Baltimore and Ohio Railroad,
Fairmont Bridge
Fairmont Vicinity
Marion County
West Virginia

HAER WV-14

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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

PHOTOGRAPHS

Historic American Engineering Record
National Park Service
Department of the Interior
Washington, D.C. 20240

HISTORIC AMERICAN ENGINEERING RECORD

BALTIMORE AND OHIO RAILROAD: FAIRMONT BRIDGE

HAER WV-14

Location:	Fairmont, West Virginia Fairmont West Quad 17.57330.4368680
Dates of Construction:	1852, 1865, 1887, 1912
Present Owner:	The Chessie System
Significance:	The first all-metal bridge on the Fink plan, its detailing influenced the development of pin-connection in American bridges. Longest iron bridge in the United States in 1852.
Historian:	Dennis M. Zembala

BALTIMORE AND OHIO RAILROAD: FAIRMONT BRIDGE

The contrast between the centuries-old methods used for excavation and the latest example of bridge construction was one of the incongruities which marked the early phases of railroad engineering. By 1851, crews of railroad workers were busily engaged in grading the line of the Baltimore and Ohio Railroad from Cumberland to Wheeling. Many of these men were fresh off the boat from Ireland, while others had left their isolated hill country farms to supplement their meager earnings with hard currency. While these workers engaged in back-breaking labor with pick and shovel, others nearby were engaged in a more sophisticated enterprise, the construction of the Fairmont Bridge.

Albert Fink's bridge over the Monongahela River at Fairmont, West Virginia, (WV-14-1) marks the culmination of the developmental period of iron truss construction. Completed in 1852, it was the first all-metal bridge on the Fink plan and the largest iron bridge in this country. Internationally, its 615-foot length was surpassed only by Stevenson's tubular bridge over the Menai Straits. Its size and its design attracted attention and home and abroad and established Fink's reputation as a civil engineer. In terms of structural design, it demonstrated the feasibility of large iron trusses and the efficiency of the American system of pinned connection. The latter technique was an important step in the development of modern structural engineering.

The Fairmont Bridge probably did more than any written volume to stimulate the proliferation of metal bridges. For example, Whipple's now-famous treatise on the subject (1847) went virtually unnoticed or at least unheeded until the mid-1850's. [1] The high first-cost of masonry and the flammability of wooden construction made all-metal structures extremely attractive, but until their reliability could be demonstrated in concrete terms, most railroad administrators were reluctant to back them with funds. It was the B&O's managers and Chief Engineer Benjamin H. Latrobe, Jr., in particular, who were willing to take a chance on this new technique. Latrobe gave engineers Bollman and Fink the opportunity to establish the reliability of all-metal construction. His decision proved to be prophetic. Once a bridge on the scale of that at Fairmont had been built, the arguments against all-metal construction virtually disappeared. During the 1850's and 1860's, hundreds of metal truss bridges were built on American railroads. Although most of these were shorter spans than that at Fairmont, the era of long-span iron bridges was not far away.

Several factors contributed to the proliferation of iron bridges after 1850. From an economic point of view, the most important of these was their relatively low cost. A masonry arch bridge was vastly more expensive and, while a timber bridge might have a lower first cost, constant repairs and the danger of fire made its use on a large scale potentially disastrous. Conversely, the iron bridge combined relatively low cost with durability and the prospect of long service.* Secondly, in terms of construction, iron bridges had the decided advantage of prefabrication, which meant that they could be assembled speedily at the site (or later in the shops) with a minimum of skilled labor. This factor was more important on American railroads (including Latin American) where the line often ran through relatively unsettled areas. The often precarious financial structure of American railroads at this time made speedy erection doubly important, since more traffic meant earlier returns on over-extended capital (see Introduction to the B&O in West Virginia, HAER). Nervous stockholders might be more easily mollified if they could be shown the rapid extension of the western terminus. This was certainly the case with the B&O, which numbered among its stockholders powerful private and public institutions capable of exerting considerable pressure (e.g., Baring Bros. Bank, the City of Baltimore, and the State of Maryland).

