A SURVEY AND PHOTOGRAPHIC INVENTORY OF METAL TRUSS BRIDGES IN VIRGINIA 1865-1932

I. An examination of the development of the truss form including an annotated list of nineteenth and twentieth century bridge companies.

by

Dan Grove Deibler
Research Analyst

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

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SUMMARY

The romance and myths long associated with the covered wooden bridges that once populated the rural roads of the American landscape have produced a multitude of popular literary works on their form, purpose and ultimate demise. Consequently, covered bridges have become something of a symbol of a past era. Similar speculation on the origins and development of the still familiar, though often ignored, metal truss bridges resulted in the undertaking of a statewide photographic and documentary survey of the remaining metal truss bridges in Virginia.

This report is an introduction to the survey project and includes an explanation of the general procedure to be followed; however, its primary concern is with the origin of truss designs and developments in structural technology during the nineteenth century. Additional reports dealing with the survey of each of the Commonwealth's eight highway construction districts are to follow.

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THE PURPOSE AND PROCEDURE

This report represents the initial efforts of a research project outlined in a Virginia Highway and Transportation Research Council memorandum of 7 December 1972 in which it was proposed to undertake a study of the history and development of road and bridge building technology in Virginia. A corrolary to this proposal was to conduct a photographic survey and documentary inventory of the pre-1932 metal truss bridges remaining in the state. Because of the well-known fate that had befallen the countless covered wooden bridges which had served the Old Dominion's roads and highways well into the twentieth century and the growing need and pressure for bridge replacement, it was deemed desirable to conduct a state-wide survey to photographically record the surviving pre-1932 metal truss bridges before they became the next victims of benign neglect and assumed obsoleteness.

The first phase of the project is to compile a complete photograph inventory of the extant trusses with some preliminary research to determine specific documentation about any one structure's design and construction. More general research has also been undertaken into the background and history of truss technology in order to relate these trusses to their nineteenth century context as well as to obtain any information possible about the companies involved with truss bridge design and construction. The latter efforts have resulted in the compilation of an annotated list of bridge companies known to have been in operation after 1850 but before 1935. From this information, it is planned to establish a set of guidelines or priorities which can be utilized in evaluating the historical or technological significance of any truss span before it is replaced or bypassed by a modern, improved bridge and road. It is hoped that these guidelines will deter, if not prevent, the inadvertent destruction of any potentially significant trusses.

The twofold nature of the bridge survey project is reflected in the organization of the survey and consequently in the format of the report. The straightforward photographic survey and documentary inventory deals with the more obvious factual information, e.g., locations, numbers, types, dates, and dimensions, and is being recorded on a locally prepared survey form (see Figure 1), one per structure.

The first step in conducting the survey has been to determine the locations and numbers of all the extant pre-1932 metal truss bridges.(1) The selection of 1932 as the cutoff point was based on the fact that it was the year the Virginia Department of Highways assumed jurisdiction over the state's secondary road system. A list was compiled from the "Structure Tabulation" printout, Virginia Department of Highways, May 1973, an inventory of all existing highway bridges known to have been built prior to 1932. One volume of the five-part series was used to determine bridge type, e.g., truss, beam or arch, while a second one was used to determine a particular bridge's location as defined by route number and crossing point, e.g., #656, Big Walker Creek. Since the entire survey is being conducted within the framework of the Department's eight highway construction districts (Figure 2), the respective structure lists are being checked against the records maintained by the several district bridge offices to obtain the most recent information regarding replaced bridges.

After the truss bridge locations were plotted on the standard county road maps, each site was visited and the truss span was photographed and recorded on the survey form (see Figure 1). Both black and white negatives (for file purposes) and color transparencies (for presentation purposes) were taken. Technical information such as dimensions or repair and maintenance schedules was extracted from the records of the pertinent district bridge office and transferred to the survey forms along with a sketch of a truss' basic geometric profile and dimensioned drawings. Analytic information for in-depth structural analysis has not been included with the forms; however, it is readily available from any district's records or those of the Central Bridge Office in Richmond, where duplicate files are retained.

For each of location, the bridges were initially plotted on the standard county road maps published by the Department of Highways & Transportation; however, to facilitate transferring the information to a nationally oriented survey, which may occur in the future, the bridge sites have also been located on the U.S.G.S. topographic maps, 7.5 minute series, following the Universal Transverse Mercator (UTM) Kilometer Grid Coordinate system.

Figure 1.

Photo Numbers:

TRUSS BRIDGE SURVEY AND INVENTORY FORM

Geographic Information

State: Virginia
Va. Dept. of Highways District: _____; No. _____.
County: _____; No. _____.
City/Town: _____.
Street/Road: _____.
River/Stream/Railroad (crossing): _____.
UTM/KGS Coordinates: _____.

Historical Information

Formal designation: _____.
Local designation: _____.
Designer: _____.
Builder: _____.
Date: _____; basis for: _____.
Original owner: _____; use: _____.
Present owner: _____; use: _____.

Historical or Technological Significance

_____ Unique/Unusual in its time: _____.

_____ Rare survivor though of standard design: _____.

_____ Typical example of its time and a common survivor: _____.

_____ Other Remarks/Explanation: _____.

Nature/Degree of any destructive threats: _____.

Reference materials and contemporary photos/illustrations with their respective locations:

Recorder: _____.
Date: _____.
Affiliation: _____.

Figure 1 (cont.)

Design Information

Compass orientation of axis: _____.

Architectural or decorative features:

No. of spans: _____; length; overall: _____.
Span types:
(1) _____; length: _____.
(2) _____; length: _____.
(3) _____; length: _____.
(4) _____; length: _____.
(5) _____; length: _____.
(6) _____; length: _____.

No. of lanes: _____; width: _____ c to c.

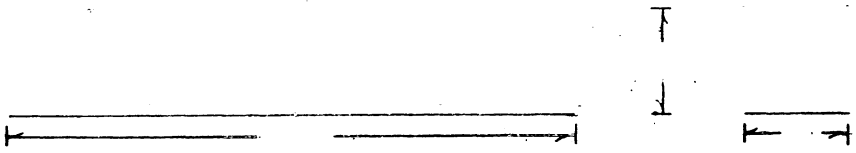
Structural Information

Substructure:
Material: _____.
Foundations: _____.
Piers: _____.
Abutments: _____.
Wings: _____.
Seats: _____.

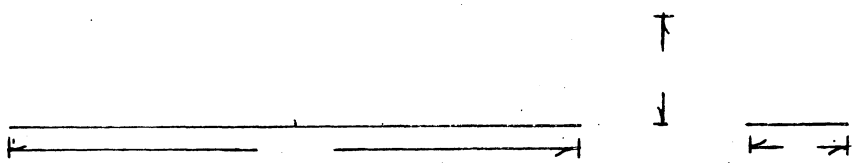
Superstructure:
Material: _____ sources _____.
Characteristics, details and members:
Connections: _____ pin.
_____ rigid.
Top Chords _____.
End Posts: _____.
Bottom chords: _____.
Posts: _____.
Diagonals: _____.
Counters: _____.

Truss Configuration

Main span type: _____ Through/Pony/Deck, Skew



Secondary span type: _____ Through/Pony/Deck, Skew



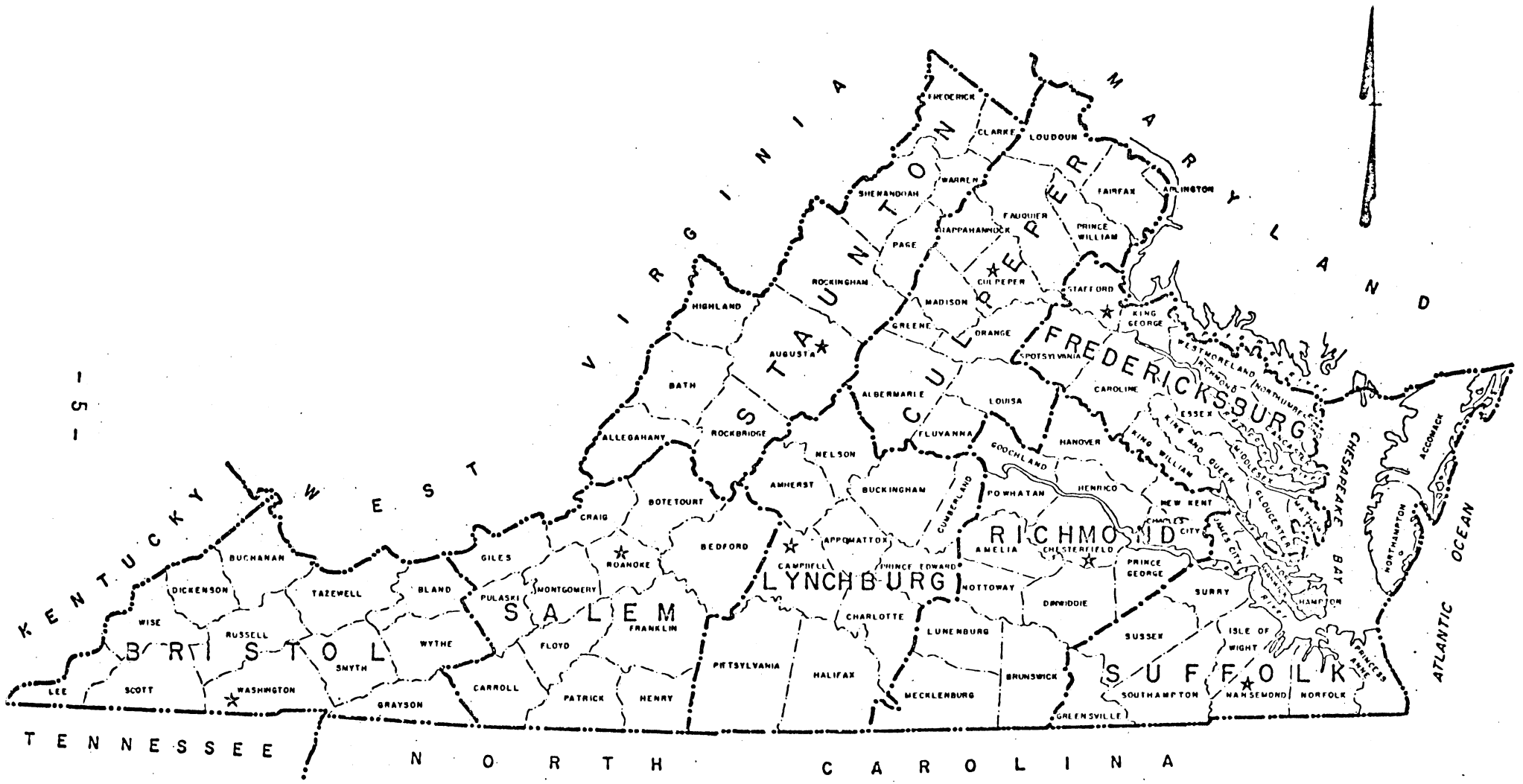


Figure 2. Virginia Department of Highways and Transportation Construction Districts.

