EAST WASHINGTON AVENUE BRIDGE
East Washington Avenue, spanning the
Pequonnock River
Bridgeport
Fairfield County
Connecticut

HAER No. CT-154

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Northeast Region
Philadelphia Support Office
U.S. Custom House
200 Chestnut Street
Philadelphia, P.A. 19106

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HISTORIC AMERICAN ENGINEERING RECORD

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Location:	East Washington Avenue, spanning the Pequonnock River, Bridgeport, Fairfield County, Connecticut. USGS Bridgeport Quadrangle, 1:24000 UTM Coordinates: 18.651870.4560775
Designer/Consultant:	Joseph B. Strauss/William H. Burr
Date(s) of Construction:	1917-1925
Builders:	Penn Bridge Company/Bridgeport Dredge & Dock Co. Bridgeport Department of Public Works United Illuminating Company
Present Owner:	City of Bridgeport, Connecticut (Under jurisdiction of Connecticut Department of Transportation until reconstruction is completed).
Present Use:	Bridge closed to vehicular traffic, open for pedestrian use only.
Significance:	The history of the East Washington Avenue Bridge is consequential in two areas. As a bridge it represents an early phase in the evolution of Strauss Bascule Bridge Company designs and embodies two of Joseph Strauss' major patents. It has transitional aspects, electrically operated but possessing a complete, manually operated mechanical backup system and a manually operated auxillary brake. Secondarily, the bridge site and surrounding neighborhood were the location of industries that developed and expanded the innovative production technology known as the "American System of Manufacturing." The bridge served a dynamic historic industrial neighborhood in an era in when United States firms rose to a dominant position in world markets.
Project Information:	This documentation commenced in April, 1995 in accordance with the Memorandum of Agreement between the Connecticut Department of Transportation and the Connecticut State Historic Preservation Office as a mitigating measure prior to replacement or rehabilitation of the bridge with a new span.
Historian:	Robert C. Stewart Historical Perspectives, Inc. Westport, Connecticut, December 1995

I. Introduction

The Connecticut Department of Transportation (CONNDOT) is preparing for rehabilitation or replacement of the East Washington Avenue Bridge in Bridgeport (State Project #15-212). The East Washington Avenue Bridge carried traffic over the Pequonnock River, connecting Bridgeport and the Pembroke section of East Bridgeport. A bridge has existed at this site since 1836. The present bridge is the third built at this location and is presently not being maintained. It is closed to motor vehicles and used only by pedestrian traffic.

The existing bridge was designed in 1916 by Joseph B. Strauss (born January 7, 1870 - died May 16, 1938) who went on to fame as chief engineer on the Golden Gate Bridge in San Francisco. The design illustrates concepts delineated in two of his patents. In addition, in common with other early bascules, it has an auxiliary mechanical brake. If electrical power fails, the bridge could be be raised and lowered manually by turning a capstan linked to a bevel gear train which rotates the primary reduction gear. The capstan was accessable on the centerline of the bridge, 12 feet west of the centerline of the main trunnion bearing (Figure 9). Two alternating current motors linked on a common shaft power the lift mechanism. Limit switches cut off power automatically just before the bascule approached fully open and closed positions.

The bridge served a neighborhood that housed several manufacturing plants that were important in American industrial history. The Wheeler and Wilson Manufacturing Company, first major factory to extensively use jigs and fixtures to mass-produce non-military goods, was located nearby. By 1857 Wheeler and Wilson were using "high armory practice[1]." They also developed precision manufacturing and quality control techniques during the same period. Until 1867 The Wheeler and Wilson Company was the world's largest manufacturer of sewing machines. Many other notable manufacturing plants located close by in the latter half of the 19th century.

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[1] High armory practice was the production technique used at leading armories, such as Springfield, Massachusetts. It was a combination of the idea of interchangeability of parts combined with the concept that machines could make things as good and as fast as human hands. Another fundamental part of armory practice was to use an inside contract system. Mechanics were usually sub- or inside contractors at the armory. Each contracted with the factory owner to use his shop space, power, machine tools and materials to produce a particular part or to manage a certain operation for a set piece rate. The contractor agreed to hire, manage and pay his own workmen. Contractors acted as foremen but had additional administrative roles. To derive greater profit from their contracts, the contractors were induced to improve the production process. The inside contract system was identified as a major stimulus to nineteenth-century manufacturing technology (Hounshell 1984:5,43,50).

II. Historical Context: Bridgeport Harbor and the Pequonnock River

During the period of the American Revolution, the region destined to become Bridgeport was an outlying and sparsely populated section of Stratford called Newfield. Newfield is located to the east of present downtown Bridgeport. Figure 1 is a location map of the area. A few English families harvested shellfish and grew salt hay in this tract. During the 1790s trade between Connecticut and the West Indies flourished. Livestock, grain, timber and some manufactured goods were exchanged for the rum and sugar of the islands. Newfield's population of merchants, sea captains, sailors and shopkeepers provided labor, services and goods for this commerce.

The commercial development of Newfield village was limited by the depth of its harbor. Only shallow draft vessels could cross the bar and enter the river. Local dredging and harbor improvements were carried out sporadically. The first local light was a lantern on top of a mast which was put up in 1844 by Captain Abraham A. McNeill. Captain John Brooks followed this with a floating light mounted on a boat moored near the channel through the bar. The first official lighthouse was erected by the federal government in 1851. This was replaced in 1871 by a modern light and marked the beginning of extensive harbor improvements (Waldo 1917:284). Eventually the United States Government built breakwaters and developed a wide, deep channel through the bar.

The East Washington Avenue Bridge serves a section of the city known as "Pembroke." The name Pembroke dates back to the 1650s and referred specifically to the level peninsula between the Pequonnock River estuary to its west and Old Mill Creek (Yellow Mill Pond or Channel) on the east. The original spelling was "Pambrook" or "Panbrook." A family of Native Americans named Pan who camped in the area of the present Lakeview Cemetery probably contributed the appellation. Pembroke survives as the name of a lake in Bridgeport's Boston Avenue Park (Hagstrom 1991 Map).

In 1800 Pembroke was a prosperous agricultural community. A settlement known as Newpasture Point was dedicated to maritime commerce. It was located south of Ann Street.

