from the centre to abutments having but an eye at one, and a screw at the other, end; with a weld ortwo between according to length. The long counter rods have two knuckles and one swivel for adjustment of strain, and convenience in welding, as well as in raising the whole.

The Cast Iron Stretcher, is octagonal without, circular within; and averages one inch of metal. It is cast in lengths according to the length of panel, and jointed in the simplest manner;—at one end of each length is a tenon, at the other a socket. The latter is bored out, and the tenon and its shoulder turned off in a lathe to fit the socket; thus, when throughly joined, to form one continuous pipe between abutments. The ends of the sections of cylinders, inserted to those contiguous, are slightly rounded, to allow a small angular movement without risk of joint fracture.

A cast iron plate, or washer, as Fig. 15, Pl. 3, sets on a bracket cast with each abutment-end of stretcher, and at right angles to the center acting rods. The tension bars are passed through this washer to receive a screw nut for the erection and adjustment of the system.

Each post is cast with a seat in the abacus to receive a ring tenon cast upon the under side of stretcher, and bolted through, as in Figs. 11 and 12, Pl. 3. The slots or openings, as seen in cross section of post, give free passage to the rods in suspension. Through the floor end of post, (Fig 11, Pl. 3,) an eye-bolt receives the eye-ends of tension, diagonal, and suspender, rods; the latter being bolted through a cast iron plate, Fig. 8, Pl. 2, the floor cross beams, and their seat the suspender washer, Fig. 9, Pl. 2. Sufficient play is here given by a slot in plate, and in cross beams, as dotted in Fig. 1, Pl. 1, for strain, expansion—.

The stretcher or straining beam, the vertical posts, and suspension bars compose the essential features of the bridge;—each post being hung by two bars from both ends of the stretcher independently of all the others; and each post and pair of tension bars forming with the stretcher a separate truss.

This system, perfect in itself, is additionally connected by diagonal rods in each panel; also by light hollow castings, acting as struts, see Figs. 3, 4, 5, Pl. 2. The diagonal side rods might be safely dispensed with, for the peculiar merit of the truss is its perfect independence of such provision. They are therefore used as a safe-guard only in case of the fracture of any of the principal suspension rods.

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By this combination of cast and wrought iron, the former is in a state of compression, the latter in that of tension; the proper condition of the two metals. It unites the principals of the Suspension and of the Truss Bridges. *Each* bar performs its own part in supporting the load in proportion to its distance from the abutment; so that the entire series of suspending rods, transmits the same tension to the points of support, as would be equally transmitted from thence to the centre of bridge. Each bar, or rod, is straight and of uniform figure; and therefore the principles of calculation are those of the Lever, "When the fulcrum is at one extremity, the power at the other, and the weight to be supported at some intermediate point." This first principle of the Lever is here exemplified in its most naked simplicity, it being sustained in equilibrium by a force applied at a given point and acting in a given direction. Consequently by the property of the Lever, the power multiplied by its distance from the fulcrum, is equal to the weight multiplied by its distance from the fulcrum. The power and weight are reciprocally as the distances. Pressure upon the fulcrum is the difference of the weight and the power.

Previous to reference of No. 2 diagram which presents the combination of cast and wrought iron,—the former in compression, the latter in tension—with section, strain, and value of metal, in the most concise and connected manner, it is prudent to state that, this matter is produced not only for those readers who may be versed in higher Mathematical attainments, but for those devoted rather to practice than mere abstract theory; and who, by understanding the data, can derive some immediate advantage from further comparison and enquiry to the performance of works confided in this country to practical men. Beside that, we have not any bent, curved, or oblique arms to make allowance for in calculation; but simply to assume such weight as has to be provided for, and the diagram No. 2, expresses the finding thereof for section, value, and tension of wrought, with compression of cast, iron.

The tensile resistance of the best American bar iron tables at 80,000 lbs. per square inch. Its practical value is generally rated at about $\frac{1}{4}$ the nominal value. In this diagram the highest given value of iron is 16,000; being reduced below any probable rate of fibral separation in any previous data.

Now to proceed as in diagram No. 2, for proportion of one rib; that is,

One-half Weight of Bridge and Load.

Weight of Iron . . .	24,000	lbs.
" " Timber . .	15,000	"
" " Load . .	184,000	"
" " Momentum .	25,000	"
	248,000	"

The total weight to be sustained by one rib.

