Liberty Memorial Bridge
Spanning the Missouri River on Interstate 94,
from Bismarck to Mandan
Burleigh County
Morton County
North Dakota

HAER No. ND-7

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
Rocky Mountain Regional Office
National Park Service
U.S. Department of the Interior
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

Liberty Memorial Bridge

HAER No. ND-7

I. INTRODUCTION

Location:	Spanning the Missouri River on Interstate 94, from Bismarck, Burleigh County and Mandan, Mandan County, North Dakota UTM: A 13.360895.5185170 B 13.361500.5185330 Quad: Bismarck, North Dakota
Date of Construction:	1920-1922
Present Owner:	North Dakota State Highway Department State Headquarters Building Bismarck, North Dakota
Present Use:	Vehicular bridge; to be rehabilitated in 1990-1991
Significance:	The Liberty Memorial Bridge is a three-span, Warren-Turner through truss bridge, a variation of the Warren through truss designed by C. A. P. Turner. This was the first highway bridge over the Missouri River constructed in North Dakota. It was also the only Warren-Turner truss bridge to be constructed in North Dakota, or elsewhere. Despite Turner's novel design, this variation of the Warren truss had little impact on American engineering.
Historian:	Nancy Ross Cultural Research Management May 1991

II. HISTORY

A. NEED FOR THE BRIDGE

The Liberty Memorial Bridge, located between Bismarck and Mandan, North Dakota was built between 1920 and 1922 by the American Bridge Company and the Foundation Company of New York. The bridge spans the Missouri River and provides an excellent view of the river as well as the surrounding communities. The bridge structure drops from low remnant uplands on the Bismarck side of the Missouri River to an abandoned bed of the Heart River on the Mandan side.

The Missouri River had a great influence on early settlers and travelers in the Missouri Slope region of North Dakota. The river was the channel of transportation and trade for westward bound home seekers, cattle ranchers, gold miners, and for Indian and government agencies. As the region became more populated, however, the automobile became a primary means of transportation, and the river became a barrier between people and businesses, and to communication.

In the spring and fall, when ice on the Missouri River was either beginning to form or breaking up, the river was impassable and crossing was dangerous. Travel over the ice during the winter was considered relatively safe, and in the summer ferry boats provided transportation across the river. Ferry boats had been used to haul wagons across the Missouri from the beginnings of settlement in North Dakota. As traffic across the river increased, and the age of rapid movement evolved, "people began to chafe at having to cross the Missouri at Mandan and Bismarck on a ferry, inconvenient and uncertain".[1] Travelers of this route were often forced to wait hours in turn for the use of the ferry to cross the river. The need for a vehicular bridge between the two cities was undeniable.

Prior to the building of the Liberty Memorial Bridge between Bismarck and Mandan, North Dakota, there was no vehicular bridge across the Missouri from Great Falls, Montana to Sioux City, Iowa, a distance of 1,389 miles.[2] In I9I2, the American Automobile Association and the U.S. Government Office of Good Roads began laying out a transcontinental highway from New York to Seattle, along what was known as the Red Trail in North Dakota. This northwest trail, passed through Fargo, Bismarck-Mandan, Dickinson, and west into Montana. The trail, blazed and marked with red posts, became known as the National Parks Highway and later U.S. 10. The highway was heavily promoted during World War I due to the restrictions on European travel. The route was used primarily from May to November, and touring this trail became very popular. In I919 it was reported that over ten thousand automobiles from outside the State passed through Bismarck-Mandan and the demands for a bridge which would allow a faster and more convenient method of crossing the river grew persistent.[3]

B. FINANCIAL RESPONSIBILITIES

To meet the urgent demand for a bridge, the North Dakota State Legislature enacted a law in 1919 enabling the state to pay one-third of the cost of bridges crossing navigable streams on state highways. The state initially set aside $225,000 to bridge the Missouri along the border between Burleigh and Morton Counties, but this figure was later increased to over $450,000. The federal government through the U.S. Bureau of Public Roads agreed to pay half of the cost of the Liberty Memorial Bridge, while each county appropriated approximately $I30,000. The bridge at that time was known as Federal Aid Project I00.

After the initial problem of exorbitant cost was overcome, a location for the new bridge was chosen. The bridge was located downstream from the Northern Pacific Railroad Bridge which would serve as a buffer for the new bridge against floating ice and floods. In May 1919, proposals for a preliminary bridge design were opened. The C.A.P. Turner Company of Minneapolis was selected by the North Dakota State Highway Commission and the U.S. Bureau of Public Roads to serve as consulting engineers, providing preliminary surveys, design plans, and specifications for the bridge. By November 1919, Turner had preliminary plans in hand for a three-span steel truss bridge with reinforced-concrete piers, abutments, and approaches. Controversy over Turner's proven flat-slab design for the approaches delayed bidding on the full structure until May 1920, while his innovative design for the superstructure was approved without controversy. At that time, the Foundation Company of New York was awarded the contract for the concrete substructure and approaches at an estimated cost of $622,938. The American Bridge Company received the contract for the fabrication and erection of the metal superstructure with a bid of $461,491.[4] According to the Bismarck Tribune, the awarding of these contracts marked "the first positive step in the realization of dreams ... entertained for more than a quarter century by far-sighted citizens of the Missouri Valley who have been able to appreciate what a retarding influence on the development of the Slope country the barrier offered by the Big Muddy has been."[5]

