

HISTORIC AMERICAN ENGINEERING RECORD

COTTER BRIDGE

(R.M. RUTHVEN BRIDGE)

HAER No. AR-15

LOCATION: U.S. Highway 62, spanning the White River, Cotter, Baxter County, Arkansas.

UTM: 15/540470/4013955

Quad: Cotter, Arkansas

DATE OF CONSTRUCTION: 1930

BUILDER: Bateman Contracting Company, Nashville, Tennessee.

ENGINEER: Marsh Engineering Company, Topeka, Kansas.

OWNER: Arkansas Highway and Transportation Department.

USE: Vehicular Bridge

SIGNIFICANCE: The Cotter Bridge is the only bridge in Arkansas known to be designed and engineered by the Marsh Engineering Company, a significant twentieth-century bridge-building company. Among the largest they ever designed, it is also an excellent example of the company's patented Marsh Rainbow Arch. A unique feature of the bridge is that it was constructed by means of a cableway, suspended across the river, over which all materials were transported to various parts of the structure. The Cotter Bridge was instrumental in making accessible a new region of the Ozarks, an important recreational area in the United States. It became Arkansas' first National Civil Engineering Landmark in 1986.

HISTORIAN: Lola Bennett

DESCRIPTION: Corinne Smith

Arkansas Historic Bridge Recording Project, 1988.

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Located on the southwestern slope of a hill overlooking the White River, the town of Cotter, Arkansas has been known for over half a century as "The Trout Capital of the World." Today, heavy traffic passes through the town on U.S. Highway 62, but the streets have a ghost-town-like appearance, belying the pace of life that existed during Cotter's heyday. Perhaps the one thing a traveler passing through Cotter will remember about the town is the magnificent bridge spanning the river. The tollbooth and tollkeepers' houses are gone now (1), and the bridge is no longer lit at night (2), but there is still something very special about the structure--perhaps the same aura of romance that evoked this description from a writer in 1930:

Probably no type bridge adapts itself to the natural scenery as this one does. The graceful arches of the structure seem to fit in with the natural green contours of the surrounding mountains. Standing high on one of the nearby hills and looking down toward the bridge it looks as if it grew there, and was not put there by the hands of man.(3)

Completed in 1930, the Cotter Bridge is significant as the only bridge in Arkansas known to be designed and engineered by the Marsh Engineering Company of Des Moines, Iowa. The Marsh Company is well known for its Rainbow Arch Bridge, a design patented in 1912 by James Barney Marsh, the company's founder.

The bridge is an excellent example of the Marsh Rainbow Arch construction technique, where the steel arches were assembled on the ground and then lifted into place on the piers. These steel arches supported their own formwork, while the concrete was cast around them, thus eliminating the need for building costly and time-consuming falsework beneath the structure. The Cotter Bridge was

uniquely constructed in that a cableway, suspended across the river, was used to transport all the necessary materials and tools out to the various parts of the bridge.

Due to its strategic location on the only east-west route in northern Arkansas, the Cotter Bridge was instrumental in opening up a new region of the Ozarks, which was to become a major resort and recreation area in the United States.

The Cotter Bridge became Arkansas' first National Civil Engineering Landmark in 1986.

EARLY HISTORY OF COTTER, ARKANSAS

Before the town of Cotter was there, the horseshoe bend in the river was known as Lake's Ferry, which, for many years was a resort and picnic area for families from the nearby communities of Mountain Home and Yellville.(4) During the nineteenth century, freight - ore and timber, in particular - was moved up and down the river on steamboats, and McBee Landing, about a mile and a half up the river, was an important stop. These steamboats were put out of business with the advent of the White River Division of the Missouri Pacific Railroad in 1903.(5) In that year, the Cotter town site was owned by the Red Bud Realty Company. The company laid out streets and railroad yards, and in November 1905 sold fourteen hundred lots.(6) Railroad employees comprised a large percentage of the population, and much of the town's early history surrounded the building of the railroad. The railroad bridge across White River at Cotter was built in 1905, and incorporation papers were filed for 600 people that same year.(7)

EARLY CROSSINGS ON THE WHITE RIVER

For many years, ferries were the only means of crossing the White River, but soon after the turn of the century, with the advent of the automobile and the consequential increase in traffic, it became apparent that a more efficient means of transporting vehicles and pedestrians across the river was necessary. The White River was known to rise rapidly, sometimes as much as "a foot per hour for 50 continuous hours," and often the only way across the river at its high stage would be to go 100 miles north to the bridge at Branson, Missouri, and cross there.(8) "It was nothing uncommon to find 100 cars waiting for the river to fall to safe ferrying stage."(9)

The first efforts to secure a bridge across White River at Cotter were made in 1912 by a Dr. J. Morrow who, together with the Hon. J.C. Floyd, introduced and secured the passage of an act "authorizing the construction of a bridge across White River at or near Cotter, Arkansas."(10) Apparently, though, funds were not available for such a bridge, because it was not until 1926 that any further steps were taken to secure one.(11)

Newspaper accounts indicate that by the 1920s, ferries were becoming increasingly inconvenient because of flooding on the river and the consequential grounding of the ferry boats. In April 1927, for instance, it rained almost continuously for five days, and the water reached 40'7" at Cotter.(12) Newspaper reports of this, and other floods, indicated the need for a bridge over the White River at Cotter:

White River went on a rampage again this week and for the fourth time this year put all ferries out of service, tied up traffic, and emphasizes the necessity of a highway bridge at Cotter as soon as it can be built. . . . With a bridge over the river at Cotter, and one

crossing North Fork, will come an end to rains tying up traffic a good part of each year.(13)

Once more, and as usual every few months, rains on the upper reaches of White River brought the stream up to more than 15 feet above normal at Cotter. . . . All ferries were put out of service for several days and traffic east and west was entirely suspended.(14)

DEVELOPMENT OF U.S. HIGHWAY 62

The other issue at this time, which had bearing on the construction of the Cotter Bridge, was the development of the highway system--both federal and state--and more specifically, the development of U.S. Highway 62, which ran through Cotter.

In the late 1920s, representatives from Arkansas and Oklahoma formed the Arkoma Highway Association, whose goal was to have a series of connected highways--including Highway 12, which ran through Cotter--classified as a federal highway. Such a designation would allow for the development of a new section of the Ozarks, which was rapidly becoming an important recreational area in the United States. An article in the Baxter Bulletin in May 1928 spoke of this regional development:

The Ozark Mountains in North Arkansas and South Missouri, are developing into one of the largest recreational centers in the Middle West or South. These beautiful green clad hills, with their sparkling, clear water streams and picturesque scenery, have caught the fancy of city people. The horde that comes to play every summer is increasing every year, and many new resorts are being developed.(15)

U.S. Highway 62 seemed "destined not only to be a commercial thoroughfare, but the most direct and popular route through the playground section of the Ozarks."(16) Officially designated

in June 1930, U.S. Highway 62 ran from Mayesville, Kentucky to El Paso, Texas, and would eventually extend from Canada to Mexico.(17) As events unfolded, it became apparent that the construction of a bridge at Cotter would be one of the key elements in the establishment of this route as a federal highway.

POLITICS AND THE COTTER BRIDGE

In November 1926 the Baxter Bulletin reported that County Judge M.E. Curlee had received a proposition from "a concern who wanted to build two toll bridges in Baxter County... one across North Fork and one across White River."(18) However, since Curlee's term of office ended the following month, it was his successor, Bob Hudson, who granted franchises for three privately owned toll bridges in January 1927, two to the Henderson Bridge Company, and one to the Denton Bridge Company. the Baxter Bulletin noted:

All three bridges will be on state highways, and will replace ferry boats. . . . The bridge companies have purchased the Smith Ferry at Henderson, . . . the Denton Ferry from Hurst & Woods and the Hutcheson Ferry from S.C. Hutcheson. The franchises did not cover the Maynard Ferry on the North Fork above Henderson or the Cotter Ferry at Cotter. These boats will run as usual after the bridges are built.(19)

There was, however, considerable opposition to the construction of privately-owned toll bridges, not only in Baxter County, but throughout the state. On February 11, 1927, the following article appeared in the Cotter Record:

No truer statement was ever made than that "Eternal Vigilance is the Price of Liberty," and its truth is brought home forcibly to the people of Baxter and Marion counties by the attempted grab of toll bridge

franchises at Denton ferry on White river and the ferries on North Fork. The construction of such bridges by private individuals, companies or corporations would in effect erect a wall about Baxter and Marion counties to the serious injury of North Arkansas, the state as a whole and to the country at large.