The report itself will be written in separate sections on a district-by-district basis as the survey in each construction district is completed. Each of the eight districts will be dealt with in a particular section that will include some analyses as to types, numbers, variety, and dates and some observations on the relative significance of various survivors.

Despite the apparent comprehensiveness of this project, it must be kept in mind that this can only be interpreted as a case study with limits defined by the geopolitical boundaries of the Commonwealth of Virginia and should not be construed as a definitive study or history of truss technology.(2) Some general discussion of truss design and technology as it developed in the latter part of the nineteenth century is contained in an introductory section which also contains the annotated list of bridge companies known to have designed and built truss bridges from 1865 to ca. 1932.

One of the most confusing problems faced in devising the format for the report was the determination of a system for classifying the inventoried trusses by specific types. Needless to say, the established categories have proven inadequate to indicate the infinite variety that occurs in truss design. Patented truss designs have long since passed out of existence; however, the names of the original patentees have been retained and applied to present-day trusses whose geometric configuration conforms or follows very closely the original patented design. For example, technically there are probably no truss bridges in Virginia patented by Thomas Pratt, but there are dozens of trusses whose geometric profiles conform to the original Pratt design. The names have come to be applied in a generic sense rather than a specific one.

In order to keep the report in a manageable format but not at the expense of oversimplification, the trusses have been divided into two basic categories, Low/Pony trusses and High/Through trusses, and then classified into 11 basic types as follows:

Low/Pony Trusses	High/Through Trusses
Pratt, half-hip	Camelback
Pratt, full-slope	Camelback, modified
Triangular	Pennsylvania/Petit
Truss Leg/Bedstead	Pratt
	Triangular, single-intersection
	Triangular, double-intersection
	Whipple

The terminology has been gleaned from a number of sources though it conforms most nearly to classifications set forth by Milo S. Ketchum, The Design of Highway Bridges and the Calculation of Stresses in Bridge Trusses (1909) and James A. L. Waddell's Bridge Engineering (1916), both of which are studies contemporary with most of the inventoried trusses.

The bibliography at the end of the general and introductory section of the report obviously indicates the specific written/published material that was used; however, this does not indicate the individuals or organizations that were contacted in efforts to obtain information or locate material such as bridge company catalogues, company histories or related records. Various national and state government agencies, as well as local historical societies and individuals, were contacted. The results, though spotty, have been extremely helpful. Since a number of bridge companies of particular interest to this survey had had their shops or headquarters in Ohio, the following organizations in that state were contacted: the Cincinnati Historical Society, Cincinnati; the Ohio Covered Bridge Committee, Cincinnati; the Ohio Historical Society, Cleveland; the Stark County Historical Society, Canton; and the Western Reserve Historical Society, Cleveland. The Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania; the DeWitt Historical Society of Tomkins County, Ithaca, New York; and the Society for the History of Technology, Atlanta, Georgia, were also contacted. The facilities and files of both the Historic American Engineering Record, and the Division of Mechanical and Civil Engineering of Smithsonian Institution's National Museum of History and Technology were made available to the writer as well. Both the Virginia State Library, Richmond, Virginia, and Alderman Library of the University of Virginia, Charlottesville, Virginia, were the main facilities used for general research, the latter of which proved to have a number of nineteenth century engineering books. No single agency or facility has been found to possess an overwhelming amount of pertinent material related to truss bridge technology in its formative years, though each was able to make some useful suggestion or possessed some relevant information. Continued research efforts will help to alleviate this situation by at least listing source materials and locations, and new information as well as companies will be added to the bridge company list as it becomes available.

THE TRUSS FORM ESTABLISHED

Even though 1932 has been set as the cutoff date for this survey, the main concern is with trusses dating from the nineteenth

century since truss technology was a well established science and the truss bridge was a commonplace form in the American landscape by 1900. The years of experimentation, 1820-1860, by trial and error, really, had resulted in a number of patented truss designs being marketed and built; however, it was not until after the Civil War that the truss bridge began to populate the landscape. The single greatest impetus to the truss technology was the expansion of the railroads, which required relatively flat, even roadbeds and economical solutions for crossing the natural topographic obstacles such as rivers and ravines that create much of the American landscape. This search for rapid, economical bridge solutions in mid-century was accompanied by a search for an economical material stronger and more durable than wood. Locomotive weights and carrier loads had increased weight factors heretofore never considered, while natural barriers once thought insurmountable now had to be realistically reconsidered since there was far too much to gain from having access to railways.

The advantages of the truss had long been considered but had been little realized or well understood. As early as the sixteenth century, Andrea Palladio, an Italian architect, had designed a viable timber truss bridge; but it was not until the nineteenth century in America that the form was seriously and conscientiously exploited. The basic structural concept was simple enough — a system of interconnected triangles built up into a rigid two-dimensional frame, the triangle itself being perfectly rigid and stable. The use of stick-like elements meant that relatively small pieces could be built up into rigid spans of great length. The physical and demographic environment of the expanding American nation made the timber truss a realistic solution for crossing most of its topographic obstacles. Abundant forests provided unlimited quantities of structural timber, while unskilled laborers were able to assemble the precut parts in as little as one day.(3) Since a relatively sparse population made labor an expensive commodity, this was a very important consideration in construction. Any time-consuming solution, e.g., a masonry arch bridge, required extensive centering or false work, both vulnerable to flash floods, skilled masons and lots of time. This philosophy was recognized by Thomas C. Clarke in a paper he delivered to the American Institute of Mining Engineers at a convention held in Philadelphia in conjunction with the Centennial Exposition of 1876.(4) Rapid and easy construction at the most practicable cost thus had an important impact on bridge design.

In the United States the first practical application of truss technology was patented in 1820 by Ithiel Town, who obtained

a patent for the Town lattice truss. (Figure 3.) The Burr truss-arch bridge had been patented three years earlier;[5] but since an arch was part of the truss system, Theodore Burr's bridge was technically not a truss. Town's lattice truss was a highly redundant design composed of all the same type members joined at their intersections. The next forty years were witness to a period of experimentation with truss designs a number of which were patented. Stephen H. Long patented the first panel truss in 1830,[6] (Figure 4) a panel being the basic unit or module which put together with other panels formed a truss span. By 1840 the interest that had been growing in other materials for truss bridges was manifest in a design by William Howe in which he utilized wrought iron rods for the vertical tension members rather than the traditional timber posts. (Figure 5.)

The abundance of wood in America certainly contributed to a lack of interest in earlier experiments with the structural capabilities of both cast and wrought iron. If the locomotive had not challenged the carrying capacity of timber bridges and demonstrated their vulnerability to fire, the search for stronger, more durable material may have been even longer delayed. The history of metal truss technology is very much tied in with the history of iron and steel production and reflects more the development of an understanding of the properties of these two materials and manufacturing techniques (machine/mass production) than it does the development of any new structural form. Except for connection details, e.g., pins and bolts, structural members had continued to be made of wood, which served quite well in both tension and compression for the loading conditions to which they were subjected up to that time. Also, the traditional method of protecting the timber superstructure from the ravages of weather by enclosing the trusses with wood sheathing worked well in prolonging their serviceability, but with the burning cinders and flying sparks from the stacks of the early locomotives, the covered bridge's vulnerability to fire became more pressingly obvious. The form needed modification, which the introduction of the Howe truss seems to have signaled. Where wood was once used, cast or wrought iron was substituted, both of which were eventually replaced by steel as its potential became recognized and its production became economical.

The 1840's and 1850's were the decades of experimentation in the search for the ideal truss. A number of new truss systems were patented during the period; some persisted with modifications; some did not. Thomas Pratt received a patent in 1844 for what has since been called the Pratt truss. (Figure 6.) In 1847, the Whipple truss (Figures 7 and 8) was patented by Squire Whipple. Each of these original designs underwent subsequent modifications and improvements which increased their reliability and economy and hence their serviceability for bridges. They became such common configurations for truss bridges in the post-Civil War period that James A. L. Waddell was able to state in 1884 that

"at least ninety percent of all American iron highway bridges are built on these systems".(7) However, some 1887 statistics(8) pertaining to railroad bridges in four states (Illinois, Iowa, Michigan, and New York) clearly show that wooden bridges (21,873) far outnumbered iron bridges (2,116). If this situation concerning railroads can be generalized to highway bridges, in actual numbers, there were not that many iron bridges being built before the 1890's. Most of the other truss systems patented in this period — e.g., McCallum's Flexible Arch Truss, patented in 1854 by Daniel McCallum; the Bollman truss (Figure 9), patented by Wendel Bollman in 1852; the Fink truss (Figure 10), patented by Albert Fink in 1854; and the Post truss, patented by S. S. Post in 1865 — seem to have had a very low survival rate, partially accounted for by their lesser popularity. They were probably more expensive to build and less structurally reliable and therefore infrequently built. Any surviving examples would indeed be rare.

The applied science of truss design was also becoming the theoretical science of structural analysis during the 1840's. The first theoretical work to be published was A Work on Bridge Building by Squire Whipple in 1847. His design for a double intersection, trapezoidal through truss (see Figure 7) which incorporated both cast iron (for compression members) and wrought iron (for tension members), reflected the growing understanding of the properties of those metals when used for structural purposes. Because of this, it is considered to be the first scientifically designed truss.(9) In 1851, the results of ten years of experiments and tests in truss and structural analysis were published by Herman Haupt.(10) His General Theory of Bridge Construction represents the second theoretical work in the area of structural analysis; but it by no means proved the inadequacies of Whipple's truss or superseded his work because the Whipple truss form continued to be used extensively throughout the remainder of the century.

John W. Murphy first modified Whipple's design by utilizing wrought iron for all components except its cast iron seatings.(11) Under this patent it would have to be called a Whipple-Murphy truss. It was subsequently modified again by Jacob H. Linville simply by using wrought iron throughout; it then became the Linville truss. By geometric configuration the same double intersection trapezoidal truss profile really applied to three distinct truss patents. A similar development occurred with the Fink and Bollman trusses: both were considered suspended through trusses with vertical end posts, the only apparent difference being no bottom chord on the Fink truss.(12) Further equally subtle innovations were made on other truss designs in the succeeding decades. The Pratt truss became an all-iron truss by the mid-1850's with subsequent modifications to its webbing profile occurring after the Civil War, when half of the diagonals were eliminated.(14)

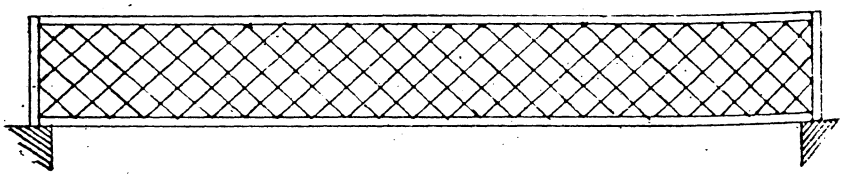


Figure 3. Ithiel Town's all timber "Lattice truss", patented in 1820. (From A Span of Bridges, H. J. Hopkins, p. 118.)