To the east of Pembroke, across Old Mill Creek, the village of Newfield began to grow rapidly. It's commercial interests petitioned the General Assembly for formation of a separate political subdivision and, subsequently, Bridgeport was incorporated as a Borough within the larger town of Stratford in 1800. As a borough government, Bridgeport could regulate construction, establish a fire department and inspect commercial cargo. The primary tradesmen during this period were ship chandlers, blacksmiths, shoemakers and blacksmiths. Two flour mills were the major business establishments (Historic Resources 1995:56).

Bridgeport fully separated from Stratford as a town in 1821. Fabrication of saddles, carriages and garments for the export trade were dominant industries and formed the town's first industrial base. With the development of railroads and the prospect of becoming a transporattion center, the town and borough were consolidated in 1836 as the City of Bridgeport.

Development in the area continued and reached the Pembroke peninsula in 1836 when the Reverend Birdsey Noble bought a 50-acre parcel from a Senator Wright. Noble's intent was to subdivide this parcel into lots. He proceeded to lay out William Street and East Washington Avenue.

Thus the reason for the first East Washington Avenue Bridge was to enable ready access to emerging housing developments on the Pembroke peninsula east of the present downtown section of Bridgeport; a bridge would make housing more marketable. The original plan was to build the bridge approximately one-quarter mile to the south of East Washington Avenue, at the foot of William Street, but public opposition, based on a fear of creating too widely dispersed a community, canceled the scheme (Orcutt 1886:852-4). Once public antagonism was overcome, the "Noble" bridge was built at the East Washington Avenue location as a toll bridge. Figure 2 shows the location of the bridge.

Also in 1836, William P. Green, President of the Thames Manufacturing Company and the Thames Bank of Norwich, laid out Walter, Green and Hamilton Streets on a 70 acre tract to the east of Noble's development (Orcutt 1886:853). Both developments failed during the financial "Panic of 1837." The depression lasted well into the 1840s and brought development to a standstill.

The period after the "War with Mexico" from 1846 to 1848, was followed by another period of speculation. Rail connections now linked Bridgeport with New York City and the Naugatuck Valley. Manufacturing began to displace agriculture and maritime commerce as the area's economic mainstay. The emerging industries were staffed by immigrants from Ireland and Germany who were housed in the developments started twelve years earlier by Noble and Green. Two new developments, "Waltersville" and "Johnsville" went up on the east side of the peninsula. Waltersville was named for George Walters, a real estate agent. It is presently the site of Father Panik Village, a public housing tract. Johnsville, just southwest of Waltersville along the Yellow Mill Pond, was named for John Leverty who built numerous houses in the area (Murray 1990:3).

Reverend Noble died in 1849 at a time when his tract was on the verge of a boom. Bridgeport's population reached 7558 in 1850 and was rapidly expanding. In addition to working class housing, some fine houses were being built on the relatively high eastern bank of the Pequonnock, one-half mile north of Noble's bridge on East Washington Avenue. William H. Noble, attorney son of the Reverend Noble, was a major creditor for his father's estate. He was the sole bidder at the estate's auction and acquired his father's 46-acre tract for $4.00.

William Noble started intensive development immediately. The walk to downtown Bridgeport was shortened by building a footbridge along the existing railroad bridge, south of the project bridge crossing. Some sites were developed for industrial use. One Carmi Hart started a factory on a lot formed by the triangle of Sterling Street and Crescent Avenue. The plant cast and finished railroad car wheels. This was the first industry located on the east side of the harbor.

Unfortunately, the factory was poorly located and obstructed free access to the area beyond until it was torn down (Orcutt 1886:853).

Lots in Noble's new development sold briskly but he needed more capital to fully realize the project's potential. Noble offered half interest in the development to P. T. Barnum for $20,000. Barnum, cash-rich with the profits from his world concert tour with the singer Jenny Lind, quickly became a partner in the venture.[2]

Astute businessman that he was, Barnum soon developed a marketing scheme to maximize profits in the venture. He hired a civil engineer, James C. Lane, to draft a new real estate speculation plan which included a formal English-style park at its center. The square exists at present as Washington Park. Figure 3 is a map of the Barnum and Noble property in 1851. Only alternate lots were sold at first, the remaining lots could then be sold later at a considerably higher price. Barnum established deed restrictions[3] to encourage rapid, high quality development. Low cost financing was made available, streets were graded and shade trees were planted. Barnum also had the right to purchase more land and to own up to three-quarters of the venture (Orcutt 1886:853). Barnum and Noble offered free land for churches willing to locate to Pembroke. Only the Methodist Episcopal church accepted a lot at the northwest corner of Washington Park.

Barnum realized that solid prosperity was dependent on enticing industry to the area. Barnum and Noble's first industrial building project was a coach factory on William Street. M.

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[2] Phineas T. Barnum had an active involvement in Bridgeport's political and economic circles. He was mayor of Bridgeport, a member of the legislature for four terms, president of the Pequonnock National Bank of Bridgeport, president of Bridgeport Hospital, president of the Bridgeport Water Company and Commissioner of Seaside Park. His popular fame rests on his activities in organizing a circus and operating numerous popular entertainments (Orcutt 1886:850).

[3] Typical deed restrictions are described in an 1854 deed to William Perry for 528-30 Noble Avenue. "(Perry) shall within four months from the date hereof erect or cause to be erected upon said lot a building the description following, to wit: a dwelling house such as the plan and elevation made by C. Graham, architect, except that the roof is to be brought down 9 in. in pitch, said plan having been exhibited to us. A neat wall is to be made on each side of the excavation and in front of the lot and pointed to hold up the earth. The windows throughout said house except basement are to be furnished with Venetian blinds. The fences are to be well made and on the sides of the lot are to have the board faces outward and to be well painted on both sides some neutral tint approved of by said Noble and blinds also painted some agreeable color....There shall not be sold on said premises any spirituous liquors or intoxicating drinks and the trees in front of said lot are not to be cut down" (Bridgeport Land Records, Volume 19, page 286).

Phillips & Company set up shop at the east end of Noble's Bridge in 1852. Phillips new mill was steam powered and made window frames, sashes, blinds, doors and builders' hardware.

