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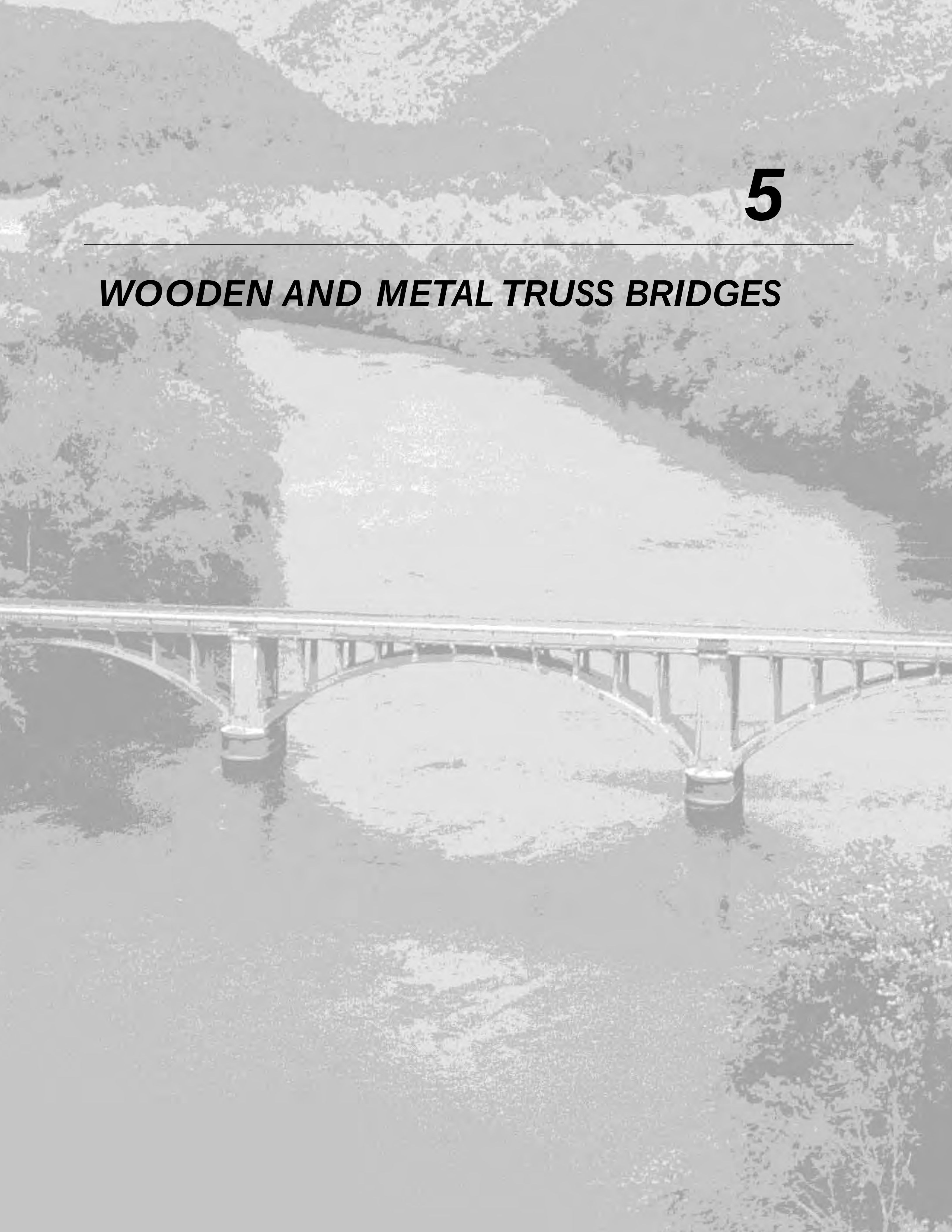
WOODEN AND METAL TRUSS BRIDGES



Marion Memorial Bridge: This historic postcard view shows the Marion Memorial Bridge (#129, 58-SR002-21.19), a high steel truss bridge that spans the Tennessee River near Jasper in Marion County. Erected by the state in the late 1920s, the bridge replaced a ferry. Until completion of the interstate, this bridge served as a vital link in interstate traffic along U.S. 41 (Author's Collection).

WOODEN AND METAL TRUSS BRIDGES

When most people reflect on "historic bridges," they most often envision covered wooden truss bridges. With its picturesque design, the wooden truss bridge has a near universal appeal. For many years, travelogues and historians alike have documented them and promoted their preservation, more than any other bridge type.

What is a truss bridge? A truss is a series of individual members, acting in tension or compression and performing together as a unit. On truss bridges, a tension member is subject to forces that pull outward at its ends. Even on a "wooden" truss bridge, these members are often individual metal pieces such as bars or rods. Compressive forces, which push or compress together, are heavier. The individual members form a triangular pattern. Bridge historian Eric DeLony describes a truss bridge in this manner:

> A truss is simply an interconnected framework of beams that holds something up. The beams are usually arranged in a repeated triangular pattern, since a triangle cannot be distorted by stress. In a truss bridge two long, usually straight members, known as chords, form the top and bottom; they are connected by a web of vertical posts and diagonals. The bridge is supported at the ends by abutments and sometimes in the middle by piers. A properly designed and built truss will distribute stresses throughout its structure, allowing the bridge to safely support its own weight, the weight of vehicles crossing it, and wind loads. The truss does not support the roadway from above, like a suspension bridge, or from below, like an arch bridge; rather, it makes the roadway stiffer and stronger, helping it hold together against the various loads it encounters (DeLony 1994:10).

The pattern formed by the members combined with the stress distribution (tension and compression) creates a specific truss type, such as a Warren or Pratt. Most truss types bear the name of the person who developed the pattern such as the Pratt truss that is named for Caleb and Thomas Pratt who patented it in 1844. For instance, the configuration of a Pratt and Howe truss appears identical (a series of rectangles with X's), but a Howe's diagonals are in compression and the verticals in tension. In a Pratt, the reverse is true.

In theory, a truss bridge contained no redundant members. Builders considered each member or element essential to the functioning of the truss, although some were more important than others. While most trusses could sustain considerable damage and lose the supports of some members without collapsing, severe traffic damage to a member could result in the collapse of the bridge.

For centuries, builders used timber as a construction material for trusses, possibly even for truss bridges. However, it was not until 1570 that Andrea Palladio published *Four Books on Architecture*, the first written documentation concerning wooden truss bridges (Hayden

1976:51). Palladio, the first to promote the use of wooden trusses for bridge design, described several wooden trusses including the basic Kingpost and Queenpost designs. However, builders in Europe did not extensively erect wooden truss bridges until the eighteenth century, and then most commonly in heavily wooded countries such as Switzerland.

Beginning in the late 1700s, builders extensively erected wooden truss bridges in the United States, and by the mid-1800s, this country led the world in wooden truss bridge design (Steinman and Watson 1957:114). A combination of factors contributed to this quick rise of the United States in wooden truss design. In the mid-1700s, the United States contained a very limited transportation system, and the Revolutionary War extensively damaged this already inadequate system. By the late 1700s, the recently formed United States needed a much expanded and improved system. Further, while the iron industry did not have widespread influence, timber and men to mill it seemed limitless. Wooden truss bridges, which used short timbers built up in sections, seemed an ideal solution.

In the early nineteenth century, a variety of builders devised various bridge designs that they promoted. (Figure V-01 contains a chart prepared by the Historic American Engineering Record that defines several wooden and metal truss types popular in the nineteenth and twentieth centuries). In a highly competitive and fluid field, every builder tried to devise "the" truss that would be economical, simple to construct, and viable for longer lengths. Out of a large number of builders, Timothy Palmer (1751-1821), Louis Wernwag (1770-1843), and Theodore Burr (1771-1822) led the development of wooden truss bridge construction during its incipiency in the United States (Steinman and Watson 1957:117-120). During this period, builders knew

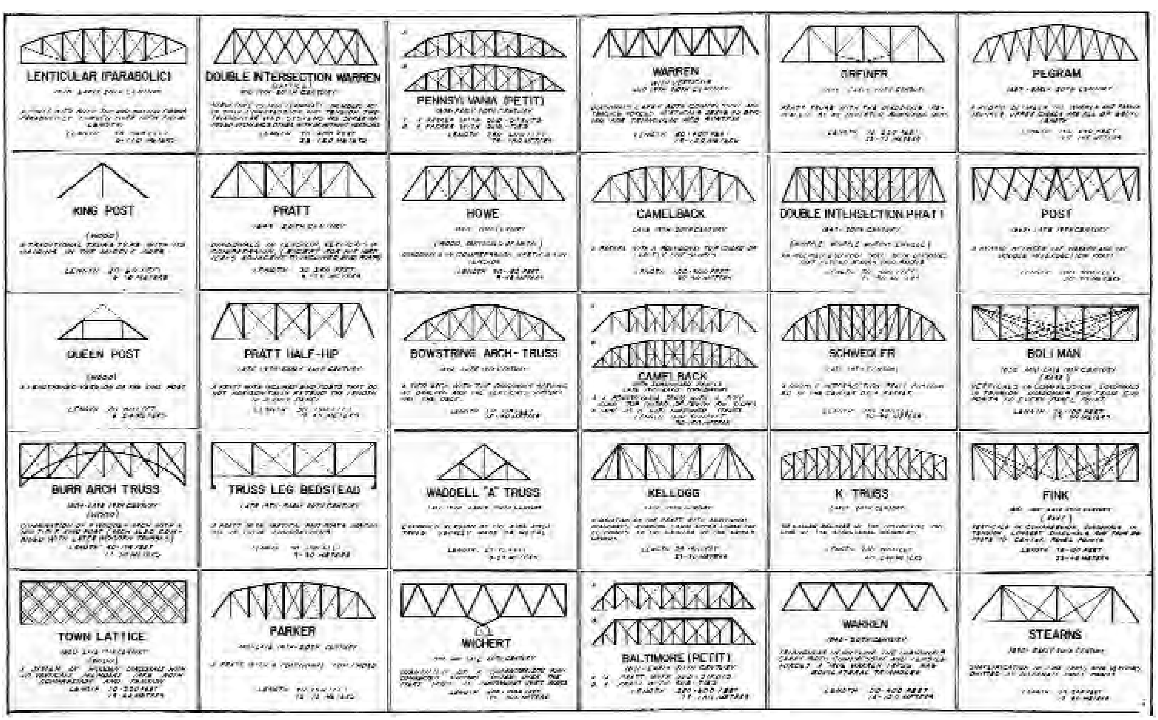


Figure V-0l: Historic American Engineering Record Bridge Chart.

little about the specific mechanics of how truss bridges worked and their exact limitations. Thus, for additional strength and additional length, builders commonly utilized a combination arch and truss design, often called "camelback" or "hump" bridges due to the appearance of an arch (Ortega 1991:2-5). Both Palmer and Wernwag used as their main component an arch supplemented by a truss. In 1806 Burr introduced the first patented bridge system widely used in the United States, a truss supplemented by an arch (DeLony 1994:10). While Burr was the most famous of the three, Palmer also had a lasting and significant impact on wooden truss bridge design.

Contrary to common perceptions, builders did not originally cover wooden truss bridges. Palmer was one of the first builders in the United States to promote covering the wooden truss (the load bearing portion of the bridge) with a barn-like structure as a means to protect the wood comprising the truss from the weatherization process. In some cases, the covering provides lateral bracing, making the entire structure more resistant to wind shear. Yet, the covering primarily existed for protection. Noted engineer Henry Tyrrell stated in 1909 that the normal life span of a covered wooden truss bridge was thirty to forty years while an uncovered bridge might last one-third as long (Tyrrell 1911:121). However, chemical preservatives such as creosote applied to the timber members could also provide protection from the weatherization process. By the beginning of the twentieth century, builders increasingly used creosote rather than covering wooden truss bridges.

In 1820 Ithiel Town received a patent for the Town lattice truss, the first true truss that acted independently of any arch action (Hayden 1976:52-54). Interestingly, it seems that Town more actively pursued selling his truss design than building it. He promoted his truss in a variety of ways, including the publication in 1831 of a pamphlet that his truss could be made from iron, but no builder tried it until 1859 (DeLony 1994:11). Town even employed agents to inspect new bridges and collect royalties on his design (Allen 1970:4). Due to the truss' simplicity and ease of construction, many builders chose to erect Town's lattice truss.

In 1840 William Howe patented the Howe truss, another truss that enjoyed widespread popularity. Howe based his design on the limited stress analysis information available at that time, the first to do so since previous trusses were unadaptable to analysis (Edwards 1976:156-157). The Howe truss used metal vertical tension rods and timber diagonal compression members. This joint use of metal and wood materials for bridge components, called a "combination truss," was a significant transitional feature in the development of an all metal truss. The popularity of the Howe truss resulted, in part, from its comparatively simple erection. The Howe truss design eliminated the need for skilled carpenters to notch and peg wooden jointed bridges by using threaded iron rods for verticals and simple junction boxes at connections (Kemp and Anderson 1987:19). As bridge historian Eric DeLony wrote, "The Howe truss may be the closest that wooden-bridge design ever came to perfection. For simplicity of construction, rapidity of erection, and ease of replacing parts, it stands without rival" (DeLony 1994:11).

In 1844 Caleb Pratt, an architect, and his engineer son, Thomas, designed the Pratt truss, another truss from this period that had widespread significance. While the configuration appears to be the same as a Howe truss, the Pratt truss' verticals functioned as compression members and diagonals functioned as tension members. The Pratt truss required more iron than a Howe truss, and due to the increased cost and less rigid construction, builders did not extensively use it for wooden trusses. However, as the cost of iron declined, its popularity increased, and it greatly impacted metal truss bridge design. The Pratt truss and its derivations became the most popular metal truss in the United States by the early twentieth century.

Wooden truss bridges provided a means to span large crossings efficiently. These new bridges not only facilitated transportation but also increased awareness and interest in bridge building. As a result, builders developed a variety of truss types and built numerous wooden truss bridges throughout the nineteenth century, the heyday of wooden truss design. At the same time, the construction of wooden truss bridges heightened awareness of the potential of truss designs and resulted in new variations in iron and later steel designs. While builders erected wooden truss bridges into the twentieth century in limited numbers, beginning in the mid-nineteenth century, subsequent designs in metal eventually eclipsed the use of wooden truss bridges and rendered them virtually obsolete by the end of the nineteenth century.

EXTANT WOODEN TRUSSES IN TENNESSEE: The survey inventoried twenty-five wooden truss bridges erected between 1875 and 1945 and two wooden truss bridges erected after 1945. Table V-01 contains a list of these bridges. Four of these are covered bridges. All utilize one of three truss types: the Kingpost, Queenpost, or Howe truss; see Figure V-02. Most of these bridges have metal tension members and joint connections and thus might be technically termed "combination bridges" rather than wooden truss bridges.

Kingpost: Builders first developed the Kingpost as the most basic and earliest truss type. The outline consisted of two diagonals in compression and a bottom chord in tension that together formed a triangular shape. A vertical tension rod (called a Kingpost and thus the origin of the truss name) divided the triangle in half. After the mid-nineteenth century, builders used metal (not wood) for tension rods. Builders typically used the Kingpost truss for shorter spans, up to about thirty-five feet. Figure V-03 contains a view from a historic postcard showing a multiple span Kingpost truss bridge near Woodbury, the county seat of Cannon County. Seven of Tennessee's twenty-five wooden truss bridges contain a Kingpost truss; one is covered.

At least one early twentieth century publication (International Library 1908:1-3) differentiated between a deck and pony Kingpost truss. This publication termed a deck Kingpost truss (in which the "bottom" chord becomes the roadway deck with the "point" of the triangle directed downward) a "Kingpost" truss, but a pony truss (with the "point" directed upwards) a "Kingrod" truss. The publication also applied those terms to Queenpost (and Queenrod) trusses. All of the wooden trusses in Tennessee are pony trusses, but since the term Kingpost (or Queenpost) is now generally applied to pony trusses, this study refers to them by that name.

Queenpost: The Queenpost, another early and basic truss type, is a variation of the Kingpost truss. A Queenpost truss contains two vertical members (rather than the one in a Kingpost). These vertical members require the use of a top chord to connect them. This arrangement forms a three panel span in which the center rectangular area may or may not have crossed diagonals. Again, the outer members act in compression and the vertical rods (wood or metal) act in tension. This truss type can support spans up to about seventy feet. Sixteen of Tennessee's twenty-five wooden truss bridges contain a Queenpost truss; two are covered.

Howe Truss: William Howe patented the Howe truss in 1840. End diagonals connect the top and bottom chords, all wood members acting in compression. Each panel had a diagonal

TABLE V-01: TIMBER TRUSS BRIDGES IN TENNESSEE

ELIGIBLE? # IN CH. 6	COUNTY	BRIDGE NUMBER	CROSSING	DATE BUILT	BUILDER	TYPE
Yes: #4	Sevier	78-A0324-00.58	E Fork Little Pigeon River	1875	E. S. Early	1 Queenpost, Covered
Yes: #8	Carter	10-A0398-00.01	Doe River	1882	E. E. Hunter	1 Howe, Covered
No	Campbell	07-A0622-00.29	L&N RR	1910	L&N RR	1 Queenpost
Yes: #67	Obion	66-NonHighway-1	Obion River Canal	1910-12	W. E. Parks	1 Kingpost, Covered
Yes: #69	McMinn	54-A0214-00.10	L&N RR	1911	L&N RR	1 Kingpost
No	Knox	47-A0061-01.39	L&N RR	1913	L&N RR	1 Queenpost
Yes: #74	Polk	70-A0317-02.09	L&N RR	1913	L&N RR	1 Queenpost
No	Roane	73-A0391-00.64	L&N RR	1913	L&N RR	1 Queenpost
No	Anderson	01-A0052-01.49	L&N RR	1914	L&N RR	1 Queenpost
Yes: #82	Monroe	62-A0520-01.49	L&N RR	1914	L&N RR	1 Queenpost
No	Polk	70-A0317-01.12	L&N RR	1915 est	L&N RR	1 Queenpost
Yes: #96	White	93-A0415-00.19	L&N RR	1917-18	L&N RR	1 Queenpost
Yes: #97	Anderson	01-02444-06.74	L&N RR	1918	L&N RR	1 Kingpost
Yes: #99	Giles	28-A0340-00.83	L&N RR	1918	L&N RR	1 Kingpost
No	Blount	05-02397-00.86	L&N RR	1920 est	L&N RR	1 Queenpost
No	Blount	05-A0005-00.08	L&N RR	1920 est	L&N RR	1 Queenpost
No	Hamilton	33-E0066-00.15	Southern RR	1920 est	Southern RR	1 Queenpost
No	Lawrence	50-03168-00.85	L&N RR	1922	L&N RR	1 Kingpost
Yes: #109	Greene	30-A0906-00.01	Little Chucky Creek	1923	A. A. McLean	1 Queenpost, Covered
No	Polk	70-04313-13.95	L&N RR	1925	L&N RR	1 Queenpost
No	Washington	90-03968-00.80	Clinchfield RR	1935 est	Clinchfield RR	1 Howe
No	Lawrence	50-01761-00.07	L&N RR	1942	L&N RR	1 Queenpost
No	Shelby	79-D0064-00.41	ICG RR	1944	ICG RR	1 Kingpost
No	Tipton	84-01473-00.65	ICG RR	1944	ICG RR	1 Kingpost
No	Sumner	83-A0391-00.54	L&N RR	1945	L&N RR	1 Queenpost
NOT EVALUATED DUE TO POST 1945 CONSTRUCTION DATE						
Unknown	Tipton	84-00810-00.83	ICG RR	1946	ICG RR	I Kingpost
Unknown	Tipton	84-00810-00.83	ICG RR	1946	ICG RR	I Kingpost

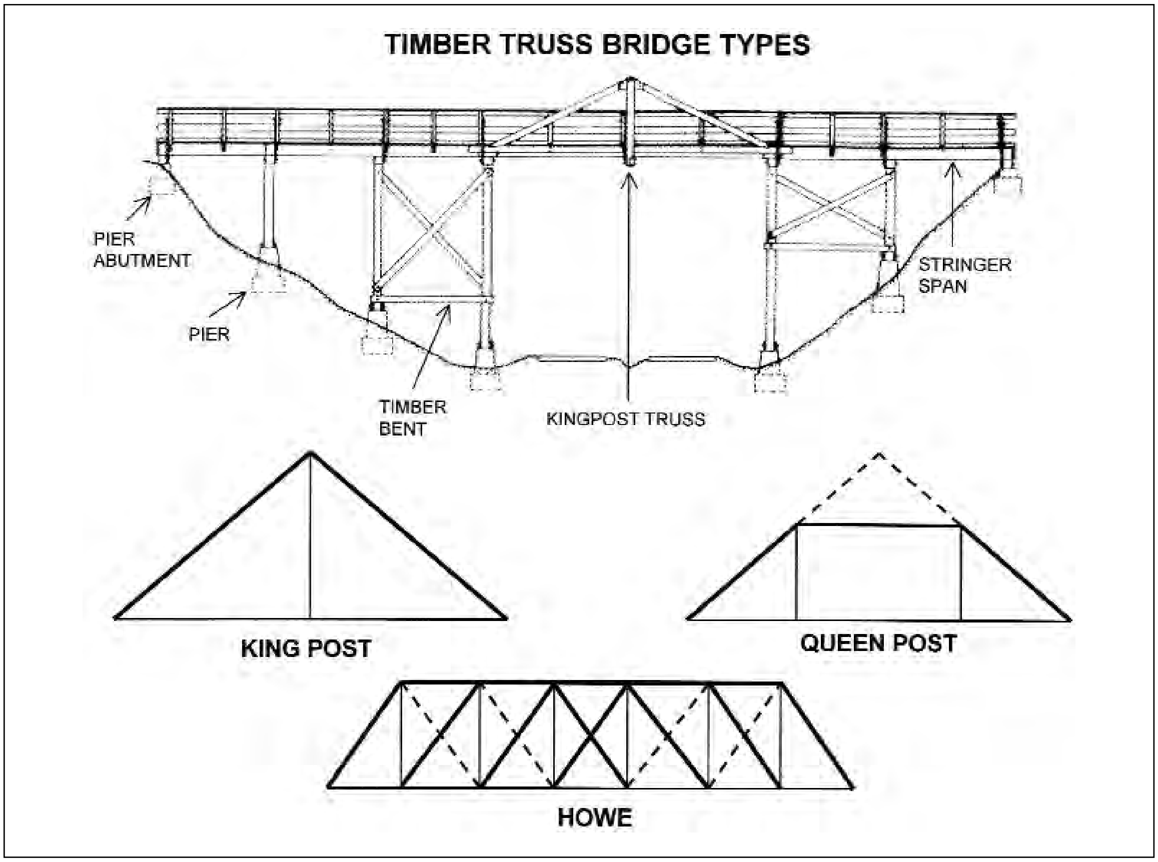


Figure V-02: Timber Truss Bridge Types.

timber compression member and a vertical metal tension member, a material that conducted tensile forces better than wood. The metal tension member eliminated a heavy wooden member and reduced the dead load weight, and builders could more easily join the screw and nut connections between iron and wood than between wood members. Builders could use multiple panels to increase the length of the bridge, typically ranging between 100 and 150 feet. Two of Tennessee's twenty-five wooden truss bridges contain a Howe truss; one is covered.