III. BIOGRAPHICAL MATERIAL

A. C.A.P. TURNER (1869-1955)[6]

After graduating from the civil engineering program of Lehigh University in 1890, Claude Allen Porter (C.A.P.) Turner worked briefly for bridge companies in Delaware, Pennsylvania, Connecticut, and Ohio. In 1897, he moved to Minneapolis to accept a position as assistant engineer with the Gillette-Herzog Manufacturing Company, a prominent bridge-fabricating firm. When Gillette-Herzog was taken over by the American Bridge Company in 1900, Turner declined to relocate to his new employer's regional office in Chicago. Instead, he went into business for himself as a consulting engineer in Minneapolis.[7]

Like other American engineers at the start of the twentieth century, Turner's training and experience had best prepared him for the challenges of steel construction, and his first commission, predictably enough, involved the design of a steel truss bridge. Turner apparently first turned his attention to reinforced concrete in 1904, when he agreed to design a warehouse in Minneapolis. At that time, typical concrete construction used a column-beam-slab configuration patterned after the standard steel structural frame.[8] Turner, however, realized that he could simplify concrete design by reinforcing the floor slab in such a way that it functioned as a continuous beam itself, thereby eliminating the beam member that previously had carried the slab over the column. This innovation significantly decreased the amount of concrete and formwork, while increasing the amount of vertical clearance, an important consideration in a warehouse. Utilized for the fist time in Minneapolis in 1906, Turner's new system of "flat-slab" construction ushered in the modern era of reinforced concrete.[9]

Although flat-slab construction appeared most frequently in factories and warehouses, Turner also successfully employed it in bridge work. By his own reckoning, he was responsible for building approximately two miles of flat-slab viaducts and bridge approaches by 1920. It is therefore not surprising that Turner proposed a flat-slab system for the approaches of the Liberty Memorial Bridge. Measuring 480 feet on the east end of the bridge and 625 feet on the west end, the approaches accounted for almost half the bridge's total length. Although Turner's flat-slab system had been discussed in the national engineering press for 15 years, it was unfamiliar territory for the government engineers assigned by the Bureau of Public Roads to monitor the Liberty Memorial Bridge project. Fearful of approving what they considered to be an untested technology, they insisted that Turner redesign the approaches as conventional column-beam-slab structures, which were about $40,000 more expensive than Turner's original design. Despite the fact that Turner stood to make about $2,000 more in engineering fees because of the revision, he protested the decision to North Dakota Governor Lynn Frazier. Frazier, however, sided with the federal engineers, saying (according to Turner): "'As the Bureau [of Public Roads] represents the government's half share of the cost if they want to spend the extra amount the state would go along with them.'" In the spring of 1920, Turner redesigned the approaches, using the column-beam-slab technique that his own flat-slab system had rendered obsolete 15 years before.[10]

Ironically, Turner's design for the bridge's superstructure was approved without controversy, even though it truly was a novel piece of engineering. Turner liked to refer to the design as a "Turner Type truss," but his contemporaries were more accurate in calling it a "Warren-Turner type."[11] The original Warren truss was invented in England in 1848 by James Warren and Wiloughby Monzani. Its distinguishing characteristic was a triangular outline in which the diagonal members carried both compressive and tensile forces. Although English engineers employed the Warren truss for both short- and long-span bridges, American engineers during the early twentieth century tended to limit its use to highway pony trusses under 100 feet in length. For highway spans between 100 and 250 feet, American engineers generally preferred the through-truss configuration of the Pratt truss, also invented in the mid-nineteenth century. For highway spans exceeding 250 feet, the common choice was a Pratt through-truss variant called the Pennsylvania truss.[12] Turner, therefore, was breaking with conventional American practice when he selected a Warren through-truss design for the three 476-foot spans of the Liberty Memorial Bridge.[13]

Turner's interest in the Warren truss preceded by several years his work on the Liberty Memorial Bridge. As early as 1913, he filed a patent application for a modified Warren truss, which he described simply as a "long span bridge." For unknown reasons, the patent was not granted. While designing the Liberty Memorial Bridge, Turner apparently refined his thinking on the subject. In renewing his patent application in January 1921, he declared that he was submitting a new drawing, which proved to be an illustration of the truss type used in the North Dakota structure. This second attempt was awarded a patent in January 1923.[14]

As was true for his innovations with reinforced concrete, Turner's goal in steel truss design was to reduce the amount of material and labor required for efficient and durable construction. His innovation was basically a method of stiffening a riveted Warren truss by reinforcing its panels with a simple framework of steel struts. On the Liberty Memorial Bridge, Turner placed the reinforcing framework in alternate panels of the trusses, a technique that he considered to be "very economical of material."[15] A stiffer, or more rigid, truss allowed Turner to increase the length of the main truss panels beyond customary practice, taking full advantage of the longest standard steel members available on the market. Longer panels meant that fewer splices were required to join the panels together, and this, in turn, resulted in considerable savings in material and labor. Turner also believed that his riveted truss design was easier to erect than the conventional pin-connected Pennsylvania truss that was generally used for long-span bridges. As he explained upon the completion of the Liberty Memorial Bridge in 1922:

> In erection this form of truss proved fully as advantageous as in its design effect. At the very first, the erection men, being not used to the work, "cussed" the design; but very quickly they got the hang of putting the work together, making phenomenal speed even on the first span. The long members and few joints brought rapid progress. . . . The general opinion of the erecting men seemed to be that the triangular type of truss could be erected 1 ½ times as rapidly as an ordinary pin-connected span, and with far greater safety to the men putting it up.[16]

Despite Turner's claims for his design, the Warren-Turner truss had little impact on American engineering. Turner's work with reinforced concrete designs, such as the flat-slab technique, proved to be far more influential. The Liberty Memorial Bridge remained the only example of the Warren-Turner truss, even in North Dakota. When state highway authorities built two more bridges over the Missouri River at Williston and Sanish in 1927, they selected conventional pin-connected Pennsylvania trusses for both structures.[17] Turner continued to tinker with the Warren truss into the early 1950s, but by that time most American engineers no longer looked to new truss designs for breakthroughs in bridge engineering. Instead, they turned their attention to new construction techniques, such as welding, and to new materials, such as pre-stressed concrete.[18]

B. THE FOUNDATION COMPANY

The Foundation Company of New York was organized in 1902 as an engineering and construction firm that specialized in designing and building "difficult" substructures. By 1925, the company had completed nearly 2,000 contracts amounting to more than 280 million dollars.[19]

The company began work on the Liberty Memorial Bridge project on 28 June 1920, when superintendent C. W. Cubbage led his team of pier workers onto the job site.[20] In addition to building two river piers and two shore piers, the company was responsible for the construction of 30 approach spans. Construction of the piers was expensive because the riverbed, composed of silt, was constantly shifting and the clay layer, in which the foundations had to be driven, was deep-seated. The openings between the piers were designed to be 481 feet from center to center, 70 feet wider than the openings of the Northern Pacific Railroad Bridge slightly upstream. In that way, floating ice that passed through the railroad bridge would easily pass through the new highway bridge.

The placing of the river piers followed the "open dredge method" in which an open steel caisson was sunk by excavating its interior. As the bridge's engineer C.A.P. Turner explained:

> The foundations were sunk by the open dridge [sic.] method, using a steel skeleton with steel cutting edge filled with concrete for the bases. The diameter of these bases for the shore piers was twenty feet, while the dimensions of those for the two river piers was 23 by 60 feet, the later [sic.] having three dredging pockets. As the material was dredged from the interior and the pier pre-cast base or shell was sunk, additional concrete was built on top and the operation proceeded until the West [pier was] down over 85 feet below low water, the second river pier about 78 feet and the other two at a lesser depth.[21]

Since much of the concrete was laid in sub-zero weather, the work crews took considerable care to keep the pours from freezing, which would weaken the piers. Their method was "to assemble the sand and gravel in perforated troughs into which live steam was injected. A 1-2-4 mix was used with hot water and the hot plastic concrete was then hauled to the piers in small hopper cars, pulled by Plymouth gasoline locomotives . . . . At night heavy tarpaulin was thrown over the fresh concrete and steam injected beneath."[22] The work progressed day and night with a construction crew of over 200 employees.

The bridge approaches were made of reinforced concrete set in a column-beam-slab manner on pile foundations, with hand-rails made of Hebron, North Dakota brick. The west approach to the bridge was built with 17 spans, approximately 625 feet long, and with a 5.5 degree curve. The east approach was constructed with I3 spans, approximately 469 feet long with a 9.5 degree curve. The curved approaches gave the entire structure an "S" shape.

Construction of the bridge did not proceed without problems. Three times the trestle used to build the bridge was washed out with breakup of ice on the river, and each time it had to be replaced. The first time the trestle was swept away, 28 November 1920, it was feared that the partially completed west pier would go as well. The pier was saved, but the repairs were costly and caused serious delays.

C. AMERICAN BRIDGE COMPANY

The superstructure of the bridge was built by the American Bridge Company. Established in 1900, the Company eventually incorporated twenty-eight bridge building companies across the country. The Company boasted of having "influenced the skyline of every city of any size in the United States," building all types of steel structures particularly bridges and buildings.

IV. THE BRIDGE

A. DESCRIPTION

The Liberty Memorial Bridge consists of three, identical, 476-foot-long, steel truss spans with a concrete substructure and concrete approaches. In terms of structural type, the steel spans are a modified form of riveted, Warren through truss with sub-divided panels and a polygonal top chord. Because this variation of the Warren truss was the work of Minneapolis engineer C.A.P.

Turner, it is known as a Warren-Turner truss. The primary modification is the reinforcing of alternate panels with a framework of steel struts. Intended to increase the overall rigidity of the truss web, the modification gives the trusses a distinctive appearance that differs considerably from the conventional Warren profile. In spite of the advantages of this novel variant of the Warren truss, the Liberty Memorial Bridge is the only example of the application of this design.

The first of the three truss spans was put in place during October 1921. The number of spans was reported to have been fixed by the number of spans (three) in the existing Northern Pacific Railroad Bridge located one-half mile upstream. The Fargo Forum indicated that 2,800 tons of steel would be used in the bridge with an additional 475 tons of concrete. The steel was reportedly "swung" into place by a crew of about 55 men. An article written by C.A.P. Turner noted that the second (middle) span was erected in record setting time for a bridge of its size, two and two-thirds days.