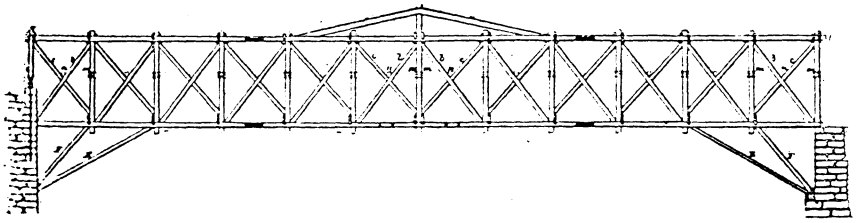


Figure 4. Stephen H. Long's panel truss timber bridge patented in 1830. (From American Building, Carl Condit, illus. 16.)

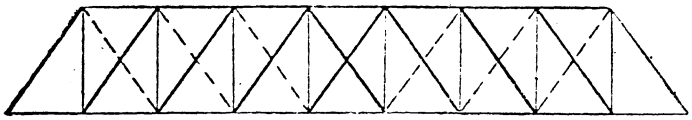


Figure 5. William Howe's timber and wrought iron truss patented in 1840. (From Bridge Engineering, James A. L. Waddell, p. 473.)

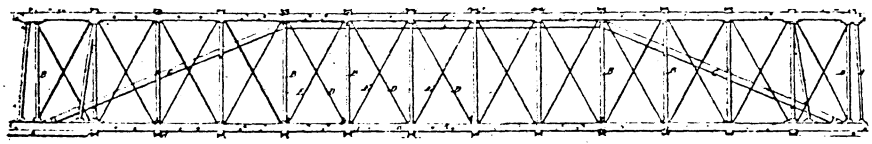
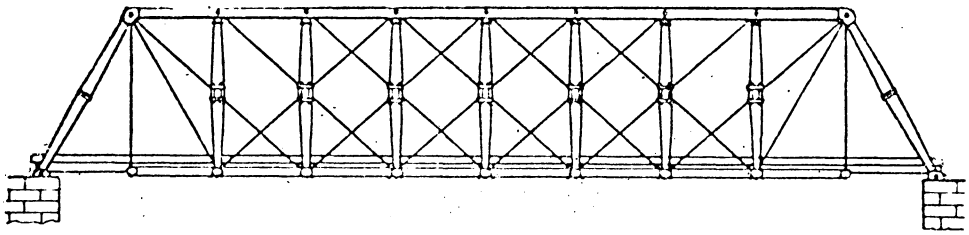
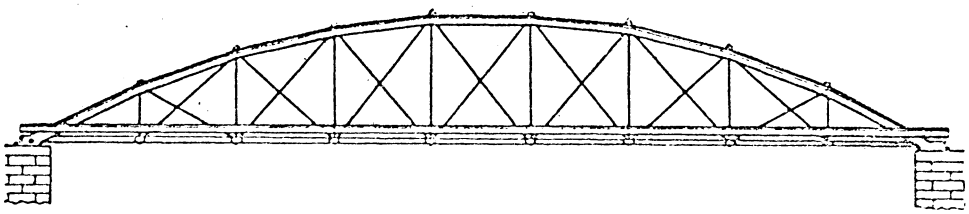


Figure 6. Thomas Pratt's truss design patented in 1844. (From American Building, Carl Condit, illus. 31.)





Figures 7 and 8. Squire Whipple's all-iron truss bridges patented in 1847, having cast iron compression members and wrought iron tension members. (From A Span of Bridges, H. J. Hopkins, p. 129.)

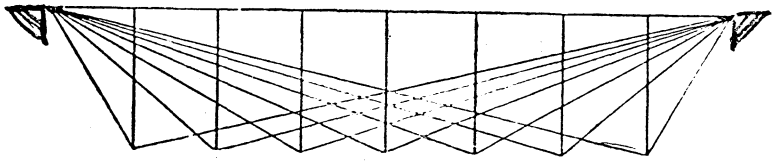


Figure 9. Wendel Bollman's suspended truss patented in 1852. (From Bridge Engineering, James A. L. Waddell, p. 473.)

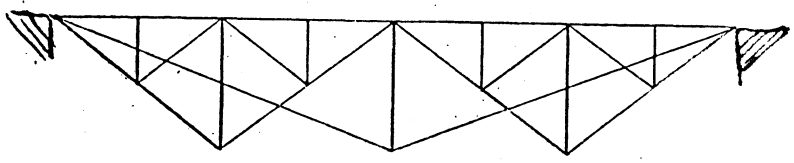


Figure 10. Albert Fink's suspended truss patented in 1854. (From Bridge Engineering, James A. L. Waddell, p. 473.)

Later its top chords were changed from horizontal to polygonal (for certain situations) which resulted in two truss forms called the Parker truss (Figure 11) and the Camelback (Figure 12); subdividing the panels of a Pratt truss with sub-struts produced the Petit or Baltimore truss (Figure 13), while a combination of these two modifications i.e., polygonal top chords with subdivided panels, resulted in a Pennsylvania truss (Figure 14).

Despite this suggestion of infinite variety in truss designs, the truss tended to be a standardized structure except where unique situations required custom designed solutions. Ninety percent of the trusses built after the Civil War were of the Pratt and Whipple systems.(15) The truss types that had proved so reliable were also the ones most frequently constructed, and concomitantly the ones most easily mass produced and fabricated. Mass production techniques could easily be applied to making the smaller parts and connection pieces. Structural reliability and fabrication economy logically resulted from and contributed to mass production of standardized parts and components for standard truss configurations.

Inclined end posts/batter braces were determined be be more economical than vertical ones as well as to contribute to the overall rigidity of a truss by facilitating a better distribution of stresses.(16) In 1889 Theodore Cooper wrote(17) that the persistence of the pin-connected joint, regardless of the basic truss configuration, was the best indication of its superiority over other methods, while the single triangulation webbing system (Pratt, Triangular) had replaced the more complicated double intersection ones (Whipple type, Quadrangular) because of their indeterminate nature and the multiplicity of of parts and members. Cooper discounted the latter types as being both structurally inefficient and not conducive to the economies of mass production and machined accuracy, which certainly contributed to their early demise. The standardization in truss type and details was accompanied by the use of a single material as well. With the perfection of an economical process for manufacturing consistently high quality steel realized by 1890, all the necessary parts and structural members formerly available in wrought iron were available at comparable prices in steel.(18) They could be sized, precut, drilled, riveted and fitted in the fabrication shop, then quickly reassembled at the site. Once this system was understood, its perfection was manifest in the formation of dozens if not hundreds of bridge building companies during the last quarter of the nineteenth century. The founding dates of many of these companies may be traced as far back as the 1840's or 1850's because of the nature of their beginnings as foundries, forges or builders; however, the heyday of the majority would have to have been during the 1880-1910 period.

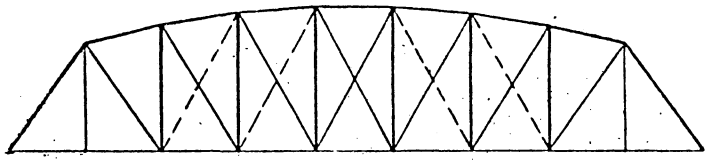


Figure 11. Parker truss, really a Pratt truss having a polygonal top chord whose slope changes at each panel point. (From Bridge Engineering, James A. L. Waddell, p. 469.)

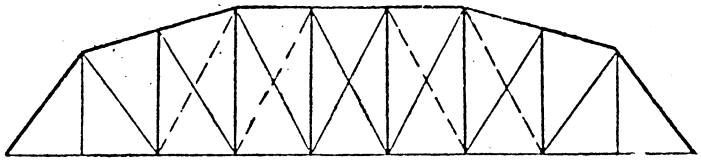


Figure 12. Camelback truss, again a Pratt truss configuration; however, here the polygonal top chord changes slope at alternating panel points. (From Bridge Engineering, James A. L. Waddell, p. 478.)

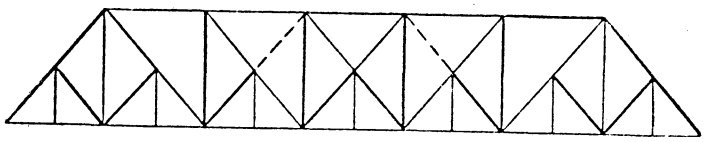


Figure 13. Baltimore/Petit truss, a Pratt truss having subdivided panels. (From Bridge Engineering, James A. L. Waddell, p. 469.)

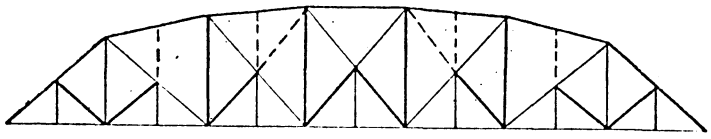


Figure 14. Pennsylvania truss, combination of Pratt, Camelback and Baltimore features. (From Bridge Engineering, James A. L. Waddell, p. 470.)

In general, bridge companies emerged out of two local traditions: (1) the local iron foundry or forge, and (2) a local builder/contractor who had become somewhat specialized in building timber bridges. As the structural possibilities for cast and wrought iron, and later steel, became widely recognized and the availability of these metals increased, it was quite natural for bridge builders to think in terms of using these new, stronger, more durable materials. Once a local bridge builder had understood the structural capabilities of iron, adopting it for parts of timber truss bridges was easy. Howe's patent clearly testifies to this. The builder would have contracted for tension rods from the local forge or for cast iron connection details from a nearby foundry. A combination of these three processes resulted in the formation of numerous bridge companies which worked primarily as designers, fabricators and erectors.

The basic feature of any truss is that it is built up from standardized structural steel or iron shapes, e.g., channels, plates, angles, rods, and rivits, all of which were being mass produced by most iron and steel manufacturers (Figure 15). Names like Bethlehem, Carnegie, Jones & Laughlin, Lackawanna, and Phoenix are to be found on many parts of these truss bridges. The bridge company purchased these standardized shapes and fabricated them into various truss components. Channels, plates and bars became top chords and end posts; channels and bars were riveted together to form posts; angles and bars became lateral struts and sway braces (Figure 16). These components were cut, machined and put together at the fabrication shop, then disassembled and shipped to the site for reassembly and erection. The one known exception to this specialization was the Phoenix Bridge Company, a division of the Phoenix Iron Company, Phoenixville, Pennsylvania, which had control of its product from the smelting process through the erection procedure. Other companies may have had similar control, but the trend to large, consolidated corporations was more common in the early years of the twentieth century, particularly in the bridge industry, with the gradual acquisition of some thirty-five independent bridge companies by the American Bridge Division of the United States Steel Cooperation.(19)

Perhaps a basic assumption needs comment — during this period, the term "bridge" appears to have precluded all types except truss bridges, and bridge companies were truss bridge (both wood and iron) fabricators and builders. In 1888 one writer observed the following:

> Since 1865 few things have advanced more rapidly in the United States than the art of bridge building. One of the notable

