Marsh Rainbow Arch Bridges

Text and photos by James C. Hippen

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He also knew that there is something inherently pleasing about saving money.

Thus, his design of the concrete Marsh Rainbow Arch bridge was doubly pleasing. This type of bridge became fairly common in the Midwest between 1911 and the 1930s. Today it is vanishing from our landscape.

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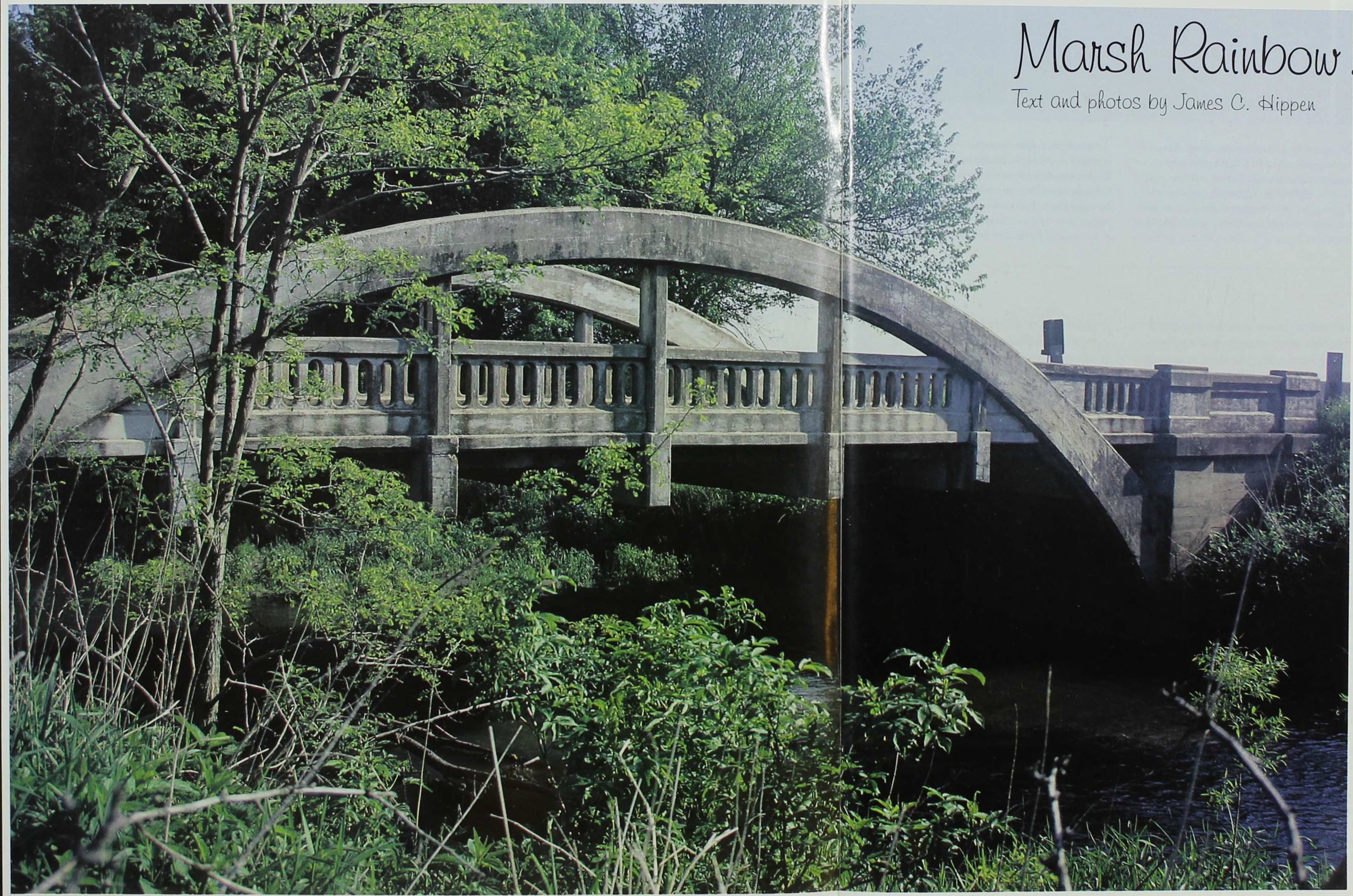
With reinforced-concrete arches rising like rainbows, the Marsh Rainbow Arch bridge was once a popular choice for spanning Iowa's waterways. Today only nine remain. The bridge on the left was built in 1918 and crosses Squaw Creek (North) in Harrison Township, Boone County.