The structure was designed to be strong enough to carry four 25-ton trucks as a concentrated load with the stringers spaced closely enough to support an interurban trolley system (although it was never utilized). I-beams and channel beams were stamped "Illinois" which indicates the metal was fabricated at South Chicago.[23] The bridge required 80,000 rivets and was built to accommodate two lanes of traffic. The 30 foot roadway included two four-foot sidewalks and had a vertical clearance of 18 feet 9 inches. The original deck was composed of reinforced concrete with a one and one-half inch layer of bituminous asphalt on the wearing surface. The total length of the bridge including the approaches was 2,548 feet, just short of one-half mile.

The structure required a year and a half to construct and was opened for traffic in August 1922. Total cost of this bridge, the longest in North Dakota, was approximately $1,375,000. On the 18th of September 1922, the 50th anniversary of the founding of Bismarck, the bridge was formally dedicated with over 12,000 people in attendance. The bridge was christened the Liberty Memorial Bridge in honor of the North Dakota World War 1 soldiers. Two plaques bearing the names of the members of the State Highway Commission, and the Boards of County Commissioners of Burleigh and Morton counties were placed on the bridge. In a speech delivered by Governor R.A. Nestos, Chairman of the State Highway Commission he stated that the bridge was "one of the most important milestones in the progress of building this part of the commonwealth."[24]

In honor of the opening of the Liberty Memorial Bridge, a three-day gala was held in Bismarck and Mandan with parades, dances, and a pageant produced by the Thurston Management Company of Minneapolis. The theme of the celebration centered around the history of the occupation and development of the region. Thousands of people attended the celebration from around the state and the Northwest.

The Bismarck Association of Commerce observed that, in addition to allowing faster and greater convenience of travel, the bridge opened a new avenue to livestock and agriculture in the western part of the state. The bridge also encouraged travel across North Dakota on the National Parks Highway. For the first time it was possible to travel from coast to coast without having to cross a river by ferry. A 1924 traffic census counted over 3,000 cars crossing the bridge in one day with a daily average of over 2,200.[25]

The <u>North Dakota Good Roads Magazine</u> in 1922 wrote of the Liberty Memorial Bridge:

> While the ordinary bridge is a structure of scarcely more than local importance and while the dedication exercises held September 18-19-20 for the Missouri River highway bridge between Bismarck and Mandan were of special interest to these two cities, nevertheless this structure itself has not only state importance but also national prominence. As a state proposition this bridge does far more than connect the 'twin cities' of North Dakota. It opens up the southeastern corner to the rest of the state and provides the Slope country with an avenue of highway egress...now except for an unusual snow blockade or an extraordinary flood or high-water, traffic between the two cities will always be possible. In other words, the Missouri River will now be as though wiped out.[26]

On July 3, 1924, the North Dakota Chapter of American War Mothers placed bronze memorials set in large boulders at each end of the bridge to honor those soldiers who lost their lives in World War 1. A crowd of over 200 people assembled at the bridge to attend the unveiling of the memorials. The east side memorial reads "1917-1919 In honor of our Sons and Daughters who offered their lives to their country in the World War." The west side memorial reads "1917-1919 In honor of our Sons and Daughters who gave their lives to their country in the World War that Liberty might live."

B. MODIFICATIONS

Several modifications have been made to the bridge since its completion nearly 70 years ago. The most significant was the 1955 replacement of the concrete deck by a steel grid floor in the truss portion of the bridge. The new floor would reportedly require less maintenance and would help curb problems of ice and snow. The John F. Beasley Company of Chicago was the prime contractor and the Addison Hedberg Company of Parshall, North Dakota made the installation. The new floor cost $248,000 and weighed more than 350 tons.[27] The original brick handrail and the original streetlights on the approaches were removed at an unknown date. Both the east and west approaches have been altered to improve traffic flow and cut down on the number of accidents. In spite of these modifications and minor problems of rust, corrosion, pigeons and collision damage, the Liberty Memorial Bridge continues to link the east and west parts of North Dakota, standing as a tribute to those citizens whose combined effort made it possible.

V. ENDNOTES

1. Mandan Daily Pioneer, 13 September 1922.

2. The Bismarck Tribune, 11 July 1923, 15.

3. Walter E. Spokesfield, The History of Wells County and Its Pioneers (Valley City, N.D.: Daily Times Record, 1928), 623.

4. W.H. Robinson, "The Missouri River Bridge in North Dakota," Good Roads 62 (May 10, 1922): 261-265.

5. Bismarck Tribune, 15 March 1920.

6. This section on C.A.P. Turner was written with the assistance of Jeffrey A. Hess, who presented a paper on Turner's concrete work at the Annual Meeting of the Society for Industrial Archeology in St. Paul, 1983. Hess has also participated in state-wide surveys of historic bridges in Minnesota, Wisconsin, North Dakota, South Dakota, Iowa, and Nebraska.

7. Who Was Who in America, vol. 3 (Chicago: The A. N. Marquis Company, 1960, 865; C.A.P. Turner, A Research in Natural Phenomena (Columbus, Ohio: C.A.P. Turner, 1951), 6.