Railroads built all of the extant non-covered wooden truss bridges in Tennessee. All but one of these bridges utilize either the Queenpost or Kingpost design. The railroads built them to carry vehicular traffic on local roads over railroad tracks, providing grade separated crossings. On the surface, it may seem inconsistent that the railroads, who were generally technologically innovative in bridge design, would use a comparatively primitive design for these bridges. Such a design probably appeared to be the most economical and efficient for bridges carrying vehicular traffic, compared to rail lines that carried heavier rail traffic.

Although no uncovered wooden truss bridges built by someone other than the railroads remain in Tennessee, the counties did build wooden truss bridges. Perhaps the last such bridge to

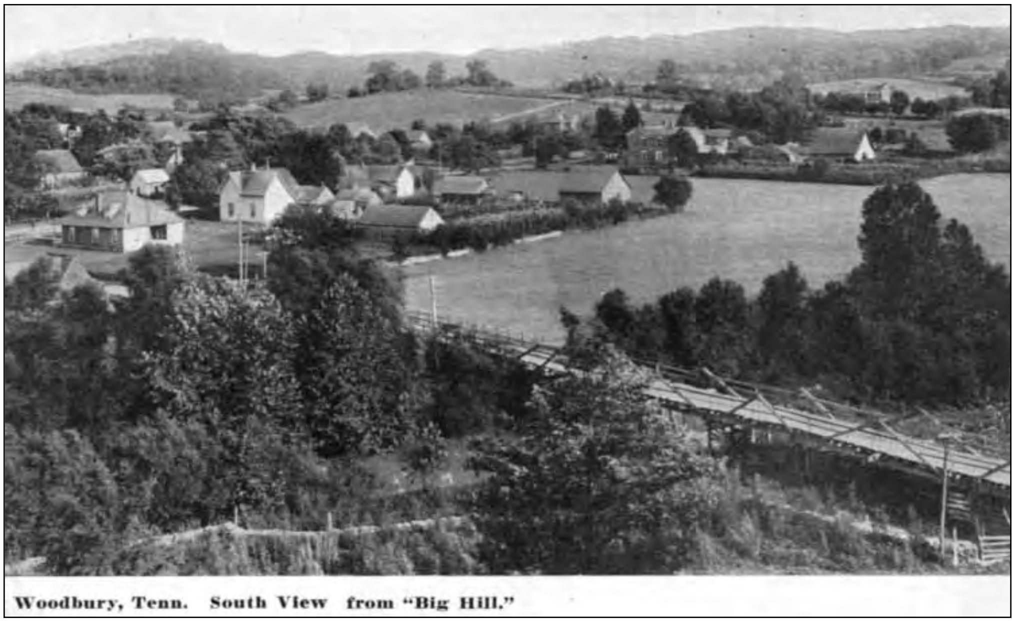


Figure V-03: Historic postcard view of a kingpost truss bridge near Woodbury (Author's Collection).

survive was a short Howe truss in eastern Montgomery County across Big McAdoo Creek. Previous Figure II-09 contains a 1982 photograph of this bridge. The county abandoned this bridge when it built a new bridge nearby about 1960. The wooden bridge collapsed in the 1980s. Also, in the late 1910s, the newly formed Tennessee State Highway Department developed a list of standardized plans for bridge types that included Howe, Queenpost, and Kingpost designs.

However, it appears that the state did not ever erect any bridges from these plans. In recent years, individuals or park managers have built modern "covered" bridges. These bridges are typically slab bridges with a barn-like covering. In the 1970s, the state reconstructed the historic Port Royal Covered Bridge after a storm destroyed the historic structure that was located in a state park. It has since washed away. The survey identified two post-1945 wooden truss bridges, both built in Tipton County in 1946 by the ICG Railroad (see Appendix B). The survey did not enumerate these bridges because they are either not true truss bridges or they do not meet the pre-1946 age criterion of the study.

BACKGROUND OF METAL TRUSS BRIDGES: The experimentation to develop a more efficient and stable wooden truss bridge led to an increased use of metal for some components of wooden trusses, called combination trusses, such as in the 1840 Howe truss that used iron tension members. Gradually, builders erected trusses originally designed for wood, such as the Pratt truss, entirely of iron.

Prior to the 1840s, most bridge builders were self-taught engineers, contractors, carpenters, architects, or millwrights who experimented with truss designs based on practical application, experience, and observation. This situation changed in the 1840s. In 1841 Squire Whipple introduced an iron bowstring truss, the Whipple truss, the first metal truss used extensively and the first based on scientific principles. Whipple continued his research in the field, and in 1846 published a pamphlet called *An Essay on Bridge Building* which he expanded the following year into a book, *A Work on Bridge Building*. Whipple's book, in which he analyzed truss members as a system of forces in equilibrium, was the first text in the United States, and possibly in the world, on scientific truss-bridge design (DeLony 1994:11, 13). Whipple's text enabled bridge builders to mathematically analyze trusses, and eventually led to the development of bridge building as a profession.

Unlike the other bridge types in this study, metal truss bridges were uniquely indigenous to the United States. A variety of factors led to the experimentation that resulted in the United States taking the lead in the development of metal truss bridges. As discussed under wooden trusses, in the eighteenth and nineteenth centuries, the United States was a newly developing and rapidly expanding country that needed the construction and expansion of an infrastructure system as quickly and economically as possible. The expansion of rail lines across the country required bridges, and the completed railroads opened many areas for widespread settlement. These settlers also required roads and bridges for local transportation. Innumerable counties and municipalities hired local contractors to meet that need resulting in a highly competitive field. These builders were willing to experiment with various designs and patented components in an effort to gain dominance in a newly emerging profession, the construction of metal truss bridges. This contrasted with the situation in Europe where a centralized government financed and approved the designs of most infrastructure improvements. Consequently, builders in the United States tended to quickly build cheap bridges that they expected to replace as the country became more settled. European builders, in a more stable and more affluent situation, tended to experiment less and build monumental and more permanent structures (DeLony 1994:11-12). The availability of materials and labor also played a positive role in the construction of metal truss bridges. Unlimited timber supplies and later large quantities of iron or steel that suppliers could ship to most parts of the country on rail-lines made trusses easily available to most communities. The prefabricated design of trusses further enhanced their accessibility. Builders could design and fabricate trusses at bridge plants and then ship them to the bridge site. Local laborers performed most of the actual erection work as opposed, for instance, to masonry arch bridges that required skilled masons to erect.

During the nineteenth century, a tremendous variety of bridge building companies proliferated until the formation in 1901 of the American Bridge Company. While some of these firms built a wide variety of types, many specialized in specific truss types for which they held a patent. Although these firms naturally built other truss types, their use of a patented truss or patented members was in effect a distinctive advertisement. During this period, builders erected a wide variety of unusual trusses in an effort to find the preeminent truss design that combined ease of construction, safety, efficiency, and cost effectiveness. Rare examples remain of anomalous trusses such as the Fink, Triple Intersection Pratt, or Bollman (see previous Figure V-01). However, as the profession advanced, the Warren and Pratt trusses with their derivations proved to be the most efficient and economical. From the end of the nineteenth century until the mid-twentieth century when truss construction essentially ceased, the Warren and Pratt trusses and their variations dominated the bridge building industry.

METAL TRUSS CONSTRUCTION IN TENNESSEE: On a national level, iron bridge construction began in the 1840s, but available records do not provide documentation concerning when builders first began to erect them in Tennessee. However, by the 1870s, national firms such as the Wrought Iron Bridge Company and the King Iron Bridge Company had erected trusses in Tennessee and by the 1880s had offices in the state. The Dobbs Ford Bridge in Bradley County (#5, 06-A0184-00.64), erected between July 1877 and July 1878 by the Wrought Iron Bridge Company, is the oldest vehicular metal truss bridge in Tennessee. The Wrought Iron Bridge Company of Canton, Ohio, opened a branch office in Chattanooga in the 1880s, and an 1883 catalog (Wrought Iron 1883) listed five bridges in Tennessee built by the company. Of these five, only the Dobbs Ford Bridge remains. The King Iron Bridge Company of Cleveland, Ohio, also opened a branch office in Chattanooga in the 1880s, and an 1884 catalog (King Iron 1858-1884) listed twelve Tennessee bridges. Only one of these twelve bridges remains, the Kelso Bridge in Lincoln County (#6, 52-A0183-05.54), a bowstring truss erected in 1878.

Between the 1880s and World War II, a wide variety of bridge companies erected thousands of truss bridges throughout the state, and it is impossible to document an exact number. However, the records of the Nashville Bridge Company do give an indication of the attrition rate. Company records indicate that between 1903 and the early 1920s (when its work load shifted to fabrication work for the state highway department), the company erected about 400 truss bridges in Tennessee. This survey inventoried only 82 of those 400 built, and counties have demolished several of those 82 bridges since the survey began.

Even though concrete arch bridges became popular in Tennessee in the 1915-1925 period, counties and the state still usually chose metal truss bridges. The preference for metal truss bridge resulted, in part, because of the limited lengths that engineers could build single concrete arch spans at that time. Also, counties had more experience in the construction of metal truss bridges and may have been more comfortable with that type. When the Tennessee State Highway Department began building bridges, it usually erected truss spans for major bridges except for some shorter crossings where it used "boxy" arches or culverts. This may have influenced some counties to continue using metal trusses. Cost may also have affected the decision. When county court minutes contained cost estimates for both metal and concrete bridges, usually concrete was more expensive. Many counties chose concrete as more cost efficient over time, but other counties opted for the less expensive bid for a metal truss.

Truss bridges continued to dominate the bridge industry until about World War II. After World War II, the use of truss bridges declined because pre-stressing concrete technology had resulted in the ability to construct longer spans. Also, the labor intensive nature of trusses resulted in a higher construction cost than girder bridges. When a builder chose a truss design for any large scale bridge after 1950, the choice usually resulted from a specific design constraint such as navigational clearances.

CHARACTERISTICS OF TRUSS BRIDGES: Truss bridges contain many variations that give individuality and interest to them. Some of these features are discussed below. Figure V-04 contains a schematic of a through truss.

Combination Of Truss Types: Many bridges contained different types of trusses. For example, the Rock Island Bridge in Warren County (#112, 89-04261-11.60) contained two types of through Parkers and two pony Warrens, and the Massengill Bridge in Anderson County (#87, 01-A0088-03.53) contained a Camelback and a through and pony Pratt. Builders based the choice of trusses on factors such as the length needed, the extent of their own experience, and the cost. Thus, one company might feel the best solution for a site would be a 100-foot Pratt and a 50-foot Warren while another might choose a 150-foot Camelback; the former perhaps being

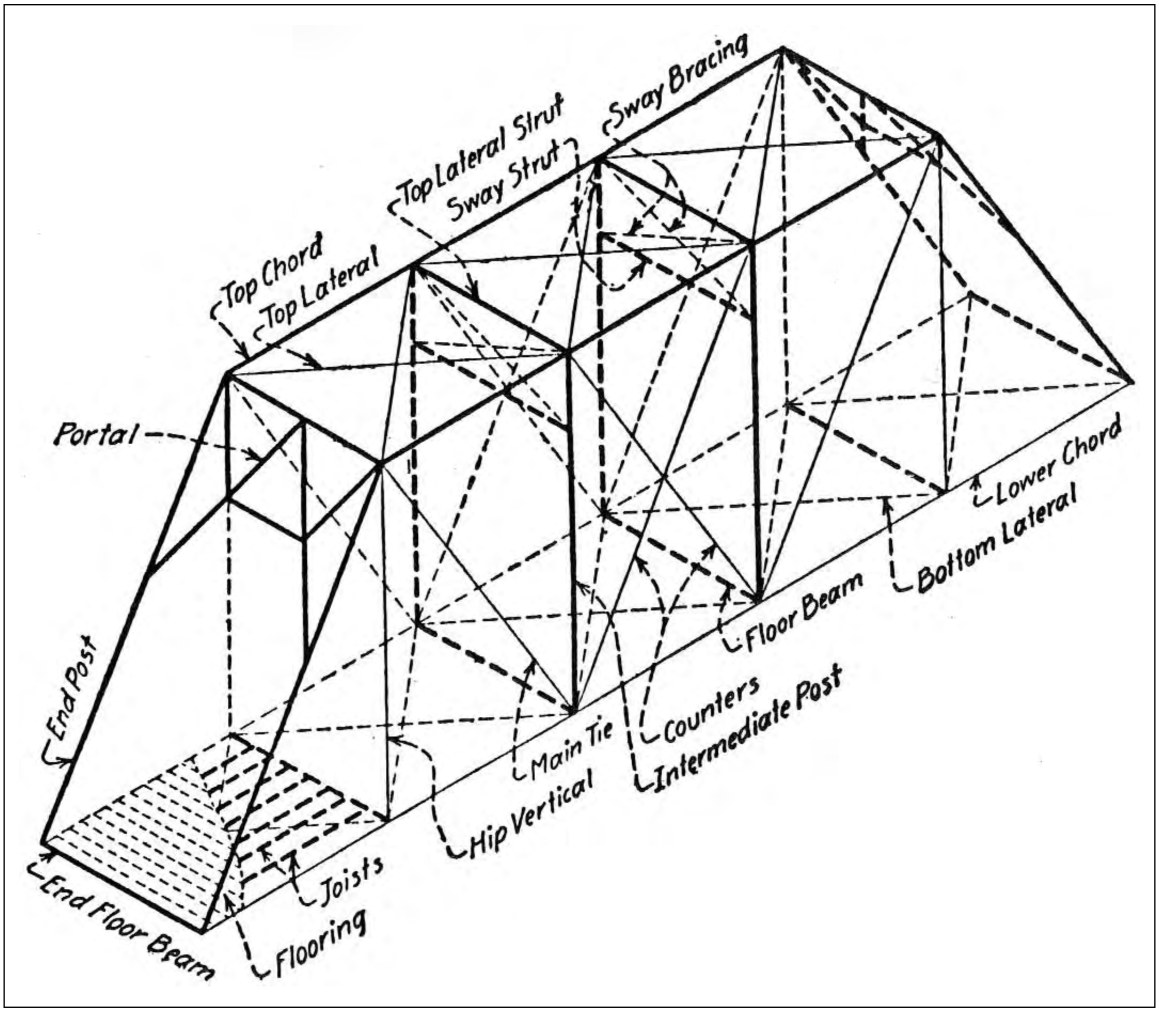


Figure V-04: Drawing of Typical Pratt Through Truss.

easier to build while the latter had a cheaper substructure. From a historian's view, multiple truss types within a bridge are more interesting because they reflect different truss designs and different building techniques such as having both pinned and riveted connections on the same bridge. They may also show different approaches to specific design elements. For instance, on the Massengill Bridge, the builder used splayed verticals on the pony truss but not on the through trusses. However, historians attach no unique engineering significance to a mixed use, and many turn of the century engineering purists would probably have considered the unbalanced and asymmetrical appearance aesthetically undesirable.

Relocation of Trusses: An inherent design feature of metal truss bridges was their mobility. The trusses were simply an arrangement of metal pieces connected with removable pins or rivets. Builders could relocate smaller spans intact and disassemble and relocate larger truss spans to new locations. Builders commonly relocated truss spans and used that feature as a marketing

Figure V-05: Photograph of a truss bridge in Dickson County. Note the combination of a pony truss in the foreground and the through truss in the background.

tool. In 1924 Arthur Dyer, President of the Nashville Bridge Company, reused a span from the 1889 Bordeaux Bridge in Davidson County when he built the Rock Island Bridge in Warren County (#112, 89-04261-11.60). He often cited this bridge as an example of the superiority of metal truss bridges over concrete arch bridges saying, "You can always reuse a steel span but you cannot move and reuse a concrete bridge" (Crouch and Claybrook 1976:18). Some counties or builders relocated trusses more than once. For example, Bedford County relocated the 1904 Moore Road Bridge (#45, 02-A0048-00.38) twice, once in 1914 due to a slight road shift and in 1950 across the county after building a new bridge at the original site.

Of the 502 metal truss bridges in this survey, 84 (17%) were not on their original locations, and it is possible that others had also been moved. In addition, builders vertically raised several truss bridges at their existing locations by adding caps to the piers or building an entirely new substructure, a design option impossible with concrete arch spans. For example, in 1950 the Tennessee Valley Authority raised the 1928-1930 Paris Landing Bridge on the Stewart-Henry County line (#125, 40-SR076-30.34) due to increased water levels resulting from the impoundment of Kentucky Dam.

Railroad Bridges: The railroad industry played a pivotal role in popularizing metal truss bridges. Due to the heavy weights that railroad bridges carried, railroad engineers were continually in the forefront of bridge design, and their innovations filtered down to highway bridges. The Baltimore and Ohio Railroad is of special interest in bridge history. Under Benjamin Latrobe Jr., the Baltimore and Ohio Railroad employed two highly innovative engineers, Wendell Bollman and Albert Fink. In the 1850s, both Bollman and Fink patented imaginative trusses named for themselves but few survive. Fink is of regional interest. He began working for the Louisville and Nashville Railroad in 1858, first as Chief Engineer and later rising to Vice-President and General Superintendent before his retirement in 1875. During his tenure, the Louisville and Nashville Railroad needed extensive bridge work due to the destruction caused by the Civil War as well as from the need to expand the line during Reconstruction.

Tennessee's survey included railroad bridges built to carry both vehicular and rail traffic as well as former railroad bridges that now carry vehicular traffic. Although railroad and highway trusses contain many similarities, railroads carried substantially heavier traffic and the individual members are usually heavier than those on highway bridges. Thus, while there might be Pratts of each, the composition would usually be quite different. The Old Pinnacle Road Bridge in Cheatham County (#32, 11-01931-00.45), which contains two Pratt trusses without counters, is a good example.

Figure V-06: Photograph of a splayed vertical, Massengill Bridge, (#087, 01-A0088-03.53), Anderson County.

Figure V-07: Photograph of the Glaze's Ford/Smith Bridge in Washington County (#36, 90-A0900-00.97). The bridge has an angled roadway between truss spans to avoid a skewed truss. Note that the end posts on the pony and through trusses are composed differently, the pony with lacing and the through with channels. On the pony truss, the verticals are paired angles. On the through truss, the verticals are small channels with lacing except the hip verticals which are paired eyebars. The through truss contains lattice portal bracing.

Skew: A skewed truss occurs when the center line is not at a right angle to the abutment. Builders erected most trusses symmetrically, or at a right (900) angle, to the roadway for a variety of reasons. Builders found it more difficult to design, fabricate, and erect skewed trusses, especially through trusses, than right angle trusses. Engineers considered skewed trusses to be a poorer design because they were less rigid than right angle trusses. Bridges built at a right angle were shorter and thus cheaper than those built on a skew. However, in some instances the topography or the desire for a straight road resulted in a skewed truss. Of the 502 simple and continuous bridges inventoried, ten contained skewed trusses. The 1909 Boulevard Bridge in Franklin County (#63, 26-A0406-00.33) contained the only skewed through truss in the state.