Stories Behind the Sites

This occasional series showcases Iowa's historic structures and places. Preserving historic places and resurrecting their stories allow us to get that much closer to the everyday drama of the past. We can amble around the structures, pace off the sites, breathe the atmosphere. We begin to understand how a building, or a bridge, or a street reflects the time in which it was first created and used. Iowa has some 5,000 structures on the National Register of Historic Places, and many more are judged eligible. Behind each is a story of why that site is significant to our history. In this issue, the story behind a particular kind of bridge. —*The Editor*



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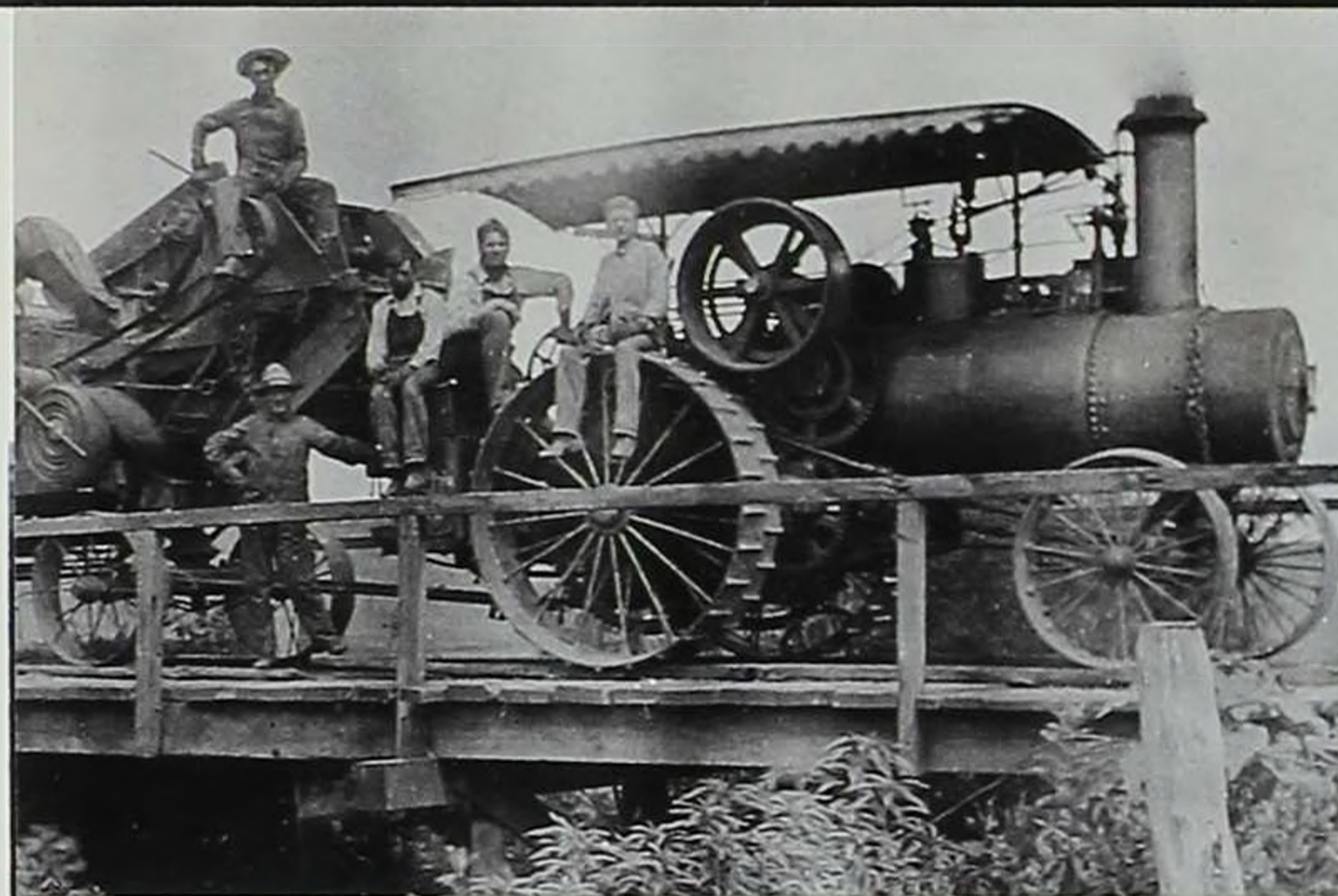
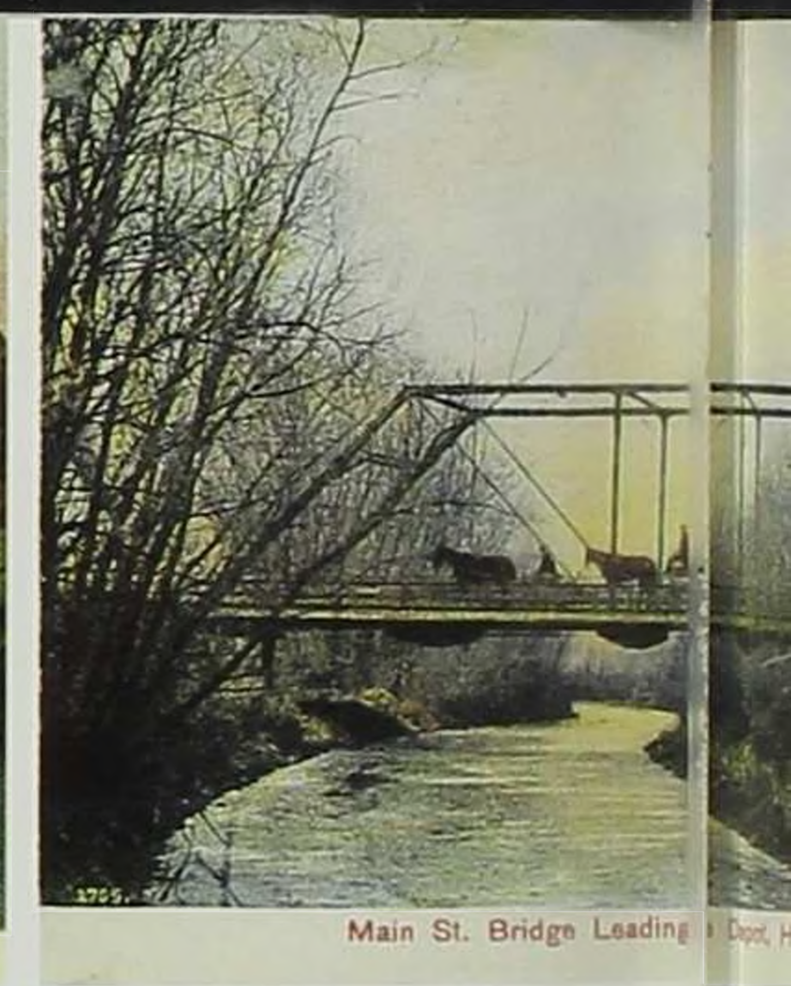