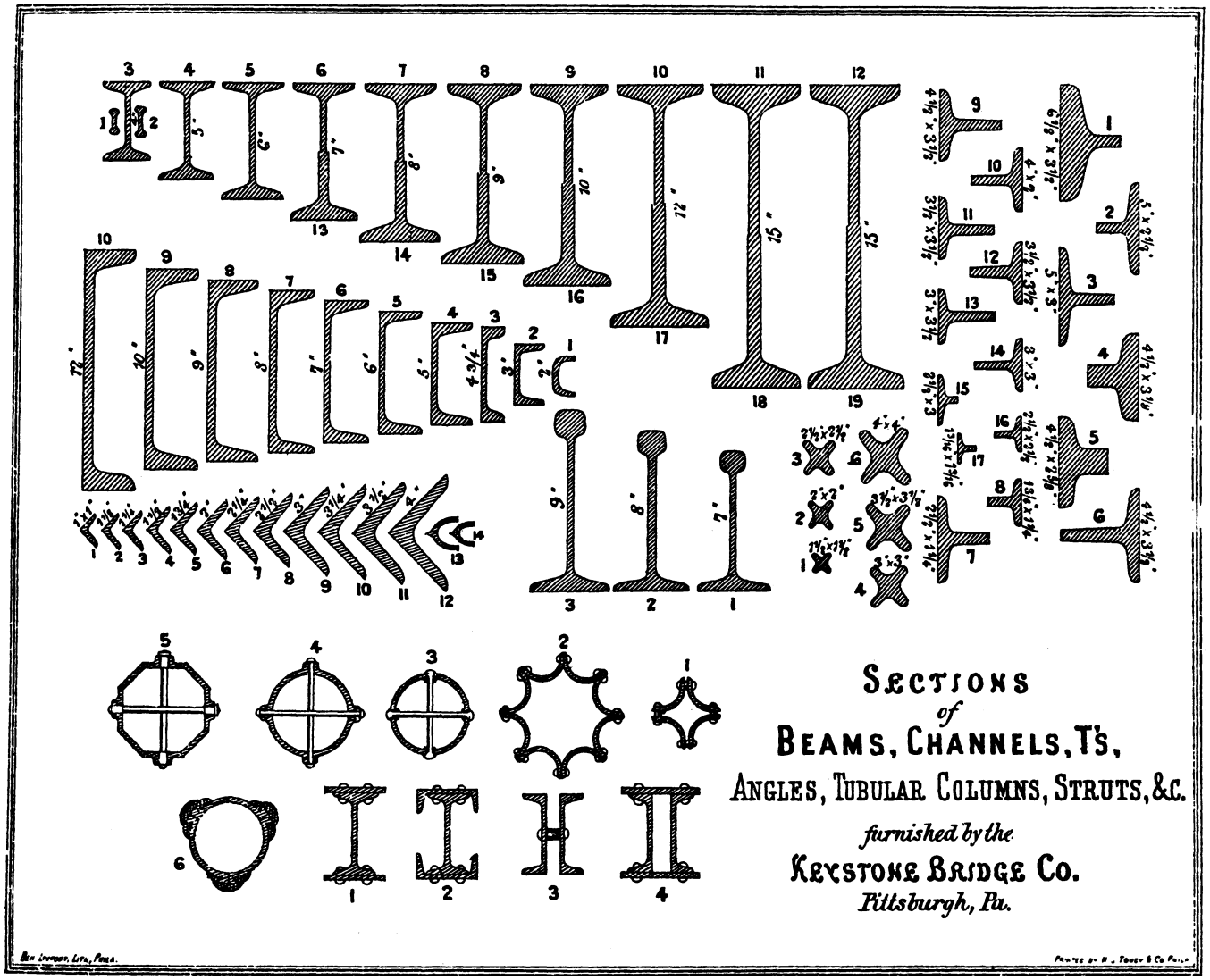


Figure 15. Cross sections of steel/wrought iron shapes used by the Keystone Bridge Company, Pittsburgh, Pennsylvania. (From files of Division of Civil and Mechanical Engineering, Smithsonian Institution, Robert M. Vogel, Curator.)

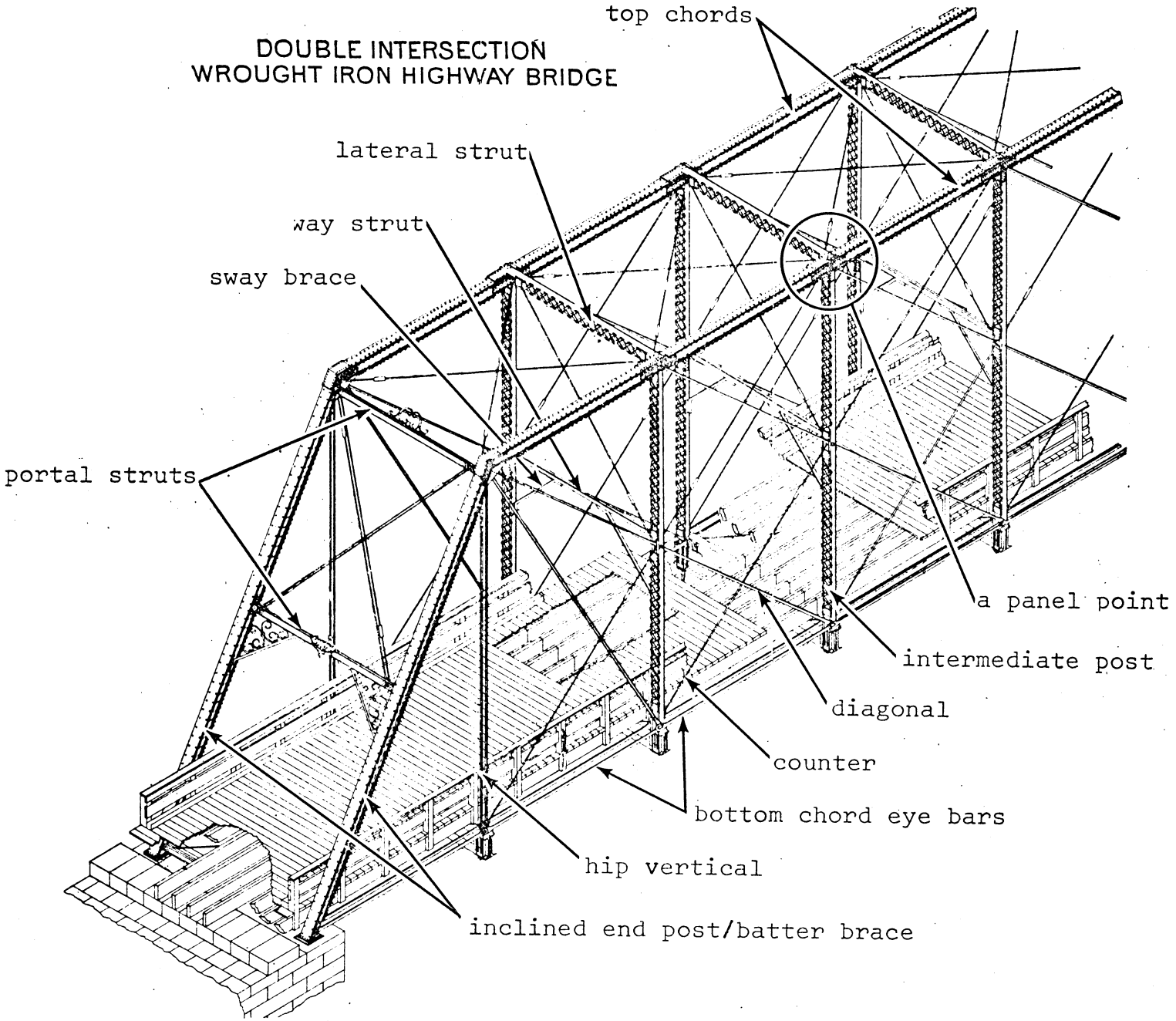


Figure 16. A double intersection metal truss highway bridge. Note component parts. (From The Designing of Ordinary Highway Bridges, James A. L. Waddell, pl. I.)

> tendencies has been towards the substitution of iron for wood, followed by an extensive substitution of steel for iron, and at a later date by a proclivity, in some directions, towards the erection of stone bridges wherever they were practicable. Intermingled,[sic] with these changes there have been many important modifications or inventions of designs, and an increasing disposition to entrust the work of building important bridges chiefly to bridge building firms or companies. A number of the latter have been formed, each of which, to a considerable extent, controls special designs. They have gained extensive reputations for the cheapness and reliability of the structures they erect, and on account of facilities and skill acquired by special attention to this important industry their services are so frequently required, that the general practice is now to have bridges built by them, instead of by railway companies.(20)

This excerpt makes it quite clear that the only alternative to a metal truss bridge was a stone masonry structure, but it was more an exceptional solution than a real one. The structural capabilities of concrete apparently were not even recognized in 1888.

The companies designed their own trusses, remembering that some reputations had been built on patented truss systems, and advertised them in catalogues, (Figures 17, 18 and 19) which usually included lists of extant examples of their works as well as some illustrated examples with appropriate commentary from satisfied customers (Figure 20). Some companies specialized in railroad bridges, which were generally longer, heavier, more dramatic spans than were required for most highway bridges of the nineteenth century. More formidable barriers, e.g., the Mississippi River, would have presented unique situations requiring specially designed structural solutions and constant engineering supervision, whereas the smaller county highway bridge represented in this survey would have been a standard 65-foot or 100-foot span built from plans kept in large supply in company files and sent to local officials on request. The large bridge companies were less likely to undertake these relatively minor projects contracted on an individual basis unless a number of such structures were involved.

Figure 17. Cover from an 1884 catalogue of the King Iron Bridge & Manufacturing Company. (From the files of Robert M. Vogel, Curator, Division of Mechanical & Civil Engineering, Smithsonian Institution.)

THE

American Bridge Company,

PROPRIETORS AND BUILDERS OF

Post's Patent Diagonal Iron and Combination Bridge and Howe Truss Bridge,

IRON AND WOOD TURNING TABLES AND ROOFS,

PNEUMATIC,

SCREW PILE AND STONE SUBSTRUCTURES.

Office, 651 Wabash Avenue, Chicago.

Organized August 1, 1870.

AUTHORIZED CAPITAL STOCK, $1,000,000.

OFFICERS.

L. B. BOOMER.....CHICAGO, *President.*
H. A. RUST,..... " *Vice-President.*
W. E. GILMAN,..... " *Sec'y and Treas.*
L. C. BOYINGTON,..... " *General Agent.*
JOHN F. BARNEY,..... " *Superintendent.*
JOHN W. GOODWIN,.....HOUSTON, TEXAS, *Gen South Western Agent.*
A. GOTTLIEB,.....CHICAGO, *Chief-Engineer.*
E. HEMBERLE,..... " *Asst. Engineer.*

New-York:
JOHN W. AMERMAN, PRINTER,
No. 47 CEDAR STREET.
1872.

Figure 18. Title page from an 1872 catalogue of the American Bridge Company. (From the files of Robert M. Vogel, Curator, Division of Mechanical & Civil Engineering, Smithsonian Institution.)

BOOK OF DESIGNS

OF

WROUGHT

IRON BRIDGES

BUILT BY THE

Wrought Iron Bridge Co.,

OF

CANTON, OHIO.

CANTON, OHIO:
HARTSELL & SAXTON, PRINTERS.
1874.