. . . A toll bridge at best is not desirable, and under such a sweeping unlimited franchise. . . is a positive menace, a crime. . . Black river is cursed with such a bridge and efforts are being made to do away with the nuisance.(20)

The opinions expressed in this article were indicative of a much more widespread problem in Arkansas, and perhaps other sections of the country as well. Until this time, the construction of roads and bridges had been left to the jurisdiction of the county courts, and later to road improvement districts. This led to haphazard and disorganized road building and financing, which failed to recognize broader interests. (See HAER report AR-27.) The State Highway Commission had been created by Act 302 of the General Assembly of Arkansas in 1913, but their position was mainly an advisory one, to assist the county courts.

Finally, in 1921, the Federal Highway Act introduced highway planning at the State level, and called for a planned system of connected highways, to be supervised by state highway departments. Under this legislation, Arkansas passed the Harrelson Road Law in October 1923, establishing the administrative structure of the State Highway Department to oversee the improvement of the State Highway System. In 1927, the Arkansas legislature passed the Martineau Road Law, proposed by Governor Martineau, which appropriated \$52 million over the following four years to develop the state highway system.(21) This act began the first era of systematic highway building and improvement in Arkansas. In discussing this new highway deal, proposed under Highway Commissioner Dwight Blackwood, the Cotter Record stated: "there is reason to

believe Arkansas will have a systematic road building program in place of the hodge podge methods pursued heretofore in building 'roads that go somewhere.'"(22)

Around this same time, Congress also passed a bill, an amendment to the Federal Highway Act, which eliminated federal aid on highways leading to privately owned toll bridges.(23) The passage of these bills ended in a lawsuit between the Highway Commission and the bridge companies whose franchises were being annihilated. In January 1928, the Supreme Court upheld the contention of the Highway Department that it, and not the county court, had jurisdiction over state highways and bridges and that the Highway Commission had the authority to build toll bridges, provided they became free bridges once the debt on the bridge had been paid off.(24)

All this debate over responsibility, and the ensuing lawsuits from the bridge companies, resulted in a three-year stalemate over the construction of the Cotter Bridge. By the time the political aspects were resolved, the citizens of Baxter County had made it desperately clear that there was still nothing they wanted more than a bridge at Cotter:

Marion and Baxter counties need this bridge. And not these counties only, but all North Arkansas demands it. For a distance of more than 200 miles on White river above Batesville there is no bridge. There can be no reason whatever for continuing this condition. Traffic demands and justifies the bridge. It should be, and the public expects it to be, taken up and pushed to completion now, not at some distant or indefinite time in the future, but now. This county hasn't a bridge except the little flimsy wooden structures on No. 12, while other ranking counties are getting splendid concrete bridges. We rejoice with them and only ask and insist that our county be given a square deal.(25)

Thus, when in 1927 the Highway Department obtained approval from the federal government to build nine toll bridges throughout the state, County Judge R.M. Ruthven, pushed for Cotter to be

put on the list of proposed sites.(26) The media, as well, promoted Cotter as the ideal location for such a bridge:

No bridge project in the state is so favorably located as is that over White river at Cotter. Sand, gravel and rock in unlimited quantity at hand, railway tracks to the site, and ideal approaches. No bridge in the state, either built or contemplated has these advantages. In fact not a state bridge erected so far has any one of them.(27)

The only thing that Cotter did not have in its favor was a traffic count sufficient enough to warrant the construction of such a bridge. Before each site could be approved, a feasibility study, including traffic count, needed to be done. This study was carried out in June 1928, and the newspaper reported:

A check will be made at both the ferry here and at Denton's ferry, to determine the number of vehicles and footmen ferried at these two points. It is necessary to have these figures to be able to estimate the probable revenue that will be produced by the bridge when it is completed.(28)

Rumor has it that the feasibility study on Cotter concluded that the bridge should not be built, but that Judge Ruthven was determined to get the Highway Commission to approve its construction anyway. Judge Ruthven was present when the Highway Department met to review the reports on the various sites. Apparently, during the meeting, the report on Cotter disappeared, but the commission assumed it was an oversight and approved it along with the others.

How this came about remained a well-kept secret for 20 years following the completion of the bridge. Judge Ruthven saw the survey report before the commission met, and he realized what it meant to the people of his county. When he returned to his home that afternoon, the Cotter report went with him, where it remained for two decades. At that time the judge mailed it to the commission.(29)

Although there is no existing documentation for this story, several independent sources--including one of Ruthven's sons and Rex Bayless, a former mayor of Cotter--confirmed the details of it. Additionally, the absence of a Cotter Bridge feasibility study in Highway Department records, would lead one to believe that the story is probably true. In any case, the State Highway Department eventually approved the construction of a bridge at Cotter, and on February 17, 1928, the Baxter Bulletin reported:

The state Highway Department has adopted the policy of building all bridges that cost less than \$250,000 as free bridges. With the road revenues as they are now, the commission finds it impossible to undertake the construction of the larger bridges except as toll bridges. There are nine such toll bridges now planned, the average cost of which will be more than \$500,000. They are at Fulton and Garland City on the Red river; at Calion and between El Dorado and Hamburg on the Ouachita river; at Newport, Augusta, Clarendon and Cotter on the White, and Ozark on the Arkansas river.(30)

In March 1928, "without a dissenting vote," the U.S. Senate passed a bill granting the State Highway Commission the right to issue bonds and construct, operate and maintain a toll bridge over the White River at Cotter.(31) The measure was approved and signed by President Coolidge on May 2, 1928.(32) The only further approval needed was that of the War Department as the Cotter Bridge would cross a navigable river, and in 1906 Congress had passed a bill stating:

That, when, hereafter, authority is granted by Congress to any persons to construct and maintain a bridge across or over any of the navigable waters of the United States, such bridge shall not be built or commenced until plans and specifications for its construction . . . have been submitted to the Secretary of War and Chief of Engineers for their approval.(33)

The Highway Department needed to obtain plans and specifications for the proposed bridge, and then submit them to the War Department.

LETTING OF BRIDGE CONTRACT

On May 10, 1929, the Cotter Record announced that Frank E. Marsh, of the Marsh Engineering Company in Des Moines, Iowa, had been in Cotter to take measurements and look over the site. The newspaper reported that, "Mr. Marsh was greatly pleased with the site selected for the bridge and will recommend a concrete arch structure and an overhead crossing."(34)

At the end of May, a crew of surveyors, under the supervision of Field Engineer A.R. Hickman, made a topographic survey of both sides of the river for a mile above and below the bridge site, in order "to secure additional data to be submitted to the War Department to determine the type of structure and whether a drawspan will be required."(35)

On July 18, the State Highway Commission approved the Marsh Engineering Company's plans and specifications for the bridge (36), which a newspaper reporter described as follows:

The design for the bridge . . . is called the Marsh Rainbow Arch Bridge. There will be five arches, two of them spanning the river. . . . If built according to the Marsh design the bridge will be the most beautiful structure of its kind in the state.(37)

Apparently there was no difficulty in obtaining approval of the plans from the War Department, because on July 26, 1929, the newspaper stated that, "There is nothing now standing in the way of the construction of the bridge across White River, Judge Ruthven states that all differences have been ironed out."(38)

The State Highway Commission began advertising for bids on the construction of the Cotter bridge in August of 1929. Bids were accepted from seven contractors on August 15, the lowest bidder being a Kansas City firm, whose bid was \$366,773.80.(39) A few days later, all the bids were rejected, because of a modification in the plans. The Missouri Pacific Railroad Company had filed a request for a slight change in the viaduct over the railway, asking that it be enlarged to allow room for four tracks instead of two.(40) The plans were revised and once again approved by the War Department. The Highway Department readvertised for bids, and a new contract was let on September 18, 1929, to the Bateman Contracting Company of Nashville, Tennessee, whose bid was \$390,729.82.(41) Contracts were also let to Westinghouse Electric Supply Company in St. Louis, for lighting fixtures; to Kansas City Structural Steel Company, for steel; and to Williamsport Wire Rope Company in Chattanooga, for cables.(42)

CONSTRUCTION OF THE COTTER BRIDGE (43)

Early in October, the newspaper reported that C.F. Bateman was on the site and that his company "would have at least 100 men on the job as soon as the material and machinery can be put on the ground, probably during the present month."(44) Within two weeks, Bateman announced that the executives and foreman would be arriving in a few days, and the newspaper stated:

Something like 100 workmen will be employed as soon as the job is fairly launched in an effort to get the five river piers in during low water and good weather. Cofferdams, forms and much false work must be built, and this will take a small army of carpenters and other workmen, so that within a very few days the bridge will be such a scene of activity as has not been witnessed in Cotter since the erection of the Mo. Pac. railway bridge 25 years ago. And thus will come to

pass the realization of the cherished dream of a highway bridge over White River at Cotter.(45)

The company expected to employ as much local labor as possible, and as soon as the office was built, the company began taking applications.(46) On November 1 the newspaper reported that the materials and machinery were arriving at the bridge site:

Among the heavy machinery now on the ground is the tram engine, a huge clamshell, concrete mixer, hoisters, a large crane, cable and motors. High platforms are being erected for the mixers from which the concrete will be carried on overhead cables, or tramways . . .