SHSI (IOWA CITY): KOCK COLLECTION



Wooden bridges (above) were quick and cheap to erect, but until creosote was applied to timber to prevent rot (starting around the turn of the century), their lifespan was only a decade. The ultimate test of a wooden bridge was whether it could hold a 15-ton traction engine, as above.

Stone bridges, on the other hand, were far more permanent. This two-span stone bridge in Elkader still carries traffic today. Built in 1888/89 by Dubuque engineer M. Tschirgi, Jr., with locally quarried stone, it is the only stone bridge of this scale built as a wagon or highway bridge in Iowa.

The postcard describes this iron bridge (center) as "Main St. Bridge Leading to the Depot, Hamburg, Iowa." Iron bridges like this one were easy to construct in the field because the joints were connected by pins, rather than by more labor-intensive rivets, which had to be heated and beaded over

ones over the hundreds of waterways that lace Iowa, they considered the options. Wooden bridges, of course, were the simplest, especially for spanning creeks and small streams, but they required high maintenance. Stone bridges were elegant and permanent, but also expensive. Iron bridges had been in increasing use after the Civil War, and, like the newer structural steel bridges, combined durability and economy. By the century's end, a promising alternative entered the discussion: the reinforced-concrete bridge.

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Nevertheless, reinforced-concrete bridges were becoming Marsh's specialty. In 1909 his company completed a three-span arch at Dunkerton, Iowa, still standing today.