Figure 19. Title page from an 1874 catalogue of the Wrought Iron Bridge Company. (From the files of Robert M. Vogel, Curator, Division of Mechanical & Civil Engineering, Smithsonian Institution.)

KING IRON BRIDGE AND MANUFACTURING CO., CLEVELAND, O.

Waltham Mass Bridge Length 250 ft. Z. King's Patent.

WE, the Bridge Committee of the town of Waltham, Mass., having contracted for an Iron Bridge of **Z. KING'S PATENT ARCH TRUSS**, manufactured by the King Iron Bridge and Manufacturing Company of Cleveland, Ohio, and the same having been erected, we, after a careful examination of the same, do unanimously recommend it for cheapness, strength and neatness, and would advise all parties contemplating the erection of Bridges, to correspond with the above named Company before building any other style of Bridge.

	AUGUSTUS TOWNSEND,	A. R. CARTER,
(Signed):	SAMUEL O. UPHAM,	J. R. SCOTT,
	HORATIO MOORE.	JOS. H. CURTIS, *Civil Engineer.*

The above Bridge consists of three spans, each 85 feet in length and 50 feet in width.

Figure 20. A satisfied customer of the King Iron Bridge & Manufacturing Company. (From a catalogue of the King Iron Bridge & Manufacturing Company, n.d.)

THE BRIDGE COMPANIES

The annotated list of bridge companies presented in this report includes those firms known to have operated as truss bridge designers and builders principally between 1875 and 1935. Doubtless there will be some duplication of firms listed because of name changes, and reorganizations or mergers; where this is known, it is so indicated. Many of these bridge building/designing companies disappeared as technology made the simple, short-span truss bridge obsolete and the realities of the depression of the 1930's forced others to liquidate or diversify into general structural steel work. The most obvious way to verify the disappearance of many would be a massive check of the pertinent city directories.

The list is basically a compilation of several similar lists, depositories and contemporary directories, the majority of such material being in the files of Robert M. Vogel, Curator, Division of Mechanical and Civil Engineering, the Smithsonian Institution, Washington, D. C., who has amassed a wealth of advertisements from late nineteenth century engineering journals along with listings from contemporary industrial directories. Additional names were contributed by Richard S. Allen, Albany, New York, a covered bridge enthusiast and author of a series of books on the subject; William P. Chamberlain of the New York State Department of Transportation; and David H. Miars, Martinsville, Ohio, a descendent of one of the early owners of the Champion Bridge Company and the author of its history. Assembling the list concomitantly led to more specific information about any one company. One objective was to locate and obtain, when possible, design catalogues published by these companies in an attempt to learn something of the truss types and configurations that a company may have devised, patented or otherwise considered its own. Drawings of technical details, e.g., connection fittings, or of decorative motifs such as side railings, portal brackets or cresting devices could aid in identifying trusses which have lost their identifying nameplates normally affixed to end posts or portal struts. The catalogues could further aid in determining when certain truss types or details were first used as well as when they were found obsolete or were simply discontinued. Collateral information related to a firm's operating dates, its founders, shop locations, or a listing of projects could clarify questions about truss dates. The list should not be looked upon as a final and definitive compilation because additions and corrections will be made as new information is obtained.

Abbott Iron Works — (address unknown)

This firm may not have been a truss bridge fabricator even though its name was carried in the list of bridge companies in Poors' Directory (1887). The entry directed the reader to "See Rail Mills".

Chester B. Albree — Allegheny, Pennsylvania

An Engineering News (1898) advertisement indicated that this company made ornamental iron railings and other decorative ironwork.

Alden & Lassig — Chicago, Illinois

Advertisement, Engineering News (1885).

American Bridge Company — Ambridge, Pennsylvania

When the United States Steel Corporation established a bridge division, ca. 1902, it absorbed some thirty-five smaller bridge fabricators into its bridge division and formed this company.

The American Bridge Company — 611 Wabash Avenue, Chicago, Illinois

An advertisement in Engineering News (1876) stated that the company built only railway bridges; however, their catalogue (published 1872) did not state this restriction. They built Post's patent iron and combination bridge, and the Howe truss, as well as turntables and roofs. The company was organized in 1870 with L. B. Boomer as president and A. Gottlieb as chief engineer. It was also listed in George Adams' Railroad Atlas (1879).

Anderson & Barr — 240 Eleventh Street, Jersey City, New Jersey

Listed in Poors' Directory (1887).

Asa Oren — Watseka, Illinois

(Information contributed by David H. Miars.)

Atlanta Bridge Works — Atlanta, Georgia, and 102 Broadway, New York, New York

This company was also known as Wilkins, Post and Company. Advertisements of the period (publication unknown) stated that they built Pratt, Post and Whipple trusses. It was also listed in Poors' Directory (1887).

* Atlantic Bridge Company — Roanoke, Virginia

This company is known to have constructed a seven-span triangular through truss bridge across the Rappahannock River near Falmouth, Virginia, in 1923. Extant plans for a truss, Fauquier County, Virginia, suggest that this firm was strictly a truss erector not a designer or fabricator.

Austin Bridge Company — Chicago, Illinois

Baltimore Bridge Company — 54 Lexington Street, Baltimore, Maryland

This company advertised in Engineering News (1876) as a designer and erector of iron, steel and composite bridges and roofs and would supply illustrations and specifications upon request.

Bellefontaine Bridge & Iron Company — Bellefontaine, Ohio

An advertisement, Engineering News (8 February 1900), stated that the company could design/construct both bridges and structural work of all kinds.

Berlin Construction Company — Berlin, Connecticut

(Information contributed by Richard S. Allen.)

Berlin Iron Bridge Company — East Berlin, Connecticut, and Binghamton, New York

An advertisement in the Engineering News (1885) listed Charles M. Jarvis as president and civil engineer and Burr K. Field as secretary-treasurer. The firm was also included in Poors' Directory (1887) listing of bridge companies.

Birmingham Bridge Company — Birmingham, Alabama

Poors' Directory (1887) listed C. W. Wood as the general manager and F. C. Osborn as the consulting engineer, with the latter's address as Pittsburgh, Pennsylvania.

Wendell Bollman & Son — Baltimore, Maryland

Inventor of the Bollman Truss around 1855.

* Denotes a company known to have built at least one metal truss bridge in the Commonwealth of Virginia.

Boston Bridge Works — 13 Pemberton Square and 70 Kirby Street, Boston, Massachusetts

The company advertised in the Railroad Gazette (1880) as a builder of wrought iron bridges and roofs. Poors' Directory (1887) listed D. H. Andrews as the owner and listed an address at 70 Kirby Street, Boston, probably the difference between shop and office.

* Brackett Bridge Company — Cincinnati, Ohio

The evolution of this company from a blacksmith shop to a bridge fabrication plant probably serves as the perfect example of the development of many of these bridge companies. It was originally the Lomas Blacksmith Shop, 211 West 2nd Street, Cincinnati, which by 1878 was producing tools and hardware under the name of William Lomas & Company. In 1880 the name was again changed to Lomas Forge & Bridge Works when it began building bridges, and finally became the Brackett Bridge Company after F. J. P. Brackett acquired the controlling interest. It continued in operation into the 1920's under the name Brackett Construction Company but subsequently went out of business.(21)

A. D. Briggs & Company — 7 Fort Block, Main Street, Springfield, Massachusetts

This firm's advertisement in Webb's N. E. Railroad and Manufacturers' Statistical Gazetteer (1869) listed the following items they could build: Truesdell's Patent Truss Bridge, Howe's Patent Truss Bridge, other trusses of iron and timber for roofs and bridges, and as well it could do bridge repair work. Plans, estimates, and specifications would be furnished on request.

Brickey Bridge & Boiler Works — Cleveland, Ohio

(Information contributed by David H. Miars.)

Buckeye Bridge Company — Cleveland, Ohio

Advertised in Engineering News (1876).

Buffalo Bridge & Iron Works — Baily Avenue, Buffalo, New York

They advertised, Engineering News (February 1900), as builders of iron and steel bridges and structural iron work. It is quite possible that the Buffalo Bridge Company, Buffalo, New York, may be the same firm of an earlier or later name.

Caldwell & Lane Company — Newark, Ohio

(Information contributed by David H. Miars.)

* Canton Bridge Company — Belden & Tenth Street, Canton, Ohio

This company was formed in 1891 by W. E. Sherlock, president; V. H. Hammond, vice president (quite possibly a relative of D. Hammond of the Wrought Iron Bridge Company); and C. E. Timkler, chief engineer. They ran an advertisement in the Engineering Record as early as 1876, which would indicate that 1891 may be the year of incorporation. Canton Bridge operated independently until 1925, when it was purchased by the Massillon Steel Joist Company, Massillon, Ohio; however, two years later, 1927, the two were merged into the Macomber Steel Company and the name Canton Bridge Company was dropped.(22) The Canton Bridge Company is credited with twelve truss spans in the Virginia Department of Highways & Transportation's Staunton Construction District.

Carnegie, Phipps & Company — (address unknown)

The entry in Poors' Directory (1887) directed the reader to "See Rail Mills", suggesting that they were not really a bridge builder/designer.

M. S. Cartter and Company — Singer Building, Fifth & Locust Streets, St. Louis, Missouri

The firm advertised, Railroad Gazette (1885), as engineers, bridge builders and contractors for iron, combination and Howe truss bridges. Also listed in Poors' Directory (1887).

Central Bridge Company — 52 Wall Street, New York, New York

This firm advertised as being engineers and contractors for steel, iron and combination bridges in Engineering News (1881). It would have been a rather early use of structural steel.

Central Iron & Steel Company — (address unknown)

The entry in Poors' Directory (1887) refers the reader to the car axle manufacturers' listing.

* Champion Bridge Compan — Wilmington, Ohio

In 1871 Zimri and Jonathan Wall formed Z&J Wall and Company, a bridge building firm that erected both timber and wrought iron bridges. The company's name was changed the following year, 1872, to the Champion Iron Bridge and Manufacturing Company. By 1874 they had patented their "Champion Wrought Iron Arch" bridge. Their fabrication shops were moved from Hamilton to Wilmington, Ohio, in 1875 and three years later the company incorporated under the above name "for the purpose of manufacturing iron bridges, farm implements, iron fences, and machinery of all kinds and general repairs of the same". The company acquired a second patent, an "eccentric bridge pin" in 1880, however, it was not their exclusive property since the Wrought Iron Bridge Company also used it. The articles of incorporation of 1878 had defined the company as being an iron bridge and manufacturing company. In order to avoid legal technicalities of building in other materials, e.g., wood and steel especially, the name was again changed to the Champion Bridge Company, which it has retained to the present day. The peak years for metal truss bridge fabrication appear to have been from about 1885-1910. This is reflected in Champion's policies: between 1885 and 1910, they opened regional offices in Atlanta, Birmingham and Chattanooga, as well as building new fabrication shops in 1893. Champion's survival in an age when the truss bridge is largely a form of the past is probably a result of their diversification into general steel erection and structural work.(23)

Chester Rolling Mills — Thurlow, Pennsylvania, and 238 S. Third Street Philadelphia, Pennsylvania

T. J. Houston was listed as the General Manager in Poors' Directory (1887). The two addresses probably refer to the locations of the mill and of the office.