Barnum and Noble's policy was to provide industrial land free of cost to manufacturers who would move their factories into the area. Barnum, who was a stockholder in a Litchfield clockmaking firm, orchestrated its relocation to Pembroke City in October of 1854 (Murray 1990:5). He also managed to merge his Litchfield clockmaking interests into the Jerome Clock Company of New Haven. By guaranteeing Jerome's commercial paper and notes, he was able to influence their relocation to a new plant on Barnum Street in Pembroke.

Unfortunately, the country was headed for another depression, The Jerome Clock Company failed and by 1857 Barnum found himself bankrupt and $400,000 in debt (Orcutt 1886:854). William Noble followed Barnum into financial ruin soon after (Murray 1990:5). But the beginnings of a new period of industrial growth and technological development was underway even as Barnum's finances collapsed.

In 1856 the Wheeler and Wilson Manufacturing Company moved into the empty Jerome Clock factory. When Wheeler and Wilson set up shop in Pembroke and started manufacturing in 1857, they adapted production technology used for manufacturing revolvers at Colt's armory in Hartford. It was an early and successful version of what was known as "The American System of Manufacturing."[4] The Wheeler and Wilson enterprise is credited with initiating Bridgeport's greatest period of prosperity and industrial growth. Orcutt (1886:854) declares:

> ...it not only brought new business to the toilers of the city, but also a lot of new inhabitants, men of vigorous mind and liberal enterprise, and a class of educated skilled mechanics, unequaled anywhere in the country. Through the influence of this manufactory upon the fortunes of Bridgeport, the city has been able to take the lead in all enterprises of an industrial character, and to constantly enlarge and multiply the structures occupied by their workers."

By 1862 Wheeler and Wilson was "a great machine shop" capable of producing more than thirty thousand sewing machines annually. With its accurate specialized machine tools, jig and fixture design and gauging system, parts never needed a "stroke of a file" during final assembly. The factory grew to have over five acres of factory floor space devoted to precision manufacturing (Hounshell 1984:73). It boosted annual production to 174,088 units in 1872.

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[4] The American system of manufacturing was a system used to manufacture completely uniform, interchangeable parts. Major running components were initially drop-forged and then machined; machining work was performed by numerous specialized machine tools which were permanently set up and operated sequentially. Uniformity was controlled by a model-based gauging system and a precision jig and fixture system. Work was performed by an inside contracting system coordinated by the factory superintendent (Hounshell 1984:70).

Wheeler and Wilson employed between 800 and 1000 workers, most lived in the vicinity of the plant. When the Elias Howe Sewing Machine Company located nearby in 1862 the number of workers in the area doubled (Murray 1990:6). Other industries located here at this time included the Union Metallic Cartridge Company, the Bridgeport Brass Company, the Winchester Arms Company, The Hotchkiss Manufacturing Company, the Glover Sanford Sons Hat Company, the Farist Steel Works, the Armstrong Factory and several cutlery factories (Orcutt 1886:855).

With all this rapid industrial growth, Pembroke encountered severe "growing pains." As a section of the Town of Bridgeport, not under the governance of the City of Bridgeport to the west, it had no police or fire protection. Its streets were not paved and lacked sidewalks. Tolls on all bridges discouraged access to the City of Bridgeport.

By 1864 consolidation with the City of Bridgeport was a passionately debated subject. On March 7, 1864, the citizens of Pembroke voted to join the City of Bridgeport. The State Legislature approved and Pembroke merged with Bridgeport on July 15, 1864 (Murray 1990:7).

The City appropriated money to improve Washington Park, organized a fire company and built a combination fire house and police station by the end of the year. The City bought the East Washington Avenue Bridge and all tolls were abolished. Construction of a new bridge across Pembroke Lake (North end of Yellow Mill Channel) on Grant Street was authorized (Murray 1990:7). Figure 4 is a "bird's eye" view of the area in 1875. The area attracted a pool of competent workers who were available to make Connecticut a leader in the American industrial revolution. As the Civil War came to a close, it continued to develop as an industrial/residential city. P. T. Barnum described Pembroke City as:

> A beautiful city, teeming with busy life, and looking as neat as a new pin. The greatest pleasure (I take is) driving through those busy streets, admiring the beautiful houses and substantial factories, with their thousands of prosperous workmen, and reflecting that I had, in so great measure, been the means of adding all this life, bustle and wealth to the City of Bridgeport (Murray 1990:7).

III. Physical Description- East Washington Avenue Bridge

The East Washington Avenue bridge is located on East Washington Avenue over the Pequonnock River in Bridgeport, Connecticut and connects downtown Bridgeport with the sections of that city known as Pembroke and East Bridgeport (Photograph of south elevation of bridge). According to a statement made by Mayor Behrens at the dedication of the present bridge in 1925, it was the third bridge at this site. No description of the first bridge was discovered. A survey plan of the second bridge, made in 1916, shows it was a cantilever through truss swing bridge, 184 feet long, bearing on a center pier 30 feet in diameter (Photocopy of Strauss' survey sheets 2 and 20).

The second bridge was extensively repaired and remodeled in 1893 (Waldo 1917:283). A trolley line was built across the bridge around this time. In the first decade of the twentieth century the need for a new bridge was obvious and the city launched plans for its replacement. To extend the life of the structure, trolleys were banned, later heavy trucks were denied access. Finally, it was closed altogether in 1917. A bridge commission was appointed on December 7, 1915.

The bridge was designed by the Strauss Bascule Bridge Company of Chicago, Illinois and is based on design concepts patented in 1903 and 1915. Plans were completed for a new bridge on February 17, 1916. The project is unusual in that the Strauss Bascule Bridge Company usually designed only the bascule components of their bridges and left the remainder to local Public Works agencies. All aspects of the East Washington Street Bridge project, architectural, substructure and operational were designed by the Strauss Company.

Litigation over land takings delayed construction work until 1923. Essentially nothing but legal maneuvering and steel fabrication was done for six years. In 1923 businesses and industries whose activities were hindered by the lack of a bridge, petitioned the General Assembly to take action. Mayor Fred Atwater supported the petition, the legislature granted authority for bonding and named a bridge commission. Mr. Atwater became chairman.