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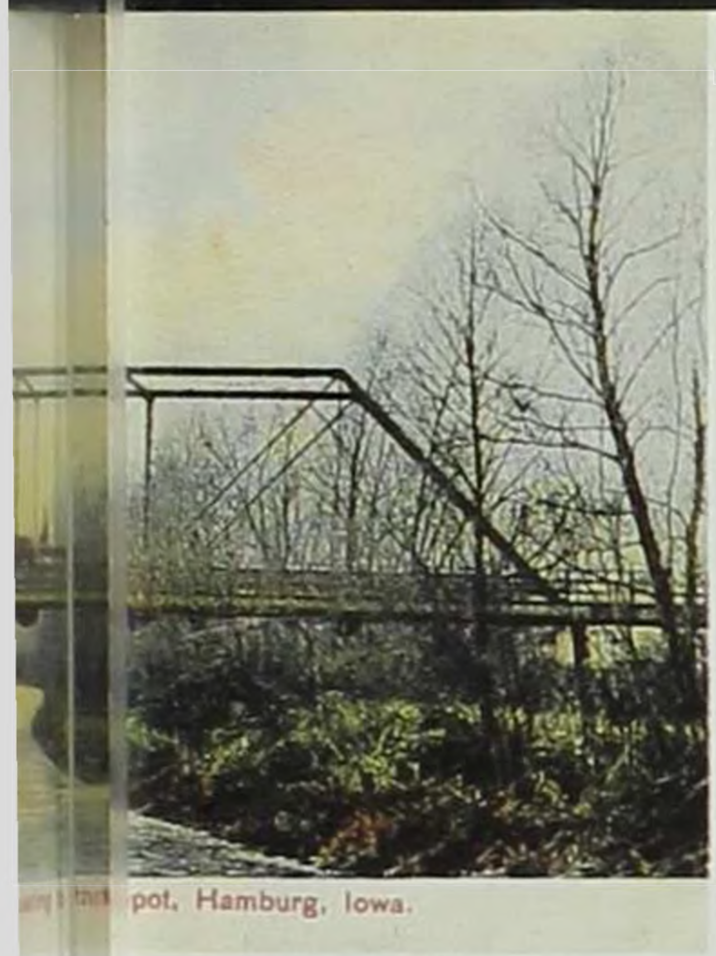
MARSH ENGINEERING CO.
DES MOINES, IOWA
Designers and builders of Safe, Economical, Beautiful and Permanent Bridges.
ASK OUR PATRONS



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A parade crosses the Melan arch bridge in Waterloo, built in 1902 by James Barney Marsh, about a decade before he patented his own Marsh Rainbow Arch bridge. Melan arch bridges pioneered the use of reinforced concrete for bridges in America.

FOUR POSTCARDS COURTESY OF THE AUTHOR

Children wade near this reinforced concrete bridge, built circa 1910 near Guthrie Center on the River to River Road (later Highway 6). It is typical of most reinforced concrete bridges in that the arches were below the roadway. In Marsh Rainbow Arch bridges, the arches were above the roadway.

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That same year, Melan bridge promoter Fritz von Emperger announced to the American Society of Civil Engineers, "If it should be possible to construct a concrete bridge for the same price as an iron bridge, it needs not a great prophet to predict a revolution in the construction of highway bridges." James Barney Marsh would become part of that revolution.

By 1896 Marsh had established himself as an independent bridge designer and contractor based in Des Moines. He undoubtedly kept a keen eye on new developments in reinforced concrete, and soon was making it his specialty.

Included in the cost of building reinforced-concrete bridges were royalties owed to the original patent holders, some of whom had become especially adept at manipulating the U.S. patent system. The trick was to load their original patent claims with nearly every possible arrangement of reinforcement and other structural elements—thereby either collecting royalties on each arrangement used, or suing for infringement. The undoubted master of this game was Daniel B. Luten of Indianapolis. By 1913 Luten held 36 patents related to concrete bridges, comprising 384 features that might be infringed.

When Luten sued Marsh for patent infringement in 1911, Luten had already brought at least ten other lawsuits into federal courts. Although Marsh eventually won, assisted by the Iowa Highway Commission, the case was not resolved for seven years. In the meantime, Marsh did not content himself with paying royalties to Luten or with building infringement-free bridges. He set out to develop and patent his own bridge design.

As both an engineer and a contractor, Marsh thoroughly understood arches and concrete, but he was also a businessman, primarily concerned with building sound bridges for competitive prices. So he masterfully adapted contemporary engineering materials to the current construction methods and market forces. Patented in 1912, the reinforced-concrete "Marsh Rainbow Arch bridge" was designed to be built without any temporary scaffolding (called "falsework" or "centering") in the streambed. The design spelled savings, in several ways.