8. "Reinforced Concrete Warehouse for Northwest Knitting Co., Minneapolis, Minn.," Engineering News 53 (June 8, 1905): 593-596; Henry T. Eddy and

C.A.P. Turner, Concrete-Steel Construction, Part 1 (Minneapolis: n. p., 1919), 29-30.

9. C.A.P. Turner, "Building Departments and Reinforced Concrete Construction," Engineering News 56 (October 4, 1906): 361-362; Carl Condit, American Building (Chicago and London: University of Chicago Press, 1982), 242-243; Henry J. Cowan, Science and Building (New York: John Wiley and Sons, 197B), 82-82.

10. Turner, Research in Natural Phenomena, 17; Robinson, 263.

11. Turner, Elasticity and Strength of Materials Used in Engineering Construction, Section 1 (Minneapolis: n.p.), n.p.; Robinson, 261.

12. In a "through-truss" span, the truss webs on opposite sides of the roadway are connected by overhead bracing. In a "pony-truss" span, the webs are not connected by overhead bracing. For an excellent discussion of truss design, see T. Allen Comp and Donald Jackson, Bridge Truss Types: A Guide to Dating and Identifying (Nashville: American Association for State and Local History, Technical Leaflet 95, 1977). On the popularity of the Pennsylvania truss (also called a Petit truss) for long-span structures, see Mansfield Merriman and Henry S. Jacoby, A Text-Book on Roofs and Bridges, Part 1 (New York: John Wiley and Sons, 1909), 238; C.B. McCullough, Economics of Highway Bridge Types (Chicago: Gillette Publishing Company, 1929), 94.

13. The rarity of long-span Warren trusses was confirmed by author's interviews with historian Jeffrey A. Hess of Minneapolis and architectural historian Clayton Fraser of Loveland, Colorado; October 15, 1991. Between the two of them, Hess and Fraser have conducted state-wide surveys of historic bridges in 11 Midwestern and Western states.

14. Claude A. P. Turner, "Long Span Bridge," Patent No. 1,441,387, application filed 10 July 1913, renewed 21 January 1921; approved 9 January 1923.

15. Turner, Patent No. 1,441,387.

16. C.A.P. Turner, "Open-Well Piers and Subdivided Warren Trusses of Bismarck-Mandan Bridge," Engineering News-Record 88 (February 2, 1922): 180-181. See also Turner, "Bismarck-Mandan Bridge Over the Missouri River," North Dakota Good Roads Magazine 2 (August 15, 1922): 13-14.

17. Clifford Johnson, "Missouri River Highway Bridges in North Dakota," Engineering News-Record 99 (September 15, 1927): 426-428.

18. For Turner's continued interest in the Warren truss, see Turner, A Research in Natural Phenomena, 502-503. On the importance of welding and pre-stressed concrete in American bridge engineering after World War II, see Jeffrey A. Hess, "Benton Street Bridge," pp. 9-11, unpublished report prepared for the Historic American Engineering Record, HAER No. IA-30, 1989, in Library of Congress.

19. "The Foundation Company, New York: Engineering and Construction Since 1902, " unpublished brochure, n.d., in Smithsonian Institution, Washington, D.C.

20. "Bridging the 'Big Muddy' at Bismarck-Mandan," North Dakota Good Roads Magazine 1 (January 1922): 29-30.

21. Turner, "Bismarck-Mandan Bridge," 13.

22. "Bridging the 'Big Muddy' at Bismarck-Mandan," 29.

23. Fredric L. Quivik, Historic Bridges in Montana (Washington D.C.: U.S.

Department of the Interior, National Park Service, Historic American Engineering Record, 19B2), 15.