The office building was completed last week and is now occupied by Mr. Bateman and staff. A cement house is being built north of the office, on the railway track and some six or eight feet above the ground on pillars.

Work of laying a railway track from the spur at the ice plant north about 400 feet is now underway . . .

At the present time some 40 to 50 men are employed on the job and more will be put to work as soon as needed. The wages being paid are about the same as prevail in this section, from \$2.50 a day and up.(47)

Newspaper accounts indicate that work on the bridge began in early December; the piers were set in place first, while construction commenced on the high wooden towers which would carry the overhead cableway.(48) Since the river was subject to rapid rises, the contractors decided to use this cableway rather than build falsework in the river. (See HAER photos AR-15-10 to AR-15-19.) This method had the added advantage of being more economical in terms of labor, time, and money. The cableway was designed to carry twenty-five tons, about three tons more than the weight of each steel arch. The cable was 2 3/4 inches in diameter, and 2000 feet long, spanning 1320 feet between wooden towers on either side of the river. The cable was strung between these two towers and

anchored to the ground below. A 54-inch double-drum Lidgerwood 125 horse-power steam hoist powered the cableway. A tram or carriage on the main cable was moved by an endless line on one drum. The other drum operated the lifting cable which raised and lowered the materials to the workers.

The bridge piers were constructed on limestone. A double-walled cofferdam was set in place where each required pier would be. Once the outer chamber was filled with concrete, and the cofferdam was pumped out, the footings were blasted a few feet below the level of the riverbed. Pier forms were fabricated on the ground, and then carried out by cableway and set on the prepared footings. After the concrete for each pier was cast, the forms were moved on to the next pier. Once the piers were in place, the haunch steel for the arches was set on the piers and fastened in place with concrete.

One-half of each steel arch, measuring 125 feet around the curve and weighing about eleven tons, was assembled and hot riveted on the river bank. An auxiliary supporting "mast" was carried out by cableway and set on the central pier as each steel arch was set in place. The top of this mast was attached to the main cable. The mast could be "drifted" to either side to align the arches at about a 30-foot spread. The first half of each arch was picked up with hand winches fastened to small carriages on the main cable. Mast and cable were "drifted" by winches to alignment with the permanent position of the arch. The half arch was carried to position, and while the top was temporarily attached to the cable, the lower end was fastened to the haunch section on the pier. The other half of the arch was then picked up and attached in the same manner. Then the two sides of

the arch were connected. The mast was then "drifted" to the opposite side of the pier, the companion arch erected, and the cross beams and hangers for the floor system put in place.

Once the steel arches were in position, formwork for casting the concrete was hung from the steel. As the concrete was cast on each part of the arch, the forms would be removed and positioned in the same place on the next arch. Forms for the floor were supported by a wooden truss with a steel tension rod placed under the floor beams. All the concrete for this was produced on site, using sand and gravel from under the bridge. Once mixed, it was carried by cableway to the point of placement and, when dry, finished by using electric rubbing machines which supplemented carborundum rubbing by hand. The thirteen 50-foot long approach spans and some shorter connecting units were built using conventional formwork on timber supports.

In order to forestall any long delays in construction, the contractors worked around the clock. "With electric lights strung all over the rising structure . . . the site took on the appearance of a busy city after the shades of night had fallen."(49) In April, the newspaper reported that the piers and approaches were complete.(50) About seven weeks later, work was begun on the arches:

A gigantic boom was placed last week with which to handle the reinforcing steel which goes into the arches. This boom is about 100 feet long and the men working on top of it look like dolls from the river bank.(51)

By July 18, three of the arches were completed (52) and on September 5, the Baxter Bulletin reported that the new toll bridge at Cotter would be completed by the first of November, six months ahead of schedule.(53) Much to everyone's surprise, the work had not been hindered by bad weather

or floods. Rapid construction was further facilitated by the contractors' round-the-clock schedule.

The local newspaper reported:

It was hardly expected that the bridge would be completed before next summer, but by working night and day with perfect working conditions, the Bateman Construction Co. . . . will complete it six months ahead of their program. Actual construction work started on the structure on November 17, 1929, and there has been no interruption in work from that time until this. There have been no high rises; White River has been in a pleasant and friendly mood for the last ten months. A river condition that the people of this section will probably not see again in half a century, and the contractor has taken advantage of every minute of it.(54)

In October the contractors were said to be "putting the finishing touches on the new highway bridge."(55) Before the last span could be completed, the head tower for the cableway had to be removed. The newspaper reported: "The town and country around lost one of its identification marks the other day when the great cable was released and the eastern tower fell its full length about 100 feet out in the park."(56) The other tower was later dismantled from the top down.

There was no doubt that the construction of the Cotter Bridge was a truly a magnificent engineering feat, but even more evident was the fact that the immense structure was aesthetically pleasing as well. Newspaper reporters delighted in writing about the it, pronouncing the bridge "a triumph of architectural design and beauty,"(57) and "one of the most beautiful bridges if not the most beautiful ever constructed in the state."(58)

It is 1850 feet long and 78 feet above the surface of White River at the middle span. Of its length 1060 ft. are in five immense rainbow arches 216 feet from base to base. There are 450 feet of deck girder viaduct on the west side, 210 feet on the east side, then a small rainbow arch over the Missouri Pacific tracks. The bridge seems to fit naturally and snugly into the landscape, its beautiful arches

blending in perfect harmony with the contours of the surrounding hills.(59)

COTTER BRIDGE CELEBRATION

The Cotter Bridge was completed on November 1, 1930, and officially dedicated on November 11. Reflecting the general aura of excitement in town, the local newspapers devoted front page columns and editorials to discussion of the upcoming bridge celebration for several weeks beforehand. One such editorial stated:

The interest being taken in the coming bridge celebration and dedication of the magnificent state bridge across the White River at Cotter, is very gratifying. It marks the largest and finest achievement of the Arkansas State Highway Department in Northern Arkansas, and it is fitting that it should be properly dedicated. It marks the passing of the old era in roads and bridges in this section of the state, and the beginning of a new and modern era for our people. It has more than a local significance, because it links together all of the counties on both sides of the river, and it goes further than this, for it furnishes a safe and sure crossing in all kinds of weather to people who are traveling who live in all parts of the United States.(60)

The bridge celebration promised to be "one of the largest affairs of its kind ever held in North Arkansas."(61) Two days, November 11 and 12, were set aside for the festivities. It was estimated that between 3,000 and 4,000 people attended the ceremonies, including representatives from seven of the states traversed by U.S. Highway 62.(62) "A parade, in which one thousand cars took part, trailing behind numerous floats was one of the features of the day."(63) The other highlight was the christening of the bridge, which the newspaper described as follows:

[A] plane appeared out of cloudy skies, hovered over the new bridge . . . for an instant, and a stream of poppies cascaded from the cockpit. As the first of the descending flowers touched the

magnificent structure Miss Betty Ruthven, Queen of the bridge celebration said, "I christen this bridge Progress and dedicate it to Service," and the bridge was formally opened.(64)

The festivities were subdued only by a written tribute to Cliff Williams and John Harley, two workers who were killed in separate accidents during the bridge's construction.(65) In honor of the bridge celebration, the Baxter Bulletin and the Cotter Record jointly published a souvenir edition, as a supplement to the November 14 issue of the newspapers. The thirty-page booklet featured a poem, entitled "The Cotter Bridge," written by Herbert Messick. The poem, dedicated "to those who built the Cotter Bridge," concluded with the following verse:

My friends, in your celebration,
Drop a tear for the lives that were lost.
And remember the money that built the bridge
Was the very least of the cost;
On it were spent two precious lives
For which no one can repay;
Remember them, and the workman's toil
On your Celebration Day.(66)

THE COTTER BRIDGE VS. THE COTTER FERRY

Apparently, the exuberant townspeople were less than exuberant when it came to actually using the bridge. To them, the bridge was a symbol of progress, but an expensive one, and a great number of people chose to continue using the Cotter ferry to cross the river. Baxter County had refused to renew the operator's ferry licence, but Marion County granted one, so the ferry continued to run, and it took more than a little persuasion to get people to use the new bridge. On July 3,

1931, the newspaper reported that the State Highway Engineer had issued the following announcement:

The new \$400,000 bridge at Cotter is not paying, because people are using other means of crossing the river. If Baxter County people want new improvements on their highways they will have to patronize those already made... The local people convinced the highway department that it was necessary that a bridge be constructed between Marion and Baxter Counties, and the bridge was built.... Our investigation shows that they now prefer to use ferries. A check of the traffic at the junction of numbers 12 and 62 verify this.(67)

This statement was made shortly after Marion County Judge R.L. Berry, and the Arkansas State Highway Commission reached an agreement with Joe McCracken, the owner of the Cotter Ferry.