Iron/Steel: The development and widespread availability of iron made metal truss bridges feasible. From about 1840 to 1880, metal truss bridges contained cast iron compression members and wrought iron tension members. Although wrought iron cost twice as much as cast iron, its superiority in resistance to tensile forces justified its cost for specific bridge components (DeLony 1994:9). The development in the 1850s and 1860s of the Bessemer process and the open-hearth method of processing steel from iron facilitated the use of steel for truss bridges. Although the two materials were virtually indistinguishable to the eye, they functioned differently with steel being stronger. Builders continued to use iron for many years for certain elements of truss bridges. However, beginning in the 1880s, as steel became more affordable and of a better quality, it replaced iron as the primary construction material for metal truss bridges. Bridge historian Eric DeLony estimates that only about six dozen iron truss bridges remain in the country (DeLony 1994:9). Based on the construction dates, it is assumed that both the Dobbs Ford Bridge in Bradley County (#5, 06-A0184-00.64), erected between July 1877 and July 1878 by the Wrought Iron Bridge Company, and the Kelso Bridge in Lincoln County (#6, 52-A0183-05.54), a bowstring truss erected in 1878 by the King Iron Bridge Company, are iron trusses. It is possible that some of the other bridges in the state erected in the 1880s might also be iron.

Composition of the Truss: Not only did builders patent truss types, but during the intense competitive period of bridge building in the nineteenth century, bridge companies commonly patented individual elements such as top chords, columns or connections. For instance, the King Iron and Phoenix Bridge Companies each had a patented tubular column. By 1900, this phase disappeared as standard shaped members became mass produced. However, the decision of which members to use and how to arrange them was still a matter of choice, and the selection and composition of truss members varied widely, often depending on truss types and connection.

Numerous straight pieces, called *members*, form a truss span. These members act in either tension or compression. A tension member is subject to forces that pull outward at its ends. These members are generally individual metal pieces such as bars or rods. Compressive forces push or compress together. Compression members are thick heavy posts or beams and are often "built-up members"; that is they contain two or more individual members joined together such as beams with lacing connected with rivets. Generally, tension members are lighter in scale and weight than compression members and can be differentiated by their size. However, by the 1920s, builders increasingly used heavier built-up structural elements for tension members. Even so, in comparison to compression members on the same bridge, they were generally lighter in scale. However, similarities within bridge classes remained. For instance, most 1900-1920 pinned Pratts were similar in composition as were 1900-1920 riveted Warrens yet each was substantially different from the other. In other words, the members of a 1900 Pratt would often be more similar to a 1920 Pratt than to a 1900 Warren.

Key members included *top chords and end posts*, compression elements that were generally alike since they functioned somewhat as an extension of each other. On most trusses channels (top and sides) with lacing or battens underneath formed these members. A less common design

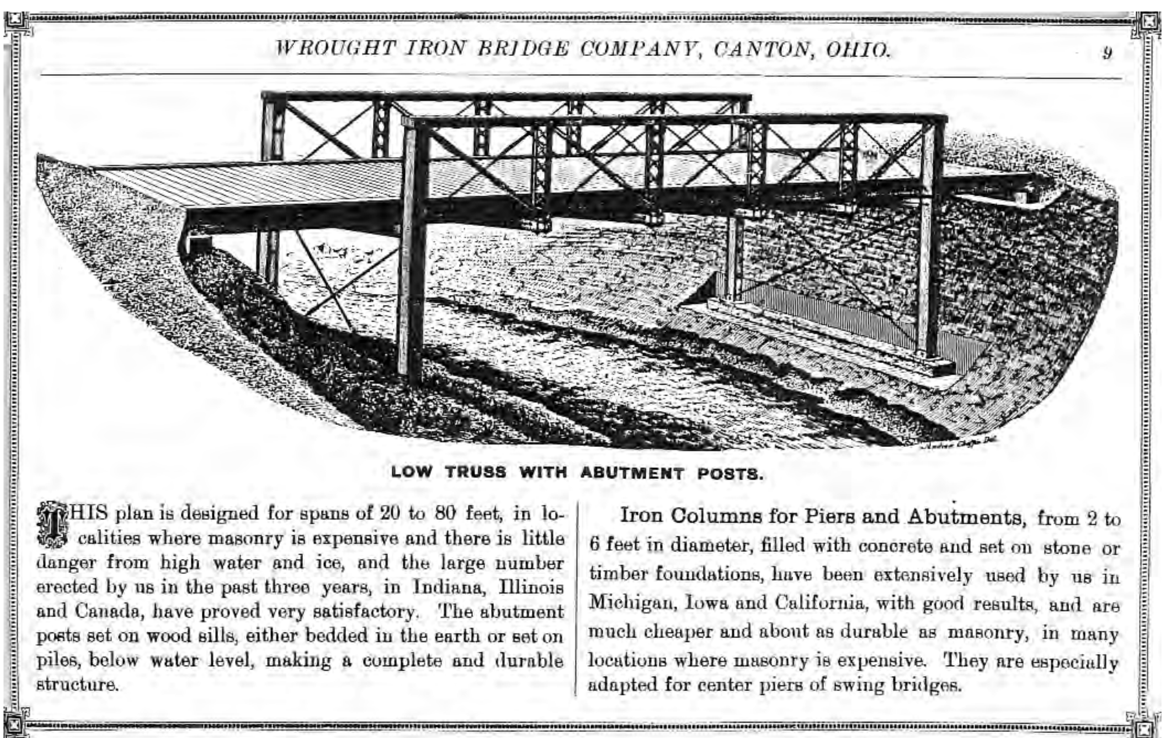


Figure V-08: Advertisement from a Wrought Iron Bridge Company catalog for a Pratt Pony Bedstead Truss catalog.

used channels with lacing on the top and bottom, a method easier to fabricate and cheaper since it used less metal but also weaker and less rigid. Truss bridges normally contained end posts that inclined at about a 45° angle, but in rare circumstances, builders used vertical end posts. Vertical end posts that extended below the bottom chord and into the ground, where they were attached to timber or concrete bedding, formed a *truss leg* or *bedstead truss*. Engineers considered vertical end posts, although cheaper to build, an inferior design due to the less efficient distribution of stresses.

Bottom chords ran the complete horizontal length of a truss, but individual components that formed the bottom chords usually extended only the length of a panel. On pinned Pratt trusses, paired eyebars usually formed the bottom chords. *Eyebars* were steel or iron bars with an eye at one or both ends. Four sided, eyebars were usually three to five inches wide and about an inch deep. At first, the eyes were looped and then welded shut, but in the late nineteenth century, it became common to cut or die forge the member as one piece. Many turn of the century bridges exhibit both loop-welded and die-forged members. On riveted trusses, channels with battens often form the bottom chords. Some bridges contained a *fishbellied bottom chord* as seen on the Buena Vista Ford Bridge in Smith County (see #56, 80-A0206-00.47). On this variation, the bottom chords on the center panels lay below the floor beams but angled up in the end panels to connect at the end joint above the floor beam level. Engineers thought that this design feature provided more lateral stability. To some extent this worked similarly to a polygonal top chord and thus allowed spans to be somewhat longer than typical. The entire area between the top and bottom chords is the *web*.

Trusses expanded and contracted due to factors such as temperature changes and live loads. Typically, one end of each truss allowed for this expansion (*expansion end*) by having the truss sit on a rocker or roller that allowed movement. The other end (*fixed end*) was considered stationary although the design often allowed a small amount of movement.

Figure V-09: Photograph of lacing on the Snapp Bridge in Washington County (90-A0912-00.22). Note the hip vertical in the foreground and its unusual composition in comparison to the other verticals.

Figure V-10: The 1899 Thomas Mill Bridge (60-A0171-01.18) spanning Fountain Creek in Maury County features laced end posts and top chords rather than the more traditional channels and decorative laced portal bracing. The hip verticals are composed of eyebars as opposed to small channels. Note the chevron shaped sway bracing, again with lacing, and the arched knee bracing.

A truss contains a series of upright members, called *verticals*. On Pratt trusses verticals, usually formed of small channels or angles connected with lacing, acted in compression except for *hip verticals* that acted in tension. On earlier trusses, eyebars often formed the verticals. A few builders used light angles or paired angles (with or without lacing) for verticals. A variation can be seen on the Snapp Bridge (90-A0912-00.22) whose verticals are small channels connected with lacing while the hip verticals are paired eyebars except for the bottom four-foot section which is composed of small channels connected with lacing.

The area between two consecutive verticals is a *panel*. Panel lengths on different bridges varied greatly, but all panels on an individual bridge were normally the same length. Pony trusses tended to have shorter panel lengths, usually in the twelve to eighteen foot range, but examples exist in Tennessee from seven to twenty feet. Pre-World War I through trusses tended to be longer, usually from fifteen to twenty-five feet. The large scale through trusses designed by the state highway department after 1925 vary but tended to have even longer panel lengths, usually twenty to forty feet long. The number of panels on a bridge is irrelevant in determining the truss type, and there could be an odd or even number of panels. Most trusses were symmetrical in that they could be cut at the center into two exact halves.

Panels contained lateral members, called *diagonals* and *counters*, which criss-crossed between the verticals. On pinned trusses, usually paired eyebars or eyerods formed the diagonals. On

Figures V-11: Decorative Portal Treatments: The 1884 King's Mill Bridge (top) (#10, 61-A022-01.14) features lattice portal bracing, arched knee bracing with a single circle, and four finials; The 1903 Kettle Mill Bridge (right) (#41, 60-NonHighway-1) contains portal knee bracing with a spoke-like or spindle element, reminiscent of some of the Victorian stylistic details such as Eastlake.

The 1909 Boulevard Bridge (top) (#63, 26-A0406-00.33) features portal bracing with a solid strut containing three cutout decorative elements composed of a large knobbed circle with five smaller circles abutting it. Between these medium sized circles are small circles. Note the skewed alignment; and the 1889 Old Bordeaux Bridge (bottom) (#16, 19-NonHighway-2) features lattice portal bracing and arched knee bracing containing a boss diamond decorative detail. Also, the span contains an elaborate two-tier lattice railing.

riveted trusses, built up angles or small channels formed them. *Eyerods*, smaller than eyebars and often about an inch in diameter, could be either rectilinear or cylindrical in shape. Paired or single eyerods usually formed the counters on pinned trusses, and built-up angles or channels formed them on riveted trusses. On pinned trusses, since it could be difficult to make eyerod counters that fit exactly, builders often used *tierods*, an eyerod with a *turnbuckle*, a threaded loop or screw which allowed the length to be adjusted.

Portal bracing, horizontal supports between the end posts below the top chords, added lateral stability on through trusses. Occasionally, through trusses added diagonal *knee bracing*, supplemental bracing canted below the horizontal portal bracing. Often bridge companies used a standard portal treatment that functioned somewhat as a distinctive trademark. Portal bracing could be quite simple, such as two crossed chevron members, a design that the Converse Bridge Company used frequently. More elaborate portal bracing contained a lattice pattern (for example, the Smith Bridge in Washington County, #36, 90-A0900-00.97) or punched out portal struts (for example, the Old Stone Fort Bridge in Coffee County, #50, 16-P0001-00.02). The King Iron Bridge Company frequently used a three circle motif for its knee bracing, and the Nashville Bridge Company commonly used a divided triangle. Even though companies consistently used patterned portal treatments, variations existed, and by themselves, portals are not a fail-safe method in identifying the bridge company. *Sway bracing*, typically located below the top chord at panel points throughout the length of the truss, provided lateral stability. Rods, angles or channels usually formed this support member which rarely featured an elaborate decorative pattern.

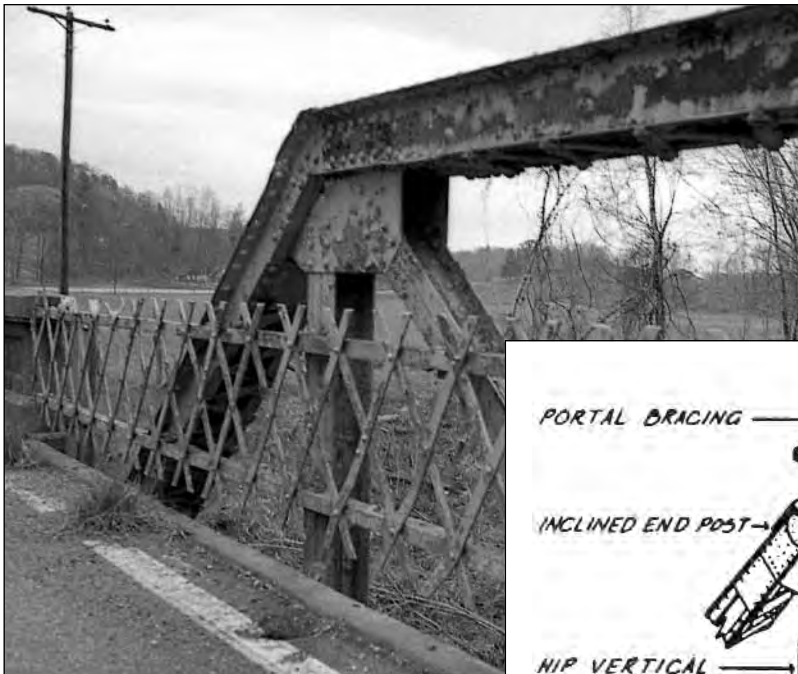
Truss bridges contained *top* and *bottom lateral bracing*, criss-crossed members that provided lateral stability and which connected to the truss at panel points formed by the junction of the chords and verticals. Builders typically used the same members to form both the top and bottom bracing. On pinned trusses, eyerods formed the bracing. On riveted trusses, builders used heavier members, typically angles or channels with or without lacing. The Kelso Bridge in Lincoln County (#6, 52-A0183-05.54) contains a rare variation. The lateral bracing on this bowstring truss consists of four rods that converge in the center of the plane at a circle where each rod is bolted to the circle. Flat beams form the *top lateral struts*, horizontal members running the width of the truss between at the tops of the verticals, and *floor beams*, horizontal members running the width of the truss at the bottom of the verticals below the deck. Some of the older truss spans, for example the Hobbs Bridge in Lincoln County (#23, 52-A0494-00.22) contain chevron shaped beams. As might be expected, builders typically used treated timber for the *flooring* prior to the 1910s. However, as the Good Roads Movement influenced road construction, the counties began to use concrete floors, even in rural areas.

Connections: Bridge companies fabricated each bridge member at shops and shipped them unassembled to the construction site where local laborers erected the bridge. The place where these members connected is a *joint*. Laborers used pins or rivets to connect the members at these joints. In *pin-connected* trusses, each member that connected at a joint contained a large hole, and a pin passed through that hole to connect the members to each other. Each projecting end of the pin contained a large nut to keep the members connected. Instead of a nut, some builders used *cotter pins* (also called lateral key or split keys). A cotter pin, which resembled a bobby pin in appearance, was a split pin put through a slot to hold together individual members, and after insertion, fastened in place by spreading the ends apart. Although cheaper to use, many engineers considered them inferior to nuts. Engineers later developed *rivets* as a connection method. In this technique, builders joined the members by inserting several rivets (ductile metal pieces) into small

Figure V-12: Photograph of the chevron-shaped bottom beams of the Hobbs Bridge in Lincoln County (#23, 52-A0494-00.22).

holes that together make up the connection. Basically a forging process, laborers originally hand-hammered rivets but later used machine-driven tools in shops. Only when riveting at erection sites became possible due to pneumatic field riveters in the late nineteenth century, did riveted connections become common. Text books of that era typically recommended riveted connections for pony trusses and shorter through trusses, with the word “shorter” open to interpretation. In that period, builders considered pin and riveted connections each to have advantages and disadvantages, but by the 1920s, the transition to all riveted connections was underway. Engineers came to consider rivets superior because of the improved rigidity, but they continued to use pinned connections on trusses whose web arrangement made them more complex to assemble.

Although much of the circa 1900 literature used truss size as its basis for recommendations concerning pinned or riveted connections, in Tennessee prior to World War I, builders clearly differentiated by truss type. Generally, builders used pinned connections on Pratts and riveted connections on Warrens, regardless of size. Tennessee’s survey identified only three pinned simple Warren trusses: the 1884 Morris Mill Bridge in Giles County (#9, 28-00966-03.54) and two former railroad bridges, the 1889 Coldwater Bridge in Lincoln County (#18, 52-SR274-06.82) and the 1912 Fountain Creek Bridge in Maury County (60-A0191-07.19). The survey identified two continuous pinned Warrens, both built by railroads in Memphis and both monumental structures that are anomalous compared to simple highway bridges of that era: the 1892 Frisco Bridge (#14, 79-NonHighway-3) and the 1917 Harahan Bridge (#77, 79-



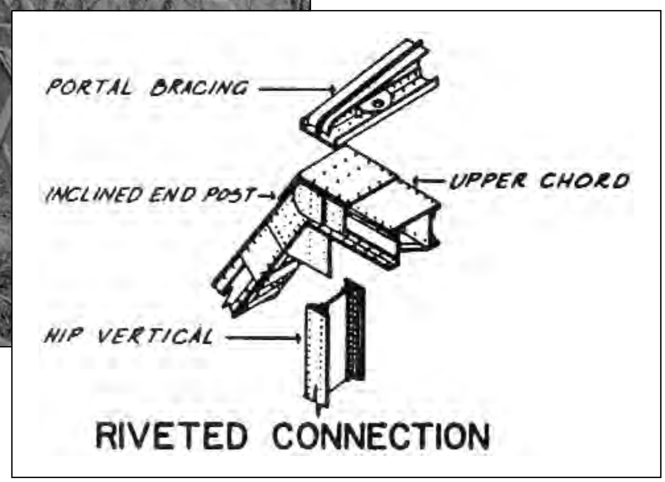
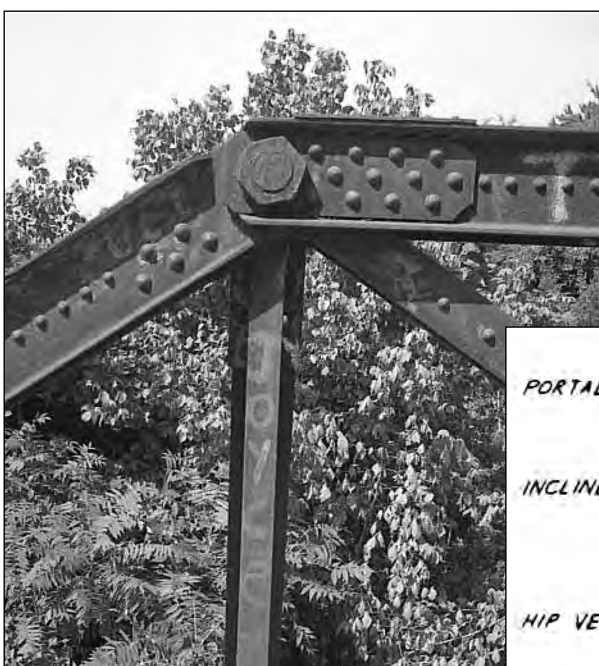
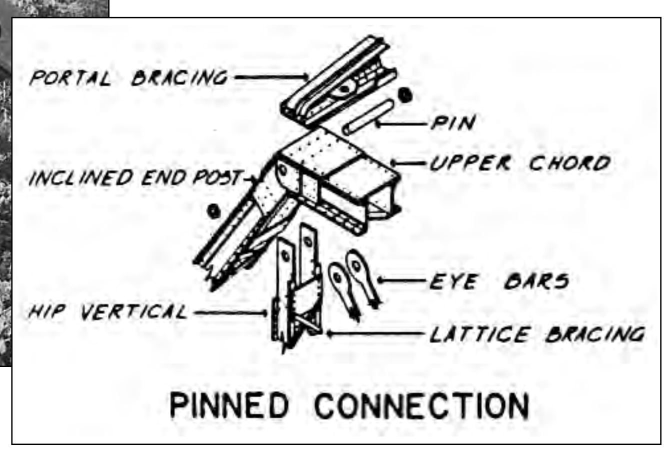


Figure V-13: Pinned and Riveted Connections: photograph and drawing of pinned connection and photograph and drawing of riveted connection.





NonHighway-4). Notably, only one of these six pinned Warrens was built for highway traffic. Of pre-1920 Pratt trusses, only two contained riveted connections: secondary pony trusses on the 1901 Mulberry Bridge in Lincoln County (#35, 52-NonHighway-3) and a 1912 through truss in Davidson County (19-D0752-01.60). The American Bridge Company erected the Mulberry Bridge. Due to its size and prominence, this company should be considered a trendsetter which may explain these early riveted Pratts (which also had unusual vertical end posts--but only on the outside ends). The builder may have used rivets on the Davidson County bridge due to its urban location and anticipated traffic demands. One through Pratt used both pinned and riveted connections, the 1918 Leatherwood Bridge (41-NonHighway-3).

After the State Highway Department began building bridges about 1920, it consistently used riveted connections, and counties gradually followed. Two of the last examples of large scale pinned bridges are located in Morgan County, both built in 1929 after a massive flood devastated the county: the Nemo Bridge (#127, 65-00444-09.58 and the Camp Austin Bridge (65-02378-07.84).