Structural steel components for the bascule had been already fabricated by the Penn Bridge Company of Beaver Falls, Pennsylvania. These were in storage near the site. The major work remaining was the building of abutments and piers. In September of 1923 a contract was executed with the Bridgeport Dredge and Dock Company to build the abutments and piers. United Illuminating Company contracted to install the electrical equipment. The Pierce Manufacturing Company installed the sewer system (Bridgeport Post 1928, 13 December).

The west abutment is part of the bascule pier and houses the counterweight pit. According to Professor William H. Burr,[5] consultant on contract performance to the City of Bridgeport, it was the largest and deepest of its type ever built. The west pier was built within a coffer dam constructed of sheet steel piling and braced by heavy timbers. The bottom of the coffer dam was 31 feet below street level. The construction method was so effective in keeping the pit dry and free of river infiltration that the bridge commission held a business meeting on the pit floor, several feet below the surface of the Pequonnock.

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[5] Professor Burr's background included contract supervision on several East River Bridges in New York and the George Washington Bridge.

Legal problems and an injunction against using "Warrenite" paving delayed installation of a permanent roadbed. Temporary paving was installed and the bridge formally turned over to Mayor Behrens, representing the City of Bridgeport, on October 14, 1925 (Bridgeport Post 1925, 15 October). The total cost was $568,796 ($556,510) (Bridgeport Post 1928, 13 December).

When placed in service, it handled considerable local heavy trucking, primarily coal and lumber. The bridge connected the major traffic arteries used by the leading industries of Pembroke and East Bridgeport.

The objective was to design a bridge combining vehicular, public transport and navigation requirements. Although designed and constructed to carry trolley traffic, no trolleys ever used the bridge. Originally the city expected to recover part of the cost of the bridge from the Connecticut Company, a provider of public transportation. The Company abandoned its route in this area when trolley cars were banned in the early years of the century. The line was no longer needed so the trolley rails in the approaches were buried under the pavement and rails were not laid on the bascule leaf. The Connecticut Company never reimbursed the city for additional cost associated with designing the bridge to carry trolleys.

The bridge is classified as a simple, trunnioned, single leaf, underneath counterweight, closed pit bascule bridge (Hool and Kinne 1923:25). Architecturally, plans indicate that it was to be embellished in an exuberant, faux oriental style, possibly to reflect the preferred style of the area's most ardent booster, P. T. Barnum. Figure 5 shows the south elevation of the bridge as designed.

The actual execution of the design was more subdued than shown on the original plan. The control house has inlaid wood panels on the outside walls which are supplanted by windows in the control room portion. The comfort station is faced with solid wood. The original roof was tiled. Figure 6 shows the operator's house as originally designed. The house has been heavily vandalized and burned in recent years (Photographs of operator's house). The original design called for a matching house on the east side of the bridge. It was to provide space for a women's comfort station but was never built (Hardesty 1994:5).

The open lattice bridge railing is another design feature (Photograph of railing detail). The bridge railing is a top and bottom rail configuration with diagonal bars and vertical bars having similar cross section. The hand rail specified was a stock item made by the Wayne Iron Works and identified as a catalog number 204. Figure 6 shows a section of the rail as designed.

The project produced a composite bridge design to span the 180 foot wide Pequonnock River (Photographs of eastern and western approaches). From shore to shore the total length of the bridge is 222 feet 11 inches backwall to backwall. The bridge is made up of four spans. Starting from the west these are a decked over counterweight span 22' 3" long, a single leaf bascule and two fixed approach spans. The stringers supporting the deck over the counterweight are supported on the approach side by the west abutment and on their eastern end by a trunnion cross girder frame between the trunnion towers. The bascule span is 89' 8" from center of the trunnion to center of bearing at the toe end of the leaf. The toe end rests on two masonry piers, which share a common footing. The trunnion towers are supported in a closed pit bascule pier. The bridge has two 55' long approach spans which are constructed in a conventional girder floorbeam and stringer scheme. The easternmost approach span is supported by a second set of masonry piers, which also share a common footing, and the east abutment. All substructure units are pile supported stone and concrete masonry structures (Hardesty & Hanover 1995:3; Strauss 1916a:1).

The foundations for the bridge piers are timber piles driven to rock. The timber fender system was designed to form a clear channel 70 feet wide.

While the bridge was structurally and mechanically solid, when completed it did not meet the requirements of the United States Government. The permit issued by the War Department specified a 70 foot wide channel and measurement showed that the channel width was short by about one foot.

Strauss' original design for the bascule pier was not regarded by Bridgeport Dredge and Dock's engineers as strong enough to carry the heavy leaf and machinery. When built, additional concrete was added to the river side of the west side pier to make up for the deficiency. This thicker wall did not leave adequate room for the fender, rack and a 70 foot channel. Thus, the as-built western fender was nine inches closer to the eastern fender than the War Department's permit specified. The reaction by the mayor and Bridge Commission to the government's complaint was one of studied indifference.

Additionally, the cornice of the operator's house extended out beyond the fender and was damaged by a passing ship. The projecting cornice was redesigned and cut back (Bridgeport Post 1926, January 29).

The bridge roadway widths in the approach and bascule sections are comparable at 43 feet. There are 8 foot 6 inch sidewalks on both sides in the approaches and on the bascule producing a total width of 60 feet. When closed, clearance over the Pequonnock River at mean low tide is 10.6 feet and 4.0 feet at mean high tide (Strauss 1916a:1). At the time of construction, plans called for a channel depth of 20 feet at mean low water. The main channel is 69 feet 3 inches wide between fenders.

When it was planned in 1916, the western end of the bridge fronted on the Frank Miller Lumber Company. Miller's yard extended to the north and south of the bridge. The eastern approach was bounded by the Patrick McGee Coal Company on the north and the Sprague Ice & Coal Company to the south. (Strauss 1916a:2).

IV. Design Considerations

Three main types of movable bridges were commonly employed in the post World War I period. They were the swing, bascule and vertical lift bridge. Several inventors and designers, notably T.E. Brown, T. Rall, A.H. Scherzer, M. Wadell and J.B. Strauss, were active in advancing bascule bridge design (Hool and Kinne 1923:28-29). The East Washington Avenue Bridge is a Strauss design and perfectly exemplifies his underneath counterweight trunnion type.