24. North Dakota Good Roads Magazine, 15 August 1922, p. 9.

25. North Dakota Highway Bulletin, December 1925, p. 14.

26. North Dakota Good Roads Magazine, 15 August 1922, p. 18.

27. The Bismarck Capital, 11 January 1955, p. 1.

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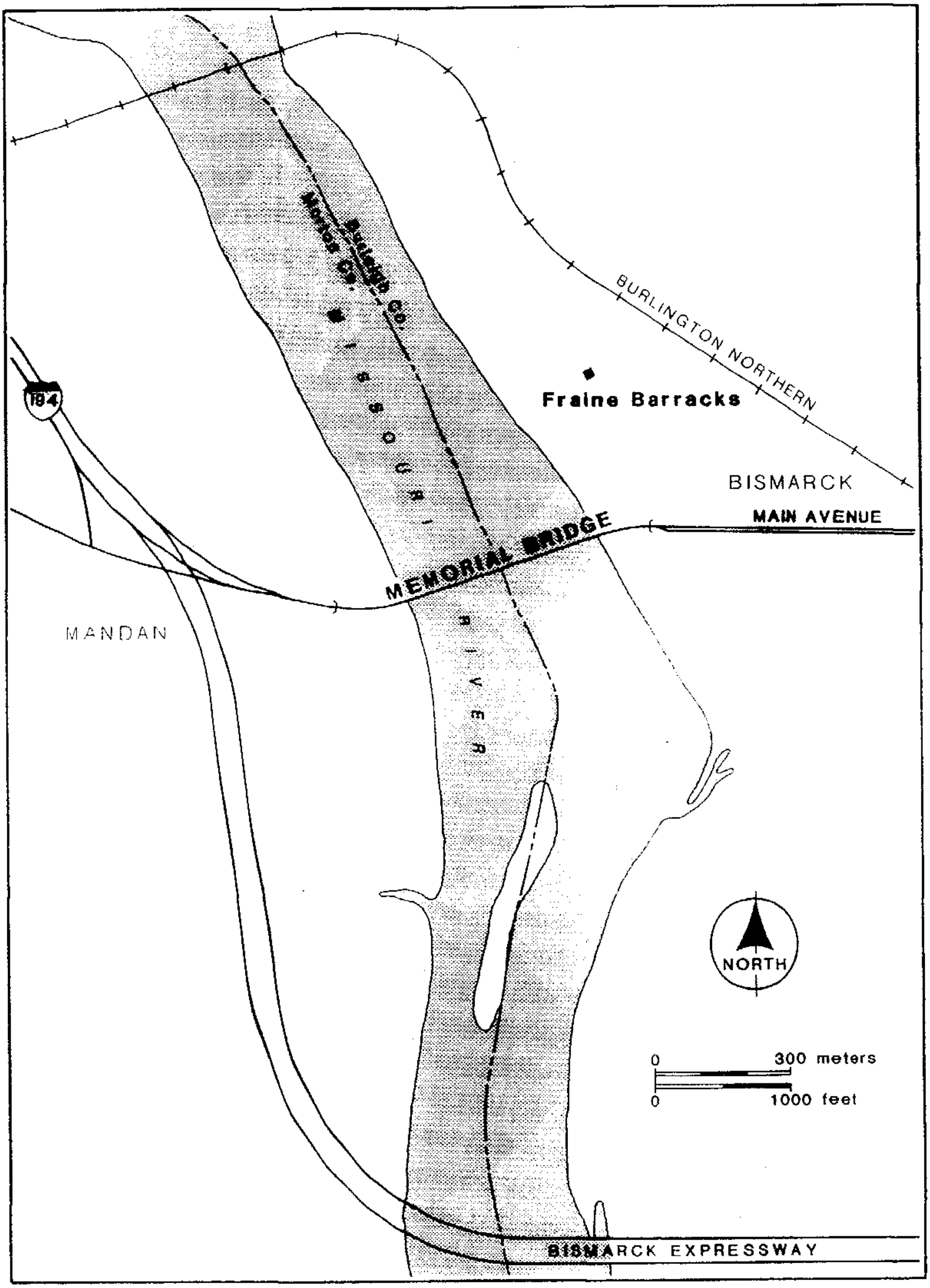
Sketch Map of Bridge Location in Relation to Major Transportation Routes



[Turner, Claude A.P., "Long-Span Bridge," Jan. 9, 1923, assignment of patent № 1,441,387 to T. Wegener, patent originally filed July 10, 1913, № 778,278]

Patented Jan. 9, 1923. **1,441,387**

UNITED STATES PATENT OFFICE.

CLAUDE A. P. TURNER, OF MINNEAPOLIS, MINNESOTA, ASSIGNOR TO T. WEGENER, OF COLUMBUS, OHIO.

LONG-SPAN BRIDGE.

Application filed July 10, 1913, Serial No. 778,278. Renewed January 21, 1921. Serial No. 439,058.

To all whom it may concern:

Be it known that I, CLAUDE A. P. TURNER, of Minneapolis, in the county of Hennepin and in the State of Minnesota, have invented a certain new and useful Improvement in Long-Span Bridges, and do hereby declare that the following is a full, clear, and exact description thereof.

My invention relates to bridge trusses, and generally stated has for its object economy of material, and the production of a structure of great stiffness. This application is filed as a renewal of application No. 778,278, filed July 10, 1913, allowed Dec. 8, 1919, and also to embrace a different embodiment of my invention from that illustrated in the drawings of my aforesaid application.

In the drawings—

Fig. 1 is a side elevation of a truss embodying my invention, the illustration being diagrammatic, for the truss shown is for a span of 480 feet;

Fig. 2 is a top plan view thereof, also diagrammatic, the floor plan appearing at the left and the top chord plan and bracing at the right;

Fig. 3 is a detail view in side elevation, showing the members of the cantilever frame extending between the top chord and the webbing.

Fig. 4 is a view like Fig. 1 of another embodiment of my invention.

Referring to the drawings, the truss shown comprises a top chord 10 and a bottom chord 11, and Warren type webbing consisting of the diagonal members 12 and the sub-verticals 13 the panel points of the two chords being located so that the bottom chord panels 1—2; 2—3; etc., are half as long as the top chord panels A—B; B—C; etc. In the truss shown in the drawings, which as I have stated is for a span of 480 feet, the top chord panels are 80 feet and the bottom chord panels are 40 feet, from which dimensions an idea of the magnitude of the structure can be obtained.