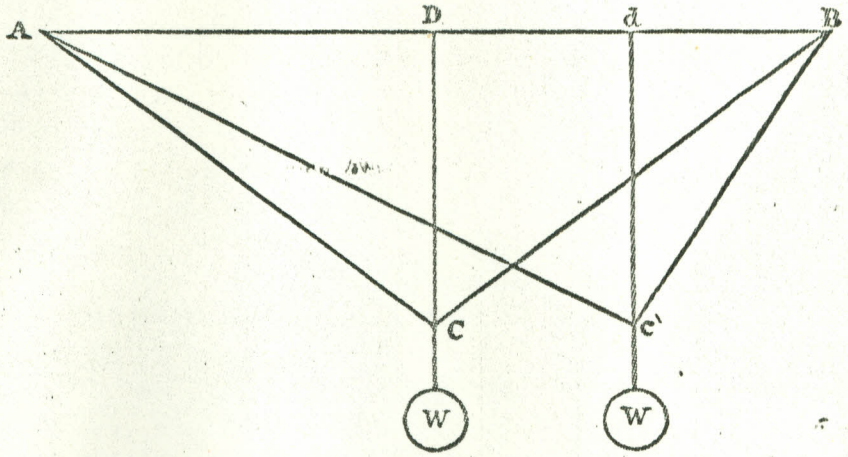
This when distributed, is carried at eight different points; at the centre by two equal, and on either side by two unequal, forces. Therefore, $\frac{248.000}{8}$=31,000 lbs. on each post; or, in other words, there is a concentration of 31,000 lbs. on each floor beam at the points of suspension.

The distance from centre of abutment to centre of bridge=64 ft.; so that $\frac{31,000 \times 64}{128}$=15,500 lbs. weight on acting rods at the center, the forces being equal.

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The distance from center of abutment, or the point of support, to the centre of post, or internal line of first, or abutment, panel,=17.5; therefore applying the principles of the Lever, as before mentioned, we have transferred to the farthest point of support $\frac{31,000 \times 17.5}{128} =$ 4,238 lbs. as the weight; which deducted from 31,000 lbs., leaves 26,761.8 lbs., as the weight transferred to the nearest point of support.

To use further plainness in application of first pinciples, let us take the following diagram.



A D = ½ A B = 6

A d = ¾ A B = 9

∴ B d = ¼ A B = 3

W = 144

In the triangle A C B, A C=C B. Then the weight being between the fulcrum and power, A B: A D or D B:: W: A C or B C 12 : 6 : : 144: 72 lbs. or $\frac{144 \times 6}{12}$=72 lbs. weight on A C or B C—the forces being equal.

B d=3. Then A B : B d : : W: A c', or 12 : 3 : : 144 : 36 lbs., or $\frac{144 \times 3}{12}$=36—144= 108 lbs. on B c', or by proportion, A B: A d : : W or 12 : 9 : : 144 : 108 lbs. on B C: the forces being unequal.

With this simple key to the calculation by first principles of mechanics for the compass of every practical man, we shall consider the

HARMONY OF THIS SYSTEM.

On harmony of construction,—equilibrium among the fibres,—depends stability. The sum of resistances of the extended fibres should equal the sum of resistances of the compressed fibres. Trussing should be a system of longitudinal bearing without extraneous thrust.

This bridge, it will be seen, is composed of seven independent trusses, which transfer the weight concentrated on each floor-beam directly to the abutments without aid from any other connection; and not from panel to panel as in general use.

The strain on cast and wrought iron is wholly in direct line; and the result, the least quantity of metal is required to carry a given weight. Its security and economy are evident; the weight of bridge and load has a vertical pressure on the piers, towers, &c., the only horizontal thrust being from the expansion of iron, which is accommodated by rollers, sliding of abutment bracket over its pedestal, or by other means: the necessary dimensions of masonry may therefore be most moderate.

It is evident, from an inspection of the drawing, that no chord is requisite at the bottom of the truss to resist tension; the only advantage of that employed is to regulate the move-

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ment produced by expansion, in the performance of which agency the resistance is one to compression.

Although the abutment bracket casting and its pedestal were so constructed as to admit of accommodation to expansion by rollers, yet such contrivance was omitted with the view of fully testing the effect of greatest expansion throughout the system.

The pedestal,—see Elevation, Fig. 1, Pl. 1, and Fig. 16, Pl. 3, seated on and hugging the top of granite column,—and bracket were carefully planed off to true surfaces for a small amount of friction between them.

It is now ten months since this bridge was erected at Harper's Ferry; during which time it has been exposed to extremes of cold and heat, and to an average run of twenty trains daily.

From the closest inspection we find that the extreme expansion measures, as near as as possible, 5-16 of an inch on each tower, or 5-8 in the entire length—128 feet of stretcher; and without the slightest perceptible derangement of masonry; the dimensions of which are 4 feet square of base, 12 feet high, and 2 feet 9 inches at top.

While on the subject of expansion it may be well to notice the effect from difference in expansion of the rods. At the first point of suspension, or where the longest and shortest rods meet, the counter rod is about four and a half times longer than the acting rod; and the expansion of the counter is four and a half times that of the acting rod. But there is also a proportionate difference in the lengths of stretcher from the point directly over the center of connection, to the extremities of these rods. This has been practically proved in this bridge.

The suspender bolt, when the expansion is extreme or 5-8 of an inch in the length of stretcher, exhibits a motive difference of 3-16 towards the short or acting rod; which difference is provided for, as seen by slot-dotted in Elevation, Fig. 1, Pl. 1, where the vertical suspender bolt moves to accommodate any such difference, and to give that proportion of weight to each rod according to the angle.

It affords easy access for repairs; for instance, should a new floor beam be required, it is but needed to slacken the horizontal rod and the keys in longitudinal strut, remove the washer under point of suspension, and let down the beam to be replaced; which can be done without trustling up any part of the bridge.