In 1902 Joseph B. Strauss began developing a series of designs for bascule bridges. Bascule bridges were rare and strictly limited in length at the turn of the century. They were also expensive, primarily because costly cast-iron counterweights were used to counter-balance the bridge deck. Early operating mechanisms were also complicated, unreliable and difficult to maintain.

To lower overall bridge cost, Strauss eliminated the cast iron counterweights. For the East Washington Avenue Bridge counterweights he substituted dense concrete which was specified to be mixed with iron ore (Strauss 1916a:11). Later designs called for slag or iron punchings as a counterweight filler. The East Washington Avenue bridge plans specify that the concrete forming the counterweight should weigh approximately 148 pounds per cubic foot (Strauss 1916a:11). This was considerably lighter than some of his later designs which, when filled with iron punchings, weighed up to 311 pounds per cubic foot (Strauss 1916b:sheet 12). While this alternative greatly reduced cost, it foreordained an expanded volume of counterweight and required a large pit to contain the counterweight. With the addition of iron in the pockets and the steel supporting frame, the counterweight average weight could be raised up to 174 pounds per cubic foot. However, Strauss specified that the pockets were to be half-filled with loose material weighing 148 pounds per cubic foot.

On larger bridges, the bulky concrete counterweights interfered with the supporting structures of bascule designs. A counterweight fixed to the end of the bascule leaf would require a larger pit to contain it when the bridge was open. Strauss solved this problem by developing a parallel link counterweight system by which the counterweight, its trunnion, the main leaf trunnion together with their connecting struts, formed a parallelogram. By using this design, the counterweight is kept in a level position relative to the bascule pit floor during opening and closing of the bridge. Strauss' patent number 738,954, issued in 1903, describes the invention (Appendix A). Figures 7 and 8 show the relationship of the link and counterweight in the open and closed positions. The design provides an additional increment of efficiency during movement by maintaining the bascule leaf in a condition of constant balance during operation of the bridge. The parallelogram linkage was first used on a "Heel Trunnion" design where the counterweight and its hangers were above the bridge deck.

Later Strauss adapted the parallelogram linkage to an "Underneath Counterweight" design. Strauss also shaped the concrete counterweight to fit between structural elements. The Strauss design utilized open spaces under the bridge deck and between the girders to accommodate the upper portion of the counterweight when the bridge was closed. This feature constituted a principal claim of Strauss' patent number 1,124,356, issued in 1915 (Appendix B) (Photocopy of plans for the East Washington Street Bridge sheet 11).

Utilization of this previously unused space compensated for a portion of the increased space requirements of a concrete counterweight. By using this space, Strauss' design could be built two feet lower or closer to the water than competing models, depending on span geometry.

The Strauss layout also concealed the counterweight and operating mechanism under the roadway, thus producing an unobtrusive, low profile bridge that was amenable to a variety of architectural treatments. A Strauss underneath counterweight bascule design would have a minimal visual impact on the surrounding environment.

Strauss' bridges were substantially standardized plans utilizing design concepts patented early in his career. Structural steelwork would be formed and partially assembled by a bridge fabrication shop, in this instance the Penn Bridge Company. This procedure further reduced on-site erection costs.

V. Operation

The operating mechanism for the East Washington Avenue Bridge was designed to be easily accessible. City Engineer James A. McElroy stated that "this meant better care, less trouble and delay and consequently greater longevity of working parts." All control functions were performed from the control house on the western abutment. The bascule leaf was raised by means of electric motors equipped with brakes. The brakes were electrically applied by means of a solenoid. The solenoid brakes on the motors were used as the main braking system on the lifting mechanism. The lifting machinery is powered by two 3 phase, 60 cycle, 220 volt motors running at 850 rpm. They had a maximum starting torque of 390 pound-feet and a running torque of 175 pound-feet. The motors are linked on a common drive shaft with a simple flange coupling (Photograph of gears and coupling). At the specified running speed of the motors, the bridge could be fully opened or closed in one minute.

The type of wound-rotor motor utilized would provide high torque at low operating speed. Resistors were sometimes used in a motor starting circuit to limit initial current. There was a drum-type motor controller in the operator's house. This was probably provided with two sets of contacts, one for controlling the starting resistance and the other for control of the speed through variation of the shunt-field resistance (Terrill 1981:7-146). Power to the drive motors was automatically turned off by limit switches before the bridge reached the fully opened position. The bridge could coast to its open rest point and be locked in place by employing the electrical solenoid and the mechanical brakes (Photograph of brake). Figure 9 shows the operating machinery. When the bridge was descending, another automatic switch cut power when the toe was about six feet above the rest pier. This would allow the toe to coast down to an unpowered soft contact which would be moderated by the resistance of the reduction gear train, the motor's solenoid brake and the operator's hand brake. The limit switches acted as safety devices in the event that the operator did not maintain control. Strauss also designed electro-mechanical interlocks to prevent improper operation of the bridge. The chain gate had to be down and warning gongs and lights operating before the releasing lock on the toe end of the bridge leaf could be disengaged. Another interlock prevented actuation of the toe locking mechanism until the bridge was fully closed (Bridgeport Post 1925, 1 October). Reversing the motors was probably accomplished by a switch which interchanged two of the three leads to the motor.

Motive power to lift the spans was transmitted through a gear train to pinion gears which meshed with rack gears on the bascule girders (Photograph of rack and pinion). Other mechanical and operating details are documented photographically and in photocopies of Strauss' original drawings. Figure 9 shows the gear arrangement.

The racks form the lower quadrant of each bascule girder radially to the main trunnion. The racks have radii of 11 feet, centered on the main trunnion bearing of each bascule girder. The rack gears have a 9 1/2" face and a pitch of 4 1/2". The linear dimensions of the bascule girders are 90 feet 8 inches from the center line of the main trunnions to the center line of the rest pier; the distance from the center line of the main trunnions to the center line of the counterweight trunnions is 13 feet. Bascule girder depth is essentially constant at 5 feet at the rest pier to a maximum of 5 feet 10 inches just before the girder enlarges to the radius of the rack support web.