Of the 502 truss bridges in the survey, 281 (55%) used riveted connections and 220 (45%) pinned connections. One bridge used a mixture. However, the surveyor often made these determinations using photographs in bridge inspection reports, and an on-site review of every bridge might have located more mixed connections. At least twenty of the pinned bridges used cotter pins.

The *length* of a truss span varied greatly and largely depended on the type of truss used. However, a general engineering principle was to make the height of the truss about one-sixth its length. A greater height resulted in a longer span, hence the reason a Parker truss evolved

TABLE V-02: METAL TRUSS BRIDGE CONNECTIONS

TRUSS TYPE	RIVETED	PINNED	TRUSS TYPE	RIVETED	PINNED
Pratt	55 *«(Both 1)»*	105	Pratt Half-hip	1	47
Whipple	0	2	K	2	0
Bedstead	0	13	Warren	181	3
Pennsylvania Petit	0	8	Double Intersection Warren	2	2
Parker	36	8	Bowstring Arch	0	1
Camelback	4	28	Kingpost	0	1
Baltimore Petit	0	1	Bailey	0	1
TOTALS:					
Riveted: 281		**Pinned 220**		**Both: 1**	

Figure V-14: Photograph of the elaborate railing on the Walnut Street Bridge in Chattanooga (#20, 33-03544-00.12).

from a Pratt for longer spans. The width of trusses varied greatly. Most rural pre-1910 bridges were twelve feet wide, but on heavily traveled roads or in urban areas they could be wider. As the Good Roads Movement affected road design, sixteen foot widths became common during the 1910s, but counties continued to use twelve-foot widths for many years on secondary roads. The state highway department built trusses with 18 foot widths in the late 1910s and expanded to 20-foot widths in the 1920s.

Decorative Features: While engineers appreciated large urban bridges as landmarks and designed or decorated them as such, they perceived most truss bridges as essentially utilitarian structures to be built at a minimum cost and rarely added decorative features. However, some representative bridges did include quite ornate items, especially prior to 1900. As the twentieth century progressed, when used, decorative items became more restrained. The most common decorative approach involved adding decorative features to a structural element, such as the portal bracing, a relatively inexpensive but highly visible treatment. Builders often used a latticed or laced portal but also featured geometric cut-outs in a solid portal strut. The Nashville Bridge Company used an unusual variation on the 1904 Moore Road Bridge in Bedford County (#45, 02-A0048-00.38), crossed bracing with rosette bosses. Triangular or arched knee bracing often contained cutouts or circles, starbursts, stars, or geometric designs.

Substructure: The substructure is an interesting and visually important but often overlooked component of a bridge. The earliest truss bridges in Tennessee all had masonry substructures, but by the 1890s, builders also used concrete. Builders primarily used steel for bents and viaducts rather than piers or abutments. From

Figure V-15: Bridge Plaques: An ornate Victorian plaque on the 1889 Blevins Bridge (left) in the Doe River Gorge in Carter County (#15, 10-A0634-01.93);

A Neo-Classical influenced plaque (left) on the 1903 Kettle Mill Bridge in Maury County (#41, 60-NonHighway-1); A Gothic influenced plaque (above) on an 1898 bridge in Cheatham County (11-A360-00.31);

An Arts and Crafts influenced plaque (above right) on the 1914 Hickory Flat Road Bridge in Meigs County (#81, 61-A0028-00.23); An Art Nouveau influenced plaque (above) from the 1920s in Bradley County; and an unadorned but functional plaque (right) erected by the Forest Service about 1931 in Monroe County (#135, 62-02340-13.67).

about the 1890s to the 1920s, builders used steel encased concrete tubular piers, round concrete piers enclosed in steel and usually in pairs with cross bracing of steel rods. Concrete generally replaced masonry about 1900-1910. The state highway department used an interesting aesthetic treatment in the 1920s and 1930s, scoring concrete substructures to resemble masonry. However, the substructure is usually not a reliable indicator of a bridge's age. Personal preferences might motivate a builder to use masonry in the 1910s or later. Also, builders often reused older masonry substructures or relocated truss spans and constructed new substructures. Sometimes counties replaced an old substructure while leaving the truss span in place. Although the substructure and superstructure together form the bridge, they are quite independent of each other and, chronologically, often unrelated.

Movable Bridges: Movable bridges are not a separate truss category but simply an adaptation of truss configurations, in this case, in a movable form. Engineers could adapt any truss type, such as Warren or Pratt, for use as a movable bridge. Builders chose movable bridges, which were expensive to build and operate, for use on navigable streams rather than building a high bridge with steep approaches. A consistent grade was especially important for rail lines, and therefore, movable bridges are more common on railroads than on highways. There are three basic types of movable bridges: a lift bridge which had a tower at each end of the span with mechanisms to vertically raise the entire span; a swing bridge which was supported at its center by a pier but which could rotate in a horizontal manner; and a bascule lift which had one or two leaves which rolled backwards. Tennessee's survey inventoried only one vehicular movable metal truss bridge, a 1916 Pratt Pony swing span in Dyer County (#92, 23-NonHighway-1). The only other vehicular movable bridge in the state is the Market Street Bridge in Chattanooga, a steel arch with a double leaf bascule lift (#85, 33-SR008-09.58).

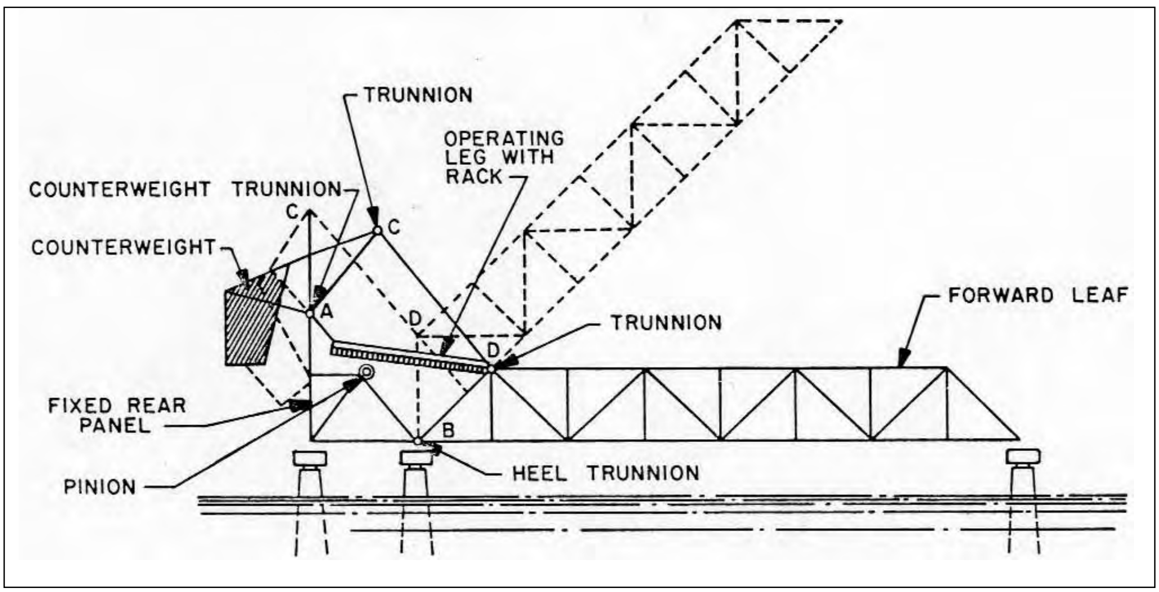
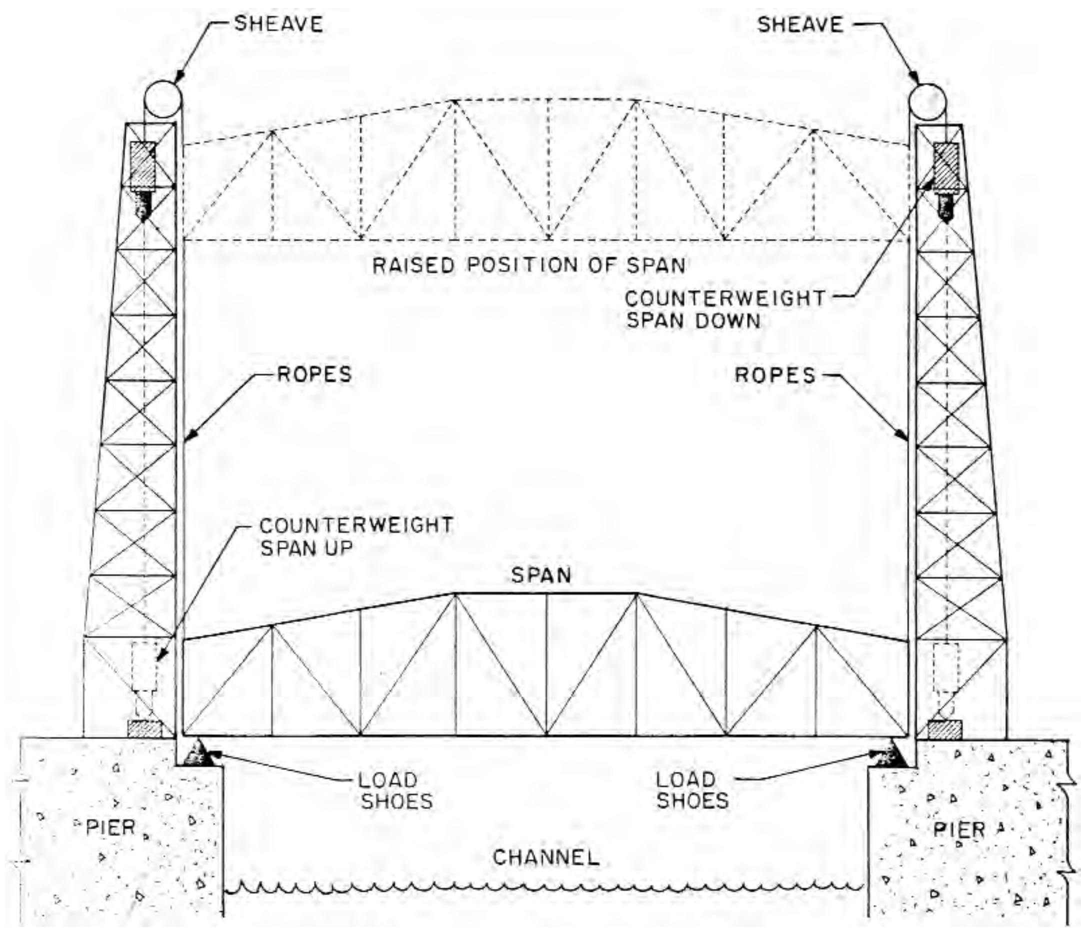


Figure V-16, Movable Bridge Types: bascule lift (top); lift bridge (next page, top); and a swing bridge (next page, bottom).


SHEAVE
SHEAVE
RAISED POSITION OF SPAN
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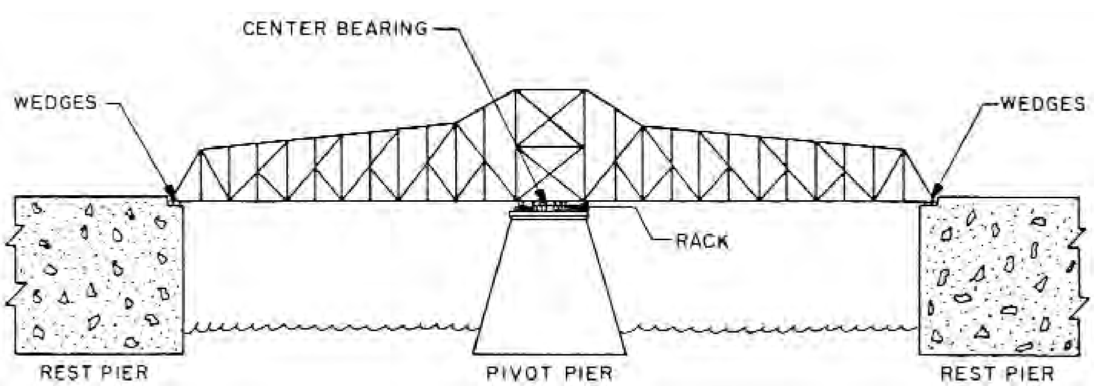
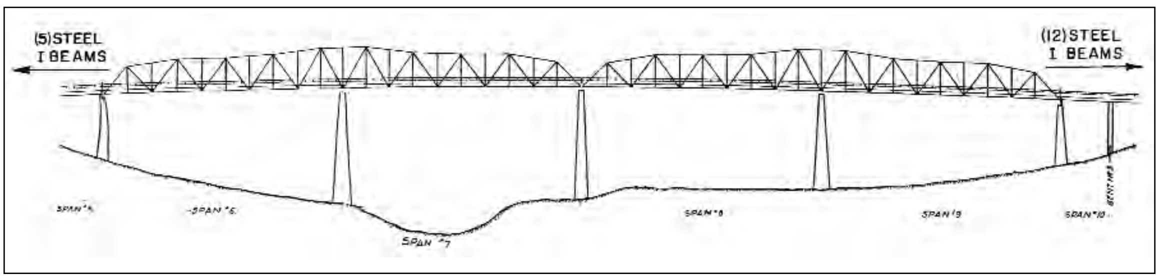
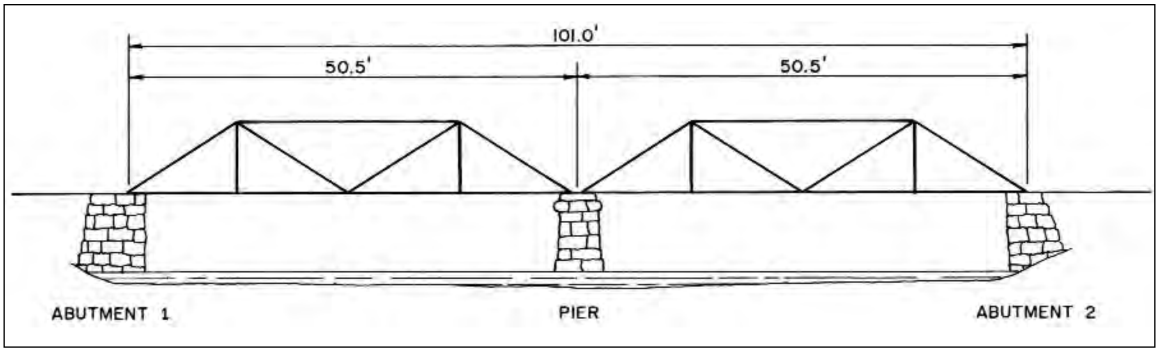

CENTER BEARING
WEDGES
WEDGES
RACK
REST PIER
PIVOT PIER
REST PIER

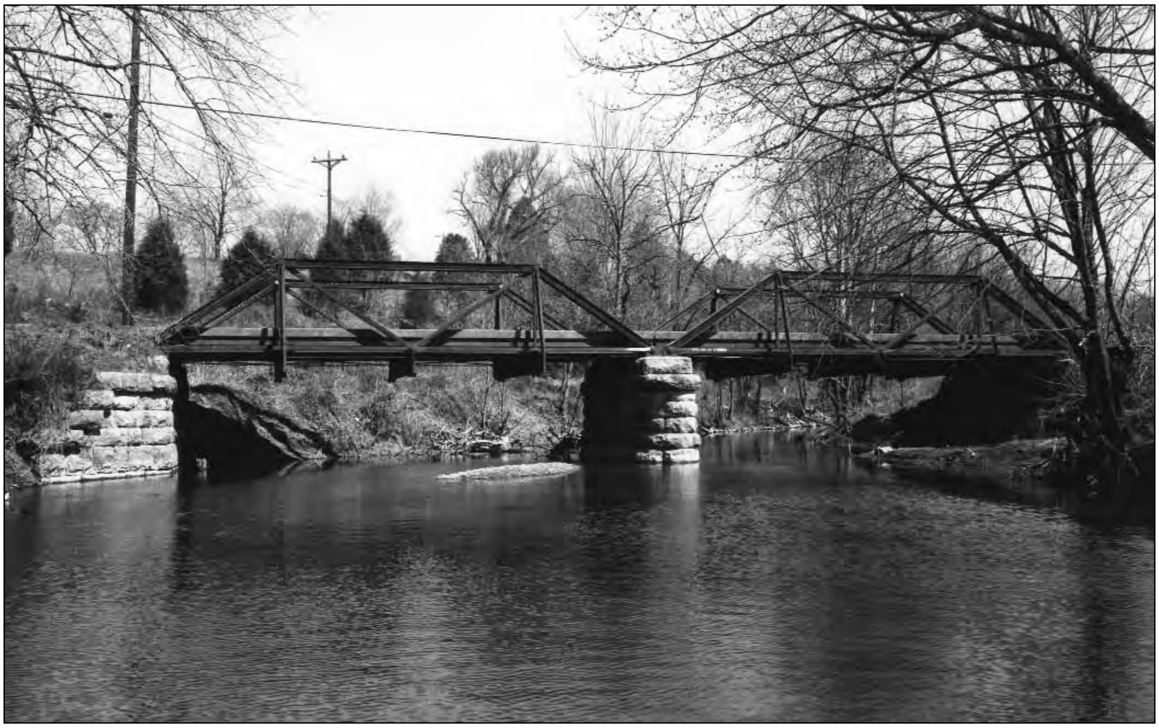
Simple and Continuous Trusses: Normally, a truss bridge refers to a simple truss; that is, a single self-contained span that functions independently of other spans. A simple span extends from pier to pier (or abutment). The vast majority of truss bridges contain simple trusses. This survey inventoried 502 truss bridges of which 484 are simple trusses.

Continuous trusses, a variation of the simple truss, enabled spans to be longer and stronger since each span anchored or balanced loads in adjoining spans by disturbing these loads throughout the entire truss superstructure rather than within just one span as in a simple truss. They could also minimize the amount of falsework needed. Continuous trusses, sometimes called cantilevered spans, formed multiple spans that functioned as one unit extending across piers. Cantilever actually referred to a method of erection in which workers began construction of the bridge from an end, and the built portion then supported new work. This system resulted in the center area being supported by—or suspended from—each end. All cantilevered trusses were continuous trusses but not all continuous trusses were cantilevered. Piers under continuous trusses functioned as secondary supports, while on a simple truss,

Figure V-17, Simple vs. Continuous Truss: Continuous (below) and simple (opposite page).







each pier functioned independently. Continuous trusses were usually taller at the point they crossed over the piers, which enabled them to resist certain stresses at these points that simple trusses did not have. Continuous trusses first appeared in the United States in the 1870s, primarily for longer structures. The 1889 Beason Creek Bridge, (36-NonHighway-2), only about 100 feet long, was unusually short. The state highway department's major river spans in the 1930s were more typical.

Tennessee's survey inventoried fourteen pre-1946 continuous trusses as well as four post-1945 continuous trusses. (The survey inventoried two TVA built bridges because TVA's period of significance spanned the 1945 cut-off date and inventoried one other post-1945 bridge scheduled for replacement.) Table V-03 contains a list of continuous trusses. All of these trusses were major river spans except for the Beason Creek Bridge in Hardin County (36-NonHighway-2). This short 1889 truss was entirely atypical of continuous trusses in length, scale, and massing. The next three bridges (in chronological sequence) can also be grouped together. The 1891 Frisco Bridge in Memphis (#14, 79-NonHighway-3), the 1895 Gay Street Bridge in Knoxville (#27, 47-03775-00.26) and the 1917 Harahan Bridge in Memphis (#77, 79-

TABLE V-03: CONTINUOUS TRUSSES

ELIGIBLE? # IN CH. 6	COUNTY	NUMBER	CROSSING	DATE BUILT	BUILDER	DESCRIPTION
Yes: #14	Shelby	79-NonHighway-3	Mississippi River	1888-92	Morison	1 4-span Double Warren Thru w/ 1 Warren Deck, Pin
No	Hardin	36-NonHighway-2	Beason Creek	1889	Brackett	1 3-span Pinned Pratt Pony
Yes: #27	Knox	47-03775-00.26	Tennessee River	1896-98	Youngstown	1 7-span Pinned Arch Pratt Deck
Yes: #77	Shelby	79-NonHighway-4	Mississippi River	1913-17	Modjeski	1 4-span modified Double Warren Thru with 1 Warren Deck, Pinned
No	Smith	80-SR024-13.36	Caney Fork River	1931-32	State	1 3-span Warren Through, Riveted
No	Knox	47-SR009-10.0N	Holston River	1932-33	State	1 3-span Parker/K Thru w/ 2 Warren Through, Riveted
No	Cocke	15-SR032-32.05	Douglas Lake	1933-34	State	1 3-span Parker/K Thru w/ 2 Warren Through, Riveted
Yes: #138	Greene	30-SR070-08.48	Nolichucky River	1934-35	State	1 3-span Warren Deck, Riveted
Yes: #139	Smith	80-SR025-11.32	Cumberland River	1934-36	State	1 3-span Parker/K Through with 6 Deck, Riveted
Yes: #140	Union	87-SR033-15.83	Clinch River	1934-36	TVA	2 2-span Warren Through, Riveted
No	Anderson	01-SR009-10.75	Clinch River	1938-40	State	1 3-span Warren Through, Riveted

No	Carter	10-SR037-17.59	Doe River	1939-41	State	1 3-span Warren Deck, Riveted
No	Grainger	29-00695-14.66	German Creek	1941	TVA	1 3-span Warren Through, Riveted
Yes: #152	Jefferson	45-SR092-09.21	French Broad River	1942-44	TVA	1 3-span Riveted Warren Through
No*	Carter	10-SR067-18.43	Watauga River	1946-48	TVA	1 3-span Warren Deck, Riveted
Yes: #155*	Shelby	79-I0055-12.00	Mississippi River	1949	Modjeski-Master	1 5-span Riveted Warren Through
No**	Sullivan	82-SR034-28.07	South Holston River	1950	TVA	1 2-span Riveted Warren Through
No***	Knox	47-SR009-10.0S	Holston River	1958	State	1 3-span Warren Deck, Riveted
NOT EVALUATED DUE TO POST-1945 CONSTRUCTION DATE						
Unknown	Dekalb	21-SR056-15.71	Caney Fork River	1948-49	Corps of Engineers	1 4-span Warren Deck, Riveted
Unknown	Knox	47-01124-02.65	Holston River	1949	Virginia	1 3-span Warren Through, Riveted
Unknown	Wilson	95-SR109-10.86	Cumberland River	1954	State	1 3- span Warren Through, Riveted
Unknown	Jefferson	45-I0040-14.68	French Broad River	1961	State	2 3-span Warren Deck, Riveted
Unknown	Dyer	23-I0155-00.00	Mississippi River	1974-76	State	1 3-span Warren Through, Riveted

* Listed on the National Register of Historic Places.