Finally, Fink's success at Fairmont set into motion an interesting phenomenon which was to become more common as industrialization spread. The initial implementation of new technology was not as easy in 1850 as it is today. Propagandists of technological progress were often led to couch their appeals in terms of traditional practices rather than rely on unfamiliar terminology. In textiles, for example, the change to machine production in England was tempered by a reliance on traditional patterns and designs. English cotton manufacturers attempted to reproduce, for example, the designs of Indian cottons which were familiar to consumers while mechanization resulted in a revolutionary change in both the scale and the quality of production. [2] The attitude that novelty was an end in itself was just beginning to take hold. The political revolution had set the stage for it, and the remarkable achievements of British engineers had done much to institutionalize invention. [3] Although Condit calls this phenomenon "the invention of the method of invention," it really has more to do with the acceptance of invention by society. Once Fink's bridge at Fairmont (and Bollman's at Harpers Ferry, 1852) had demonstrated the feasibility of metal structures, other railroads were quick to adopt them out of a desire not to appear too "conservative." The Pennsylvania Railroad, for example, built a number of iron bridges with spans from 65 to 110 feet on its western and mountain divisions during the 1850's. In 1857, F. C. Lowthrop built his first railroad bridge on the Catasauqua and Foglesville Railroad in Pennsylvania. Like Fink's bridge, it had chords and posts of cast iron and tension members of wrought iron. Its 11 spans had a total length of 1,122 feet. [4] While initial implementation of this innovation in bridge engineering was slow, its acceptance increased dramatically once its advantages had been demonstrated.

Construction of the Fairmont Bridge began in 1850 with the erection

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* No one foresaw the exponential increase in the weight of rolling stock, which would make these structures obsolete before their time.

of a temporary wooden trestle bridge (four spans of 156 feet each) to facilitate construction. [5] Work on the masonry piers began at the same time and was expected to be completed by December, but due to unexpected difficulties they were not finished until late 1851. The Monongahela River at Fairmont was a main artery of the lumber trade, and the river bottom was a mass of sunken logs and silt. This situation greatly increased the labor and cost of the masonry. While the deck of the bridge was 39 feet above low water, the pier footings were set 2 feet into bedrock, 64 feet below the base of the rail. [6] (Photo WV-14-5.) The cost of the masonry was $98,987 out of a total of $138,192 [7], and it is likely that this figure did not include much of the initial excavation (although it is unlikely that it cost $490,000, as one Baltimore newspaper reported). [8] Installation of the iron superstructure was much faster. The iron work had been completed the previous year at the company's Mt. Clare Shops under the direction of James B. Jordan, Superintendent of Foundry. During the spring of 1852, the parts were transported to the site and speedily assembled.

The three spans of the Fairmont Bridge were the prototypes for Fink's patent of 1854. [9] Each was 205 feet in length, with cast-iron posts and chords and wrought-iron tension bars. The terminal endposts were quadruped towers whose verticals were joined horizontally by similar cast-iron struts with bolted flanges. (WV-14-3.) Each vertical was a hollow octagonal, 7 inches outside dimension and a round interior of 5 inches. Each tower was 4 feet square at the base, but the end pair of verticals were slightly inclined so that while from an end-on view the posts were parallel, a side view showed a slight batter. On top of the verticals rested a complex cast-iron cap pierced transversely by a hole to receive a 6-inch diameter wrought-iron pin. A series of suspenders (3 feet 6 inches long) were hung from this pin. Another pin at the bottom of these suspenders received the two chords and the primary and secondary tension bars. One of the most remarkable features of this structure was the casting which formed the top chord of the end panel. This piece was like the endpost in construction--octagonal outside and round inside--but larger (12 inches external diameter). The end which attached to the tower was flared and squared off in a manner which provided spaces for its connection to both the suspenders and the various tension rods (WV-14-2 figs. 8 & 9). The size and complexity of this casting is another illustration of the role Fink's designs played in the evolution of structural detail in iron bridge construction (see HAER reports on Tray Run and Buckeye Run Viaducts). The remainder of the top chord was composed of similar octagonal sections joined every 12 feet by means of a square dowel and sleeve assembly. The vertical posts (8 inches) and transverse struts (6 inches) were of identical construction. The longitudinal struts of the bottom chord were lighter (6 inches) than those of the top chord and illustrated the basic principle of Fink's design: that of the suspension truss in which the major forces were assumed by the heavy tension members (in the deck version of this truss, this lower chord was generally absent). Each truss had three sets of primary tension members (WV-14-3); each set was composed of two bars, 4-1/2 x 1-1/4 inches, for a total of six bars. The maximum length of wrought-iron bars seems to have been about 25 feet; consequently, they were joined every so often by iron pins. The use of bars in pairs facilitated such construction. The primary tension members were joined in the middle of the truss by a cast-iron shoe which also supported the middle post. The secondary tension members were of similar construction (4-1/2 x 1 inches), except that their ends were joined by some sort of pin-and-ring connection. Each set went from the top of the tower to the foot of the quarter posts, where it was joined to its opposite number by a pin. This pin also connected the tertiary tension members and a suspender which supported the timber deck joists (6 x 16 inches) (see WV-14-2 figs. 10 and 11). The rails were laid on two sets of longitudinal timber stringers, each pair set in cast-iron chairs bolted or spiked to the joists. Overall, the bridge was 16 feet wide and the depth of the truss was about 20 feet. Its complexity was further increased by the fact that, since it crossed the river at an angle, the last panels of the two corresponding trusses were of unequal length. (WV-14-3.)