The specifications for the primary balance weight on the bascule leaf call for a cast concrete counterweight with iron ore or stone aggregate which is formed over and around a steel truss. The counterweight is reinforced with 3/4" bars and a 3" mesh wire net placed 2" below all surfaces. Overall dimensions of the counterweight are 49' long, 14' 9" wide and 14' 9" deep. Four pockets were formed in the top of the counterweight. These are 11' 3" long, 3' 6" wide and 4' deep. The volume of the adjustment pockets is about 7% of the total volume of the counterweight. Fine balance of the leaf was achieved by adding to or removing loose stone aggregate from the material in the pockets (Strauss 1916a:11). Weight would also be adjusted to compensate for seasonal conditions. All bascule designs are painstakingly counterbalanced. With close attention to maintaining balance, power requirements to raise bascule bridges are minimal.

The counterweight truss provides attachment points for the counterweight trunnion bearings and link brackets. The counterweights pivot on forged and polished steel trunnions. Each counterweight trunnion has two bearing surfaces 15 1/4" long and 13 14" in diameter. The counterweight trunnions rotate in cast steel bearing housings which support 3/4 inch phosphor bronze bushings (Photocopy of Strauss plans sheets 11 and 14). Each counterweight trunnion is mounted with cast steel collars bolted to each side of the heel of the bascule girder.

The auxiliary or emergency brake for the bascule leaf was manually operated. A hand lever located in the operator's house is linked to white metal brake pads located adjacent to the primary reduction gear. A 75 pound counterweight applies torque on a lever arm and keeps the brake pads clamped to the brake drum. The system assures that the brakes are "on" unless the operator deliberately releases them. The brake lever could be locked in the off position with a ratchet device which was released with a hand grip located at the top of the brake lever (Photocopy of Strauss plans sheets 12 and 19).

The bascule leafs consist of two interior, constant depth girders connected together with three steel plate floorbeams (Photocopies of Strauss plans sheets 8 and 9). Girders are built-up riveted construction and angles and plates for fastening laterals are also riveted.

As designed, the original bascule deck was carried on longitudinal 12" x 32# "I" beams butted to the floorbeams and fastened with riveted angle brackets. A 4" crown in the roadway was formed by varying the position where the web of the "I" beam was attached to its angle bracket. (Photocopy of Strauss plans sheets 7 and 8). A 3" x 6" nailing strip was bolted to the top of each "I" beam. These nailing strips were made of "Kyanized"[6] long-leaf yellow pine. Subplanking, 4" thick, Kyanized long-leaf yellow pine planks were bolted to the nailing strips. The original surface of the bascule span surface was paved with 3" thick, creosote saturated long-leaf yellow pine blocks, end grain exposed. The approach spans had a 6' thick poured concrete slab covered by a 1" thick sand cushion. This also was surfaced with the creosoted yellow pine blocks. (Photocopy of Strauss plans sheet 15).

The two bascule girders pivot on forged steel trunnions (Photocopy of Strauss plans sheet 14). The trunnions have two bearing surfaces 18 inches long and 15 inches in diameter. Individual trunnions are bolted to their girders by collars mounted on each side of the girder. The main trunnions rotate in split cast steel bearing housings that contain 3/4 inch phosphor bronze bushings on the lower half and 1/2 inch anchored Babbitt metal bushings on the upper half. The bearing housings are supported by a steel framework which bears on stone and concrete piers. The bascule piers are built on timber piles (Photocopy of Strauss plans sheets 4, 5, 6 and 6A).

In the down position the bascule span is secured with two 4" x 1 1/2" steel locking bars mounted on the leaf (Photocopy of Strauss plans sheet 13). These fit into cast steel sockets mounted on the rest pier. As originally designed, the locking bars are electrically operated with an alternating-current 3 phase, 60 cycle, 220 volt, 850 revolution per minute, 5 horsepower motor. If there is an electrical failure the locks can be manually operated through a gear train which extends to a capstan flush with the road surface (Photocopy of Strauss plan sheet 12).

All the measurements and construction details recorded in this document, not otherwise attributed, were taken from plans drafted by the Strauss Bascule Bridge Company. A complete

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6 In the Kyanizing process, timber was soaked in a solution containing 1 part mercuric chloride to 150 parts water. The soaking proceeded for 5 to 10 days until the timber was saturated with the preservative. Mercuric chloride was used where creosote was not suitable (Timber 1924:647).

set of original plans for the bridge and site plans are preserved at the City of Bridgeport's Engineers Office, Bridgeport, Connecticut.

VI. Personnel

The designer of the bridge, Joseph Baermann Strauss, was born on January 7, 1870. His career began in 1892 subsequent to receiving his degree in civil engineering from the University of Cincinnati. The first ten years of his career were spent becoming thoroughly familiar with practical aspects of bridge design. The Sanitary District of Chicago employed Strauss to revise and redesign the early types of bascule bridges then being installed. In 1904 he developed the principle of the trunnion bascule bridge and founded the Strauss Bascule Bridge Company, later known as the Strauss Engineering Corporation. In 1906 he developed a method of building ribbed concrete arch bridges that did not require the use of false work (temporary supporting structure) during construction.

Strauss produced four types of bascule bridge: the heel trunnion, the vertical overhead counterweight, the underneath counterweight and the simple span type. His first underneath counterweight bascule span was the Burnside Bridge in Portland, Oregon. It was 252 feet from trunnion center to trunnion center and eighty-three feet wide. Strauss also developed a vertical lift bridge that used a rack and pinion drive to replace the more typical lifting cables.

Strauss' most distinguished achievement was the Golden Gate Bridge across the mouth of San Francisco Bay. It is generally conceded to be one of the world's most beautiful bridges. He also designed the Arlington Memorial Bridge in Washington, D.C. and was a consulting engineer on The George Washington Bridge and the Bayonne arch (National Cyclopedia 1959:27:30-31).

Information on personnel and businesses committed to the project was obtained from newspaper accounts and is contained in Appendix C.