** Since TVA's period of significance spanned the cut-off date of 1945, the survey evaluated all TVA built bridges, regardless of construction date.

*** The survey evaluated this bridge because it was scheduled for replacement.

NonHighway-4) represent a municipality or a railroad's attempts to span major streams. While another bridge type could have spanned the Tennessee River in Knoxville, continuous trusses were virtually the only type that could have spanned the Mississippi at this point.

The Mississippi River bridges in Memphis (#14, 79-NonHighway-3 and #77, 79-NonHighway-4) contain an unusual design feature, bi-modal usage. Congress stipulated in the charter of the Frisco Bridge that the Kansas City & Memphis Railway and Bridge Company would provide an "independent roadway for wagons and animals on each approach of said bridge, and, for the

TABLE V-04: CONSTRUCTION DATES OF METAL TRUSS BRIDGES

DATES	NUMBER	DATES	NUMBER
1878-1900	44 (9%)	1921-1930	117 (24%)
1901-1910	96 (19%)	1931-1945	69 (14%)
1911-1920	169 (34%)	1945 +	7 (0.01%)

TABLE V-05: METAL TRUSS BRIDGES

TRUSS TYPE	SIMPLE			CONTINUOUS TABLE V-3		POST 1945 (NOT EVALUATED FOR ELIGIBLITY)	
	TABLE Ch. 5	TOTAL	ELIGIBLE	TOTAL	ELIGIBLE	SIMPLE	CONTINUOUS
Pratt	V-6	159	26	2	1	5	
Double Intersection Pratt (Whipple)	V-7	2	2				
Pratt Truss Leg Bedstead	V-8	13	4				
Pratt Half-hip	V-9	48	3				
Camelback	V-10	32	12				
Parker*	V-11	41	10	3	1	2	
Baltimore Petit	V-12	1	1				
Pennsylvania Petit	V-13	8	4				
K	V-14	2	2				
Warren**	V-15	172	14	12	4	1	4
Double Intersection Warren	V-16	2	2	2	2		
Bowstring Arch	V-17	1	1				
Kingpost	V-18	1	1				
Bailey	V-19	1	1				
SUBTOTALS		**483**	**83**	**19**	**8**	**8**	**4**
	EVALUATED 502 BRIDGES * * Includes 2 post-1945 Parker trusses ** Includes 6 post-1945 Warren trusses					NOT EVALUATED 12 POST-1945 BRIDGES	

entire length of the bridge proper, a roadway of sufficient width for wagons to pass each other without inconvenience" and that the bridge was to "be open for the passage of wagons and animals at all times except when trains are actually passing" (Fraser 1984:450). These lanes were apparently within the truss alongside the single rail track. However, the grade of the vehicular approach viaduct on the west (Arkansas) end was so steep, perhaps intentionally so, that wagon traffic does not seem to have utilized the bridge to a great extent. Also, rail traffic became increasingly heavy on this bridge which would have also limited its availability for vehicular traffic. The Harahan Bridge contained two lanes devoted exclusively to vehicular traffic cantilevered outward from the truss. When built, these structures were the only bridges of any type to span the Mississippi River south of the Ohio River confluence. The state did not build a true vehicular bridge spanning the Mississippi River at Memphis until 1949.

The remaining continuous truss bridges are fairly consistent in scale and design. The state built most of them. As a result of impoundment projects, TVA built five continuous trusses and the Army Corps of Engineers built one. In 1976 the state built the most recent continuous truss bridge (23-I0155-00.00) which is also the most recently built truss bridge in the state.

INDIVIDUAL TRUSS TYPES: This survey inventoried a total of 509 simple and continuous truss bridges built between 1877 and 1976. Of these, 494 were built prior to 1945. Of these 494 pre-1945 truss bridges, 480 are simple trusses and 14 are continuous trusses. As shown on Table V-04, most of these were built in the 1900 to 1930 period. An additional eleven simple and nine continuous trusses were built after 1945. The survey included three of these twenty post-1945 bridges. The survey evaluated two bridges that TVA designed because TVA's historical context spanned the 1945 cut-off date and one scheduled for replacement. (Appendix B contains a list of the post-1945 bridges.) Thus, the survey evaluated 502 metal truss bridges evaluated (495 pre-1945 and 7 post-1945).

During the nineteenth century, builders erected a tremendous variety of truss types, but by the late 1800s two basic trusses dominated, the Pratt and Warren. (Previous Figure V-01 contains a chart of truss types that was prepared by the Historic American Engineering Record.) Since most of Tennessee's bridges date from the twentieth century, they reflect this trend. See Table V-05. The basic Pratt design has many variations such as the Whipple, Pratt Truss Leg Bedstead, Pratt Half-hip, Camelback, Parker, Pennsylvania Petit, and Baltimore Petit. In Tennessee, of the 502 truss bridges evaluated, over 300 used Pratt or Pratt derivative designs. Builders used Warren designs on 185 of the bridges evaluated. The survey also inventoried Bowstring, Kingpost, and Bailey trusses. A discussion of each type, with a list of bridges in with that truss type as its main span, follows. Other bridges exist that are not on this list but which contain examples of these truss types as secondary spans.

Pratt: In 1844 Thomas and Caleb Pratt patented this truss as a timber or combination truss, but it accrued widespread popularity as a metal truss. However, after it evolved into a metal truss, it essentially became the "workhorse" of truss bridges as it and its variations became one of the predominant truss types built in the late nineteenth and early twentieth centuries. As on virtually all simple trusses, the end posts and top chords acted in compression while the bottom chords acted in tension. The verticals or posts supported the top chord and acted in compression except for the hip verticals which supported the deck and acted in tension. The diagonals, which supported the deck and live loads of moving traffic, acted in tension although, under certain conditions, live loads reversed the stresses causing the diagonals to act in compression.

TABLE V-06: BRIDGES WITH PRATT TRUSS AS MAIN SPAN

SIMPLE TRUSSES						
HISTORIC? # IN CH. 6	**COUNTY**	**BRIDGE NUMBER**	**CROSSING**	**DATE BUILT**	**BUILDER**	**SPANS**
Yes: #5	Bradley	06-A0184-00.64	Candies Creek	1877-78	Wrought Iron	1 Pony, Pin
Yes: #10	Meigs	61-A0022-01.04	Sewee Creek	1884	Champion	1 Through, Pin
Yes: #12	Bradley	06-A0163-00.19	Candies Creek	1886	Wrought Iron	3 Pony, Pin
Yes: #15	Carter	10-A0634-01.93	Doe River	1889	Keystone	1 Through, Pin
No	Marion	58-A0081-00.64	Sequatchie Rv	1890	King Iron	1 Through, Pin
Yes: #21	Montgomery	63-A0456-01.88	Sulphur Fork Cr	1890	Converse	1 Through, Pin
No	Sequatchie	77-02164-01.64	Sequatchie Rv	1890 est		1 Through, Pin
Yes: #24	Marion	58-A0502-00.36	Battle Creek	1891	King Iron	1 Through, Pin
No	Montgomery	63-01853-07.84	Barton's Creek	1893	Converse	1 Through, Pin
No	Montgomery	63-A0458-03.62	Yellow Creek	1893	Converse	1 Through, Pin
Yes: #25	Sequatchie	77-NonHighway-1	Sequatchie Rv	1893 ca	King Iron	1 Through, Pin
No	Rhea	72-02180-01.30	Piney Creek	1895 est		1 Through, Pin
No	Roane	73-A0391-00.14	Poplar Creek	1895 est		1 Through, Pin
Yes: #31	Sullivan	82-NonHighway-1	Beaver Creek	1898	New Columbus	1 Through, Pin
Yes: #32	Cheatham	11-01931-00.45	Harpeth River	1898, 1911 PG	Railroad	2 Through Pin, 1 Plate Girder
No	Maury	60-A0171-01.18	Fountain Creek	1899		1 Through, Pin
No	Greene	30-A0094-00.86	Lick Creek	1900 est		1 Through, Pin
No	Decatur	20-A0275-01.41	Turbo Creek	1901		1 Through, Pin
No	Maury	60-NonHighway-7	Globe Creek	1901		1 Through, Pin
No	Washington	90-01357-00.50	Nolichucky River	1901 & 1941	George Crafts	Through, 1 1901 Pin & 2 1941 Rivet
Yes: #36	Washington	90-A0900-00.97	Nolichucky River	1901-02	Southern	2 Thru Pin & 1 Pratt Pony Rivet
No	Giles	28-01891-00.02	Richland Creek	1902	Lomas/ Brackett	1 Through, Pin
No	Marshall	59-A0129-00.04	Big Rock Creek	1902	Champion	1 Through, Pin
Yes: #38	Stewart	81-NonHighway-2	South Cross Cr	1902	American	1 Through, Pin
No	Carter	10-02688-02.52	Wilbur Lake	1902; ’42		4 Deck, Rivet

No	Warren	89-A0530-03.40	N Prong Barren Fork River	1902-03		1 Through, Pin
Yes: #40	Hardin	36-NonHighway-1	Snake Creek	1903	Chattanooga	1 Through, Pin
No	Warren	89-A0143-02.55	N Prong Barren Fork River	1903	Cotton States	1 Through, Pin
Yes: #45	Bedford	02-A0048-00.38	North Fork Creek	1904	Nashville	1 Through, Pin
Yes: #47	Dickson	22-01864-02.86	Jones Creek	1904		1 Through, Pin
No	Williamson	94-A0066-00.64	Harpeth River	1904	W.T. Young	1 Through, Pin
No	Putnam	71-A0059-00.77	Martin Creek	1905 est		1 Through, Pin
No	Trousdale	85-A0109-00.14	Rocky Creek	1905 est		1 Pony, Pin
No	White	93-02206-06.14	Calfkiller River	1905 est		1 Through, Pin
Yes: #50	Coffee	16-P0001-00.02	Duck River	1906	Joliet	1 Through, Pin
No	Greene	30-02590-00.10	Lick Creek	1906	Converse	1 Through, Pin
No	Marion	58-A0191-00.00	Sequatchie Rv	1907	Converse	1 Through, Pin
Yes: #56	Smith	80-A0206-00.47	Lick Creek	1907	W.T. Young	1 Pony, Pin
No	White	93-02188-02.33	Caney Fork River	1907 & 1930	Nashville	1 Through Pin & 1 Thru Rivet
No	Campbell	07-A0137-01.98	Capuchin Creek	1908	Converse	1 Through, Pin
No	Greene	30-A0930-02.18	Lick Creek	1908	Converse	1 Pony, Pin
No	Sumner	83-B0090-01.08	Bledsoe Creek	1908	Joliet	1 Through, Pin
Yes: #61	Van Buren	88-NonHighway-1	Cane Creek	1908 & 1924	Nashville	1 Through Pin & 1 Warren Pony Rivet
No	Cocke	15-A0405-00.02	Pigeon River	1909	Chattanooga	2 Through, Pin
Yes: #63	Franklin	26-A0406-00.33	Wagner Creek	1909	Nashville	1 Through, Pin
No	Hamblen	32-A0507-02.73	Nolichucky Rv	1909	Converse	3 Through, Pin
No	Perry	68-A0302-03.45	Buffalo River	1909		1 Through, Pin
No	Blount	05-A0860-00.00	Nine Mile Creek	1910	Converse	1 Through, Pin
No	Marion	58-A0060-01.29	Sequatchie Rv	1910	Converse	1 Through, Pin
No	Campbell	07-02433-02.23	Elk Creek	1910 est		1 Through, Pin
No	Davidson	19-C0571-02.21	Long Creek	1910 est		1 Pony, Rivet
No	Greene	30-02590-00.42	Lick Creek	1910 est		1 Pony, Pin
No	Greene	30-A0894-01.09	Nolichucky Rv	1910 est		3 Through, Pin

No	Hancock	34-A0099-03.50	Panther Creek	1910 est		1 Pony, Pin
Yes: #68	Humphreys	43-A0340-00.01	Hurricane Creek	1911	Nashville	1 Through, Pin
No	Wayne	91-A0121-01.11	Forty-eight Creek	1911	Nashville	1 Through Pin & 1 Warren Pony Rivet
No	Cocke	15-A0386-00.01	Pigeon River	1912	Converse	3 Through, Pin
No	Davidson	19-D0752-01.60	Harpeth River	1912	Nashville	1 Thru, Rivet
Yes: #72	Polk	70-SR315-00.02	Hiwassee River	1912	Roanoke	5 Through, Pin
No	Sullivan	82-02593-03.21	S Fk Holston Rv	1912	Converse	4 Through, Pin
Yes: #73	White	93-A0285-00.95	Lost Creek	1912	Nashville	1 Pony, Pin
No	Hamilton	33-C0180-00.79	Falling Water Cr	1912 ca		1 Through, Pin
No	Greene	30-A0164-00.75	Roaring Fork Cr	1912 est		1 Pony, Pin
No	Greene	30-02358-00.63	Lick Creek	1913	Chattanooga	1 Through, Pin
No	Greene	30-A0912-01.95	Lick Creek	1913	Converse	1 Pony, Pin
No	Greene	30-B0091-00.96	Lick Creek	1913	Converse	1 Pony, Pin
No	Hickman	41-NonHighway-5	Duck River	1913	Nashville	2 Pinned Thru & 2 Riveted Warren Pony
Yes: #75	Sullivan	82-C0539-00.01	S Fk Holston Rv	1913	Converse	3 Through, Pin
Yes: #81	Meigs	61-A0028-00.23	Sewee Creek	1914	Champion	1 Through, Pin
No	Rutherford	75-NonHighway-1	W Fk Stones Rv	1914-16	Nashville	1 Through, Pin
No	Hardin	36-A0133-01.54	Indian Creek	1915	Nashville	1 Through, Pin
No	Jackson	44-A0118-00.01	Roaring River	1915	Vincennes	1 Through, Pin
No	Bledsoe	04-A0080-00.43	Sequatchie Rv	1915 est	Virginia	1 Pony, Pin
No	Cheatham	11-A0032-02.19	Sycamore Cr	1915 est		1 Through, Pin
No	Dyer	23-A0405-00.90	N Fk Forked Deer	1915 est		1 Through, Pin
No	Greene	30-A0946-00.12	Little Chucky Cr	1915 est		1 Through, Pin
No	Greene	30-SR340-00.48	Nolichucky Rv	1915 est		3 Through, Pin
No	Hamilton	33-03600-00.86	Chickamauga Cr	1915 est		1 Through, Pin
No	Hawkins	37-A0044-01.39	Branch	1915 est		1 Pony, Pin
No	Hawkins	37-A0183-00.70	Caney Creek	1915 est		1 Pony, Pin
No	Madison	55-A0629-05.37	Tuscumbia Rv	1915 est		1 Through, Pin
No	Obion	66-NonHighway-3	Stored	1915 est		1 Pony, Pin

No	Rutherford	75-NonHighway-5	Overall Creek	1915 est		1 Through, Pin
No	Sullivan	82-B0514-00.66	Sluice Branch	1915 est	Virginia	2 Through, Pin
No	Weakley	92-NonHighway-1	Spring Creek	1915 est	Vincennes	1 Through, Pin
No	Lincoln	52-NonHighway-2	Walker Creek	1916	Virginia	1 Pony & 2 Warren Pony Pin
No	Marion	58-A0189-00.70	Sequatchie Rv	1916	Converse	1 Through, Pin
No	Washington	90-02628-00.92	Cherokee Creek	1916		1 Pony, Pin
No	Anderson	01-A0027-00.38	Coal Creek	1916 est		1 Pony, Pin
No	Anderson	01-A0141-02.26	Hinds Creek	1916 est		1 Through, Pin
No	Gibson	27-A0349-01.82	Rutherford Fk Obion	1916 est		1 Pony, Rivet
No	Coffee	16-A0348-01.92	Duck River	1917	Nashville	1 Pony, Rivet
Yes: #92	Dyer	23-NonHighway-1	Lake	1917	Vincennes	1 Pin Swing Pony, Pin
No	Hamblen	32-02461-05.11	Nolichucky River	1917	Virginia	3 Through & 1 Pratt Pony, Pin
No	Polk	70-04356-02.45	Hiwassee River	1917 ca		2 Through, Pin
No	Hickman	41-NonHighway-3	Duck River	1918	Nashville	2 Through, Pin & Riveted
No	Morgan	65-A0191-03.08	Clear Fork River	1918	Nashville	1 Through, Pin
No	DeKalb	21-SR264-03.27	Smith Fork Cr	1919	Nashville	2 Through, Pin
No	Wayne	91-01773-06.97	Buffalo River	1919	Nashville	3 Through, Pin
No	Cumberland	18-A0279-03.96	Fall Creek	1920 est		1 Pony, Pin
No	Davidson	19-E0654-01.47	Mill Creek	1920 est		1 Pony, Rivet
No	Lincoln	52-A0073-03.25	Cane Creek	1920 est		1 Through, Pin
No	Scott	76-A0276-04.22	Clear Fork Creek	1920-21	J.I. & E.J. Foster	1 Thru & 1 Half-hip Pony, Pin
No	Robertson	74-A0126-02.14	S Fork Red Rv	1921	Champion	1 Through, Pin
No	Giles	28-01873-01.40	Elk River	1922	Nashville	3 Thru, Rivet
No	Dickson	22-A0047-00.18	Yellow Creek	1923	Nashville	1 Through & 1 Warren Pony, Rivet
No	Cheatham	11-SR001-04.76	Harpeth River	1924-26	State	1 Thru, Rivet
No	Cocke	15-00931-04.13	Pigeon River	1925		2 Through, Pin
No	Fentress	25-00452-02.04	Wolf River	1925	Nashville	1 Thru, Rivet

No	Bradley	06-A0779-02.67	Chestuee Creek	1925 est		1 Pony, Pin
No	Cocke	15-02540-05.74	French Broad Rv	1925 est		6 Through, Pin
No	Jackson	44-SR085-15.52	Jennings Creek	1926-27	Nashville	1 Through, Pin
No	Lauderdale	49-SR210-03.38	Forked Deer Rv	1926-28	State	1 Thru, Rivet
No	Obion	66-SR211-02.82	Obion River	1927-28	State	1 Thru, Rivet
No	Carter	10-SR037-22.86	Watauga River	1927-29	State	3 Thru, Rivet
No	Monroe	62-02340-05.20	Tellico River	1928	US Dept Ag	1 Pony, Rivet
No	Madison	57-SR005-10.79	S Fk Forked Deer	1928-29	State	1 Thru, Rivet
No	Sullivan	82-SR034-07.27	Holston River	1928-29	State	2 Thru, Rivet
No	Haywood	38-NonHighway-1	Hatchie River	1929		1 Thru, Rivet
No	Warren	89-SR286-00.64	Big Hickory Cr	1929	State	1 Thru, Rivet
No	Warren	89-A0403-00.71	Barren Fork Rv	1929		2 Thru, Rivet
No	Smith	80-A0138-00.18	Caney Fork River	1929-30	Steel and Lebby	3 Through & 1 Warren Pony, Rivet
No	Marion	58-SR002-16.56	Sequatchie Rv	1929-31	State	1 Thru, Rivet
No	Cheatham	11-SR049-09.53	Sycamore Cr	1930	State	1 Thru, Rivet
No	Monroe	62-02340-07.50	Tellico River	1930	US Dept Ag	2 Riveted Pony
No	White	93-02190-01.41	Caney Fork Rv	1930		1 Thru, Rivet
No	White	93-02208-01.21	Calfkiller River	1930		1 Thru, Rivet
No	White	93-A0174-00.02	Calfkiller River	1930		1 Thru, Rivet
No	Gibson	27-01585-03.43	Rutherford Fk Obion	1930 est		1 Pony, Rivet
No	Greene	30-B0431-01.01	Paint Creek	1930 est		1 Pony; Semi-deck, Rivet
No	Greene	30-B0431-01.96	Paint Creek	1930 est		1 Pony; Semi-deck, Rivet
No	Madison	57-00868-01.68	N Fk Forked Deer	1930 est		1 Thru, Rivet
No	Madison	57-01399-01.83	S Fk Forked Deer	1930 est		1 Thru, Rivet
No	Madison	57-A0112-00.05	Panther Creek	1930 est		1 Riveted Pony
No	Maury	60-NonHighway-6	Bigby Creek	1930 est		1 Thru, Rivet
No	Polk	70-A0344-00.43	Brush Creek	1930 est		1 Thru, Rivet
No	Shelby	79-C0010-01.37	West Beaver Cr	1930 est		1 Riveted Pony
No	Shelby	79-NonHighway-5	Big Creek	1930 est		1 Riveted Pony
No	Smith	80-NonHighway-1	Driveway/RR	1930 est	L&N RR	1 Pony, Pin