Chicago Forge & Bolt Company — (address unknown)

The entry in Poors Directory (1887) directed the reader to "See Car Axle Manufacturers".

Cincinnati Bridge Company — Cincinnati, Ohio

This firm advertised in Engineering News (1876).

Clarke Bridge Company — 7 South Street Baltimore, Maryland

This company advertised as "engineers and contractors of wrought iron bridges, roofs, trestles, etc." in an unidentified advertisement.

Clarke, Reeves & Company — 410 Walnut Street, Philadelphia, Pennsylvania, and 43 Williams Street, New York, New York

This company was organized in 1869 and operated under the above name until 1885, when it was reorganized as the Phoenix Bridge Company.[24] In 1873 and 1884, the firm published its "Album of Designs", which would be sent on request, though it was most likely an annual publication. An unidentified advertisement indicates that the company built bridges for railway companies; however, these may not necessarily have been for carrying rail traffic. One extant Phoenix bridge in Covington, Virginia, was built to carry vehicular traffic across the Chesapeake and Ohio RR tracks but it was probably built by the railroad company.

Cleveland Bridge & Car Works — Lake & Mason Street, Cleveland, Ohio

This firm advertised as "builders of bridges and roofs either iron or wood" in the Railroad Gazette (1885).

Clinton Bridge Company — Clinton, Iowa

An Engineering News (1876) advertisement stated the company built bridges, turntables and roofs, and furnished plans, strain sheets and estimates on request. This company may be an earlier or later reorganization of the Clinton Smith Bridge Company, Cleveland, Ohio. (See below.)

Cofrode & Saylor — 257 S. Fourth Street, Philadelphia, Pennsylvania

This firm was listed in Poors' Directory (1887).

* Columbia Bridge Company — Dayton, Ohio

The company had its beginning in 1848 as a builder of wooden bridges under the ownership of D. H. and C. C. Morrison. By 1868 Morrison was erecting a patented iron bridge. The company advertised in the Engineering News (1876) and was listed in Poors' Directory (1887).

Columbus Bridge Company — Columbus, Ohio

Listed in Poors' Directory (1887).

W. G. Coolidge & Company — Chicago, Illinois

Listed in Poors' Directory (1887).

Continental Bridge Company — 110 S. Fourth Street, Philadelphia, Pennsylvania

This company advertised as a "builder of Henszey's Patent Wrought Iron Arch bridge with iron or wood floor beams".

Corrugated Metal Company — East Berlin, Connecticut

An 1881 company letterhead indicated they built "wrought iron bridges, roofs, buildings, Douglas Patent wrought iron and combination bridges". They would furnish plans, strain sheets and estimates, and further requested to be notified of any bridge lettings.

Simon DeGraff — Syracuse, New York

Information from William P. Chamberlin, Albany, New York, states that there is an existing cast and wrought iron bowstring truss bridge with an 1867 date plate in the proximity of Albany built by Simon DeGraff.

Dean & Westbrook — New York, New York

Delaware Bridge Company — Trenton, New Jersey, and New York, New York

This firm was also known as Cooper, Hewitt & Company and advertised as being "engineers and contractors for construction of bridges, roofs, viaducts, iron piers", Engineering News (1876).

Detroit Bridge & Iron Works — Detroit, Michigan

This company was probably the same as the Detroit Bridge and Iron Company, Detroit, Michigan. They advertised in Engineering News at various times between 1876 and 1900 as "engineers and bridge builders" for "steel, iron and combination bridges". Poors' Directory (1887) listed Willard S. Pope as president and engineer and W. L. Baker as superintendent and engineer.

J. B. Diver & Company — Keokuk, Iowa

Listed in Poors' Directory (1887).

Dominion Bridge Company — Montreal, Quebec, Canada

Listed in Poors' Directory (1887).

Edge Moor Iron Company — Edge Moor on the Delaware River, Wilmington, Delaware, and 1600 Hamilton Street, Philadelphia, Pennsylvania

The company advertised, Engineering News (1898), that it would furnish estimates for any specifications it received from railway companies, engineers or contractors. Poors' Directory (1887) listed William Sellers as company president and George H. Sellers as general superintendent.

Elmira Bridge Company, Ltd. — Elmira, New York

Advertisements in Engineering News (1898, 1900) listed the company as "engineers and manufacturers" of "steel and iron bridges, roofs and turntables".

Eureka Bridge & Iron Company — Chicago, Illinois

This firm advertised in Engineering News (1876).

John P. Eyre & Company — 450 Richmond Street, Philadelphia, Pennsylvania

Listed in Poors' Directory (1887).

* Farris Bridge Company — Pittsburgh, Pennsylvania

This firm is known to have built one two-span low Pratt truss bridge in 1909, Hinton, Rockingham County, Virginia.

Fort Pitt Bridge Company — Cannonsburg, Pennsylvania

Advertised in Engineering News (1898). The company purchased Massillon Bridge Company in 1933, when economic conditions precipitated liquidation.

James Gates — Market & Sixth Streets, St. Louis, Missouri

Advertised in the Railroad Gazette (1878) as a "designer and builder of wrought-iron, combination and wooden bridges".

Genesee Bridge Company — Rochester, New York

(Information contributed by Richard S. Allen.)

R. W. Gibson — 300 Walnut Street, Philadelphia, Pennsylvania

Listed in Poors' Directory (1887).

Gibson Road Machinery Company — Marathon, New York

(Information contributed by Richard S. Allen.)
(To call a truss bridge a piece of "road machinery" would certainly be a novel terminology.)

Gillette-Herzog Manufacturing Company — Minneapolis, Minnesota

An advertisement in Engineering News (1900) stated they were builders of both "steel and combination bridges for railways and highways". This would certainly be a late use of combination (built of timber and wrought iron) bridges.

A. Gottlieb & Company — Major Block, Chicago, Illinois

Listed in Poors' Directory (1887).

* Groton Bridge & Manufacturing Company — Groton, New York

The company advertised, Engineering News (1900), as being able to furnish plans and estimates for steel bridges and buildings.

T. H. Hamilton — Toledo, Ohio

Hamilton advertised, Railroad Gazette (1885), as a "bridge builder and general contractor" who built "Howe's Patent Truss". Also listed in Poors' Directory (1887).

Hamilton Bridge Company — Hamilton, Ontario, Canada

Listed in Poors' Directory (1887).

T. H. Hardman — Brookville, Indiana

(Information contributed by David H. Miars.)

Hawkins, Herthel & Burrall — 88 Main Street, Springfield, Massachusetts

An advertisement in Webb's N.E. Railway and Manufacturers' Statistical Gazetteer (1869) showed them to be "builders of iron and timber bridges, roofs, turntables, etc." This is probably the same firm as R. F. Hawkins, Iron Works, listed in Poors' Directory (1887).

Hilton Bridge Construction Company — Commercial Bank Building, Albany, New York

This company advertised as engineers and contractors for "wrought iron and steel bridges, roofs, trestles and turntables, riveted girders, tanks, beams, pillars, etc." Also listed in Poors' Directory (1887).

Hocking Valley Bridge Company — Lancaster, Ohio

(Information contributed by David H. Miars.)

H. S. Hopkins Bridge Company — St. Louis, Missouri

(Information contributed by Richard S. Allen.)

* Horseheads Bridge Company — Horseheads, New York

(Information contributed by David H. Miars.)

H. E. Horton Bridge Company — Rochester, Minnesota

(Information contributed by David H. Miars.)

Independent Bridge Company — Newville Island, Pennsylvania

Advertisement, Engineering News Record (1931).

Indianapolis Bridge Company — Indianapolis, Indiana

Advertisement, Engineering News (1876).

Iron City Bridge Company — Pittsburgh, Pennsylvania

Advertisement, Engineering News (1876)

Iron Substructure Company — Columbus, Ohio

Listed in Poors' Directory (1887).

Joliet Bridge & Iron Company — Joliet, Illinois

The company advertised as "manufacturers of bridges and general structural work" in Engineering News (1900).

Jones & Benner — 218 South Fourth Street, Philadelphia, Pennsylvania

This firm advertised in the Railroad Gazette in both 1880 and 1885 as "engineers and contractors, iron and wooden bridges and buildings" and more specifically for "wrought iron and combination bridges". Poors' Directory (1887) listed W. M. Levering as president and M. Brenner as engineer.

Kansas City Bridge & Iron Company — Kansas City, Missouri

Listed in Poors' Directory (1887)

Kellogg & Maurice — Athens, Pennsylvania

Advertisement in Railroad Gazette (1880).

Charles Kellogg & Company — Detroit, Michigan

Kellogg Bridge Company — Buffalo, New York

Advertisements in Engineering News (1876, 1881) and Railroad Gazette (1880) termed the company as "bridge builders and contractors supplied with finished iron materials" who built "wrought iron railroad and other bridges".

Kenwood Bridge Company — Chicago, Illinois

The advertisement for this company, Engineering News (1900), simply stated that they built steel trusses.

* Keystone Bridge Company — 51st & Harrison Streets, Pittsburgh, Pennsylvania

This company was founded by J. H. Linville and Piper. Linville had earlier been the bridge engineer for the Pennsylvania Railroad and pioneered in the use of wide, die-forged eye bars for tension members.(25) When Linville and Piper established Keystone Bridge Company in the mid 1860's, they initiated using wrought iron for all principal truss members. An 1873 advertisement stated that they were able to "design and construct wrought iron, steel and combination bridges" and that their "album of designs and actual bridges constructed" would be "sent free on request". They developed a tubular column made up of riveted circular segments, which was used for posts and other compression members. Because of these innovative efforts, Keystone Bridge would have to be considered as one of the pioneers in the development of truss technology.

* King Iron Bridge & Manufacturing Company — St. Clair & Wason Streets, Cleveland, Ohio

Though this company was not organized under the above name until 1871, the company traces its beginnings back to 1858 under the proprietorship of Zenas King, who had built a number of arch and swing bridges in northern Ohio. By 1884 the reorganized company was able to claim the largest highway bridge works in the United States. Their reputation had been established on Z. King's Patent Tubular Arch bridge, first built in 1859. In the early years, King Bridge never built more than two dozen such truss spans annually; however, by 1874 their catalogue was claiming an annual number of 250-300 Tubular Arch spans with over 2700 in use by that year. Between 1874 and 1875, they had built 15 truss spans in Virginia, both Tubular Arch and high/through trusses.(26)

Koken Iron Works — Koken Building, St. Louis, Missouri

Their advertisement in Engineering News (1900) could not have been more terse: "bridges -- all classes".

Lafayette Bridge Company — Lafayette, Indiana

(Information contributed by David H. Miars.)

John Laird & Company — Canton, Ohio

A foundry owned and operated by John Laird in 1840 had expanded into a wrought iron producer and bridge builder by 1867.

P. E. Lane Bridge Company — 177 LaSalle Stree, Chicago, Illinois

Listed in Poors' Directory (1867)

Lassig Bridge & Iron Company — Chicago, Illinois

(Information contributed by David H. Miars.)