VII. Structural Modifications

The present bascule deck is a steel grating, a portion of which is filled with concrete to protect the underlying machinery. This replaced the original bascule deck of creosote impregnated long leaf yellow pine paving blocks in the early 1940s. The original sidewalks made of "Kyanized" spruce planks were also replaced with concrete. Since construction, the bridge has undergone major repairs and modifications. The original chain gates were replaced with semaphore type gates.

The existing fender systems were replaced in October of 1960 (Bridgeport Post 1960, 5 October). The old ornamental lamps were replaced with 20,000 lumen street lights in June of 1968 (Bridgeport Post 1968, 7 June).

Most of the historic engineering features of the bridge are extant, however, years of vandalism and neglect have resulted in the loss or damage of architectural details. The original appearance and engineering features are preserved in Strauss' original plans at the Bridgeport City Engineer's office.

VIII. Recommendation

The East Washington Avenue Bridge original plans will continue to be an extremely valuable historical and technological resource. Detailed mechanical plans on linen are in fair condition. The available information is sufficient to build a replica or large scale working model of this Strauss' patent bascule bridge. The plans are especially interesting when examined in context with earlier and later Strauss plans; the development of the design is apparent. When the drawings are no longer of current engineering interest to The City of Bridgeport, the drawings should be transferred to an archive for preservation and protection.

BIBLIOGRAPHY AND SOURCES OF INFORMATION

Engineering Drawings:

Strauss, J, B. et. al.
1916a East Washington Avenue Bridge Plans: Strauss Trunnion Bascule Bridge
Strauss Bascule Bridge Company, Chicago
City of Bridgeport, Archives and Record Department
45 Lyon Terrace, Room 13
Bridgeport, CT 06604

Strauss, J, B. et. al.
1916b Tomlinson Bridge Plans: Strauss Trunnion Bascule Bridge
Strauss Bascule Bridge Company, Chicago
Connecticut Department of Transportation
2800 Berlin Turnpike
Newington, CT 06111

Strauss, J. B.
1903 U. S. Patent # 738,954 - Bridge
U. S. Patent and Trademark Office
Box 9
Washington, D.C. 20231

Strauss, J. B.
1915 U. S. Patent # 1,124,356 - Bascule Bridge
U. S. Patent and Trademark Office
Box 9
Washington, D.C. 20231

Legal Documents:

Baker, Alschuler and Evans
1919 "City of Chicago vs. Strauss Bascule Bridge Co."
Circuit Court of Appeals, Seventh Circuit. No. 2677
(Cite as: 261 F. 358)

Bridgeport. Land Records Volume 19, Page 286
City of Bridgeport, Town Clerk's Office
45 Lyon Terrace
Bridgeport, CT 06604

Bibliography:

Bridgeport Post
Clippings File: Bridges. Historical Collection. Brigeport Public Library.

Dunigan, Francis P.
"Receipt and Release for the East Washington Avenue Bridge." Bridgeport Life, (n.p., 17 October 1925).

Hardesty & Hanover
1994 Structural Inspection Report, East Washington Avenue Bridge. Hardesty & Hanover, Consulting Engineers, New York.

Hardesty & Hanover
1995 Substructure Inspection Report, SR 724, East Washington Avenue Bridge. Hardesty & Hanover, Consulting Engineers, New York.

Historic and Archaeological Resources, (Newington, Connecticut: Connecticut Department of Transportation - Improvements to I-95 in Bridgeport, 31 January, 1995). (HistoricResources)

Hool, S.B. & Kinne, W.S.
Moveable and Long Span Bridges.
New York: McGraw-Hill Book Company, Inc., 1924.

Hool, S.B. & Kinne, W.S.
Steel and Timber Structures.
New York: McGraw-Hill Book Company, Inc., 19243. (Timber)

Hounshell, David A.
From the American System to Mass Production 1800-1932. Baltimore: Johns Hopkins University Press, 1984.

Murray, Cora
"Pembroke City Historic District." Study Report for Local Historic District, (Bridgeport, Office of Planning and Economic Development, 1990).

National Cyclopedia. 1959 Volume 27 pp 130-131.
"Joseph B. Strauss."

Orcutt, Samuel
A History of the Old Town of Stratford and the City of Bridgeport - Part I. Bridgeport: Fairfield Historical Society, 1886.

Terrill and Croft
American Electrician's Handbook. New York: McGraw Hill, 1981.

Waldo, G.C., Jr.
History of Bridgeport and Vicinity, (Bridgeport, S.J. Clarke Publishing Company, 1917).

Maps:

Beers, Ellis and Soule
1867 Atlas of New York and Vicinity. Plate 31. Published in New York. Bridgeport Public Library

Beers and Company
1876 Atlas of Bridgeport as Surveyed by Scofield. Plates 6 and 31. Published in New York. Bridgeport Public Library.

Hagstrom
1991 Fairfield County Atlas
Hagstrom Map Company. Maspeth, New York

Hopkins, G. M.
1917 Plat Book of the City of Bridgeport. Plates 5 and 29. Published in Philadelphia. Bridgeport Public Library.

Hopkins, G. M.
1929 Plat Book of the City of Bridgeport. Plates 3 and 28. Published in Philadelphia. Bridgeport Public Library.

Hopkins, G. M.
1888 Atlas of Bridgeport. Plates 6 and 19. Published in Philadelphia. Bridgeport Public Library.

Kershaw, W. H.
1910 Atlas of Bridgeport. Plates 17 and 31. Published in Bridgeport. Bridgeport Public Library.

Pidgeon, Roger H.
1896 Atlas of the City of Bridgeport. Plates 11, 15 and 20. Published by D.L. Miller and Company. Bridgeport Public Library.

Sanborn
1889 Insurance Maps/Bridgeport. Bridgeport Public Library.

Sanborn
1913 Insurance Maps/Bridgeport, Plate 74.
Bridgeport Public Library.

Sanborn
1939 Insurance Maps/Bridgeport, Volume 2, Sheet 201.
Bridgeport Public Library.

Sanborn Perris
1898 Insurance Maps/Bridgeport, Plate 4.
Bridgeport Public Library.