In case of fire, the floor may be entirely consumed without any injury to the side truss.

The permanent principle in bridge building, sustained throughout this mode of structure and in which there is such gain in competition with every other, viz: the direct transfer of weight to the abutments, renders the calculation simple, the expense certain, and facilitates the erection of secure, economical, and durable structures.

GENERAL REMARKS.

Experience proves the necessity of founding premises upon observed and tried results; of adopting a form consistent with the constructive quality of the material employed; with harmonious disposition to mutual adaptation of every part.

The natural qualities of materials should be the first consideration; then how far they may be suited to the objects in view. To acquire durability in the readiest, simplest, and cheapest manner, is vitally important to general interest.

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Masonry may stand alone in bridge conjunction, but not to the effect obtainable from the operations of the iron founder and smith. It is true that, circumstances have often controlled the employment of material; certain localities furnishing but one, and first cost restringing the use of any other where single means could possibly arrive at the end.

It is always most desirable to construct a bridge with the fewest possible supports, which after being formed at much trouble and expense are the most liable to injury. Neither from cost alone may masonry be found objectionable, but rather because its bulky supports force natural circulation into confined local extension, to the great risk of detriment to their foundations.

Wooden structures also require extensive props, as well as security against atmospheric action, and destruction by fire and flood; and from liability to early decay, by exposure, changes of bulk produce differences in form that contribute so much to their comparatively early end.

Iron as a principal element, has the most estimable qualities; its tenacity, and great power of resistance to compression, in a comparatively small substance allow of the production of effects with it in construction that cannot be gained from any other material in use.

In analyzing iron bridge structures we find two most distinctly opposite figures introduced together for combination;—that of the arched form applied to material for resistance to compression, and that of the beam for security of bearing. The plates in the assumed arch are so connected as to make a beam more or less cambered, and two most opposite figures dissimilarly proportioned in deflection, with dependence for strength upon the form and connection of spandrils with ribs and curb plates, through which provision is made for trussing of beam.

In the extensive employment of the tension principle, and the more common practice is that of fixing the extremities of the chain above the upper surface of the beam to obtain such a curve that it shall not hang below the under surface of the beam, the tension bar either being hung as a catenary or in combination with the beam, the rigidity of the beam is effected by screwing up the tension bar so as to force or strain the beam into the form of a curve or arch.

The wire suspension mode requires a large mass of masonry for anchorage of the catenary chain; and the principle upon which the tapering of the chain depends, as regards the distribution of forces and situation of the oblique suspending rods, cannot be considered a fixed one, nor free from much difficulty.

To procure stiffness should be the great aim of all construction; for surely the design of bridge building is, that all parts should give rigidity to the road-way; and in trussing that it should not exert any thrust upon the bearing points.

That the plan of bridge herewith presented embraces in a most eminent degree all of the essentials to a perfect combination with iron, is clearly shown by the following results.

"Particulars of a trial made under my supervision on the 1st day of June, 1852, to prove the stiffness of an Iron Bridge erected by Wendel Bollman, at Harper's Ferry, and known as the Winchester Span of the R. R. Viaduct at that place.

"Three first class tonnage engines with three tenders, were first carefully weighed, and then run upon the bridge, at the same time nearly covering its whole length, and weighing

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in the aggregate 273,550 lbs., or 136,775 (2,000 lbs,) tons nett, being over a ton for each foot in length of the bridge.

"This burden was tried at about eight miles per hour, and the deflections, according to guages properly set and reliable in their action, were at Centre Post—1⅜", and at the first post from abutment 9-16 of an inch."

W. PARKER,
Sup't B. & O. R. R.

Having referred in the title to another structure of similar principle, it may be satisfactory to give also, "the tests applied to an Iron Bridge, of 76 feet span on the Washington Branch R. R. (erected by Wendel Bollman,) and their results.

"A passenger train passing quickly caused a deflection of 9-16 of an inch at centre. An engine and tender weighing forty tons of 2,210 lbs., caused a deflection of 5-8 of an inch. Two engines and tenders at rest—back to back—an aggregate of 77½ tons—caused 11-16ths deflection; the same at ten miles per hour 13-16ths; the same—*head to head*—under motion gave, at 4 miles per hour, - - - - - - - - - 13-16ths.
8 " " " - - - - - - - - - a *little* more.
20 " " " - - - - - - - - - 14-16ths."

W. PARKER.

From the test at Harper's Ferry it is found, that the load did not cover the entire length of bridge by about thirteen feet, yet the excess of weight in the middle, and at a speed of about eight miles per hour, produced no greater deflection than 1⅜ of an inch at the center post, and 9-16 of an inch at the first point from abutment.

It may be well to add for general explanation of the last trial on the Washington Branch R. R. that, when two first class engines and tenders stand *head to head*, they nearly concentrate a weight of 48 tons in 36 feet; yet at twenty miles per hour the deflection at centre was but 14-16ths.