Leichton Bridge & Iron Works — Rochester, New York

An advertisement in Engineering News (1876) indicated that this company actively solicited orders from civil engineers and contractors and would fabricate and erect "wrought iron riveted lattice railroad and highway bridges". This suggests a separation in the design/fabrication process not indicated before.

Licking Iron Works/Licking Rolling Mill Company — Covington, Kentucky

The Poors' Directory (1887) entry listed I. Droege as the president.

Louisville Bridge & Iron Company — Oldham and Eleventh Streets, Louisville, Kentucky

This company advertised in both Engineering News (1876) and Railroad Gazette (1880) as building "triangular, Whipple and Fink trusses and other forms of iron and combination bridges". Poors' Directory (1887) also listed the company.

Lowthrop & Henderson — 78 East State Street, Trenton, New Jersey

This company advertised as being "engineers and builders of bridges and turntables all wrought iron or wrought and cast iron". F. C. Lowthrop was listed as the civil engineer for the firm.

Lukens Rolling Mills — Coatesville, Pennsylvania

Poors' Directory (1887) listed Charles Huston & Sons as the owner.

McClintic-Marshall — Bethlehem, Pennsylvania

An Engineering News Record (1931) advertisement for this firm stated their capacity for "fabrication and erection of steel for bridges, buildings, and other steel structures".

J. McCormick — Albany, New York

Listed in Poors' Directory (1887).

Charles MacDonald — 80 Broadway, New York, New York

MacDonald advertised (publication undetermined) as being an "engineer and contractor for the construction of iron and wooden bridges".

Massillon Bridge Company — Massillon, Ohio

Joseph Davenport, credited with being the builder of the first cantilever bridge, founded the company in 1869 as the Massillon Iron Bridge Company. It advertised in Engineering News (1876, 1900) as a builder of "iron, steel and combination railroad and highway bridges and structural iron work". The plant or fabrication shop was retained in Massillon while the offices were located in the Merchants' National Bank Building, Toledo. Also listed in Poors' Directory (1887) the same year it was incorporated. The name was changed around 1900 to Toledo-Massillon Bridge Company, reflecting a change in ownership. In 1909 it was reincorporated as the Massillon Bridge & Structural Company, under which it operated until 1933, when it was liquidated and absorbed by the Fort Pitt Bridge Works, Canonsburg, Pennsylvania. The company ceased bridge building operations in 1943.(27)

Memphis Bridge Company — Memphis, Tennessee

(Information contributed by David H. Miars.)

Henry T. Merriam — Millbury, Massachusetts

This is the only firm whose advertisement (unknown publication) included architectural work: "wrought iron bridges, iron fronts".

R. Merydith & Son — Marietta, Ohio

(Information contributed by David H. Miars.)

Milwaukee Bridge Company — Milwaukee, Wisconsin

The advertisement, Engineering News Record (1931), for this company suggested the demise of the truss bridge: "Steel framed structures of all kinds."

Milwaukee Bridge & Iron Works — Milwaukee, Wisconsin

This company may have been the predecessor of the Milwaukee Bridge Company (see above). It advertised, Engineering News (1876, 1900), as a builder of "railroad bridges, structural iron for buildings, roofs, etc."

Missouri Valley Bridge & Iron Works — Leavenworth, Kansas

Listed in Poors' Directory (1887) and advertised in Engineering News (1900) as builder of "wrought iron, steel, Howe truss and combination bridges... etc."

Morse Bridge Company — Youngstown, Ohio

A company letterhead (1886) stated the firm's capabilities as "engineers and manufacturers of bridges and structural work in iron and steel". The company may have become the Youngstown Bridge Company and finally turned into the Youngstown Street Car Company. (This is the opinion of David H. Miars.)

Mount Vernon Bridge Works — Mount Vernon, Ohio

The company was listed in Poors' Directory (1887) and advertised in Engineering News (1900) as "engineers and manufacturers of iron and steel mill buildings and structural work, railway and highway bridges, roofs, viaducts, etc."

Murray, Dougal & Company — Milton, Pennsylvania

(Information contributed by Richard S. Allen.)

Murray, Hazlehurst — Vulcan Works, Baltimore, Maryland

A firm of "civil and mechanical engineers" with "special attention paid to iron bridges for railways and common roads" was the way they advertised themselves (publication undetermined).

National Bridge & Iron Works — 32 Hawley Street, Boston, Massachusetts

This company advertised (publication undetermined) as "contractors for building and erecting wrought-iron railway and highway bridges". C. H. Parker, inventor of the "Parker" truss in the mid-1870's, was their chief engineer. They later reported an address at 15 State Street, Boston, Massachusetts.

* Nelson & Buchanan, Engineers and Contractors — Chambersburg, Pennsylvania

This firm is known to have built one three-span through/high Pratt truss bridge in Allegheny County, Virginia, in 1896, which crosses the Cowpasture River.

New Columbus Bridge Company — Columbus, Ohio

This company's advertisement, Engineering News (1900), simply stated "railway and highway bridges".

New England Iron Company — Sears Building, State Street, Boston, Massachusetts

This company advertised (undetermined publication) as the "successors to the Moseley Iron Building Works" in addition to being "builders of wrought iron bridges".

New Jersey Steel & Iron Company — Trenton, New Jersey

This company was founded in 1845 by Abram Hewitt. Poors' Directory (1887) listed their representatives as Cooper, Hewitt & Company, 17 Burling Slip, New York, New York, and Edward Cooper was listed as the president. An advertisement appeared in the Engineering News (1898).

Niagara Bridge Works — Forest Avenue, Buffalo, New York

Advertised (undetermined publication) as "builders of iron lattice bridges, for railroads and highways". G. C. Bell was listed as the manager and S. J. Fields as the company's engineer in Poors' Directory (1887).

Ohio Falls Iron Works — New Albany, Illinois

W. C. DePauw was listed as president and Peter R. Stoy as general manager in Poors' Directory (1887).

Oregonia Bridge Company — Oregonia, Ohio

This company was originally a blacksmith shop, Lebanon, Ohio, operated by Bradbury and Spencer, who had manufactured parts for truss bridges. In 1888 the firm had built their first complete bridge. The name of the company was probably changed when it moved to Oregonia, Ohio in 1903.(28)

Owego Bridge Company — Owego, New York

(Information contributed by Richard S. Allen.)

Passaic Rolling Mill Company — Paterson, New Jersey

The company advertised in Engineering News (1900) as able to "manufacture all kinds of iron and steel work for bridge and buildings". They would furnish plans and estimates on request. Poors' Directory (1887) listed Watts Cooke as president and John K. Cooke as the superintendent.

Patapsco Bridge & Iron Works — Baltimore, Maryland

The company advertised in an Engineering News (no date).

Pencoyd Iron Works — 261 S. Fourth Street, Philadelphia, Pennsylvania

Advertised in Engineering News (1898) as "designers and builders of train-sheds, viaducts, bridges, elevated railroads and all steel structures". However, Poors' Directory (1887) advised the reader to "See Car Axle Manufacturers".

Penn Bridge Works or
Penn Bridge & Machine Works — Beaver Falls, Pennsylvania, and New Brighton, Pennsylvania

These may have been two different companies or one company that relocated (New Brighton and Beaver Falls are very near each other) to new facilities and made a name change at the same time. In any event, they advertised, Engineering News (1898), as "contractors for iron, combination and Howe truss bridges, roofs, etc.", for which they would furnish estimates upon request. Poors' Directory (1887) listed J. W. Shipman as their Eastern agent with offices in the Tribune Building, New York, New York.

Pennsylvania Steel Company — Steelton, Pennsylvania

The company advertised, Engineering News (1900), as building bridges and "all structures of steel and iron".

Philadelphia Bridge Works — 257 S. Fourth Street, Philadelphia, Pennsylvania

Advertisements for this company appeared in both the Railroad Gazette (1885) and the Railway Review (1885) and referred to it as "civil engineers and bridge builders". The address is that of Cofrode & Saylor (see same above), which would probably mean a name change occurred.

Phillipsburg Manufacturing Company — Phillipsburg, New Jersey

(Information contributed by Richard S. Allen.)

* Phoenix Bridge Company — Phoenixville, Pennsylvania

This company was started in 1869 as Clarke, Reeves & Company, under which name it operated until 1885, when it was reorganized as the Phoenix Bridge Company. The company is known to have published their "Album of Designs" in 1870, 1873, 1884, 1885, 1888; however, it was probably an annual issue. Phoenix was a vertical operation, from smelting their own ore to designing and erecting their own bridges. The firm favored the through/high Pratt and Whipple truss systems and patented a compression member called the Phoenix column, which was a series of vertical segments riveted together forming a cylindrical column. This is an easy identifying feature of a Phoenix bridge. The company primarily built railroad bridges but not exclusively. For example, a railway company may have contracted for a vehicular bridge as an overpass for the train tracks. An 1886 advertisement (publication undetermined) boasted a rather comprehensive repertoire, being "engineers and builders of bridges, viaducts, roofs, turntables, elevated railroads, ocean piers, and all structures of iron and steel". Poors' Directory (1887) listed David Reeves as president and W. H. Reeves as superintendent. The "Album of Designs" for 1888 listed Adolphus Bonzano as chief engineer and contained an extensive list of constructed bridges, including 17 bridges built in Virginia for the Petersburg Railroad Company, the Seaboard & Roanoke Railroad and the Gay Manufacturing Company. There are several extant Phoenix bridges in Virginia not included in the list, which would indicate a post-1887 construction date. The company, by 1888, had opened a branch office in Kansas City, Missouri. Phoenix was internationally known as well with bridges having been built in Canada, Mexico and Brazil. It is also of interest that James A. L. Waddell worked for Phoenix between 1886 and 1892.

* Pittsburgh Bridge Company — Pittsburgh, Pennsylvania

They advertised in Engineering News (1898, 1900) for "bridges, steel buildings, and general structural work".

Pittsburgh Locomotive & Car Works — 10 Sixth Street, Pittsburgh, Pennsylvania

An advertisement (publication undetermined) stated only "iron or steel bridges".

Post & McCord — Brooklyn, New York

(Information furnished by David H. Miars.)

Pottstown Bridge Company — Pottstown, Pennsylvania

Advertised in Engineering News (1900) for "bridges, buildings, turntables, castings. Estimate furnished. Drawings and specifications solicited."

Raymond & Campbell — Council Bluffs, Iowa

(Information furnished by David H. Miars.)

C. O. Richards & Company — 15 Cortlandt Street, New York, New York

Advertised in Railroad Gazette (1885) as "builders of iron and wooden bridges". Also listed in Poors' Directory (1887).

Ritter-Conley Company — Pittsburgh, Pennsylvania

Advertised in Engineering News (1898).

* Roanoke Bridge Company — Roanoke, Virginia

This firm built a number of truss bridges in Virginia's western counties. It seems quite possible that the company was later renamed and reorganized as the Roanoke Iron & Bridge Company since there is a distinct break from 1913-1916 in bridge dates built by each firm.

* Roanoke Iron & Bridge Company — Roanoke, Virginia

The trusses inventoried to date, which were definitely built by this company, carry date plates no earlier than 1916, while those built by the Roanoke Bridge Company (see above) date no later than 1913.