First, labor costs, on the rise since 1900, were minimized because concrete construction required only an experienced foreman, a few carpenters, and some unskilled workers.

Second, not only did the arches and open spandrels require a minimum of concrete, but Portland cement was affordable and no farther away than Mason City. Rock and sand for aggregate were also usually close at hand.

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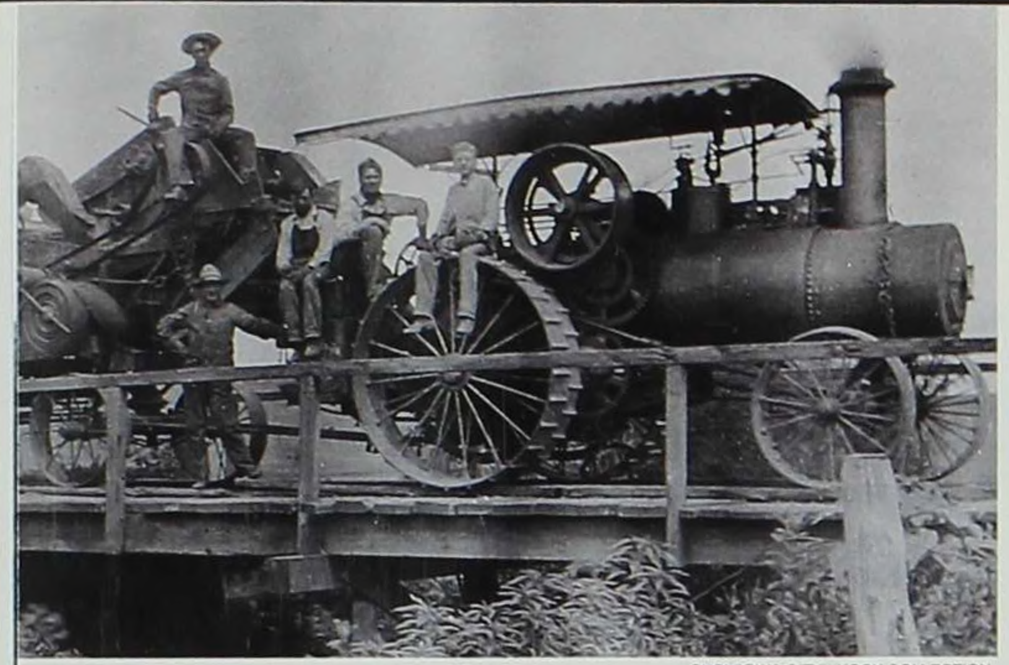

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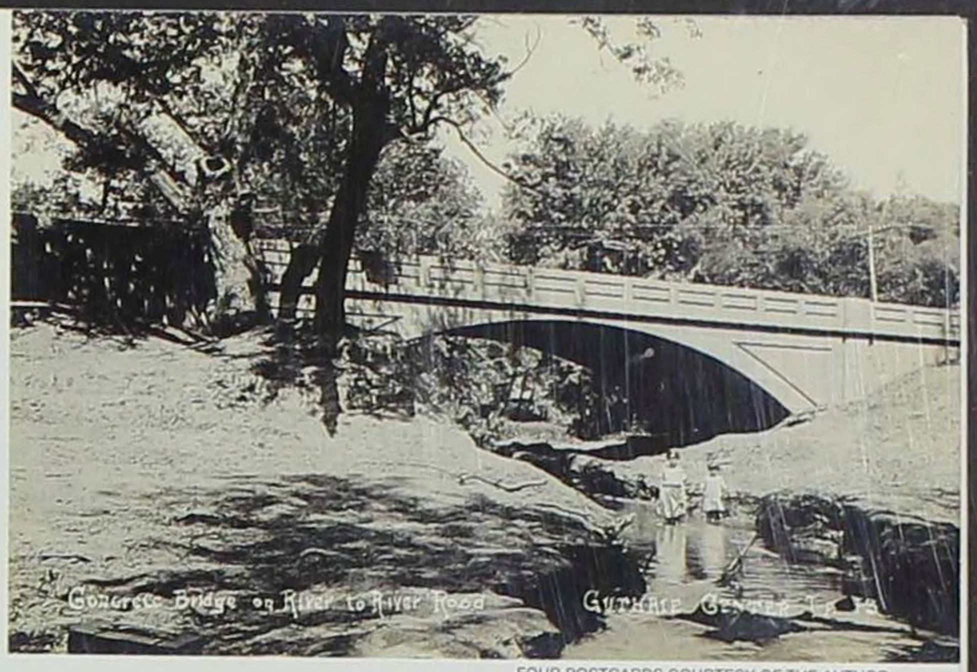