The agreement stated that for the sum of \$250:

Joe McCracken hereby agrees to and does definitely discontinue the operation of his certain ferry across White River, . . . near the Cotter Bridge. He . . . agrees to destroy . . . and entirely put out of business the said ferry and not to hereafter directly nor indirectly resume such business at or near the place of the above described ferry.(68)

Putting the offending ferry completely out of business apparently solved the problem almost immediately, for on August 7, the newspaper noted:

Business over the highway bridge at Cotter shows a decided gain. July was the best month since the bridge was opened to traffic, and averaged \$40.20 per day. The best day since the bridge was built was last Saturday when the tolls reached \$63.00. The increase is not so much because of heavier traffic but because the traveling public is learning of the bridge.(69)

RECENT HISTORY OF THE COTTER BRIDGE

Although most people still refer to it by its original name, the bridge was renamed in honor of Judge Ruthven in December 1976. Commemorative plaques, mounted next to the original plaques, read as follows:

R.M. RUTHVEN BRIDGE
DEDICATED DECEMBER 31, 1976
TO HIS MEMORY AND RECOGNITION
FOR HIS YEARS OF DISTINGUISHED
SERVICE TO THE PEOPLE OF
BAXTER COUNTY

The historic and architectural significance of the bridge have not gone unnoticed either. On October 18, 1986, the bridge was dedicated as a National Historic Civil Engineering Landmark by the American Society of Civil Engineers.(70) It is the first National Historic Civil Engineering Landmark in Arkansas, and one of only a small number of bridges (less than fifty) in the United States to be distinguished with this award.

Work has now begun on a new \$7.6 million highway bridge over White River at Cotter, just north of the Cotter Bridge. The Arkansas Highway and Transportation Department originally planned to dismantle the old bridge, but local citizens protested, and there are now plans to restore the structure and maintain it as a functioning highway bridge.

MARSH ENGINEERING COMPANY

James Barney Marsh was born in 1856 in North Lake, Wisconsin. He attended college at Iowa State University, where he received a degree in mechanical engineering in 1882. The following

year, Marsh accepted a position as contracting engineer with the Des Moines branch of the King Bridge Company of Cleveland, Ohio (see HAER report AR-32), and made patented improvements on the company's standard metal bowstring truss bridge. In 1896 he formed the Marsh Bridge Company and began to experiment in concrete bridge construction. By 1909 the company had expanded and changed its name to the Marsh Engineering Company.

In 1912 J.B. Marsh patented his Rainbow Arch Bridge (U.S. patent no. 1,035,026). His design paralleled a design proposed by M.A. Considere, a well-known French engineer, eight years earlier. The object of Marsh's invention was:

to construct an arch bridge of reinforced concrete in such a manner as to permit a limited amount of expansion and contraction both of the arches and of the floor which are, of course, the longest members of the bridge.(71)

By designing the bridge so that the arches would spring from points in the abutments below level of the deck, and hanging the deck from the arch with vertical members, Marsh accomplished his goal.

(See patent in appendix.)

By 1915, James Marsh was mainly designing bridges, while his son, Frank, had taken over the field supervision of the company's projects.(72) During the 1920s and 1930s, the Marsh Engineering Company was known primarily for its many concrete arch bridges in the midwest, particularly Iowa and Kansas. Reinforced concrete arch bridges were relatively inexpensive and quick to build, when compared with other types of bridge construction, and required less maintenance than traditional iron bridges. During the 1920s and '30s the tremendous demand for highway bridges led highway departments and local governments with tight budgets to commission

many concrete bridges.(73) Success enabled the Marsh company to open a second office in Topeka, Kansas.(74)

J.B. Marsh died in June 1936, at the age of 60. An obituary in the Des Moines Tribune stated that Frank Marsh was still operating the Topeka branch of the company, but the company disappeared from the Topeka business directory soon after, corresponding with the decline in popularity of the reinforced concrete arch bridge.(75) Apparently, no other company records for the Marsh Engineering Company can be located.(76)

R.M. RUTHVEN, COUNTY JUDGE

Roderick McKenzie Ruthven was born in Jefferson City, Missouri, on January 22, 1885, son of W. Ruthven, superintendent of construction for the state of Missouri for fifty-three years. R.M. Ruthven received his formal education in the public schools in Jefferson City. After graduating from high school in 1903, he worked on his father's farm for four years until he entered the employ of the G.C. Ramsey Tie Company in 1907. His position as field representative took him to Cotter, Arkansas, where he made his home for the rest of his life. After six years with the company, he purchased it, and for the next sixteen years he was the manager and owner of the Ruthven Timber Company, a highly successful enterprise. Ruthven held the office of County Judge for six terms during the 1930s and early 1940s and at one time he was president of the Arkansas County Judges Association. He also served several terms as mayor of Cotter. He worked closely with the administration of President Franklin D. Roosevelt in planning the federal Works Projects Administration program; he is credited with securing many improvements for Baxter County,

including three major highway bridges, at Cotter, Norfolk and Henderson. Several major county highways were constructed during his administration - he mobilized Baxter County citizens to build county roads with donated labor and little machinery during the depression years, and the effort was commended by officials in Washington as an example for the rest of the nation.

A biography of R.M. Ruthven, stated that he had "probably made more substantial contributions to the civic betterment of his community than any other individual in the immediate vicinity."(77) When Ruthven died in 1962, at the age of 77, his obituaries mentioned the Cotter Bridge as one of the crowning achievements of his life.

DESCRIPTION

The Cotter Bridge is a five-span, 1,850-foot Marsh rainbow arch bridge, comprised of five 216-foot concrete arches, an arch viaduct of 132 feet, and 638 feet of deck girder approaches, with a 24-foot-wide roadway. The viaduct is 26 feet from the east abutment and is separated from the five main arches by 141 feet of approach spans. Following the Marsh arch design, concrete was applied over the steel frame, maintaining the basic outline of the structural elements.

Each arch increases in depth from the crown toward the spring line. Eighteen panels are formed in each arch by hangers and spandrel columns, which are made from four angles with double lacing, resembling an I in cross-section. The hangers, as the name implies, hang from the arch down to the road deck, and the spandrel columns rise from the arch up to the deck. The roadway crosses the arch at the third panel point from either end. Pairs of hangers suspend, and pairs of columns

support, the floor girders, which are made from angles and reinforced with steel bars. A two foot tall concrete balustrade spans the distance between the hangers.

The two lines of arches are braced laterally above and below the deck. Three lateral struts cross the road at the crown. The struts, four angles joined by double lacing, rise at a five degree angle from the two arch lines, to meet over the center of the road. Underneath the road, a beam connects the two arch lines near the springline, and angles with lacing cross just above the beam.

The concrete formwork was laid horizontally for most of the bridge. The exception was the placement of the forms along the curve of the arch. Along the arch, the concrete was poured in a sequence to induce the least amount of stress in the steel from the added dead load of the concrete. First the concrete was poured at the haunches and on either side of the crown. The crown and mid-height of the arch were next, and lastly the rest of the arch was covered. Two-inch-thick lumber was used to create a panel along the outer face of each arch. The girders were poured monolithically with the arch. The floor deck was poured before the hangers were covered so that the hangers were carrying the full dead load. Having the steel component of the hangers almost fully extended reduced the amount of cracking of the concrete cover when tension forces from live load were applied.

ENDNOTES

1. The two tollkeepers' houses were bought as private homes and have been moved to residential streets nearby.

2. The original globes on the lampposts were destroyed by vandals. The globes were replaced in the 1970s and for a few years the bridge was kept lit. In the early 1980s, it was determined that the electrical conduits were rusting and it would be very expensive to replace them, so the lights were removed.

3. Baxter Bulletin, September 5, 1930 (Mountain Home, Arkansas), p.1.

4. "Souvenir Edition Celebrating Dedication of Cotter Bridge," supplement to the Cotter Record, November 14, 1930, p.9.

5. Frances H. Shiras, History of Baxter County (J.W. Daniel and Shiras Bros. Print Shop, n.l., n.d.) p.48.

6. *ibid.*, p.51.

7. *ibid.*

8. Hal W. Hunt, "Structural Steel in Concrete Arch Bridge Rings Provides for Cableway Erection Over White River," unpublished manuscript, 1985, p.1.