W. BOLLMAN.

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APPENDIX E

SUMMARY OF BRIDGE HISTORY

1835	Construction of piers begins
1837	First locomotive crosses Extensive repairs on masonry
1841-42	Y span added Bridge covered
1844-45	Collapse of 2 spans
1851	Winchester Span reconstructed on Bollman principle
1859	John Brown Raid
1861-65	Destroyed and rebuilt 9 times during Civil War Partial Bollman construction
1868-70	Completely Bollmanized
1894	Becomes highway bridge exclusively
1924	Severely damaged in flood
1936	Destroyed by flood

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Large maps for illustrating the bridge

are filed on the 3rd. flr. (I&RM's Rm.)

in a labeled tube.

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NOTES

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1 Hungerford, Edward, The Story of the Baltimore and Ohio Railroad 1827-1927, (New York, 1928), I, 146. (Hereafter cited Hungerford).

2 Ibid, I; 148. (Quote from Virginia Literary Magazine, 1829).

3 Annual Report of the President and Directors to the Stockholders of the Baltimore and Ohio Railroad Company, (Baltimore, 1835), 112. (Various Annual Reports are used throughout text and will be hereafter cited as B & O Report with year and page following).

4 Malone, Dumas, ed., Dictionary of American Biography, (New York, 1933), XI, 25-26.

5 Vogel, Robert M., "The Engineering Contributions of Wendel Bollman", in United States National Museum Bulletin 240, (Smithsonian Institution, Washington, D. C., 1964), 85. (Hereafter cited Vogel).

6 B & O Report - 1835, 112.

7 Snell, Charles W., A History of the Island of Virginius 1751-1870, (Unpublished NPS Report HF-29, 1958), 15. Wernwag's personal papers were lost from the family home in the flood of 1870.

8 American Contract Journal, August 15, 1885, 99.

9 B & O Report - 1836, 3.

10 Virginia Free Press, October 20, 1836

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11 Ibid., January 26, 1837

12 B & O Report - 1837, 29

13 Vogel, 80-81

14 Virginia Free Press, April 27, 1837

15 Snell, Charles W., Wager Lot No. 1 & The Bridge Lot, (Unpublished NPS-HBS Report, HF-47, 1958), 23. (Snell cites source as "Deeds of B. & S., December 2, 1839, pp. 37-38; December 13, 1839, pp. 43-44.") - (Hereafter cited Snell HF-47).

16 Virginia Free Press, January 23, 1840

17 Snell HF-47, 20-21. (Snell cites source as "National Archive R.G. 121 Public Buildings Service, Harpers Ferry Laminated Material").

18 The assumption that the same abutment was used is based on the map on Page 10.

19 Hungerford, I, 210

20 Ibid., 211

21 B & O Report - 1845, 11

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PART II

1 B & O Report - 1844, 4ff. Also, Virginia Free Press, September 12, 1844

2 B & O Report - 1844, 4

3 Ibid., 5-6

4 B & O Report - 1845, 10ff. Also, Virginia Free Press, March 20, 1845. The newspaper report states the train consisted of 27 cars.

5 B & O Report - 1845, 11

6 Ibid., 11

7 Ibid., 11

8 B & O Report - 1847, 37

9 B & O Report - 1850, 31

10 B & O Report - 1847, 39

11 Vogel, 85ff. Fire as well as rot was a source of danger to wooden bridges.

12 Ibid., 89

13 B & O Report - 1851, 34

14 Vogel, 90

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15 Ibid., 90. According to Vogel the pamphlet and drawings "were copies in a number of leading technical journals in England and Germany."

16 Bollman, Wendel, Iron and Suspension and Trussed Bridge as constructed for the Baltimore & Ohio Railroad Company at Harpers Ferry, and on the Washington Branch of the Road, Designed and Patented by Wendel Bollman, (Baltimore, 1852), 9-10

17 B & O Report - 1857, 100 and 1858, 107

18 Barry, Joseph, The Strange Story of Harpers Ferry, (Martinsburg, 1903 - 1964 reprint edition), 47ff. (Hereafter cited Barry).

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PART III

1 Barry, 97ff

2 Ibid., 105

3 Strother, David Hunter, Manuscript Journal, 18. Strother suggests that the Confederates used camphor as an incendiary agent.

4 B & O Report - 1861, 47

5 Ibid., 48. Also, Barry, 105

6 An excellent account of the construction of the pontoon bridge is found in Battles and Leaders of the Civil War (New York, 1956 - Yoseloff Reprint Edition), II, 155-156

7 B & O Report - 1862, 51-52

8 Ibid., 52

9 The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies, (Washington, GPO, 1902), Series I, Volume XII, Part III, 30. (Hereafter cited OR with Series, Volume and Part following in Roman Numerals and Page in Arabic).

10 B & O Report - 1862, 53-54

11 Strother, David Hunter, "Personal Recollections of the War by a Virginian", Harper's New Monthly Magazine, (No. 204, May, 1867).

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12 Jackson's movements in the Shenandoah Valley were designed to divert Federal troops from the Peninsula.

13 B & O Report - 1862, 55

14 Vogel, 92

15 B & O Report - 1862, 55

16 O.R., I, XIX, I, 814. (Report of J.E.B. Stuart).

17 Ibid., 549. (Report of Casualties in Federal forces at Harpers Ferry).

18 O.R., I, XIX, II, 336. (Message from Stoneman to Banks dated September 20, 1862).

19 B & O Report - 1862, 56

20 O.R., I, XIX, II, 325 (Message from Telegraph Operator Wm. C. Hall at Point of Rocks to Captain Eckert, dated September 18, 1862).