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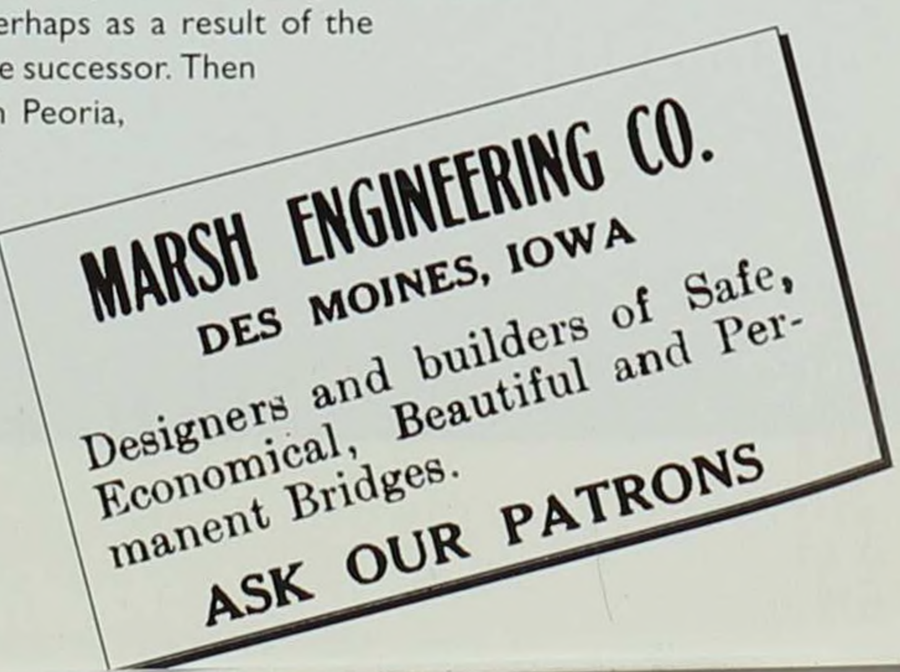

A Marsh Rainbow Arch bridge (built in 1916/17) crosses Big Creek (North) in Garden Township, Boone County. Note how the end of each arch tapers toward the abutment, and how the arch is anchored into the abutment below floor level.

Finally, since Marsh held the patent, he would owe royalties to no one.

Marsh's design of the "Rainbow Arch" may not have been a triumph of original invention. The key design feature was that the floor slab was not tied to the arches, and thus could slide independently of the arch ribs. The patent text explains that this allows for temperature changes and the consequent changes in length of the arches and the floor. Yet without challenging the actual necessity for this, it is not unfair to note that the most tangible benefit was the great savings in reinforcing steel and in labor costs.

Essentially, Marsh was patenting the technique of *not* doing something—tying the ends of the arches to the floor—which everyone else was trying very hard to do. But this was his genius: to omit something and to do the job in another way at lesser cost.

Marsh also seized on a name for his bridge that was a public relations triumph. Although not part of the patent, the name "Rainbow Arch" already appeared in advertisements in 1912. The name appealed to all the deep-seated folklore about rainbows and good fortune. And the arch itself—visible above the bridge floor, not below it—was its own aesthetic selling point. Now even rural townships could have bridges that resembled the elegant bridges in Des Moines, Cedar Rapids, and other big cities.

Arches appealed to the public, and concrete was the ideal material for building arches. If so desired, concrete could be made to resemble the ever-popular stonework. Furthermore, concrete arches looked more sturdy than the 19th-century iron bowstring arches, and they did shake less—especially under the increasing load and speed of motor vehicles.

Perhaps the ultimate testament to the Rainbow Arch's aesthetic appeal is a concrete bridge in Minot, North Dakota. To avoid infringing on Marsh's patent, the bridge was built in a different form, but non-structural arches were raised along the roadway to give the bridge the look of a genuine Marsh Rainbow Arch.

Marsh continued to build Rainbow Arches into the 1930s, particularly in Iowa, Kansas, and other plains states. Probably the largest he ever designed is the five-span Rainbow Arch at Cotter, Arkansas, now a National Historic Civil Engineering Landmark.