No	Smith	80-NonHighway-2	Driveway/RR	1930 est	L&N RR	1 Pony, Pin
No	Campbell	07-SR090-06.07	Clear Fork Creek	1930-31	State	1 Pony; Semi-deck, Rivet
No	Montgomery	63-SR013-01.54	Yellow Creek	1930-31	State	2 Thru, Rivet
Yes: #135	Monroe	62-02340-13.67	Tellico River	1931	US Dept of Agriculture	1 Pony; Semi-deck, rivet
No	DeKalb	21-SR264-03.94	Walker Creek	1931-32	State	1 Thru, Rivet
No	Dyer	23-SR078-07.93	Obion River	1934	State	1 Thru, Rivet
No	Benton	03-00905-00.81	Dry (Morgan) Cr	1935 est		1 Pony, Rivet
No	Dyer	23-A0623-00.17	Slough Creek	1935 est		1 Pony, Rivet
No	Houston	42-A0180-00.01	White Oak Cr	1935 est		1 Thru, Rivet
No	Jackson	44-A0060-05.69	Jennings Creek	1935 est		1 Thru, Rivet
No	Lawrence	50-01832-03.93	Blue Water Cr	1935 est		1 Thru, Rivet
No	Lawrence	50-A0645-00.44	Shoal Creek	1935 est		1 Thru, Rivet
No	Madison	57-00926-05.28	S Fk Forked Deer	1935 est		1 Thru, Rivet
No	Rutherford	75-NonHighway-3	Lytle Creek	1935 est		1 Riveted Pony
No	Cheatham	11-SR112-04.79	Sycamore Cr	1935-36	State	1 Thru, Rivet
Yes: #150	Fentress	25-SR028-29.24	Wolf River	1939-40	State	1 Thru, Rivet
No	Carter	10-01385-01.99	Watauga River	1940	Johnson City Foundry	2 Thru, Rivet
No	Carter	10-00743-01.76	Watauga River	1941	Johnson City Foundry	2 Thru, Rivet
No	Bedford	02-SR016-22.93	Duck River	1943	State	1 Thru, Rivet
No	Sevier	78-00687-13.36	Little Pigeon Rv	1944	State	1 Thru, Rivet
CONTINUOUS TRUSSES						
No	Hardin	36-NonHighway-2	Beason Creek	1889	Brackett	1 3-span Pratt Pony, Pin
Yes: #27	Knox	47-03775-00.26	Tennessee River	1896-98	Youngstown	1 7-span Arch Pratt Deck, Pin
NOT EVALUATED DUE TO POST-1945 CONSTRUCTION DATE						
Unknown	Dyer	23-SR020-06.89	Obion River	1946	State	1 Thru, Rivet
Unknown	Hardin	36-SR069-10.06	Hardin	1949	State	1 Thru, Rivet
Unknown	Haywood	38-SR076-08.97	Haywood	1949	State	1 Thru, Rivet
Unknown	Decatur	20-SR069-04.90	Decatur	1950	State	1 Thru, Rivet
Unknown	Hawkins	37-02604-09.47	Hawkins	1955		3 Thru, Rivet

Counters added to the center panel(s) compensated for this by acting in tension to carry live loads. Counters appeared only in panels with a diagonal although diagonals could be used alone. However, a Pratt truss with an odd number of panels distributed stresses differently than one with an even number of panels. For that reason, a truss with an odd number of panels must have two members in the center panel and both function as diagonals. Thus, theoretically, a Pratt with an even number of panels did not need counters in the center panels, but they normally did. The Kingston Springs Bridge (#32, 11-01931-00.45), originally designed for rail traffic, is an example of a Pratt with an even number of panels without counters.

The Surprise Bridge in Meigs County (#10, 61-A0022-01.04) contains another unusual variation on a Pratt truss, an additional horizontal member. This single rod acted in tension but it is unclear how it would have improved the stability of the truss (which is perhaps why builders rarely used it).

The Tennessee survey inventoried 161 pre-1946 bridges with Pratt trusses as their main span. See Table V-06. Of these 161 Pratts, 118 were through trusses, 41 were pony trusses, and 2 were deck trusses. Two of the 161 were continuous trusses. In addition, at least sixteen bridges contained Pratts as secondary spans but had another truss type as the main span.

Whipple-Murphy, Linville, or Double Intersection Pratt: First built in 1846, Squire Whipple patented this trusses in 1847. In 1863 John Murphy modified the design, and J. H. Linville made other modifications. The primary difference between it and a Pratt truss was that the counters and diagonals extended across two panels forming an overlapping triangular pattern. This enabled builders to lengthen the truss from 100-150 feet up to the 300-foot range. Although extremely popular from about 1865 to 1885, builders rarely used it after that, preferring the Camelback or Parker trusses, in part, because these trusses were less complex to erect. The inventory located two Double Intersection Pratts in Tennessee. See Table V-07.

Pratt Truss-Leg Bedstead or Bedpost: Reputedly, the railroads developed this truss in the 1880s for use in the Midwest where there was little rock available for masonry abutments

TABLE V-07: BRIDGES WITH DOUBLE INTERSECTION PRATT AS MAIN SPAN

ELIGIBLE? # IN CH. 6	NUMBER & COUNTY	CROSSING	DATE BUILT	BUILDER	DESCRIPTION
Yes: #11	76-A0040-08.03	South Fork Cumberland River	1885 est		1 Pinned Through
Yes: #17	52-A0487-04.85	Elk River	1889	King Iron	1 Pinned Through &1 Pratt Half-hip Pony

TABLE V-08: BRIDGES WITH TRUSS-LEG BEDSTEAD TRUSS AS MAIN SPAN

HISTORIC? # IN CH. 6	COUNTY	BRIDGE NUMBER	CROSSING	DATE BUILT	BUILDER	BOTTOM CHORDS
Yes: #19	Roane	73-A0330-00.84	Paint Rock Creek	1889	Champion	Angled
Yes: #29	Roane	73-A0323-02.19	Paint Rock Creek	1898	Champion	Angled
No	Decatur	20-A0257-00.85	White Creek	1900 ca	Champion	Angled
No	Lincoln	52-A0505-00.22	Bradshaw Creek	1900 est		Angles in End Panels
No	McMinn	54-A0235-00.05	Conasauga Creek	1903	Champion	Angled
No	Rhea	72-02281-01.53	Yellow Creek	1905 est		Angled
Yes: #65	Meigs	61-NonHighway-1	Big Sewee Creek	1909-10	Champion	Angled
No	Hamilton	33-NonHighway-1	Wolftever Creek	1910 est		Angled
No	Roane	73-A0320-02.05	Paint Rock Creek	1910 est		Angled
No	Meigs	61-A0127-01.01	Gunstocker Creek	1915	Champion	Angled
No	McMinn	54-A0298-00.89	Chestuee Creek	1915 est	Champion	Angled
No	McMinn	54-A0509-00.04	Rodgers Creek	1915 est	Champion	Angled
Yes: #95	Meigs	61-NonHighway-2	Big Sewee Creek	1917	Champion	H-beams in End Panels

NOTE: All bridges contain one Pratt pony truss span. All bridges have pinned connections. None have secondary truss spans.

(Weitzman 1980:68). Builders used it from the 1880s through the 1910s. Since the design eliminated substantial abutments, it appeared inexpensive, but the trusses contained several inherent design problems.

In this variation of the Pratt, vertical endposts (not inclined endposts) extended below the bottom chord and into the ground where they were attached to timber or concrete bedding, forming an abutment. In theory, the dead load weight kept the bridge in place. Unlike other trusses, these legs carried the thrust of the fill as well as the live and dead load of one-half of the span. For this reason the truss needed to have stiff lower chords that could resist this thrust. However, the original design placed the lower chord in tension, but these thrusts sometimes caused either the entire lower chord or the end panels only to act in compression. A design variation that tried to compensate for the generally light composition of tension members was to angle the bottom chord down below the deck level and to construct it of heavier materials so that it could better withstand these pressures. For instance, H-bars form the bottom chord on the Ten Mile Road Bridge in Meigs County (#65, 61-NonHighway-1). On the Surprise Bridge in Meigs County (#95, 61-NonHighway-2), the bottom chord in the center panel contains paired eyebars while the flanking panels are I-beams. This is quite different from the paired eyebars normally used as the bottom chord for pinned bridges of that period. Also, the exposed legs rusted easily, and the freeze-thaw cycles combined with pressures from the ground cause this type of bridge to wash out easily (*Engineering News* 1909:439; Luten 1902:303-304). Some Tennessee counties have encased several truss legs in concrete, creating the appearance of a traditional abutment. Unfortunately this "repair" interfered with the way the original truss design functioned and usually made it less efficient.

In theory, any truss type such as a Warren or any bridge type such as a concrete beam could have legs, often called Leg Bridges. However, in Tennessee all the leg trusses inventoried contained pin-connected Pratts. One bridge, the 1900-01 Mulberry Bridge in Lincoln County (#35, 52-NonHighway-3) contained two secondary spans that contained a hybrid Pratt-Bedstead that used riveted connections. While not rare, builders did not use this truss type extensively. As shown on Table V-08, the survey inventoried thirteen truss-leg bridges in Tennessee.

Pratt Half-hip: In this variation of a Pratt, the end panels did not contain a vertical, and the end posts did not incline at the same degree as the diagonals. However, each panel measured the same length. The survey inventoried forty-eight examples in Tennessee; see Table V-09. Five other bridges that did not have half-hips as their main span had pin-connected Pratt Half-hip pony trusses as secondary spans.

Pratt with Inclined (or Polygonal) Upper Chord--Camelback and Parker Trusses: The greater the distance between the top and bottom chords of a truss resulted in a corresponding improved resistance to stresses, allowing builders to lengthen the truss span. Using this concept, engineers added an inclined upper chord to the basic Pratt truss, creating the Camelback and Parker trusses. Further variations and refinements led to Petit and K trusses. All of these truss types are quite similar in design and basically overlap. Writers in some early twentieth century bridge literature do not use the terms Camelbacks or Parkers but rather called the trusses Pratts with Inclined (or Polygonal) Top (or Upper) Chords. Some of the literature differentiated between Camelbacks and Parkers while other texts seem to have treated them the same.

Camelback trusses had a polygonal top chord of exactly five slopes that included the two end posts, the flat center, and the slopes on either side connecting the two. Changes in slope occurred at the hip vertical and at a subsequent post or vertical. On most bridges in Tennessee, this slope spanned the two panels between the hip vertical and third vertical. Some shorter Camelback trusses had a one-panel slope spanning only the panel between the hip vertical and second vertical. Builders seem to have used the one-panel variation when the span was somewhat too long for a Pratt but not long enough for a Camelback. The Halls Mill

Bridge in Robertson County (#49, 74-00979-01.58) is an example of a Camelback with a one panel slope. On the other hand, engineers could increase the slope to span three panels for longer spans, such as on the Walnut Street Bridge (#20, 33-03544-00.12). Again, this slope variation reflects the principle that the greater the depth between the chords, the longer the truss could be.

TABLE V-09: BRIDGES WITH PRATT HALF-HIP TRUSS AS MAIN SPAN

HISTORIC? # IN CH. 6	COUNTY	NUMBER	CROSSING	DATE BUILT	BUILDER	SPANS
Yes: #26	Bradley	06-A0165-00.21	Candies Creek	1895	New Columbus	3, Pin
No	Williamson	94-A0243-00.35	Harpeth River	1895 est		2, Pin
No	McMinn	58-A0212-00.77	Owens Springs Br	1900		1, Pin
No	Greene	30-A0163-00.04	Roaring Fork Creek	1905 est		1, Pin
No	McMinn	58-A0510-02.56	Battle Creek	1906	Converse	1, Pin
No	Greene	30-A0082-00.34	Lick Creek	1906 est	Champion	1, Pin
No	Polk	70-04313-13.67	Conasauga Creek	1907 ca	Champion	1, Pin
Yes: #60	Greene	30-A0934-00.16	Lick Creek	1908	Converse	1, Pin
No	McMinn	54-NonHighway-1	Cane Creek	1908		1, Pin
Yes: #64	Grainger	29-A0051-00.06	Flat Creek	1909	Converse	1, Pin
No	Carter	10-A0925-00.11	Stoney Creek	1910 est		1, Pin
No	Greene	30-A0101-00.01	Lick Creek	1910 est	Champion	1, Pin
No	Greene	30-A0106-00.01	Lick Creek	1910 est	Champion	1, Pin
No	Greene	30-A0155-02.00	Roaring Fork Creek	1910 est	Champion	1, Pin
No	Greene	30-A0204-00.73	Lick Creek	1910 est	Champion	1, Pin
No	Greene	30-A0916-01.57	Lick Creek	1910 est	Champion	1, Pin
No	Greene	30-A0973-01.35	Little Chucky Creek	1910 est	Champion	1, Pin
No	Monroe	62-A0301-00.20	Cane Creek	1910 est		1, Pin
No	Morgan	65-A0271-00.13	Beach Fork Creek	1910 est		1, Pin
No	Robertson	74-A0007-03.22	Elk Fork Creek	1910 est		1, Pin
No	Grainger	29-A0410-01.87	Richland Creek	1911	Converse	1, Pin
No	Grainger	29-02548-01.80	Indian Creek	1912	Converse	1, Pin

No	Greene	30-B0061-02.83	Lick Creek	1912	Converse	1, Pin
No	McMinn	54-A0249-00.40	Chestuee Creek	1912	Champion	1, Pin
No	Carter	10-A0144-00.01	Sinking Creek	1913	Converse	1, Pin
No	Carter	10-A0299-00.01	Storage	1913	Converse	1, Pin
No	Grainger	29-A0026-00.38	Williams Creek	1915 est		1, Pin
No	Greene	30-A0182-01.12	Lick Creek	1915 est		1, Pin
No	Knox	47-D0696-00.83	Limestone Creek	1915 est		1, Pin
No	Lincoln	52-01902-03.48	Swan Creek	1915 est		1, Pin
No	McMinn	54-A0201-00.20	Conasauga Creek	1915 est	Champion	1, Pin
No	Morgan	65-A0001-00.14	Crab Orchard Creek	1915 est		1, Pin
No	Morgan	65-A0173-02.33	Bone Camp Creek	1915 est	Champion	1, Pin
No	Polk	70-A0278-00.22	Four Mile Creek	1915 est	Champion	1, Pin
No	Robertson	74-NonHighway-2	Storage	1915 est	Vincennes	1, Pin
No	Morgan	65-02394-04.50	Greasy Creek	1918 est	Champion	1, Pin
No	Greene	30-02523-01.46	Little Chucky Creek	1919	Champion	1, Pin
No	Greene	30-A0725-01.19	Cove Creek	1919	Champion	1, Pin
No	McMinn	54-A0422-00.06	Oostanaula Creek	1920 ca	Champion	1, Pin
No	Bradley	06-A0347-00.53	Branch	1920 est		1, Pin
No	Bradley	06-NonHighway-1	Mill Creek	1920 est		1, Pin
No	Grainger	29-A0380-01.24	Buffalo Creek	1920 est		1, Pin
No	Marshall	59-A0117-00.82	Rich Creek	1920 est		1, Pin
No	Morgan	65-A0144-02.28	White Creek	1920 est		1, Pin
No	Robertson	74-A0130-02.10	Honey Run Creek	1920 est		1, Pin
No	Greene	30-02535-01.66	Lick Creek	1923	Champion	1, Pin
No	Stewart	81-A0305-05.26	N Fk Leatherwood Br	1925 est		1, Rivet
No	Morgan	65-02386-02.15	Emory River	1930 est		1, Pin

C. H. Parker developed the Parker truss which had more than five slopes. Since additional slopes increased the height of the truss, builders could extend the length of the span. Thus, a Parker's primary advantage over a Camelback was its greater length. Although each panel length of the upper chord was straight, builders could place the joints to form an elliptical arch, a variation known as an "elliptical truss" or "curved-chord truss." Many engineers considered an elliptical upper chord more aesthetically attractive than a typical Parker truss. A few elliptical examples remain in Tennessee such as the Old Bordeaux Bridge in Davidson County (#16, 19-NonHighway-2). The length of the span dictated the number of flat topped panels (for Parkers, Camelbacks, and Pennsylvania Petits). In theory, if the span contained an odd (or even) number of panels, it contained a corresponding odd (or even) number of flat panels in the center; a concept related to the symmetrical nature of the truss.

Beginning in the late 1920s, the state highway department used a variation on some Parkers and Camelbacks and even one Warren, a hybrid-K design. The most common variation used the K design in the two center panels creating a "diamond" appearance. On a few bridges, the central four or six panels contained the K feature.

TABLE V-10: BRIDGES WITH CAMELBACK TRUSS AS MAIN SPAN

HISTORIC? # IN CH. 6	COUNTY	NUMBER	CROSSING	DATE BUILT	BUILDER	DESCRIPTION (Panel Incline)
Yes: #20	Hamilton	33-03544-00.12	Tennessee River	1889-91	Thacher	6 Thru, Pin, Petit Variation (3)
No	Marion	58-A0185-00.51	Sequatchie Rv	1897	King Iron	1 Thru, Pin (2)
No	Cheatham	11-A0360-00.31	Harpeth Rv	1898	Groton	1 Thru, Pin (2)
No	Monroe	62-00468-14.41	Citico Creek	1900 est		1 Thru, Pin (2)
No	Sullivan	82-B0383-00.24	Horse Creek	1900 est		1 Thru, Pin (2)
No	Lincoln	52-NonHighway-1	Elk River	1900-01	American	1 Thru, Pin, Petit Variation (2)
Yes: #35	Lincoln	52-NonHighway-3	Elk River	1901	American	1 Thru & 2 Pratt Pony, Pin, Petit Variation (2)
No	Perry	68-A0152-00.92	Buffalo River	1901		1 Thru, Pin (2)
Yes: #39	Sullivan	82-A0872-00.05	South Fork Holston River	1902-03	Cope	1 & 1 Pratt Through, Pin (2)
Yes: #42	Humphreys	43-NonHighway-1	Duck River	1903	Nashville	2 Thru, Pin, Petit Variation (1)
Yes: #43	Maury	60-NonHighway-2	Duck River	1903-04	Young (NBC)	1 Thru, Pin, Petit Variation (2)
Yes: #49	Robertson	74-00979-01.58	Sulphur Fk Cr	1905	Champion	1 Thru, Pin (2)
Yes: #54	Perry	68-NonHighway-2	Buffalo River	1906	Virginia	1 Thru & 1 Pratt Pony, Pin (2)
Yes: #57	Smith	80-NonHighway-3	Caney Fork River	1907-08	Chicago	1 Thru & 1 Pratt Half-Hip Pony, Pin (2)

No	Carter	10-A0797-00.01	Elk River	1908	Converse	1 Thru, Pin (2)
No	Robertson	74-A0016-00.07	Red River	1910	Champion	1 Thru, Pin (2)
No	Campbell	07-A0366-01.76	Big Creek	1910 est		1 Thru, Pin (2)
No	Cocke	15-A0385-00.01	Pigeon River	1910 est		1 Thru, Pin (2)
No	Perry	68-A0177-01.15	Buffalo River	1912-13		1 Thru, Pin (2)
Yes: #84	Perry	68-NonHighway-1	Buffalo River	1914	Vincennes	1 Thru & 2 Pratt Pony, Pin (2)
No	Polk	70-02309-02.54	Ocoee River	1914	Champion	2 Thru, Pin (1)
No	Campbell	07-02470-06.55	Cedar Creek	1915 est		1 Thru, Pin (2)
No	Fentress	25-SR085-08.50	E Fk Obey Rv	1915 est		1 Thru, Pin (2)
Yes: #87	Anderson	01-A0088-03.53	Clinch River	1916	Virginia	1 & 2 Pratt Thru; 1 Pratt Pony; Pin (2)
No	Washington	90-A0969-00.02	Limestone Cr	1916		1 Thru, Pin (2)
Yes: #91	Grainger	29-A0025-02.62	Hogskin Cr	1916-17	Nashville	1 Thru, Pin (2)
No	Hamilton	33-SR002-14.85	Chickamauga Creek	1929	State	1 Thru, Rivet, Central K (1)
Yes: #127	Morgan	65-00444-09.58	Emory River	1929	Atlantic	3 Through, Pin (1 & 2)
No	Morgan	65-02378-07.84	Emory River	1929	Atlantic	2 & 1 Pratt Through, Pin (1)
No	Davidson	19-SR100-06.37	Harpeth River	1930	State	1 Thru, Rivet, Central K (1)
No	Shelby	79-SR014-07.11	ICG/RR & Nonconnah Cr	1930	State	1 Thru, Rivet, Central K (1)
No	Hamilton	33-SR002-09.48	Railroad Tracks	1938	State	1 Thru, Rivet, Central K (1)

Since the multi-sloped top chord of the Parker was generally deeper than the five-sloped Camelback, Parker trusses were generally longer. Tennessee's Camelback trusses, with two exceptions, range in length from about 125 to 200 feet. The state's Parker trusses all exceed 150 feet in length and about one-fourth exceed 300 feet.