21 B & O Report - 1863, 42

22 O.R., I, XIX, II, 520. (Garrett to McClellan dated October 31, 1862).

23 Ibid., 528. (McClellan to Garrett dated November 1, 1862). McClellan was relieved of command within two weeks of this message.

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24 B & O Report - 1863, 43

25 Ibid., 44

26 Ibid., 45-46

27 Ibid., 49, 54. The Battle of Gettysburg was fought on July 1, 2, and 3, 1863. Harpers Ferry was occupied by Confederate forces on June 30. These troops were still in possession of the town on July 9 and fired on a B & O crew which had come to repair the bridge.

28 Ibid., 50. "Several army corps were crossing over into Harpers Ferry during the progress of this work, occupying the Railroad and countryside so that it was almost impossible to get the necessary materials to the bridge."

29 B & O Report - 1864, 53-54

30 Ibid., 54

31 Ibid., 55. During this period a cable ferry was set up for the transfer of mail, baggage, and passengers. The cables were brought by special train from Baltimore. The first cable was lost on the 18th when the men transporting it in a life boat were forced to drop it in the river to keep from sinking.

32 Ibid., 57. The report states, "The work of destruction was not confined to this part of the line, nor to the enemy."

33 Ibid., 59

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34 B & O Report - 1865, 42

35 The B & O continued on a war footing for several months.

36 B & O Report - 1865, 33

37 Barry, 138

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1 Lang, P.G. Jr., "Ninety-Four Years of Bridges at Harpers Ferry" in Engineering News - Record (September 17, 1931), 448. (Hereafter cited Lang)

2 Vogel, 92

3 Barry, 175

4 Lang, 448. ". . . the steady growth in weight and dimensions of motive power and rolling stock and the demands for increased speed and economy of operation motivated agitation for an improvement in alignment and the construction of a bridge better adapted to current requirements. The powerful explosives that had become available . . . rendered practicable the piercing of Catoctin Mountain /sic/ with a tunnel; thereby greatly reducing the curvature . . . on the north side of the river to circumvent this obstacle and also to improve . . . the reverse curvature . . . at the southern extremity of the bridge."

5 Ibid., 448. The new deck plate-girder bridge, still carrying the main line, was completed on June 1, 1931.

6 The 1894 freight bridge carried the highway from 1936 until 1947 when the new highway bridge was completed.

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ILLUSTRATIONS

Following is a collection of 28 drawings and photographs intended to illustrate the bridge at various points in its history. They are arranged so that the textual material is on the page next to the photograph it is describing. In most cases there is no information on the original source of the photograph. In a few, however, such information is available and has been included at the bottom on the caption page. The illustrations are numbered as referred to in the main text (Photograph #1, etc.) but the catalog number from the Park photograph file (HF-11, etc.) is included also.

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PHOTOGRAPH #1
(HF-23)

This view shows the covered wooden bridge (Wager Bridge) built by Lewis Wernwag in 1824. Probable date of the picture is spring or summer of 1835. (Railhead established at north end of Wager Bridge in December, 1834 and work was begun on new bridge in October, 1835).

"View of Harpers Ferry, Va., From the Potomac Side."

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PHOTOGRAPH #2
(HF-251)

This view shows the covered Wager Bridge and the uncovered Railroad Bridge. Probable date is early 1837 since the canal span is uncovered. Drawing is not accurate in regard to curves over canal, etc.

"Harpers Ferry from the Virginia Side by W.H. Bartlett and W. Radclyffe. Published for the Proprietor, by George Virture, 26 Ivy Lane, London, 1838."

HF 23

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PHOTOGRAPH #3
(HF-247)

This view shows the canal span covered. The absence of the Wager Bridge, the Y, and other spans being covered indicates a date of 1840.

Republished in 1859 "Harpers Ferry, Virginia, from Jefferson Rock" - Published in Ballon's Pictorial, Vol. 17, p. 317 (1859).

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HARPER'S FERRY, VIRGINIA, FROM JEFFERSON ROCK.

[For description, see page 23

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PHOTOGRAPH #4
(HF-246)

This view is during the period 1841-1850 since the Y is present but the Bollmanized Winchester Span is not. Note that the railroad is on the downstream side of the bridge. The drawing also suggests that the highway portion of the Canal Span was not covered.

"Harpers Ferry - Scene of the late Insurrection" in Harpers Weekly, Vol. 3, 1859, p. 692.

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HARPER'S FERRY—THE SCENE OF THE LATE INSURRECTION.

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PHOTOGRAPH #5
(HF-450)

This photograph and the three following (#6, 7 and 8) show the bridge as it appeared during the 1851-1861 period. This one shows the uncovered, Bollmanized Winchester Span with its triple trusseling dividing the railroad and highway portions. Note that the covering of the main-line portion of the Y is higher than the rest of the covering. This was apparently due to the necessity of a higher superstructure on the switch span. (This was true even after the bridge was completely Bollmanized as shown in Photograph #23).