Rochester Bridge & Iron Works — Rochester, New York

Listed in Poors' Directory (1887). Also advertised in Engineering News (1900) as "designers and builders of wrought iron and steel railroad bridges". This would seem a rather late date to still be using wrought iron for major structural work.

John A. Roebling's Sons Company — Trenton, New Jersey

This firm advertised in Engineering News (1898).

Rust & Coolidge — Dearborn & Monroe Streets, Chicago, Illinois

An advertisement, Railway Review (1885), referred to this company as being "engineers and contractors, bridges and roofs--subcontractors".

St. Louis Bridge & Iron Company — St. Louis, Missouri

(Information furnished by Richard S. Allen.)

San Francisco Bridge Company — World Building, New York, New York

The firm advertised simply as "engineers and contractors" in the American Society of Civil Engineers (1893).

Schultz Bridge & Iron Company — McKee's Rocks, Allegheny County, Pennsylvania

An advertisement in the Engineering News (1900) referred to this company as "manufacturers of Bridges and structural work". (It is highly probable that this is the same company as C. J. Schultz, Pittsburgh, Pennsylvania.)

Sebastain Bridge Works — St. Louis, Missouri

(Information contributed by David H. Miars.)

B. M. & J. F. Shanley — 16 Exchange Place, Jersey City, New Jersey

Listed in Poors' Directory (1887).

Shiffler Bridge Company — 48th Street, Pittsburgh, Pennsylvania

Listed in Poors' Directory (1887) as the Shiffler Bridge Works. An 1894 advertisement, American Society of Civil Engineers, indicates that the company did not build highway bridges but rather "steel, iron and combination railroad bridges".

Shoemaker Bridge Company — New York, Philadelphia, Pottstown

Advertised in 1931, Engineering News Record, as a builder of "bridges and buildings".

Smith & McNeill — Lynchburg, Virginia

An advertisement for this firm (publication unidentified) stated their purpose as "civil and mechanical engineers and bridge builders". Interestingly enough, no truss bridges by this firm have yet been inventoried in Virginia.

Smith Bridge Company — Toledo (East Toledo), Ohio

Robert W. Smith, Toledo, founded this bridge building firm in 1867 and began producing his pre-cut timber Smith truss. By 1875, the Smith Bridge Company was making wrought iron truss bridges. The company's name was changed to the Toledo Bridge Company ca. 1890 and later absorbed by the U.S. Steel Corporation's American Bridge Division.[29] Smith advertised in the Railroad Gazette (1878) as being able to "design and construct iron, wooden and combination bridges". The company's address was given as East Toledo in Poors' Directory (1887).

C. Shaler Smith — St. Louis, Missouri

An 1885 advertisement in Railroad Gazette stated their work as a "designer and builder of bridges and viaducts". Listed in Poors' Directory (1887).

Clinton Smith Bridge Company — Cleveland, Ohio

See above entry for Clinton Bridge Company, Clinton, Iowa

Sooysmith & Company — 2 Nassau Street, New York, New York

Listed in Poors' Directory (1887).

Southern Bridge Company — Birmingham, Alabama

(Information contributed by David H. Miars.)

C. L. Strobel — 1744-8 Monadnock Block, Chicago, Illinois

Strobel advertised in the Engineering News (1900) as a "contracting engineer and designer and builder of bridges, viaducts and structural iron work, improved turntables and movable bridges". It is rather ironic that this firm's address is one of the last major nineteenth century sky-scrapers built with load-bearing brick masonry walls rather than having the more advanced skeletal steel superstructure.

Stupp Brothers Bridge & Iron Company — St. Louis, Missouri

The company advertised in Engineering News (1900) as "manufacturers and contractors of bridges and structural work".

Swifts Iron & Steel Works

The entry in Poors' Directory (1887) referred the reader to "see rail mills".

Thatcher, Burt and Company — Cleveland, Ohio

This firm's name was first changed to McNairy, Claflen and Company, which by 1885 became the Cleveland Bridge and Car Works (see above entry).(30)

Toledo Bridge Company — Toledo, Ohio

See above entry for Smith Bridge Company.

Tredegar Iron Works — Richmond, Virginia

Listed in Poors' Directory (1887), reader is referred to the listing for "car axle manufacturers".

Union Bridge Company — 18 Broadway, New York, New York

This company advertised as "civil engineers and contractors of bridges, tunnels and public works" in the Engineering News (1900). Earlier advertisements appeared in 1885 and 1898. Poors' Directory (1887) listed fabrication shop locations in both Athens, Pennsylvania, and Buffalo, New York.

Union Iron Mills

This company was listed in Poors' Directory (1887); however, the reader was referred to the listings for "rail mills".

United Construction Company — Albany, New York

(Information contributed by Richard S. Allen.)

* Variety Iron Works Company — Cleveland, Ohio

The advertisement Variety submitted to the Engineering News (1898, 1900) indicated it worked in the three "B's", "Bridges, buildings, boilers". At present only two bridges have been inventoried in this survey that were built by Variety.

Vermont Construction Company — St. Albans, Vermont

This company was a subsidiary of R. E. Hawkins Iron Works, Springfield, Massachusetts.(31) (See above listing Hawkins, Herthel & Burrall.)

* Virginia Bridge & Iron Company — Roanoke, Virginia

A late advertisement, 1931, in the Engineering News Record, stated only "Steel buildings, bridges, etc." The company built a number of truss bridges in the early decades of the twentieth century in the western counties of Virginia.

Walker Brothers, Contractors — Charlestown, West Virginia

This firm is known to have built one low Pratt truss span bridge in Rockingham County, Virginia.

J. W. Walker — Pittsburgh, Pennsylvania

Listed in Poors' Directory (1887).

Wallis Iron Works — 7-13 Morris Street, Jersey City, New Jersey

The company advertised in the Railroad Gazette (1885) as a builder of "iron bridges..."

Watson Manufacturing Company — Paterson, New Jersey

(Information contributed by Richard S. Allen.)

F. Weinhagen — Milwaukee, Wisconsin

Listed in Poors' Directory (1887).

Wells & French Company — 147 Dearborn Street, Chicago, Illinois

This company advertised in Railroad Age (1881) as being "bridge and car builders". A later entry in Poors' Directory (1887) advised the reader to "see car builders".

* West Virginia Bridge Works — Wheeling, West Virginia

This company may be the same as West Virginia Bridge & Construction Company, Wheeling, West Virginia. (Information contributed by Richard S. Allen.)

Wilson Brothers & Company — Philadelphia, Pennsylvania

Listed in Poors' Directory (1887). This was a very important and successful turn-of-the-century structural engineering firm having designed and built both the train sheds for Reading Terminal, Philadelphia, and Broad Street Station, Philadelphia.

Wisconsin Bridge & Iron Company — 706 Pabst Building, Milwaukee, Wisconsin

The company advertised in American Railway Engineering (1903) as manufacturers and designers of railroad bridges.

* Wrought Iron Bridge Company — Canton, Ohio

This company grew out of a foundry owned and operated by John Laird as early as 1840. It later expanded to include iron bridge buildings. By 1867 the foundry was called the wrought iron works of John Laird and Company, possibly organized as such in 1867. In 1871 David Hammond and Job Abbott, who had invented and patented a wrought iron arch bridge, reorganized and incorporated the company as the Wrought Iron Bridge Company. They published their "Book of Designs" in 1874, probably an annual publication, which included their patented "Hammond and Abbott Arch Bridge". The

company apparently became one of the leading bridge building firms in the United States, employing 270 men (1881) and having erected bridges in 25 states.(32) Sometime between 1899 and 1902, Wrought Iron Bridge was absorbed by the American Bridge Division of the United States Steel Corporation; however, the Wrought Iron Bridge Company advertised in 1900 in Engineering News as being builders of "iron and steel bridges, girders, turntables, buildings and structural work", which would indicate a date later than 1899. Nine truss spans in Virginia's Staunton Construction District have so far been attributed to the company.

York Bridge Company — York, Pennsylvania

Youngstown Bridge Company — Youngstown, Ohio

An advertisement in Engineering News (1900) simply stated "bridges and buildings". An earlier advertisement made no such claims. Thought to be the successor to Morse Bridge Company (see above).

Footnotes to General/Introductory Section

1. It should be noted that a number of truss spans exist that are in use on private property or simply survive as abandoned bridges, truss ruins, so to speak. Such structures are not retained in Departmental records nor maintained by the Department since they are non-state structures.

2. More comprehensive and competent coverage of this topic can be found in Carl Condit's American Building, Chicago, University of Chicago Press, 1968; or James A. L. Waddell's Bridge Engineering, New York, John Wiley & Sons,Inc., 1916; or, more recently, David Plowden's Bridges, New York, The Viking Press, Inc., 1974.

3. J. L. Ringwalt stated the following work schedule: "Spans up to 150 feet can be erected by a gang of 20 men in a single day, if necessary; a 200 foot span, 2 to 3 days; a 250 feet, 3 to 4 days, &s." Development of Transportation Systems in the United States, Philadelphia, J. L. Ringwalt, 1888, p. 303.

4. Ibid., pp. 302-3.

5. Ibid., p. 36.

6. David Plowden, Bridges, 1974, Viking Press, New York, p. 38.

7. James A. L. Waddell, The Designing of Ordinary Iron Highway Bridges, New York, John Wiley & Sons, Inc., 1891 (fifth edition), p. IV.

8. Ringwalt, op. cit., p. 302.

9. Plowden, op. cit., p. 61.

10. Herman Haupt, General Theory of Bridge Construction, New York, D. Appleton & Company, 1851, p. 6.

11. H. J. Hopkins, A Span of Bridges, New York, Praeger Publishers, Inc., 1970, p. 131.

12. Plowden, op. cit., p. 64.

13. Ibid., p. 65.

14. Hopkins, op. cit., p. 131.

15. James A. L. Waddell, The Designing of Ordinary Highway Bridges, p. IV.

16. Ibid.

17. Theodore Cooper, "American Railroad Bridges", Transactions, American Society of Civil Engineers, July 1889, 21:8.

18. James A. L. Waddell, Bridge Engineering, New York, John Wiley & Sons, Inc.

19. Edward T. Heald, The Stark County Story, 1805-1874, Canton, Ohio, Stark County Historical Society, 1949, p. 630.

20. Ringwalt, op. cit., pp. 302-3.

21. David H. Miars, A Century of Bridges, Wilmington (Ohio), 1972, p. 21, all information.

22. Heald, op. cit., p. 631.

23. Miars, op. cit., pp. 6-24.

24. Album of Designs of the Phoenix Bridge Company, 1885, p. 3.

25. Cooper, op. cit. 21:16.

26. Catalogue, King Iron Bridge & Manufacturing Company, Cleveland, Ohio, 1884, pp. 9-15.

27. Heald, op. cit., pp. 632-4.

28. Miars, op. cit., p. 18.

29. Miars, op. cit., p. 6.

30. Miars, letter, 30 August 1973.

31. Richard S. Allen, letter, 8 August 1973.

32. Heald, op. cit., p. 629.

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