Table V-10 contains information about Camelback trusses, and Table V-11 contains information about Parker trusses inventoried in Tennessee.

Petit Trusses: The Petit truss, another Pratt variation for longer lengths, contained panels subdivided by subdiagonals (or subties) that ran from the mid-point of the main diagonals either

TABLE V-11: BRIDGES WITH PARKER TRUSS AS MAIN SPAN

HISTORIC? # IN CH. 6	COUNTY	NUMBER	CROSSING	DATE BUILT	BUILDER	DESCRIPTION K Variation (K-# Panels)
Yes: #16	Davidson	19-NonHighway-2	S Harpeth River	1889	Mount Vernon	1 Parker Through, Pin
No	Marion	58-02128-00.85	Sequatchie River	1905 est		1 Parker Through, Pin
No	Lincoln	52-A0414-00.05	Elk River	1907	Vincennes	1 Pinned Parker Thru & 1 Riveted Warren Pony
Yes: #58	Davidson	19-03245-01.47	Cumberland River	1907-09	Foster Creighton	1 Parker & 2 Camelback Through, Pin
No	Davidson	19-03258-00.40	Cumberland River	1907-10	Foster Creighton	1 Parker & 2 Camelback Through, Pin
No	Polk	70-01154-02.67	Ocoee River	1909	Converse	1 Parker Through & 2 Pratt Pony, Pin
Yes: #70	Polk	70-01223-02.53	Hiwassee River	1911	Joliet	1 Parker & 2 Pratt Through, Pin
No	Washington	90-A0912-00.22	Nolichucky River	1916		1 Parker Through, Pin
No	Warren	89-SR001-26.63	Caney Fork River	1924-25	State	2 Parker Through, Rivet
Yes: #112	Warren	89-04261-11.60	Collins River	1924; 1889	Nashville; Mt Vernon	2 Parker Through, Rivet
Yes: #122	Davidson	19-SR045-02.03L	Cumberland River	1927-29	Freeland, American	1 Parker & 2 Camelback Thru, Rivet; K-2 Panels
No	Loudon	53-SR002-06.75	Tennessee River	1927-29	State	6 Parker Through, Rivet
No	Bedford	02-SR010-09.96	Duck River	1928-29	State	1 Parker Through, Rivet; K-2 Panels
No	Hamilton	33-SR017-08.07	Chickamauga Creek	1928-29	State	1 Parker Through, Rivet; K-2 panels
No	Meigs	61-SR058-05.22	Hiwassee River	1928-29	State	1 Parker & 2 Pratt Through, Rivet; K-2 panels

No	Montgomery	63-SR012-15.41L	Red River	1928-29	State	1 Parker Through, Rivet; K-2 panels
No	Clay	14-SR052-19.32	Cumberland River	1928-30	State	1 Parker & 4 Warren Thru-PTC, Rivet; K-2 panels
Yes: #125	Henry	40-SR076-30.34	Tennessee River	1928-30	State	3 Parker Through, Rivet; K-2 panels
No	Stewart	81-SR076-10.31	Cumberland River	1928-30	State	2 Parker & 1 Pratt Through, Rivet; K-2 panels
No	Washington	90-01369-05.57	Watauga River	1929		4 Parker Through, Rivet; K-2 panels
No	Davidson	19-SR024-20.71	Stones River	1929-30	State	1 Parker Through, Rivet
No	Hickman	41-SR048-13.60	Duck River	1929-30	State	1 Parker Through, Rivet; K-2 panels
Yes: #129	Marion	58-SR002-21.19	Tennessee River	1929-30	State	2 Parker & 2 Warren Thru-PTC, Rivet; K-2 panels
Yes: #130	Roane	73-SR058-11.92	Tennessee River	1929-30	State	1 Parker & 2 Warren Thru-PTC, Rivet; K-2 panels
No	Wilson	95-SR010-20.91	Cumberland River	1929-30	State	2 Parker Through, Rivet; K-2 panels
No	Cheatham	11-SR049-05.05	Cumberland River	1930-31	State	1 Parker & 2 Pratt Through, Rivet; K-2 panels
No	Roane	73-SR001-14.91	Clinch River	1930-31	State	1 Parker & 3 Warren Thru-PTC, Rivet; K-2 panels
No	Washington	90-SR034-23.04	Watauga River	1931	State	1 Parker & 2 Warren Thru-PTC, Rivet; K-2 panels
No	Cocke	15-SR009-10.56	French Broad River	1931-32	State	3 Parker & 1 Pratt Through, Rivet; K-2 panels
No	Lincoln	52-SR015-22.46	Elk River	1932	State	1 Parker Through , Rivet; K-2 panels
No	Cheatham	11-SR049-00.45	Harpeth River	1932-33	State	1 Parker & 1 Pratt Through, Rivet; K-2 panels

No	Jefferson	45-SR009-16.52	French Broad River	1932-33	State	1 Parker & 4 Deck, Rivet; K-4 panels
No	Rutherford	75-SR010-19.81	Stones River	1934	State	1 Parker Through, Rivet; K-4 panels
No	Cheatham	11-01933-08.55	Harpeth River	1938	MeCann Nabors	1 Parker & 1 Warren Thru, Rivet
No	Sullivan	82-SR075-00.22	Holston River	1938	State	3 Parker & 2 Warren Thru-PTC, Rivet; K-4 panels
No	Maury	60-SR007-15.24	Duck River	1939	State	1 Parker Through, Rivet; K-4 panels
No	Bradley	06-SR002-21.13	Hiwassee River	1939-40	State	1 Parker Through, Rivet; K-2 panels
Yes: #154	Pickett	69-SR042-03.27	Obey River	1943-46	US Corps Engineers	3 Parker & 3 Warren Through, Rivet; K-6 panels
No	Humphreys	43-A0316-00.15	Duck River	1944	TVA	1 Parker Through, Rivet
No*	Dekalb	21-SR026-24.58	Caney Fork River	1948	US Corps Engineers	5 Parker Through, Rivet
No*	Humphreys	43-SR013-07.72	Duck River	1949-51	State	1 Parker Through, Rivet
CONTINUOUS TRUSSES						
No	Knox	47-SR009-10.03N	Holston River	1932-33	State	1 3-span Parker & 2 Warren Through, Rivet; K-6 panels
No	Cocke	15-SR032-32.05	Douglas Lake	1933-34	State	1 3-span Parker Through, Rivet; K-4 panels
Yes: #139	Smith	80-SR025-11.32	Cumberland River	1934-36	State	1 3-span Parker Through & 6 Deck, Rivet; K-6 panels
NOT EVALUATED DUE TO POST-1945 CONSTRUCTION DATE						
Unknown	Hickman	41-SR050-16.02	Duck River	1951	State	1 Parker Through, Rivet; K-4 panels
Unknown	Davidson	19-SR045-02.03R	Cumberland River	1967-70	State	1 Parker & 2 Camelback Through, Rivet; K-4 panels

* The survey evaluated this bridge because it was scheduled for replacement.

TABLE V-12: BRIDGES WITH BALTIMORE PETIT TRUSS AS MAIN SPAN

ELIGIBLE? # IN CH. 6	NUMBER & COUNTY	CROSSING	DATE BUILT	DESCRIPTION
Yes: #23	52-A0494-00.22 Lincoln	Elk River	1891	1 Pinned Baltimore Petit Through & 2 Pratt Half-hip Pony

TABLE V-13: BRIDGES WITH PENNSYLVANIA PETIT TRUSS AS MAIN SPAN

HISTORIC? # IN CH. 6	COUNTY	NUMBER	CROSSING	DATE BUILT	BUILDER	SPANS
Yes: #37	Giles	28-A0153-01.95	Elk River	1902	King Iron	1 Through, Pinned
No	Hickman	41-NonHighway-2	Duck River	1903	Nashville	1 Through, Pinned
Yes: #41	Maury	60-NonHighway-1	Duck River	1903	Nashville	1 Through & 1 Pratt Half-hip Pony, Pinned
Yes: #55	Hickman	41-NonHighway-1	Duck River	1907	Nashville	1 Through & 1 Pratt Through, Pinned; 1 Warren Pony, Riveted
No	Hickman	41-NonHighway-4	Duck River	1907	Nashville	1 Through, Pinned
No	Perry	68-00921-01.02	Buffalo River	1914	Nashville	1 Through, Pinned
Yes: #90	Washington	90-B0586-00.00	Watauga River	1916	Nashville	1 Through, Pinned
No	Hawkins	37-01197-03.81	Holston River	1917	Nashville	2 Through & 2 Pratt Pony, Pinned

down to the bottom chord or up to the top chord. For long panels, builders could extend light vertical struts from the mid-point of the diagonal to the top chord for additional support.

In 1871, builders first used this variation on a Pratt truss, called a *Baltimore Petit*. The Baltimore and Ohio Railroad used it extensively on its line, hence its name. Its popularity peaked in the late 1800s, and its use largely disappeared after World War I. Tennessee's survey inventoried only one Baltimore Petit, and that of a modified design, as shown on Table V-12. This bridge, the Hobbs Bridge in Lincoln County (#23, 52-A0494-00.22), had subties of paired eyerods (in tension) which dropped at mid-point from the diagonal. A substrut of paired angles with lacing, acting in compression and supporting the top chord, extended upward from this point. In the end panels, a substrut extended from the bottom chord to the mid-point of the end post. While on first glance, this span appeared to contain ten twenty-foot panels, it actually contained five forty-foot panels. The subdivision of the panels allowed builders to extend this basic Pratt to 200 feet with panel lengths of 40 feet while comparable Pratt trusses of this period generally spanned 100-120 feet and contained 15-20 foot panels.

Engineers working on the Pennsylvania Railroad about 1875 applied the Petit subdivisions to the Parker truss, creating the *Pennsylvania Petit*. Around the turn of the century, many engineers considered it the standard design for longer trusses, but its use declined after World War I. In the late 1910s, builders could erect standardized riveted Parkers of comparable lengths more easily than they could the relatively complex Petit designs. Tennessee's survey inventoried eight Pennsylvania Petit trusses, all a modified design. Table V-13 contains a discussion of these trusses. The Nashville Bridge Company erected all but one of these trusses. Each truss is different, but these bridges had subties as well as substruts. At least two had struts extending diagonally from the midpoint of the diagonals outward to the verticals which further subdivided the panels. The trusses contained panels in the forty-foot range.

The survey identified five spans with five-sloped polygonal top chords with sub-members as a Camelback did and enumerated them as modified Camelbacks rather than as Pennsylvania Petits. Again, this indicates that early twentieth century engineers tended, to some extent, to consider Camelbacks and Parkers as interchangeable designs rather than as distinct types.

K Truss: The K truss, another variation of the Pratt truss, had its origins in an 1830 patent by Stephen H. Long, but builders rarely used it after his death. Its use in the 1910s on the Quebec Bridge, now an International Civil Engineering Landmark, somewhat revived its popularity. Even so, engineers used the K truss only to a limited extent and then for longer spans.

The distinctive arrangement of members, which form a "K" in each panel, gave the truss its name. In this Pratt variation, diagonal compression members extending from the mid-point of the vertical to the top and bottom chords at the connection created a forward or backward K configuration. Such an arrangement of members allowed tall verticals which increased the truss's overall height (and length) while breaking the height of the vertical which allowed it to be stiffer and to resist stresses more efficiently. However, a true K truss had vertical end posts that generally did not distribute stresses as well as inclined end posts. Designers of the two examples in Tennessee tried to solve this problem by using inclined end posts. Another problem involved the large number of individual members. More individual members in a truss created a greater possibility of mistakes in the shop fabricating the steel members as well as in the field erecting the bridge. This large amount of metal also increased the cost of the

TABLE V-14: BRIDGES WITH K TRUSS AS MAIN SPAN

ELIGIBLE? # IN CH. 6	NUMBER & COUNTY	CROSSING	DATE BUILT	BUILDER	DESCRIPTION
Yes: #108	63-00973-03.88 Montgomery	Cumberland River	1922-25	State Highway Department	1 K Through & 2 Warren-PTC Through, Riveted
Yes: #119	44-SR056-10.96 Jackson	Cumberland River	1926-28	State Highway Department	1 K Through & 2 Warren-PTC Through, Riveted

bridge, making a Parker truss with its comparatively simple design more cost effective for most lengths.

Table V-14 contains a chart showing the two K trusses inventoried in Tennessee. However, as discussed previously, rather than using a true K truss, some designers incorporated the K configuration into the central panels on other truss types in an effort to combine the advantages of both truss types. Twenty-nine bridges (twenty-four Parkers, four Camelbacks, and one Warren) contained this hybrid K design.

Warren: A Belgian engineer named Neuville originally patented this truss in France in 1838 (DeLony 1994:11). However, British engineer James Warren with Willoughby Monzani developed an improved version in 1848, hence its name. The original truss design included diagonal members in a "W" pattern, which combined with the chords, formed equilateral triangles. However, later trusses did not usually feature equilateral triangles. As with most trusses, the top chords and end posts acted in compression, and the bottom chords acted in tension. The diagonals alternately functioned in compression and tension as loads passed. Builders did not widely use this truss in the United States until the late 1800s after which it became extremely popular.

A later variation involved subdividing the panels (as in the Petits). In this variation on a Warren, verticals extended between chords and could either function as posts in compression supporting the top chord or as hangers in tension carrying the deck. Only two of the Warren trusses in Tennessee did not contain some arrangement of verticals, the Morris Mill Bridge in Giles County (#9, 28-00966-03.54) and Little Swan Creek Bridge in Lincoln County (52-01902-02.05). Typically, verticals occurred at every panel point, but on a few Warrens they occurred only at alternating panels. On Tennessee examples, when the span contained the alternating arrangement, the verticals were at the connection formed by the diagonals meeting at the top chord (as opposed to the diagonals forming a "V" at the bottom chord). Only about one-fourth of Tennessee's Warrens had hip verticals and those were generally on the through trusses, polygonal top chord pony trusses, and the heavier and later county or state built bridges. An exception was the 1904 Newsom Mill Bridge (#46, 19-D0981-02.00) which had hip verticals.

TABLE V-15: BRIDGES WITH WARREN TRUSS AS MAIN SPAN

HISTORIC? # IN CH. 6	COUNTY	NUMBER	CROSSING	DATE BUILT and BUILDER	DESCRIPTION
Yes: #7	Morgan	65-NonHighway-1	White Oak Creek	1880-20 Champion	1 Warren Pony*
Yes: #9	Giles	28-00966-03.54	Big Creek	1884 Penn	1 Warren Pony, Pinned
Yes: #18	Lincoln	52-SR274-06.82	Coldwater Creek	1889	2 Warren Pony, Pinned
No	Davidson	19-NonHighway-10	Whites Creek	1898 Youngstown	1 Warren Pony
Yes: #46	Davidson	19-D0981-02.00	Harpeth River	1904 Nashville	3 Warren Pony
No	Davidson	19-C0539-00.10	Sulphur Creek	1908 Nashville	1 Warren Pony
Yes: #59	DeKalb	21-A0028-01.21	Smith Fk Creek	1908 Nashville	2 Warren Pony
No	Williamson	94-01917-04.79	South Harpeth River	1908 W. T. Young	1 Warren Pony
Yes: #62	Davidson	19-NonHighway-1	Richland Creek	1908-1910	1 Warren Pony
No	Giles	28-A0335-00.14	Jenkins Creek	1909 Nashville	1 Warren Pony
No	Putnam	71-A0030-00.03	Big Indian Cr	1909 Nashville	1 Warren Pony
No	Macon	56-06289-00.83	Middle Fork Goose Creek	1910 Nashville	1 Warren Pony
No	Sumner	83-B0119-00.07	Bledsoe Creek	1910 Nashville	1 Warren Pony
No	Cannon	08-A0199-05.25	Carson Fork Cr	1910 est	1 Warren Pony
No	Decatur	20-A0071-00.96	Lick Creek	1910 est	1 Warren Pony
No	DeKalb	21-A0320-00.10	Clear Fork Cr	1910 est	2 Warren Pony
No	Lincoln	52-01902-02.05	Little Swan Cr	1910 est	1 Warren Pony
No	Lincoln	52-NonHighway-4	Little Cane Cr	1910 est	1 Warren Pony
No	Williamson	94-01930-00.81	McCrorys Br	1910 est	1 Warren Pony
No	Sumner	83-A0434-00.24	Station Camp Cr	1912 Nashville	1 Warren Pony
No	Sumner	83-A0489-02.21	Maxwell Br	1912 Nashville	1 Warren Pony
No	White	93-A0178-00.17	Calfkiller River	1912 Nashville	2 Warren Pony
No	Maury	60-A0191-07.19	Fountain Creek	1912 est	1 Warren Thru Pinned
No	Cheatham	11-A0017-00.77	Half Pone Creek	1913 W. T. Young	1 Warren Pony

No	Robertson	74-A0438-03.98	Brushy Creek	1913 Nashville	1 Warren Pony
Yes: #76	Sumner	83-NonHighway-1	Caney Fork Cr	1913 Nashville	1 Warren Pony-PTC
No	White	93-00571-00.82	Post Oak Br	1913 Nashville	1 Warren Pony
No	Williamson	94-A0232-00.19	Harpeth River	1913 Nashville	1 Warren Pony
No	Cumberland	18-A0814-02.62	Laurel Creek	1914 Nashville	1 Warren Pony
Yes: #83	Obion	66-NonHighway-2	Indian Creek	1914 Nashville	1 Warren Pony
No	Campbell	07-A0094-00.32	Elk Fork Creek	1915 Nashville	1 Warren Pony
No	Decatur	20-A0313-02.07	E Prong Doe Cr	1915	1 Warren Pony
No	Sumner	83-A0444-00.30	E Campbell Cr	1915 Nashville	1 Warren Pony
No	Van Buren	88-A0118-00.10	Rocky River	1915 Nashville	1 Warren Pony
No	Cannon	08-00501-03.71	Shelton Branch	1915 est	1 Warren Pony
No	Cannon	08-A0047-02.13	Andrews Creek	1915 est	1 Warren Pony
No	Cheatham	11-A0152-02.77	Sycamore Creek	1915 est	1 Warren PTC & 2 Warren Pony
No	Cumberland	18-A0523-00.55	Daddys Creek	1915 est Vincennes	1 Warren Pony
No	Hickman	41-01854-07.57	Bear Creek	1915 est	1 Warren Pony
No	Jackson	44-A0039-00.01	Jennings Cr	1915 est	1 Warren Pony
No	Jackson	44-A0055-03.72	Jennings Cr	1915 est	1 Warren Pony
No	Maury	60-NonHighway-5	McCutcheon Cr	1915 est	1 Warren Pony
No	Overton	67-02302-00.40	E Fk Obey Rv	1915 est	1 Warren Pony
No	Overton	67-A0240-00.14	Medlock Br	1915 est	1 Warren Pony
No	Overton	67-NonHighway-1	Town Creek	1915 est	1 Warren Pony
No	Putnam	71-A0012-00.02	Big Indian Cr	1915 est	1 Warren Pony
No	Sumner	83-A0435-00.09	Station Campbell Creek	1915 est	1 Warren Pony-PTC
No	Union	87-A0161-01.14	Bull Run Creek	1915 est	1 Warren Pony
No	Union	87-A0170-00.79	Bull Run Creek	1915 est	1 Warren Pony
No	Union	87-A0173-00.66	Bull Run Creek	1915 est	1 Warren Pony
No	White	93-01163-02.22	Cherry Creek	1915 est	1 Warren Pony
No	Smith	80-02080-01.24	Peyton Creek	1915-1920	2 Warren Pony
No	Campbell	07-A0102-01.63	Elk Fork Creek	1916 Nashville	1 Warren Pony
No	Humphreys	43-A0039-03.15	White Oak Cr	1916 Nashville	1 Warren Pony-PTC
No	Smith	80-A0167-00.51	Hickman Creek	1916 Nashville	1 Warren Pony