9. Baxter Bulletin, September 27, 1929, p.1.

10. Cotter Record, January 11, 1912 and February 29, 1912 (Cotter, Arkansas).

11. "Souvenir Edition" Cotter Record, p.5.

12. Cotter Record, April 22, 1927, p.1.

13. Cotter Record, December 16, 1927, p.1.

14. Cotter Record, February 1, 1929, p.1.

15. Baxter Bulletin, May 4, 1928, p.1.

16. "Souvenir Edition," p.30. Cotter Record.

17. Baxter Bulletin, June 6, 1930, p.1.
18. Baxter Bulletin, November 12, 1926, p.1.
19. Baxter Bulletin, January 21, 1927, p.1.
20. Cotter Record, February 11, 1927, p.1.
21. Arkansas State Highway Commission, Ninth Biennial Report of the Arkansas State Highway Commission, 1929-1930, (Russellville, Arkansas: Russellville Printing Co., 1930), p.17.
22. Cotter Record, February 18, 1927, p.1.
23. Cotter Bulletin, February 11, 1927, p.1.
24. "Act 104," Acts of Arkansas, 1927, pp.282-289.
25. Cotter Record, February 3, 1928, p.1.
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31. Cotter Record, March 23, 1928, p.1.
32. Cotter Record, May 4, 1928, p.1.
33. J.A.L. Waddell, Bridge Engineering (New York: John Wiley & Sons, Inc., 1916) pp. 1138-1139.
34. Cotter Record, May 10, 1929, p.1.
35. Cotter Record, June 7, 1929, p.1.
36. Cotter Record, July 19, 1929, p.1.

37. Cotter Record, August 9, 1929, p.1.
38. Baxter Bulletin, July 26, 1929, p.1.
39. Cotter Record, August 16th, 1929, p.1.
40. Cotter Record, August 23, 1929, p.1.; Baxter Bulletin, August 23, 1929, p.1.
41. Cotter Record, September 20, 1929, p.1.
42. "Job #939, White River Bridge, Cotter, Arkansas," Arkansas Highway and Transportation Department Files (Little Rock, Arkansas).
43. Harold W. Hunt, "Constructing the Cotter Bridge Over White River," The University of Iowa Transit, January 1931, pp. 86-87, 95. Hunt, "Cableway Erection Over White River," 1985.
44. Cotter Record, October 4, 1929, p.1.
45. Cotter Record, October 18, 1929, p.1.
46. Rex Bayless (former Mayor of Cotter), interview with Lola Bennett, project historian, July 6, 1988 (Cotter, Arkansas).
47. Cotter Record, November 1, 1929, p.1.
48. Cotter Record, November 8, 1929, p.1.
49. Baxter Bulletin, September 5, 1930, p.1.
50. Baxter Bulletin, April 4, 1930, p.1.
51. Baxter Bulletin, May 23, 1930, p.1.
52. Baxter Bulletin, July 18, 1930, p.1.
53. Baxter Bulletin, September 5, 1930, p.1.
54. *ibid.*
55. Baxter Bulletin, October 24, 1930, p.1.

56. Baxter Bulletin, October 17, 1930, p.1.
57. "Souvenir Edition," p.2.
58. Baxter Bulletin, October 10, 1930, p.1.
59. Baxter Bulletin, November 7, 1930, p.1.
60. Baxter Bulletin, October 31, 1931, p.1.
61. Baxter Bulletin, October 10, 1930, p.1.
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63. *ibid.*
64. *ibid.*
65. Baxter Bulletin, July 18, 1930, p.1.; August 22, 1930, p.1.
66. Herbert Messick, "The Cotter Bridge," poem, Souvenir Edition, p.1. Cotter Record.
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68. "Bridge No. 702: Memorandum of Agreement," Arkansas Highway and Transportation Department Files (Little Rock, Arkansas).
69. Cotter Record, August 7, 1931, p.1.
70. "Cotter Bridge Designated as National Landmark," Arkansas Highways, Winter 1986, p.16.
71. J.B. Marsh, Patent No. 1,035,026, August 6, 1912.
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73. Carl Condit, American Building Art: 20th Century (New York: Oxford University Press, 1961)

74. Correspondence for the Cotter Bridge was from the Topeka office of the Marsh Engineering Company.

75. Condit.

76. Larry Jochims (Kansas State Historic Preservation Office), Telephone interview with Lola Bennett, project historian, August 30, 1988.

77. "Roderick McKenzie Ruthven," Annals of Arkansas (Little Rock, Arkansas: The Historical Record Association, 1947), p.1727.

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HISTORIC AMERICAN ENGINEERING RECORD

Index to Photographs

Cotter Bridge (R.M. Ruthven Bridge)
Spanning White River on U.S. Highway 62
Cotter
Baxter County
Arkansas

HAER No. AR-15

NOTE: These photographs are Government material and are not subject to copyright. However, the courtesy of a credit line identifying the Historic American Engineering Record and the photographer would be appreciated.

Photographs numbered 1 to 9 were taken by Louise Taft in July 1988.

- AR-15-1 LOOKING NORTHWEST, GENERAL VIEW OF CONCRETE SPANDREL ARCH BRIDGE FROM ROADBED
- AR-15-2 LOOKING SOUTH, DISTANT VIEW OF BRIDGE
- AR-15-3 LOOKING SOUTHEAST, VIEW OF BRIDGE AND SURROUNDINGS
- AR-15-4 LOOKING NORTHEAST, GENERAL VIEW OF BRIDGE
- AR-15-5 VIEW OF CENTER SPAN OF BRIDGE FROM RIVERBED, LOOKING SOUTHWEST
- AR-15-6 VIEW OF CONCRETE RAINBOW ARCH SPAN WHICH CROSSES THE LINE OF THE MISSOURI-PACIFIC RAILROAD, LOOKING NORTHWEST
- AR-15-7 VIEW OF BRIDGE FROM UNDERNEATH SHOWING CONCRETE PIER AND CONCRETE DECK SUPPORT SYSTEM, LOOKING NORTHWEST
- AR-15-8 VIEW UNDERNEATH BRIDGE SHOWING CONCRETE GIRDER CONNECTION AT PIER, LOOKING SOUTHEAST
- AR-15-9 DETAIL VIEW OF DATEPLATES AT NORTHEAST CORNER OF BRIDGE

Photographs numbered 10 to 19 are attributed to Hal Hunt, construction engineer for the Bateman Contracting Company, and were taken during the construction of the Cotter Bridge in 1930.

- AR-15-10 VIEW OF BRIDGE UNDER CONSTRUCTION, SHOWING CENTRAL ARCH AND PIERS, WITH CABLEWAY ABOVE AND TOWER ON BACKGROUND

- AR-15-11 VIEW OF APPROACH SPAN UNDER CONSTRUCTION
- AR-15-12 VIEW, LOOKING NORTH, SHOWING CABLEWAY AND TRAM ABOVE AN ARCH UNDER CONSTRUCTION, WITH RAILROAD BRIDGE IN BACKGROUND
- AR-15-13 VIEW OF ARCH UNDER CONSTRUCTION
- AR-15-14 VIEW OF BRIDGE UNDER CONSTRUCTION, SHOWING STEEL ARCHES IN FOREGROUND
- AR-15-15 VIEW, LOOKING WEST, SHOWING BRIDGE UNDER CONSTRUCTION, WITH APPROACH SPAN IN FOREGROUND
- AR-15-16 VIEW, LOOKING WEST, SHOWING ARCHES UNDER CONSTRUCTION
- AR-15-17 VIEW OF BRIDGE UNDER CONSTRUCTION, TAKEN AT NIGHT
- AR-15-18 VIEW OF BRIDGE UNDER CONSTRUCTION, TAKEN AT NIGHT
- AR-15-19 VIEW, LOOKING NORTH, SHOWING COMPLETED BRIDGE, WITH RAILROAD BRIDGE IN BACKGROUND

The Cotter Bridge.

Well! folks, here's your bridge all ready,
As fine as you'll ever see;
As a structure of use and beauty,
A monument it will be
To the ones who have been its builders.
And the ones who have put it through;
To them the praise and the honor,
The credit is certainly due.

The bridge in its sublime dignity
Bows its head from azure blue
To our efficient Highway Commission,
And the construction engineers too.
To Judge Ruthven and the Governor,
To the contractors and all the rest.
Each one has worked like blazes.
Each tried to do his best.

But friends, let me call your attention
To the men who have done the work;
This rough handed crew of laborers,
Whose hardihood scorned to shirk
The toil and the danger of building
Through days in the broiling hot sun,
Through fog and rain, through sleet and snow,
They worked 'till the task was done.