Fink's original bridge at Fairmont had a relatively short life. In April of 1863, it was blown up by a troop of Confederate cavalry led by Jones and Imboden. The destruction of this and six other bridges on the western portion of the line illustrates the strategic importance of the railroad not only from a purely military and logistical point of view, but also as a symbol of the critical impact of northern manufacturers on the war's outcome. Because of these factors, the line was reconstructed as rapidly as possible when the area had been secured by Federal troops. The Fairmont Bridge was replaced by a wooden trestle for the duration of the conflict. In 1865, two of the spans were reconstructed on Fink's plan, and three years later the final span was also rebuilt. With the exception of the new Italianate towers reflecting the railroad's new status, the second bridge was identical to the first (WV-14-4). This was possible only because the railroad retained Fink's drawings of the original (Fink himself had moved to the Louisville & Nashville Railroad in 1858). The second bridge served the line for about 20 years. In 1875, the chords and bearing timbers were "renewed" (probably reinforced or some sections replaced). [10] By the mid-1880's, however, the increase in the size and speed of trains made it obsolete, and it was replaced in 1887 by a more modern version, probably of wrought iron. This third bridge, in turn, served until 1912, when the existing steel trusses (modified Warren type) were installed (WV-14-5). At that time, the track level was raised 2 feet 3 inches by the addition of masonry to the original piers (see HAER photo WV-14-8). The new spans were built by the American Bridge Company of New York and contain 1,558 tons of steel. [11]

The significance of Albert Fink's bridge over the Monongahela River at Fairmont lies in the fact that both its scale and execution were remarkable for their time. While the grading of the track proceeded with the primitive hand labor, the bridge was a product of the latest engineering techniques. The successful demonstration of this system on a scale vastly beyond what had been attempted led to the construction of metal bridges on other major railroads and to the proliferation of new truss designs. It provoked new experimentation and did much to further the spread of the basic principles and techniques of metal structures.

Footnotes

1. Carl Condit, American Building Art: the 19th Century (New York, 1960), p. 114. Of course, Whipple also built examples of his own designs which contributed to this general acceptance of iron bridges, but these were shorter spans.

2. A. P. Wadsworth and Julia Del. Mann, The Cotton Trade in Industrial Lancashire (Manchester, 1939), p. 193.

3. Condit, p. 124.

4. Theodore Cooper, "American Railroad Bridges," Trans. A.S.C.E., Vol. XXI (July, 1889), p. 15.

5. Baltimore and Ohio Railroad, 25th Annual Report (Baltimore, 1850), p. 44. Annual reports cited hereafter by number.

6. 26th Annual Report, p. 47.

7. 27th Annual Report, p. 24.

8. Ibid.

9. U.S. Patent Office, No. 10,887.

10. 49th Annual Report, p. 47.

11. Smithsonian Institution, Museum of History and Technology, Division of Civil and Mechanical Engineering. Xerox copy of article from Fairmont Times (no date).