At each side of each top chord panel point, a strut 14 extends between the top chord and a diagonal member 12, inclining upward and outward from the latter and between the lower ends of the two struts 14 a horizontal strut 15 extends, these various parts being riveted together, as shown, so that it will be seen a frame work is provided that extends around the top chord panel point, or the apex, as a center, by which the length of the top chord section between adjacent panel points is divided and the weight thereof supported so that excessive bending stress is avoided. In the case shown in Figs. 1 to 3 in the drawings the top chord sections are supported by the inclined struts 14 at a point 20 feet from the panel point. The frame work formed by the struts 14 and 15 is indicated diagrammatically in Fig. 1 by the lines *d*, *e*, *f* and *g*.

It will be observed that each of the struts 14 and 15 acts in compression, the struts 14 being in a sense cantilever arms and the intermediate strut 15 sustaining the thrust of the arms.

It will be seen that as the struts 14 (corresponding to the members *d*, *e* and *f* and *g* of Fig. 1) are comparatively short, secondary stresses in the top chord sections due to stress in the diagonal members 13 of the webbing stretching or elongating said diagonal members, are largely eliminated.

To stiffen the diagonal web members 12 I connect them above each lower chord panel point by a horizontal brace, or tie 16 which opposes the tendency of said diagonal members to bow outwards under load. The braces 16, it will be noted, alternate with the struts 15 of the cantilever frame and each, it will be noted, is joined to the web member at a point that is a fraction of their height or the distance from chord to chord, which preferably is about a quarter thereof.

The floor plan, as shown at the left of Fig. 2, includes floor beams 17, laterals 18 and stringers 19, and the top chord bracing, as shown at the right of Fig. 2, consists of laterals 20.

The cantilever framework acts the same way, whether the apex of the truss is one of a single span, or one supported at its ends, or a draw bridge truss. The weight is supported by the members of the frame work by cantilever action by the balancing of the loads, or if there is any difference in the loads, that is taken up by flexure in all the members meeting at the apex.

Referring to what is shown in Fig. 4 which illustrates a design for a Span 470 feet centers, the struts, 140, corresponding with the inclined struts, 14 of Fig. 1 extend from a point on the top chord. 100 midway between the panel points and to the

[Turner, Claude A.P., "Long-Span Bridge," Jan. 9, 1923, assignment of patent № 1,441,387 to T. Wegener, patent originally filed July 10, 1913, № 778,278]

diagonal, 120, of the webbing at a point substantially midlength thereof where they are joined to the strut, 150, corresponding to the strut, 15, of Fig. 1; and the framework thus formed by said struts is applied only to alternate panels. The arrangement illustrated in Fig. 4 works out very economically of material in practice.

By my invention a truss as provided that uses a minimum of material, it has great stiffness and it eliminates, or greatly reduces secondary stresses.

Having thus described my invention what I claim is—

1. In a bridge truss, the combination of top and bottom chords, webbing connecting the two chords that comprises diagonal members that meet in an apex at the top chord, and a frame comprising struts constituting compression members which extend from points on the top chord on opposite sides of said apex downward to said diagonal members and supporting respectively the portions of the top chord to which they extend which lies between the supported extremities of said portions of the top chord, said frame including a compression member extending between said diagonal members at the points where the lower ends of said top chord engaging members join said diagonal members.

2. In a bridge truss, the combination of top and bottom chords, webbing connecting the two chords that comprises diagonal members that meet in an apex at the top chord, and a frame at alternate panels comprising struts constituting compression members which extend from points on the top chord on opposite sides of said apex downward to said diagonal members and supporting respectively the portion of the top chord to which they extend which lies between the supported extremities of said portion of the top chord, said frame including a compression member extending between said diagonal members at the points where the lower ends of said top chord-engaging members join said diagonal members.

In testimony that I claim the foregoing I have hereunto set my hand.

CLAUDE A. P. TURNER.

Witnesses:

CHAS. J. WILLIAMSON,
A. T. HAYES.

[Turner, Claude A.P., "Long-Span Bridge," Jan. 9, 1923, assignment of patent № 1,441,387 to T. Wegener, patent originally filed July 10, 1913, № 778,278]

Jan. 9, 1923. 1,441,387.

C. A. P. TURNER.

LONG SPAN BRIDGE.

ORIGINAL FILED JULY 10, 1913. 3 SHEETS SHEET 1

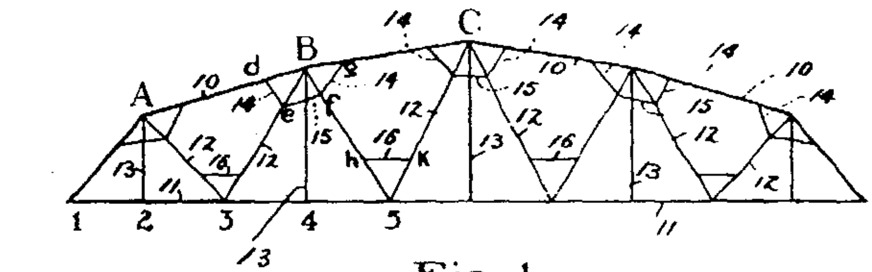


Fig. 1

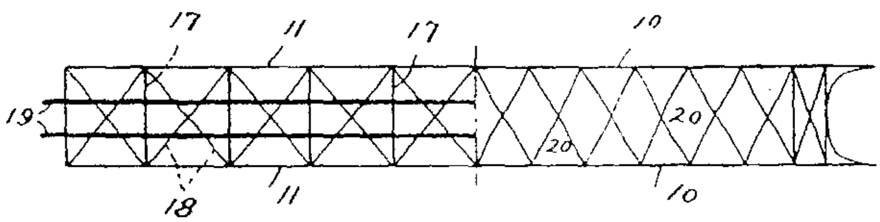


Fig. 2

WITNESSES: J. J. Hurley
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INVENTOR.