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PHOTOGRAPH #6
(HF-64)

This photograph clearly shows the difference in covering between the Y span and the rest of the bridge.

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PHOTOGRAPH #7
(HF-623)

This photograph suggests that the highway portion of the Canal Span was not covered. Note also the peaked roof which was different than that over the main-line Y (Photograph #6).

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PHOTOGRAPH #8
(HF-65)

This photograph is made from an almost identical angle as the drawing following (Photograph #9).

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PHOTOGRAPH #9
(HF-102)

The incident illustrated is described on pages 26-27. It occurred on June 14, 1861, rather than June 15 as stated in the Harpers Weekly caption. This drawing is almost from the exact angle of the preceding photograph.

"Destruction of the Railroad Bridge at Harpers Ferry by the Rebels, June 15, 1861" from Harpers Weekly, July 6, 1861, p. 429.

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HF 65

DESTRUCTION OF THE RAILROAD BRIDGE OVER THE POTOMAC, AT HARPER'S FERRY, BY THE REBELS, JUNE 15, 1861.—SKETCHED BY OUR SPECIAL ARTIST.—[SEE PAGE

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PHOTOGRAPH #10
(HF-538)

The incident illustrated is mentioned on page 27. It occurred on June 20, 1861. Note that the artist has incorrectly numbered the Engine "169" when it was actually "165".

"Locomotive and Tender Thrown from the Railway Bridge at Harpers Ferry by the Rebels" from Harpers Weekly, July 20, 1861, p. 455.

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LOCOMOTIVE AND TENDER THROWN FROM THE RAILWAY BRIDGE AT HARPER'S FERRY BY THE REBELS.

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HF-538

PHOTOGRAPH #11
(HF-48)

This photograph was made between June, 1861 and March, 1862. It shows the destruction of all but the Bollmanized Winchester Span.

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PHOTOGRAPH #12
(HF-457)

Drawing of General Banks' crossing of the Potomac as related on page 29. As in Photograph #11, the Bollman Span is visible.

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HF-48

THE WAR IN VIRGINIA—GENERAL BANKS'S DIVISION OF THE ARMY OF THE POTOMAC CROSSING THE POTOMAC RIVER, AT HARPER'S FERRY, FEBRUARY 26TH.—FROM A SKETCH BY OUR SPECIAL ARTIST, MR. C. S. HALL.

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PHOTOGRAPH #13
(HF-617)

This photograph shows the bridge as it appeared in August, 1862. The Bollmanized Winchester Span is visible on the extreme right. Moving to the left, temporary trestling is visible under the wide or switch span. The next span (#3) shows a Bollman superstructure with support trestling, indicating that construction was still in progress. The next span (#4) is completely Bollmanized. (See Diagram on page 36). All of this iron-work was destroyed by Confederate forces in September, 1862.

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PHOTOGRAPH #14
(HF-11)

This photograph, probably made in October, 1862, shows the temporary bridge erected following the total destruction attendant to the Maryland Campaign. Note the wooden "false-work" on the #5 Span, the first step in the construction of a Bollman Span. It was completed in November. (See page 37).

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PHOTOGRAPH #15
(HF-619)

This photograph carried a date of "1863-64" but, as the two following (#16 and 17), shows the bridge as it appeared from April, 1863 to 1868. The 4 Bollman iron spans have been completed. They remained as a part of the post-war bridge. (See Diagram on page 37).

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PHOTOGRAPH #16
(HF-61)

This photograph shows the bridge late in the war. Note the small deck-trusses under the non-Bollman spans (Diagram on page 47). The coloring on the iron on the #5 span is noticably lighter than that of the other spans. This is the iron that was salvaged from the Potomac in the fall of 1862. The iron for the other three spans was fabricated at Mount Clair during the winter of 1863-64. (Pages 35 and 38).

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HF 619



Sharp, Artist.

HARPER'S FERRY.

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PHOTOGRAPH #17
(HF-236)

Another late war view similar to #16. The deck-trusses and the light colored #5 span are also visible.

(This is labeled in Park files as a Brady photograph of April or May, 1865).