Ay! don't say 'twas all for the money,
For, though we're a rough looking lot,
We took pride in the bridge we were building;
A great deal of pleasure we got
In doing our dead level best;
And though the hours were hard and long,
We found no time for grumbling,
But lots for cheery song.

My friends, in your celebration,
Drop a tear for the lives that were lost.
And remember the money that built the bridge
Was the very least of the cost;
On it were spent two precious lives
For which no one can repay;
Remember them, and the workman's toil
On your Celebration Day.

Dedicated to those who Built the Cotter Bridge.
—Herbert A. Messick.

UNITED STATES PATENT OFFICE

JAMES B. MARSH, OF DES MOINES, IOWA.

REINFORCED ARCH-BRIDGE.

1,035,026.

Specification of Letters Patent.

Patented Aug. 6, 1912.

Application filed November 1, 1911. Serial No. 658,060.

To all whom it may concern:

Be it known that I, JAMES B. MARSH, a citizen of the United States, residing at Des Moines, in the county of Polk and State of Iowa, have invented certain new and useful Improvements in Reinforced Arch-Bridges, and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to bridges, and more especially to those employing arches; and the object of the same is primarily to construct the bridge of reinforced concrete and in such a manner that the latter may expand and contract under varying conditions of temperature and moisture. This and other objects are carried out by the construction hereinafter more fully described and claimed and as shown in the drawings wherein—

Figure 1 is a side elevation of this bridge complete, with the arch partly in section; Fig. 2 is a central longitudinal sectional view thereof; Fig. 3 is a cross section on the line 3-3 of Fig. 1 showing but one half of the bridge as the other is like this; Figs. 4 and 5 are sectional views on the lines 4-4 and 5-5 respectively of Fig. 3; Fig. 6 is a section on the line 6-6 of Fig. 2, the same being taken on a smaller scale than Figs. 3, 4 and 5; Fig. 7 is a section on the line 7-7 of Fig. 1, and Fig. 8 is a section on the line 8-8 of Fig. 7; Fig. 9 is a section on the line 9-9 of Fig. 1, this view being taken on a smaller scale than Figs. 7 and 8; Figs. 10 and 11 are a side elevation and cross section (on the line 11-11 of Fig. 10) respectively of one of the wear plates; and Figs. 12 and 13 are perspective details thereof which will be referred to hereinafter; Fig. 14 is a plan view showing the lapping of the parapet on the bridge with that on the abutment; Fig. 15 is a side elevation of one of the abutments partly broken away to show it in section, and Fig. 16 is a plan view thereof; Fig. 17 is a longitudinal vertical section on an enlarged scale taken on the line 17-17 of Fig. 15.

Broadly speaking the object of the present invention is, to construct an arch bridge of reinforced concrete in such manner as to permit of a limited amount of expansion and contraction both of the arches and of the floor which are, of course, the longest mem-

bers of the bridge. Broadly speaking, the parts of this structure as shown in the drawings are two abutments (which could be piers) P, a pair of arches A disposed between and springing from said abutments, the floor F carried by and between said arches and reaching from one abutment to the other where it aligns with the approaches, and the parapets or rails R along opposite sides of the floor line. These several parts will now be described.

The abutments P might well be piers between spans of a longer bridge than shown as above suggested, but in the present instance they are illustrated as composed of two side walls 1 which are of concrete surrounding a metallic reinforce composed of horizontal rods *a* and upright rods *b* formed into any suitable type of skeleton framework; braces 2 connecting these walls at suitable points and also of reinforced concrete structure; front or inner cross walls 3 connecting the inner edges of the side walls and rising to about the same height, these front walls also being of reinforced concrete structure and their skeleton frameworks *c* interlocking with those in the side walls; and footings 4 under all these walls, in which footings may be embedded piles 5 as best seen in Fig. 2.

The arches A are by preference two in number, and as they are duplicates of each other I will describe but one. These spring from points 6 within the bases 4 of the abutments P, pass through the front walls 3 and arch or curve over the stream being spanned, their curvature being such as to carry their crowns above the line of the floor F for quite some distance at the center of the bridge, and their distance apart being such as to permit the interposition of a floor F of sufficient width. It is quite possible to build a broader bridge than one with a single drive-way as illustrated in Fig. 9, by utilizing three or perhaps four of such arches, all disposed side by side and in strict parallelism; but the present specification will describe the simplest type of bridge, the understanding being that amplifications could be made without departing from the principle of my invention.

Structural details of the arch itself are shown at the top of Figs. 3 and 4. By preference it comprises two angle irons 8, beneath them two other angle irons 9 which are parallel with the angle irons 8 as to

width but which by preference diverge slightly from them in their upright planes toward the extremities of the arch as seen in Fig. 1, and oblique braces or lattice-work 10 connecting four angle irons at frequent intervals: the rectangular skeleton framework thus produced being embedded in a concrete body 11 of proper consistency, size, configuration and color, and molded therein and thereon by any appropriate means forming no part of the present invention. Riveted to the angle irons 8 and 9 at proper points are plates 12, to which in turn are riveted angle irons 13 and 14 standing in parallelism with each other and connected at intervals by suitable braces 15, and all forming an upright skeleton structure depending from the arch A and constituting with its surrounding and inclosing body 16 of concrete a hanger by means of which the floor F is supported from the arch A. As seen in Fig. 1, for a bridge of the size and shape illustrated there would be about five of such hangers, and the section line of Fig. 3 is taken through the longest which is at the center of the arch. By preference the metallic framework of each hanger consists of two angle irons 13 and two others numbered 14—four in all—and near their lower ends there are plates 17 and 18 riveted outside of the outer irons 14 and inside the inner irons 13, and other plates 19 and 20 at lower points as shown in Fig. 3; and the lower ends of the several irons are firmly connected by oblique braces 21, everything being of course surrounded by the concrete body 16. The upper plates 17 and 18 of each hanger are connected with the similar plates of the hanger opposite by means of cross rods 22, preferably having depressed centers 23 as seen in Fig. 3, and the lower plates 19 and 20 are similarly connected with the corresponding plates on the opposite hanger by lower cross rods 24. At intervals these four cross rods 23 and 24 are caught in the bend of a U-shaped yoke 25 as seen in Fig. 5, the upper extremities of the side arms of said yoke being bent outward as shown at 26 so as to pass over transverse rods 27 which in turn rest upon longitudinal rods 28 that extend throughout the length of the floor. In addition, if desired, other pieces 29 may be disposed as indicated in dotted lines in Fig. 3, and these may be taken as typical of amplifications of the metallic framework which is embedded in and surrounded by a concrete body 30 molded thereupon and therearound in any suitable way as above suggested. In this manner is built up what might be called "ties" crossing the bridge structure and connecting the lower ends of the hangers in pairs. Where the arches cross the floor line occur what might be called "beams" best illustrated in Figs. 7 and 8. Here are side plates

31 connected by cross rods 32 having depressed centers 33, their lower portions connected by a number of cross rods 34 interposed between said depressed centers and passing through the lower portions of the plates 31, and several upper cross rods 35— all making up a skeleton framework which is surrounded by a concrete body 36 molded thereon in the manner above suggested so that the beams integrally connect the arches at these two points.

The railing or parapet R may, of course, have any fanciful design but essentially comprises a hand rail 40 and preferably includes another or mid-rail 41, both in the present instance formed of a concrete body surrounding one or more metallic reinforces, and extending the full length of the bridge. Where these rails pass the hangers, the latter support them as seen in Fig. 6; where they pass the beams (at points where the arches cross the floor line as above described) these rails are supported on upright posts 42 as best seen in Figs. 7 and 9; and at both ends of the arch these rails are connected integrally with end posts 43 which stand above the cross walls 3 of the abutments P, so that that portion of the parapet numbered 44 and built upon the abutment has its own post 45 outside said end post 43 and is entirely separate from that portion which is carried by the bridge proper.