BY Chas. J. Williamson
ATTORNEY

[Turner, Claude A.P., "Long-Span Bridge," Jan. 9, 1923, assignment of patent № 1,441,387 to T. Wegener, patent originally filed July 10, 1913, № 778,278]

Jan. 9, 1923. 1,441,387.

C. A. P. TURNER.

LONG SPAN BRIDGE.

ORIGINAL FILED JULY 10, 1913. 3 SHEETS—SHEET 2

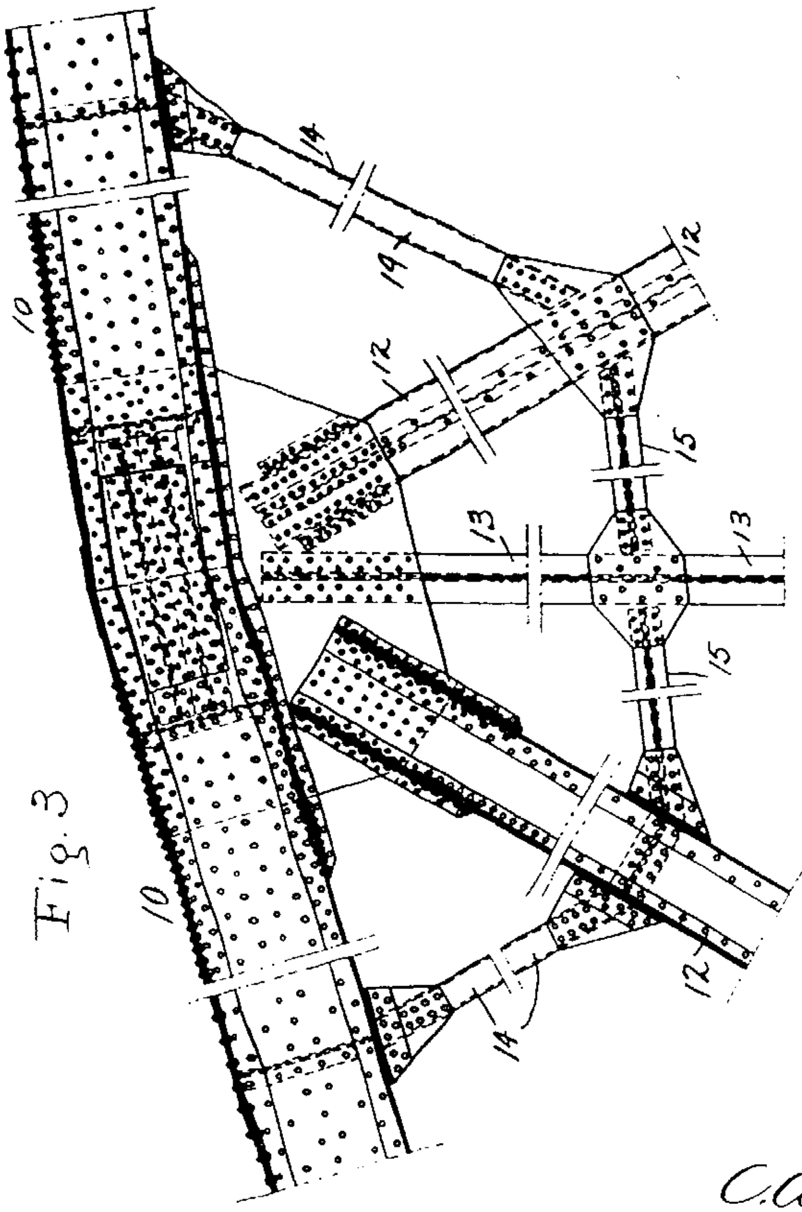

Fig. 3

WITNESSES:
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C. F. Sternberg

C. A. P. Turner
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BY Chas. F. McIlhaney
ATTORNEYS.

[Turner, Claude A.P., "Long-Span Bridge," Jan. 9, 1923, assignment of patent № 1,441,387 to T. Wegener, patent originally filed July 10, 1913, № 778,278]

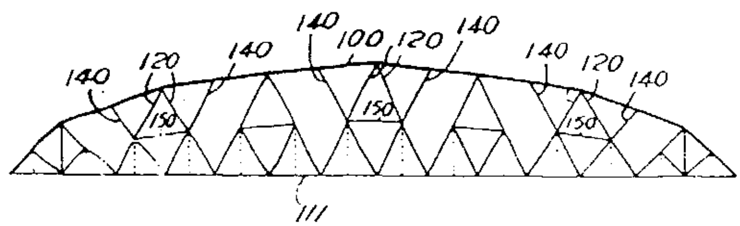
Jan. 9, 1923. 1,441,387.

C. A. P. TURNER.

LONG SPAN BRIDGE.

ORIGINAL FILED JULY 10, 1913. 3 SHEETS—SHEET 3

Fig. 4.



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