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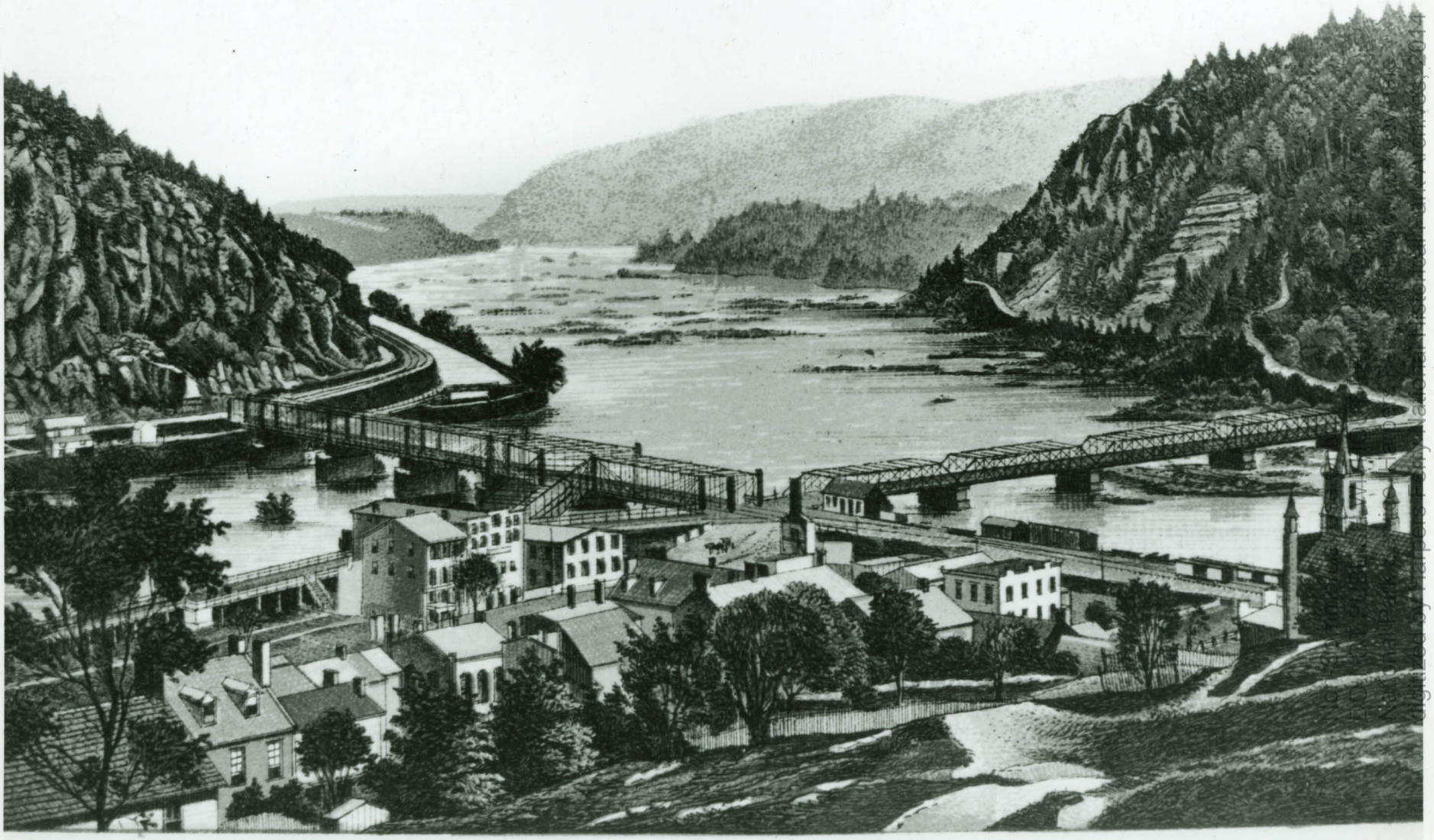
HF-64

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PHOTOGRAPH #18
(HF-670)

This drawing shows the completely Bollmanized bridge, carrying both railroad and highway, as it appeared during the 1870-1894 period. Note the new (1882) bridge over the Shenandoah River.

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HARPER'S FERRY. LOOKING DOWN THE POTOMAC.

PHOTOGRAPH #19
(HF-669)

This is a companion drawing to #18.

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HF 670



HARPER'S FERRY FROM MARYLAND HEIGHTS.

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PHOTOGRAPH #20
(HF-642)

These views show the eastern approach to the bridge as it appeared during the 1870-1894 period.

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HF-669



184 — Harpers Ferry, Va., U. S. A.