No	Coffee	16-A0377-01.46	Baschaw Creek	1916-1917 Nashville	1 Warren Pony
Yes: #93	Hawkins	37-A0131-01.67	Poor Valley Cr	1917 Nashville	1 Warren Pony
No	Humphreys	43-A0055-00.04	Little Richland Cr	1917 Nashville	1 Warren Pony
No	Humphreys	43-A0348-00.34	Campbell Br	1917 Nashville	1 Warren Pony
No	Rutherford	75-NonHighway-2	Stewart Creek	1917	1 Warren Pony
No	Sumner	83-B0039-00.01	Little Trammel Fork Creek	1917 Nashville	1 Warren Pony
No	Sumner	83-B0111-00.09	Bledsoe Creek	1917 est	1 Warren Pony-PTC
No	Macon	56-A0450-04.66	Goose Creek	1919 Nashville	1 Warren Pony
No	Williamson	94-A0434-00.68	W Harpeth Rv	1919 Nashville	1 Warren Pony
No	Franklin	26-A0345-01.88	Rose Creek	1920 Nashville	1 Warren Pony
No	Giles	28-A0058-00.42	Big Creek	1920 Nashville	1 Warren Pony
No	Benton	03-A0170-01.58	North Fork Harmon Creek	1920 est Hipco	1 Warren Pony
No	Bledsoe	04-A0084-00.05	Sequatchie Rv	1920 est	1 Warren Pony
No	Cannon	08-A0204-00.23	Carson Fork Cr	1920 est	1 Warren Pony
No	Cannon	08-A0225-00.66	Hollis Creek	1920 est	1 Warren Pony
No	Cheatham	11-A0317-00.13	Dry Creek	1920 est	1 Warren Pony
No	Clay	14-A0230-00.08	Mill Creek	1920 est	1 Warren Pony
No	Cumberland	18-02174-01.96	Sequatchie Rv	1920 est	1 Warren Pony
No	Cumberland	18-A0313-01.40	Byrds Creek	1920 est	1 Warren Pony
No	DeKalb	21-A0313-01.16	Clear Fork Cr	1920 est	1 Warren Pony
No	Humphreys	43-00925-08.60	Blue Creek	1920 est	1 Warren Pony
No	Monroe	62-02344-02.22	N Fk Notchy Cr	1920 est	1 Warren Pony
No	Overton	67-A0294-00.21	East Fork Obey River	1920 est Champion	1 Warren Pony
No	Robertson	74-A0176-00.41	S Fk Red River	1920 est	1 Warren Pony
No	Rutherford	75-NonHighway-4	Middle Fork Stones River	1920 est	1 Warren Pony
No	Scott	76-NonHighway-1	Buffalo Creek	1920 est	1 Warren Pony
No	Shelby	79-NonHighway-2	Grays Creek	1920 est	1 Warren Pony
No	Stewart	81-No Number	Hurricane Cr	1920 est	1 Warren Pony
No	Stewart	81-NonHighway-4	North Cross Cr	1920 est	1 Warren Pony
No	Sumner	83-A0510-00.36	Red River	1920 est	1 Warren Pony

No	Sumner	83-B0102-01.08	Bledsoe Creek	1920 est	1 Warren Pony
No	Sumner	83-NonHighway-3	Lick Creek	1920 est	1 Warren Pony
No	Trousdale	85-A0045-01.73	Goose Creek	1920 est	1 Warren Pony
No	Trousdale	85-NonHighway-1	Little Goose Cr	1920 est	1 Warren Pony
No	White	93-A0075-01.23	Irwin Branch	1920 est	1 Warren Pony
No	White	93-A0172-00.18	Zion Branch	1920 est	1 Warren Pony
No	White	93-A0439-00.80	Darkey Spring Br	1920 est	1 Warren Pony
No	Williamson	94-A0246-02.28	Little Turnbull Cr	1920 est	1 Warren Pony
No	Williamson	94-A0848-00.12	W Harpeth Rv	1920 est	1 Warren Pony
No	Williamson	94-NonHighway-1	Mill Creek	1920 est	1 Warren Pony
Yes: #101	Madison	57-01644-00.05	South Fork Forked Deer	1920-21 Nashville	1 Warren Through
No	Franklin	26-02106-07.70	Boiling Fork Cr	1921 Nashville	1 Warren Pony
No	Overton	67-A0419-01.98	E Fk Obey Rv	1921 Nashville	1 Warren Pony
No	Williamson	94-01921-01.80	S Harpeth Rv	1921 Nashville	1 Warren Pony
No	Williamson	94-01921-03.20	S Harpeth Rv	1921 Nashville	2 Warren Pony
No	Williamson	94-A0266-00.08	Rutherford Cr	1922 Nashville	1 Warren Pony
No	Cannon	08-00501-02.93	Brawleys Fk Cr	1923 Nashville	1 Warren Pony
No	Putnam	71-A0303-03.94	Falling Water Rv	1923 Nashville	1 Warren Pony
No	Wayne	91-A0292-02.63	Butler Creek	1923 Nashville	2 Warren Pony, Semi-Deck
Yes: #111	Giles	28-NonHighway-1	Elk River	1923-24 State	1 Warren Thru-PTC
No	Humphreys	43-NonHighway-2	Hurricane Cr	1925 est	1 Warren Pony
No	Stewart	81-NonHighway-1	Pryor Creek	1925 est	1 Warren Pony
No	Trousdale	85-NonHighway-2		1925 est	1 Warren Pony
No	Williamson	94-01922-01.27	Lick Creek	1925 est	1 Warren Pony
No	Hamilton	33-03552-01.78	Citco Rail Yard	1926 Virginia	2 Warren Through
No	Grundy	31-SR002-02.70	Elk River	1926-27 State	1 Warren Pony, Semi-Deck
No	Campbell	07-03749-03.40	Big Creek	1926-28 State	1 Warren Pony, Semi-Deck
Yes: #120	Morgan	65-A0450-03.25	Emory River	1926-28 State	1 Warren Pony, Semi-Deck
No	Scott	76-SR029-08.98	New River	1926-28 State	3 Warren Through

No	Washington	90-A0234-00.36	Big Limestone Creek	1927 County Workhouse	1 Warren Pony
No	Cheatham	11-06275-02.72	Bartons Creek	1928	1 Warren Pony
Yes: #123	Hancock	34-SR070-01.65	Clinch River	1928 State	1 Warren Thru-PTC
No	Montgomery	63-SR012-20.6r	Ringgold Creek	1928-29 State	1 Warren Thru-PTC
No	Scott	76-SR063-07.90	Buffalo Creek	1928-29 State	1 Warren Pony, Semi-Deck
No	Hancock	34-SR066-06.48	Clinch River	1928-30 State	1 Warren Thru-PTC
No	Knox	47-SR073-01.12	Tennessee River	1929-30 State	1 Warren Thru-PTC, Hybrid K, 4 Camelback Thru
No	Cumberland	18-SR068-12.81	Whites Creek	1930 State	1 Warren Pony, Semi-Deck
No	Davidson	19-SR100-01.06	S Harpeth Rv	1930 State	1 Warren Through
No	Morgan	65-SR299-09.89	Emory River	1930 State	3 Warren Thru-PTC
No	Rhea	72-SR029-31.81	Whites Creek	1930 State	1 Warren Thru-PTC, 1 Pratt Through
No	Warren	89-SR286-02.59	Barren Fork Rv	1930 State	4 Warren Thru-PTC
No	Wayne	91-SR069-03.66	Second Creek	1930 State	1 Warren Pony
No	Morgan	65-02378-05.07	Crab Orchard Cr	1930 ca	1 Warren Pony
No	Morgan	65-02396-05.77	White Oak Cr	1930 ca	1 Warren Pony
No	Scott	76-A0179-02.48	Straight Fork Cr	1930 ca	1 Warren Pony
No	Bledsoe	04-02174-06.89	Stephens Br	1930 est	1 Warren Pony
No	Bradley	06-A0121-00.33	Candies Creek	1930 est	1 Warren Pony
No	Carroll	09-A0481-00.89	Big Sandy Rv	1930 est	1 Warren Pony
No	Davidson	19-C0757-02.96	Whites Creek	1930 est	1 Warren Pony
No	Fentress	25-A0071-00.07	Wolf River	1930 est	1 Warren Pony
No	Gibson	27-SR105-10.77	Rutherford Fork Obion	1930 est	1 Warren Pony
No	Hamilton	33-A0788-00.46	Chattanooga Creek	1930 est	1 Warren Pony-PTC
No	Lake	48-00828-02.78	Running Reelfoot Bayou	1930 est	1 Warren Pony, Semi-Deck
No	Madison	57-01646-01.23	Johnson Creek	1930 est	1 Warren Pony
No	Smith	80-01077-02.89	Hickman Creek	1930 est	1 Warren Pony
No	Stewart	81-00351-11.82	Dicks Creek	1930 est	1 Warren Pony
No	Stewart	81-A0234-01.18	Dyers Creek	1930 est	1 Warren Pony

No	Sumner	83-A0659-00.47	W F Drakes Cr	1930 est	1 Warren Pony
No	Union	87-A0152-00.20	Little Bull Run Cr	1930 est	1 Warren Pony
No	Van Buren	88-A0129-00.30	Cane Creek	1930 est	1 Warren Pony
No	Montgomery	63-SR013-23.68	Red River	1931 State	1 Warren Thru-PTC
No	Rhea	72-SR029-23.02	Piney Creek	1931 State	1 Warren Thru-PTC
No	DeKalb	21-A0323-00.21	Smith Fork Cr	1931 ca	4 Warren Pony
No	Coffee	16-SR002-12.74	Duck River	1932-33 State	1 Warren Thru-PTC
No	Humphreys	43-SR013-24.61	Big Richland Creek	1933 State	1 Warren Pony, Semi-Deck
No	Bedford	02-SR130-10.82	Duck River	1934 State	2 Warren Pony, Semi-Deck
No	Grundy	31-SR056-32.10	Collins River	1934 State	2 Warren Pony, Semi-Deck
No	Carroll	09-01707-02.90	Big Sandy Rv	1935 est	1 Warren Pony
No	Gibson	27-01593-06.10	S Fk Obion Rv	1935 est	1 Warren Pony
No	Stewart	81-01824-05.35	Hurricane Cr	1935 est	1 Warren Pony
No	Knox	47-SR073-06.60	Little River	1937-38 State	1 Warren Thru-PTC
No	Giles	28-SR011-01.66	Sugar Creek	1938 State	1 Warren Pony
No	Lincoln	52-SR050-02.59	Cane Creek	1938 State	1 Warren Pony, Semi-Deck
No	Bledsoe	04-A0309-01.65	Sequatchie Rv	1938 ca	1 Warren Pony
No	Hawkins	37-A0069-00.62	N Fk Holston Rv	1938 State	3 Warren Deck
No	Jackson	44-SR053-01.26	Martin Creek	1938-39 State	1 Warren Thru-PTC
No	Macon	56-A0459-00.02	Goose Creek	1939 NYA	1 Warren Pony
Yes: #156**	Hamilton	33-01151-00.78	Sale Creek	1954 County	1 Warren Pony-PTC
No	Perry	68-SR013-01.31	Buffalo River	1939-40 State	2 Warren Thru-PTC
No	Smith	80-SR024-02.96	Round Lick Cr	1940 State	1 Warren Thru-PTC
No	Davidson	19-A0592-00.01	Mill Creek	1940 est	1 Warren Pony
No	Davidson	19-C0554-01.24	Marrowbone Cr	1940 est	1 Warren Pony
No	Sumner	83-B0218-01.32	Slaters Creek	1940 est	1 Warren Pony
No	Williamson	94-A0235-00.83	Harpeth River	1940 est	1 Warren Pony
No	Warren	89-SR056-11.77	Barren Fork Rv	1941-42 State	2 Warren Thru-PTC
No	Rutherford	75-SR096-18.48	E Fk Stones Rv	1944 State	1 Warren Thru-PTC
No	Morgan	65-A0251-00.01	Emory River	1945 est	2 Warren Deck

CONTINUOUS TRUSSES					
No**	DeKalb	21-SR056-15.71	Caney Fork River	1948-1949 Corps Engineers	1 4-span Warren Deck
No	Smith	80-SR024-13.36	Caney Fork River	1931-32 State	1 3-span Warren Through
Yes: #138	Greene	30-SR070-08.48	Nolichucky River	1934-35 State	1 3-span Warren Deck
Yes: #140	Union	87-SR033-15.83	Clinch River	1934-36 TVA	2 2-span Warren Through
No	Anderson	01-SR009-10.75	Clinch River	1938-40 State	1 3-span Warren Through
No	Carter	10-SR037-17.59	Doe River	1939-41 State	1 3-span Warren Deck
No	Grainger	29-00695-14.66	German Creek	1941 TVA/Nashville	1 3-span Warren Through
Yes: #152	Jefferson	45-SR092-09.21	French Broad River	1942-44 TVA	1 3-span Warren Through
No*	Carter	10-SR067-18.43	Watauga River	1946-48 TVA	1 3-span Warren Deck
Yes: #155	Shelby	79-I0055-12.00	Mississippi River	1949 Modjeski	1 5-span Warren Through
No*	Sullivan	82-SR034-28.07	South Holston River	1950 TVA/Virginia	1 2-span Warren Through
No**	Knox	47-SR009-10.0s	Holston River	1958 State	1 3-span Warren Deck
NOT EVALUATED DUE TO POST-1945 CONSTRUCTION DATE					
Unknown	Knox	47-01124-02.65	Holston River	1949 Virginia	1 3-span Warren Through
Unknown	Wilson	95-SR109-10.86	Cumberland River	1954 State	1 3-span Warren-PTC Through
Unknown	Jefferson	45-I0040-14.68	French Broad River	1961 State	2 3-span Warren Deck
Unknown	Shelby	79-C0106-01.37	Big Creek	1963	1 Warren Pony
Unknown	Dyer	23-I0155-00.00	Mississippi River	1974-76 State	1 3-span Warren Through

Notes:
All trusses are riveted unless otherwise noted.
PTC denotes Polygonal Top Chord.
* Since TVA's period of significance spanned the cut-off date of 1945, the survey evaluated all TVA built bridges, regardless of construction date.
** The survey evaluated this bridge because it was scheduled for replacement.

In Tennessee, builders generally used the Warren pony truss with parallel top chords for 50-70 foot spans. The survey inventoried six pony trusses with a polygonal top chord (designated PTC on the charts) which allowed builders to extend the truss length to the 100-foot range. Most Warren through trusses in the survey ranged in length from about 100-160 feet.

The survey identified 180 pre-1945 bridges with a Warren truss as the main span and seventeen other bridges with Warrens as secondary spans. Of these 180 bridges, 149 were pony trusses (six with polygonal top chords) 27 were through trusses (13 with polygonal top chords), and 4 were deck trusses. Ten of the pony trusses contained a semi-deck configuration. See Table V-15.

Double Intersection Warren: Superimposing a second separate triangular web over the basic Warren web created another variation of the Warren truss, the Double Intersection Warren. Builders could erect this truss with or without verticals and with a parallel or polygonal top chord. Although it did not evolve from a wooden lattice truss, it resembled that truss and functioned similarly. The survey inventoried two simple and two continuous bridges having a Double Intersection Warren as their main span (Table V-16). However, railroad engineers used this truss type more often than highway engineers, and rail examples do exist in the state.

Bowstring: Squire Whipple patented the Bowstring truss in 1841, and other builders developed numerous variations. Engineers used this truss extensively in the 1860s and 1870s, but its

TABLE V-16: BRIDGES WITH DOUBLE INTERSECTION WARREN AS MAIN SPAN

ELIGIBLE? # IN CH. 6	NUMBER & COUNTY	CROSSING	DATE BUILT	BUILDER	DESCRIPTION
Yes: #14	79-NonHighway-3 Shelby	Mississippi River	1888-1892	Morison	1 four-span modified continuous Warren Through & 1 Warren Deck
Yes: #33	19-NonHighway-9 Davidson	Richland Creek	1900 est		1 span, riveted
Yes: #34	83-NonHighway-4 Sumner	Dry Fork Creek	1900 est		1 span, riveted
Yes: #77	79-NonHighway-4 Shelby	Mississippi River	1913-1917	Modjeski	1 four-span modified continuous Warren Through & 1 Warren Deck

popularity waned after that. Zenas King patented one variation in 1861, a square hollow column for the top chord. The popularity of the bowstring truss is largely due to King's influence since his company, one of the largest in the country, heavily promoted its use and relied on it as the mainstay of the firm.

An arched or curvilinear top chord, which created a bowed appearance and eliminated end posts, formed the standard feature of a bowstring truss. This member had a gradually increasing sectional area from each end toward the center. This tubular top chord acted in compression and was anchored against the abutment. The bottom chord acted in tension. Unlike Pratts, whose verticals acted in compression, these verticals acted in tension. According to the patent, "the roadway is supported by a tie-beam attached to each end or foot of the arch, and connected to the arch by radial rods passing at various points from one to the other." Tennessee's survey inventoried only one Bowstring truss (Table V-17).

TABLE V-17: BRIDGES WITH BOWSTRING AS MAIN SPAN

ELIGIBLE? # IN CH. 6	NUMBER & COUNTY	CROSSING	DATE BUILT	BUILDER	DESCRIPTION
Yes: #6	52-A0183-05.54 Lincoln	Elk River	1878	King Iron	1 Pinned Bowstring Through

Kingpost: Builders most commonly used the Kingpost truss for timber trusses, but on rare occasions, they used it for short (20 to 40-foot) metal trusses. The two chords forming the apex acted in compression while the bottom chord acted in tension. Builders often included a vertical tension bar between the apex and the floor beam, subdividing the panel and making it stronger. The survey inventoried only one metal Kingpost truss (Table V-18).

TABLE V-18: BRIDGES WITH KINGPOST AS MAIN SPAN

ELIGIBLE? # IN CH. 6	NUMBER & COUNTY	CROSSING	DATE BUILT	BUILDER	DESCRIPTION
Yes: #152	19-NonHighway-3 Davidson	Drakes Branch	1941	Nashville Bridge	1 Pinned Pony

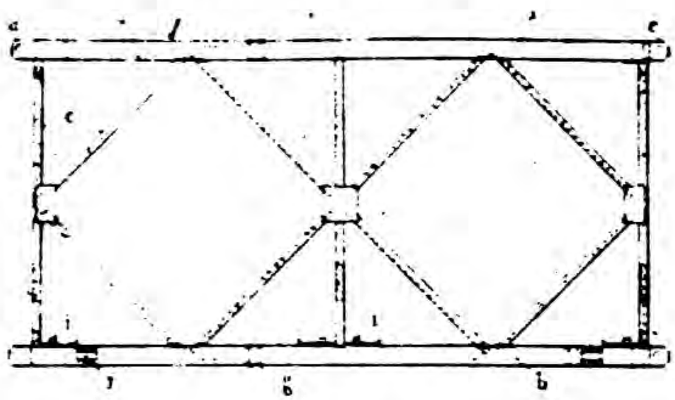
Bailey Truss: In 1941 Donald Coleman Bailey applied for a patent in England for this truss. Bailey filed his patent in the United States in 1943 and received the patent in 1945 (Figure V-18). Prefabricated braced panels interconnected with pins formed the Bailey truss. Theoretically, soldiers (or workmen) could form these standard panels into a structure such as a bridge, building, or tower cheaply and efficiently as well as dismantle and relocate the truss system just as easily. Its flexibility and ease in erection ensured its widespread use in World War II. After World War II, the government sold many of these trusses as surplus property or reused them on government sites, such as the Blair Bridge (#154, 73-00653-04.34) at the Oak Ridge facility. However, users perceived them as "temporary" bridges, and few of these older bridges remain. The military, government agencies, and road builders still use the truss type extensively for temporary bridges. Tennessee's survey inventoried only one Bailey truss (Table V-19).

TABLE V-19: BRIDGES WITH BAILEY AS MAIN SPAN

ELIGIBLE? # IN CH. 6	NUMBER & COUNTY	CROSSING	DATE BUILT	BUILDER	DESCRIPTION
Yes: #154	73-00653-04.34 Roane	Poplar Creek	1943; 1946	Corps of Engineers	1 Double-Double & 3 Double-Single

Figure V-18: Bailey Truss patent.

2,376,023
CONSTRUCTION OF BRIDGES AND OTHER METAL FRAME STRUCTURES
Donald Coleman Bailey, Christchurch, England
Application January 11, 1943, Serial No. 472,027
In Great Britain October 14, 1941
4 Claims. (Cl. 14—13)



1. In a frame structure a prefabricated braced panel including upper and lower parallel chords each composed of two members spaced from each other, joists connected at their ends between members forming the chords to maintain them in spaced relation and forming the web of the panel, means between said chord members to enable panels to be connected in superposed relation to one another, male jaw members extending longitudinally from adjacent ends of the chords at one end of the panel, and female jaws extending longitudinally from the chords at the other end of the panel, whereby a plurality of panels may be united end to end to form a girder by disposing the female jaws of one panel to receive the male jaws of an adjacent panel and uniting the two by a simple pin connection capable of taking the necessary stresses.