After the 1930s, however, few Marsh Rainbow Arch bridges were built. For one reason, although engineers admired the boldness of the design and construction method (especially that it required no falsework for temporary support), they also worried that construction errors or shortcuts by less experienced contractors or careless laborers could end in disaster. Second, although the arch rises above the roadbed, thereby escaping the brunt of ice and high water, uprooted trees and flood debris, the bridges were not invulnerable. When the concrete did chip or break away, the steel reinforcement was eventually exposed, leading to rust and more deterioration and weakening. Finally, because the arches were above the roadway and therefore fixed its width, the bridges could not be widened. As farm equipment increased in size, the bridges took their share of gouges, scrapes, and curses from farmers trying to ease their wide loads between the arches. Once a popular design for "wagon" or

Troubled Bridges

Close-up photos document problems that have plagued Marsh Rainbow Arches. Here, the concrete surrounding the steel reinforcements has broken away, inviting rust. Built in 1915, this bridge crosses Lake Creek near Rockwell City in Calhoun County. (Note new bridge in the distance.)

Built in 1914, the bridge on Beaver Creek (southern Union Township, Boone County) was replaced in 1996. Near right: Deteriorated concrete had left structural steel exposed on the arch ribs. Far right: Ice and logs during high water had damaged the arches' ends, where they were anchored to abutments.

A tractor and farm machinery squeeze between the arches of the Beaver Creek Bridge (North) in Beaver Township, Boone County. Built in 1919, the bridge carried early Lincoln Highway traffic—when vehicles were far lighter and narrower.

"highway" bridges, in time, Marsh Rainbow Arches no longer served the needs of road traffic.

For half a century, James Barney Marsh prospered in the bridge business, starting his career as a salesman for iron bridges and ending as an accomplished designer of concrete arches. Besides Rainbow Arches, he also designed a number of beautiful and functional open spandrel deck arch bridges, ranging from one at Mederville, Iowa (1918, still standing today) to the magnificent six-span Henley Bridge at Knoxville, Tennessee (1932). His life outside his Des Moines office and drafting room was what might be expected of a successful Iowa entrepreneur earlier in this century: He was married, had three children, was an Episcopalian, a Republican, and an active Mason. He died June 26, 1936.

Today, as few as nine Marsh Rainbow Arches stand in Iowa, but recent inventories and documentation projects have helped to secure the bridge's place in history. Once dismissed by bridge historians as a wasteful combination of structural steel and concrete, the design should actually be considered structurally and economically sophisticated for its day. In creating the Marsh Rainbow Arch, James Barney Marsh combined his sense of aesthetics and his masterful handling of reinforced concrete to design a bridge form that appealed to public taste and the public pocketbook. ❖

The author is a historian in Decorah, Iowa. He specializes in bridges, railroads, highways, and similar subjects.

NOTE ON SOURCES

For a general background on the history of bridges, see: Carl Condit, *American Building* (Chicago, 1968); Eric DeLony, *Landmark American Bridges* (NY, 1993); and Donald C. Jackson, *Great American Bridges and Dams* (Washington, 1988).

Specific sources on Marsh arch bridges include several unpublished reports, generally accessible through the State Historic Preservation Offices (in Iowa, Kansas, Minnesota, and Ohio) or sponsoring agencies. For Iowa, see FRASERdesign, "Iowa Historic Bridge Inventory," prepared for Iowa Dept. of Transportation, 1993, and the following HAER reports [Historic American Engineering Record], held by the National Park Service, Dept. of the Interior in Washington, D.C.: David L. Cook and Randall Raber, "Marsh Rainbow Arch Bridge [Newton, Iowa]," HAER No. IA-19 (1987); Juliet Landler, "Lake City Rainbow Bridge," HAER No. IA-46 (1995); Richard Vidutis and James Hippen, "Mederville Bridge," HAER No. IA-79 (1996); and Dawn M. Harrison and Dario Gasparini, "Reinforced Concrete Arch Bridges," HAER, Iowa Historic Bridges Recording Project II (1996). For a more extensive bibliography, order the booklet featured on the opposite page.

Marsh Rainbow Arch bridges were sophisticated, affordable choices, especially for rural Iowa earlier in the 20th century. Below, a Marsh Rainbow Arch bridge built in 1916 crosses the east fork of the Des Moines River, in Kossuth County.