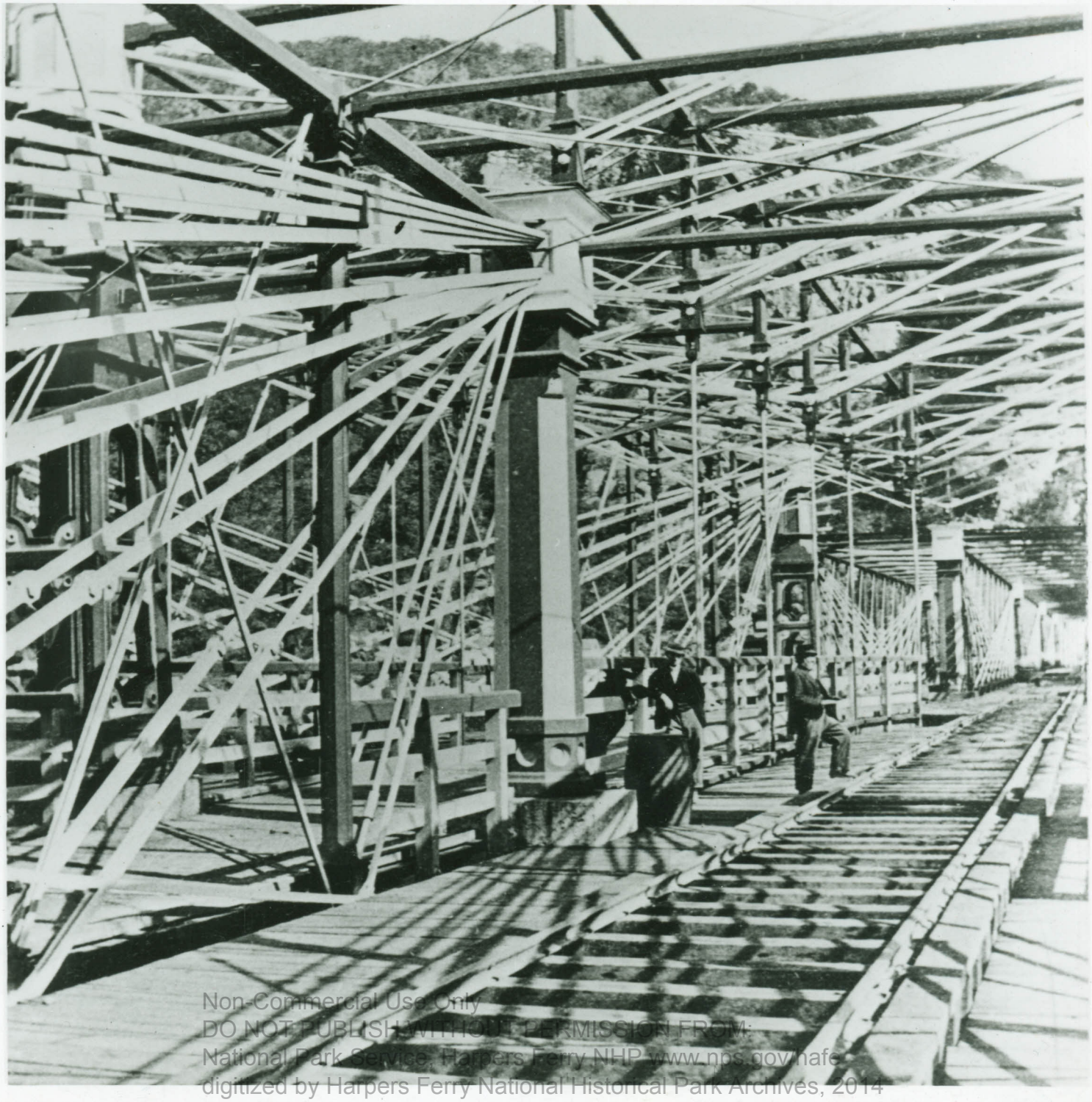
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PHOTOGRAPH #21
(HF-679)

This is an excellent view of the bridge interior during the period 1870-1894. It is looking east from the railroad portion of the Winchester Span. The men are standing on the Winchester part of the Wide Span, (between Piers 1 and 2).

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HF. 692



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PHOTOGRAPH #22
(HF-771)

This view is looking directly into the Winchester Span. The man is standing at about the same point as on the preceding photograph except he is now on the highway portion of the bridge. The railroad switch-point can be seen just beyond the barrell.

Date: May 29, 1886

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PHOTOGRAPH #23
(HF-766)

Note in this photograph that the superstructure on the Wide Span (between Piers 1 and 2) is noticably higher than the other spans visible. This would indicate that for some engineering reason the switch had to be higher. This was apparently true when the bridge was wooden, as discussed in the caption of Photograph #5.

Date: May 29, 1886

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PHOTOGRAPH #23
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Date: May 29, 1886

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PHOTOGRAPH #24
(HF-96)

This 1896 photograph shows the changed situation following the completion of the new main-line bridge in 1894. Note that the track portion of the Winchester Span has been removed as well as the entire span of the Y between Pier #1 and the abutment. (See Diagram on page 51). The situation remained as shown until a new main-line bridge was completed in 1930.

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PHOTOGRAPH #25
(HF-541)

This photograph shows the bridge situation as it was during the period 1930-1936. The upstream bridge is the new (1930) main-line bridge which is still in use. The next is the Freight Bridge (still in use) which carried the main-line between 1894 and 1930. Next (blurred) is the subject bridge in use as a highway. The bridge across the Shenandoah was also a highway structure. The latter two were destroyed in the 1936 flood.

Date: April 30, 1932

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PHOTOGRAPH #26
(HF-837)

This photograph shows the bridge as it appeared during the period 1924-1936. Note the good condition of the Bollman iron-work which at the time of the photograph was between 63 and 70 years old. Note also the higher superstructure on the Wide Span.

Date: February 16, 1933

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PHOTOGRAPH #27
(HF-836)

This is a companion photograph to #26. Note the modern superstructure on the three spans washed out in the 1924 flood. (See page 52).

Date: February 16, 1933

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PHOTOGRAPH #28
(HF-709)

This photograph shows the remains of the bridge immediately after the flood of 1936. The destruction of the piers precluded any possibility of repair. Compare with diagram on page 53 which shows that the present condition of the piers is the same as in the 1936 photograph.

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NUMBER: HF-487
SUBJECT OR TITLE: BRIDGE, SHENANDOAH - 1892
NEGATIVE ON FILE: X YES ____ NO
LOCATION OF PIX:
COMMENTS: BUILDERS ON UNCOM-
PLETED STRUCTURE. PHOTO BY
FLYNN & CUMMINS OF H.F.

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