The floor F of this improved bridge comprises a concrete slab or body 50 molded upon and surrounding transverse rods 58 at intervals crossing the series of longitudinal wires 28 which were described above as extending throughout the length of the bridge and which form the skeleton reinforce for this slab, and at both edges of the same are curbs 51 also by preference reinforced by rods 52, the surface of the floor being a filling of earth or any suitable material, 53, lying upon said slab and disposed between the curbs. The latter where they pass the hanger are extended outward and integrally united therewith, or in other words the hanger is shouldered as seen at 54 in Fig. 6 so that it is united integrally with the curb 51; but where the curbs pass the arches above the beams already described, they are free from said arches as indicated in Fig. 7, and in fact the entire slab 50 is free from the beams at these points on the bridge whereas it is molded integral with the ties where it crosses them and the transverse reinforce rods of said ties are connected with the longitudinal rods 28 by means of the yokes 25 as above described. This detail of construction accounts for the numerous cross rods 31 in the beams instead of the two cross rods 24 in the ties, and also for the presence of the upper cross rods 35 in the beams; as the latter must be

self-sustaining between their points of integral connection with the arches A, whereas the ties are integrally connected with and supported by the hangers but are also integrally connected with the floor F and are therefore not necessarily self-sustaining. It will be seen, therefore, that in the type of bridge illustrated the floor F, the ties, the hangers supporting them, and those portions of the arches to which said hangers are connected, all constitute one unitary reinforced concrete structure; the extremities of the floor beyond the endmost hangers project over the beams and between the two arches and rest upon the end walls 3 of the two abutments P, while the arches are disconnected from the floor at these points; and the parapets are integral with the hangers where they pass them, supported on their own posts above the beams, and supported at their extremities on individual posts 43 flush with and rising from the two extremities of the floor F. Hence the arches may expand and contract to allow for changes in temperature and other climatic conditions and the extremities of the floor will slide upon the walls 3 in a manner which will be clear.

Wear plates 60 carried by headed pins 61 are supported beneath the slab 50 of the floor at points over said beam by having said pins molded into the slab as shown in Fig. 7; and these plates rest upon other plates 62, preferably having side flanges 63, and which are supported by the beam in any suitable manner as by rivets or studs 64 molded thereto. Details of these plates are shown on sheet 3 of the drawings, and Figs. 7 and 8 illustrate their use. During the expansion or contraction of the members of this improved bridge on account of climatic changes or the stress of weight upon it, the rise and fall of the arches due to their longitudinal expansion and contraction may cause the beams to move slightly beneath the ends of the floor, and this is accommodated by the disconnection of the beam structure and the slab and the inter-

position of the wear plates just described. On the other hand, the expansion and contraction of the floor F may cause its ends to move over said beams, and this is accommodated in the same manner.

What is claimed as new is:

1. In a bridge, the combination with the abutments, parapets along the side walls thereof, a pair of arches springing from points in the abutments below the upper edges of their walls, and beams integrally connecting said arches at two points between the abutments; of a floor of reinforced concrete whose extremities rest slidably on the front walls of said abutments and whose body overlies said beams, flat wear plates secured respectively to the beams and floor and in slidable contact with each other, posts rising from the edges of said floor, the endmost posts standing inside those on the parapets, and rails connecting the posts on the floor.

2. In a reinforced concrete bridge, the combination with the abutments, a pair of arches integral with and springing from points low in the inner walls of said abutments, and two beams integrally connecting said arches at points adjacent the abutments; of hangers depending from the arches in pairs between said beams, cross ties integrally connecting the lower ends of said hangers in pairs, a floor consisting of a depressed body and raised curbs along its edges, the body formed integral with said ties and slidably mounted on said beams and parapets and the curbs formed integral with said hangers but separate from said arches, flat wear plates secured respectively to said beams and to the floor where it crosses them, and a filling upon the body of the floor between its curbs.

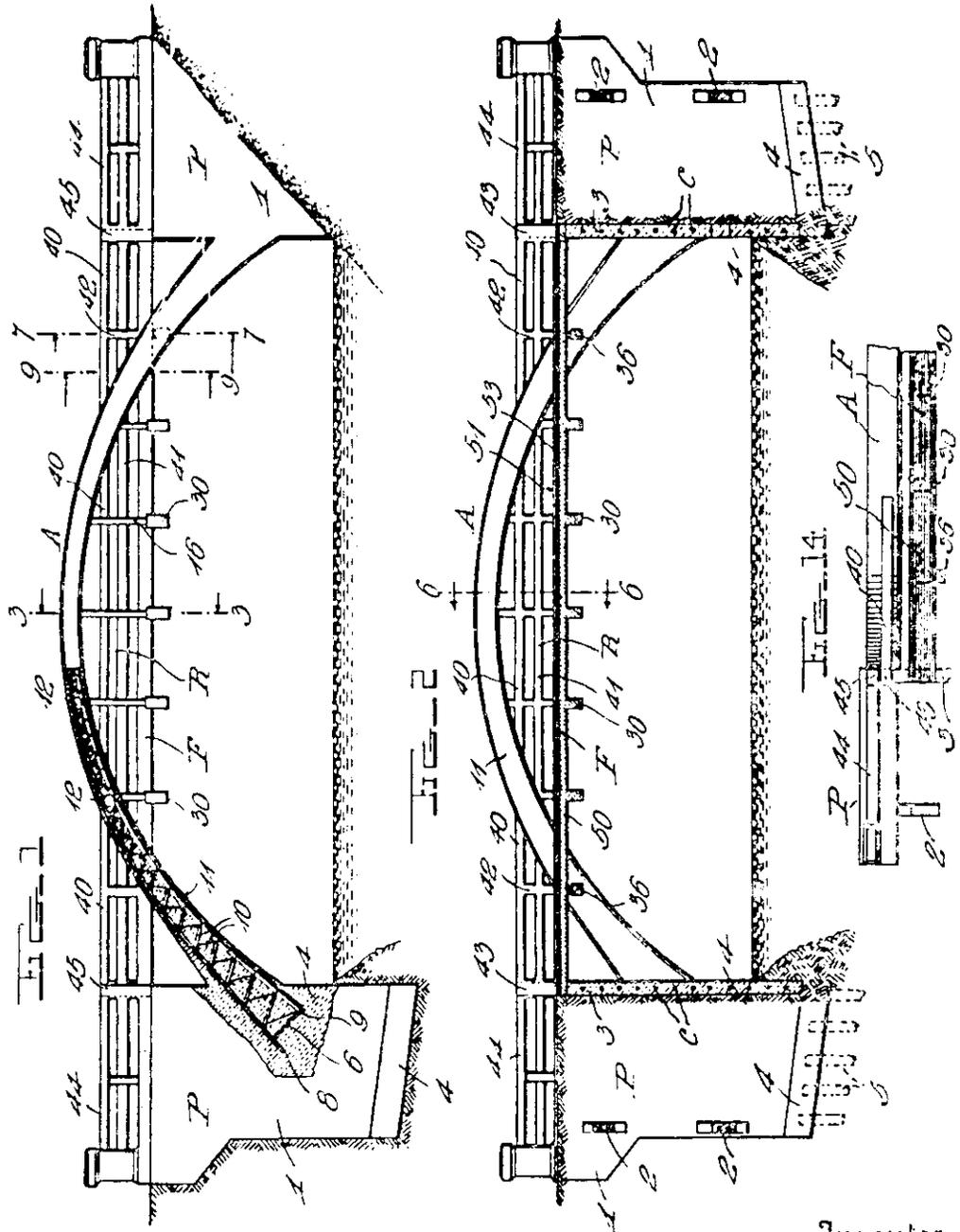
In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

JAMES B. MARSII.

Witnesses:

H. H. FLANAGAN,
N. E. MARSII.

1,035,026.



Witnesses

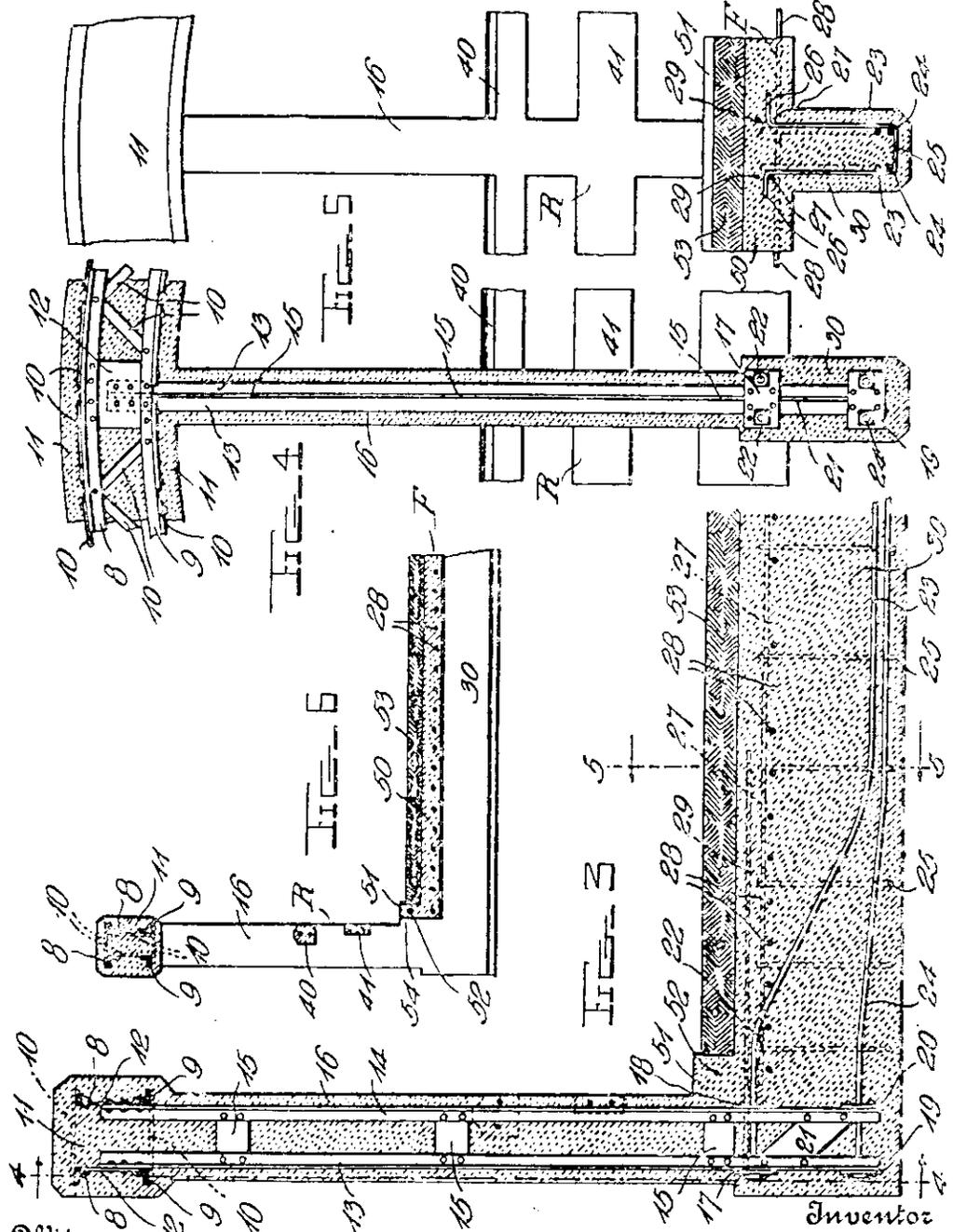
E. ...
M. ...

Inventor

J. B. Marsh

By *A. B. ...*

Attorneys



Witnesses
N. Hollamer

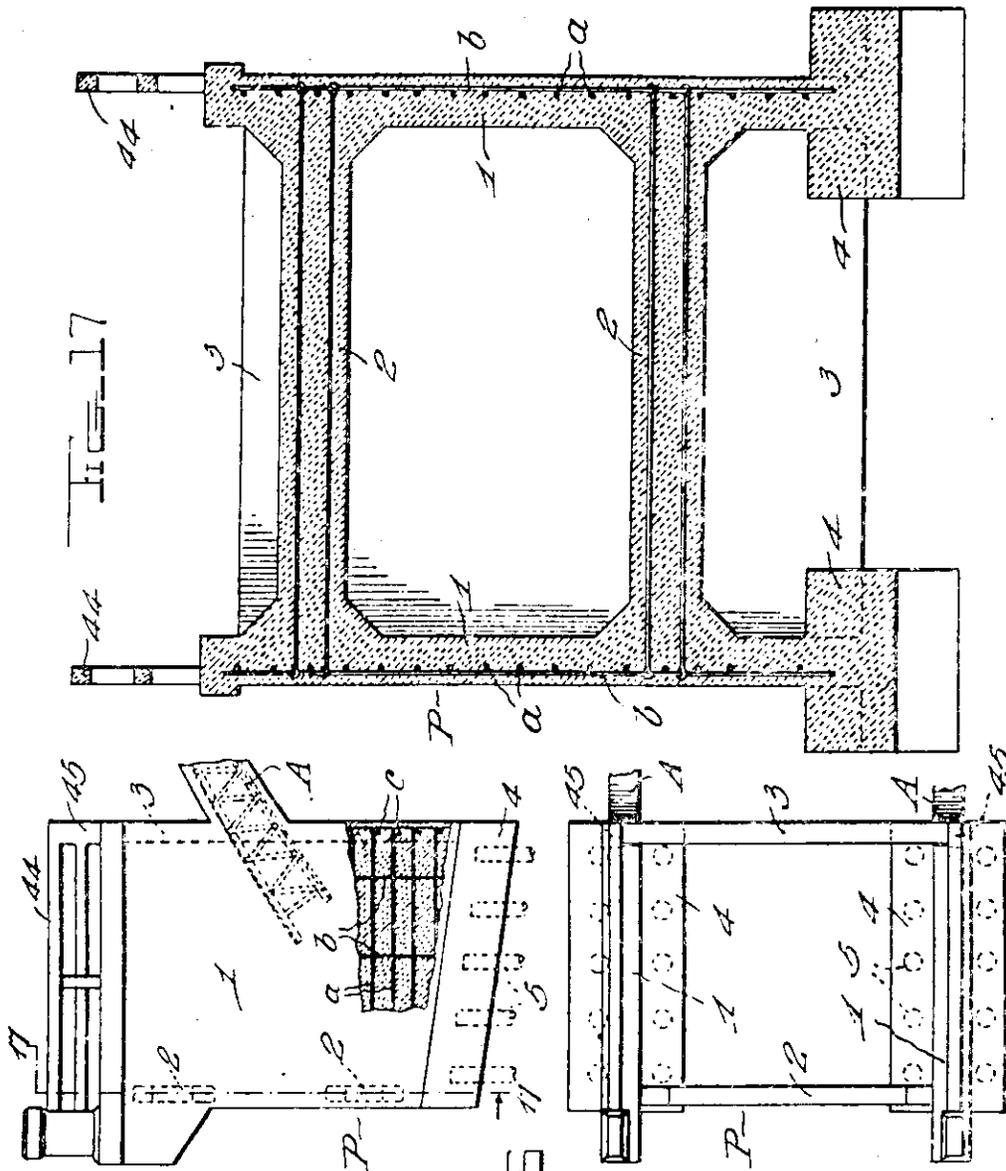
Inventor
J. B. Marsh
By A. Wilson
Attorneys

J. B. MARSH.
 REINFORCED ARCH BRIDGE.
 APPLICATION FILED NOV. 1, 1911.

1,035,026.

Patented Aug. 6, 1912.

4 SHEETS-SHEET 4.



Witnesses:

E. Ellerman

M. Colamer

Inventor:

J. B. Marsh

By *A. B. Wilson & Co.*

Attorneys.

Contract

THIS CONTRACT AND AGREEMENT, Made and entered into this the _____ day of

1929, by and between

Belman Contracting Company Party of the First Part, and
W. B. Alastwood, J. B. Clarke, J. L. Williams,
Sam J. Nelson & Justin Matthews

in their capacity as the State Highway Commission of the State of Arkansas, Party of the Second Part.
WITNESSETH:

That for and in consideration of the payment to be made as hereinafter set forth, the Party of the First Part hereby agrees to furnish all tools, labor, equipment and materials and to build and construct the Marsh Rainbow Arch Bridge, over the White River, with reinforced concrete girder approaches, including a viaduct over the Missouri Pacific Railroad Company tracks, at Cotter, on Highway No. 12, between Marion and Baxter Counties, Arkansas, in exact accordance with the plans and specifications on file in the office of the State Highway Commission at Little Rock, Arkansas, and with the proposal filed with the State Highway Commission on the fifteenth day of August, 1929; and same being attached hereto and made a part hereof as fully as though copied in full herein, under the direct supervision, and to the entire satisfaction of the State Highway Department; subject to the inspection, at all times, and the approval of the Secretary of Agriculture of the United States, and in accordance with the laws of the State of Arkansas, and the rules and regulations of said Secretary of Agriculture made pursuant to the Act of Congress, approved July 11, 1916 (39 Stat. 355) entitled "An Act to Provide That the United States Shall Aid States in the Construction of Rural Post Roads, and for Other Purposes."

It is agreed and understood between the parties hereto that the Party of the First Part agrees to accept, and the Party of the Second Part agrees to pay for the work at the prices stipulated in said proposal, such payment to be in lawful money of the United States, and the payment shall be made at the time, and in the manner set forth in the specifications.

The Party of the First Part agrees, for the consideration above expressed, to begin work within ten days after being ordered to begin work by the Engineer, and to complete the work within three hundred (300) calendar days thereafter. If the Party of the First Part shall fail to complete the work in the time herein specified, he shall pay to the Party of the Second Part, as liquidated damages, ascertained and agreed, and not in the nature of a penalty, the sum of one hundred (\$100) dollars for each day delay, which shall be deducted from the final amount of the estimate made the Contractor.

WITNESS OUR HANDS, this the _____ day of _____ 1929.

Party of the First Part.

By _____
ARKANSAS STATE HIGHWAY COMMISSION,
Party of the Second Part.

By _____