APPENDIX A

Strauss Bascule Bridge Patent No. 738,954

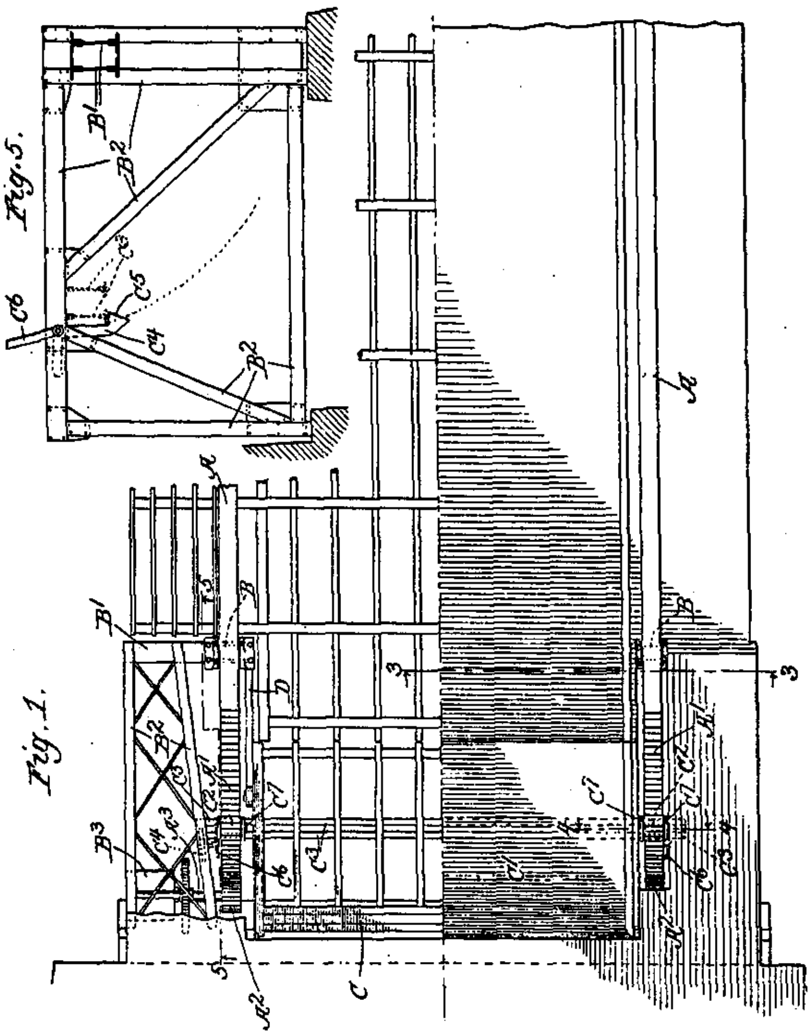
No. 738,954. PATENTED SEPT. 15, 1903.

J. B. STRAUSS.

BRIDGE.

APPLICATION FILED DEC. 19, 1902.

NO MODEL. 6 SHEETS—SHEET 1.



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No. 738,954. PATENTED SEPT. 15, 1903.

J. B. STRAUSS.

BRIDGE.

APPLICATION FILED DEC. 19, 1902.

NO MODEL. 5 SHEETS—SHEET 2.

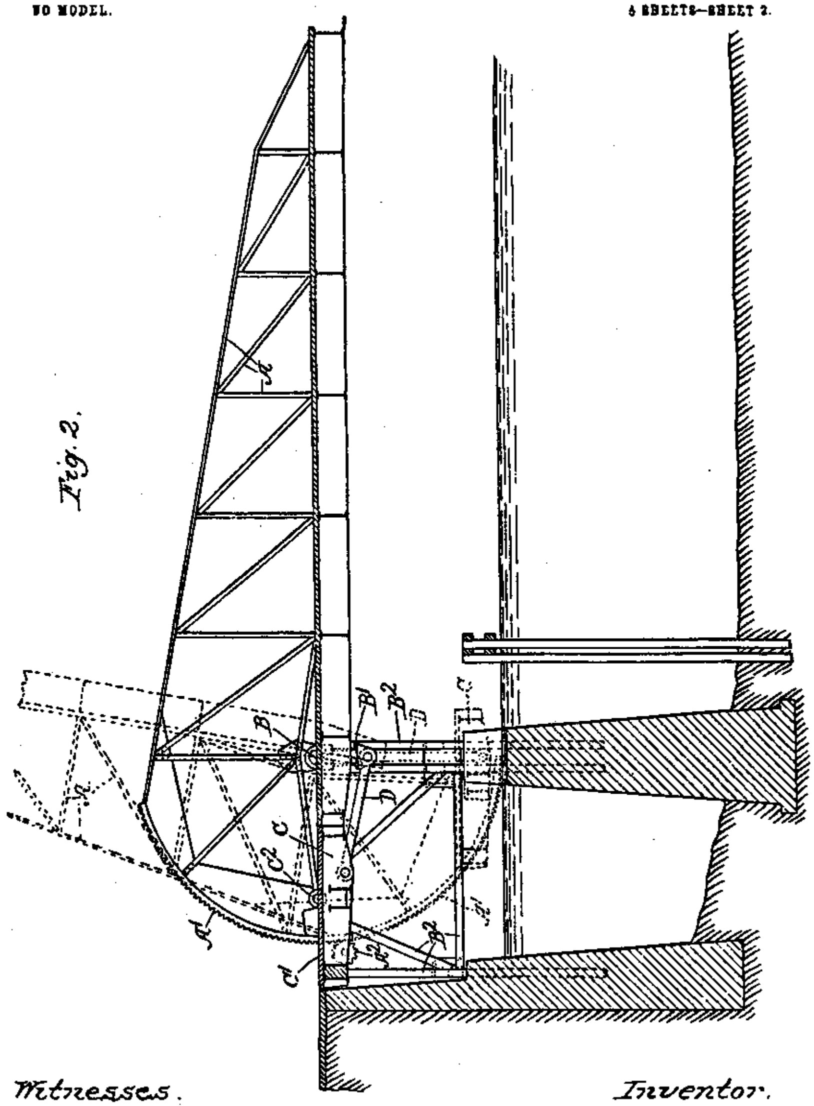

Fig. 2.

Witnesses.

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No. 738,954. PATENTED SEPT. 15, 1903.

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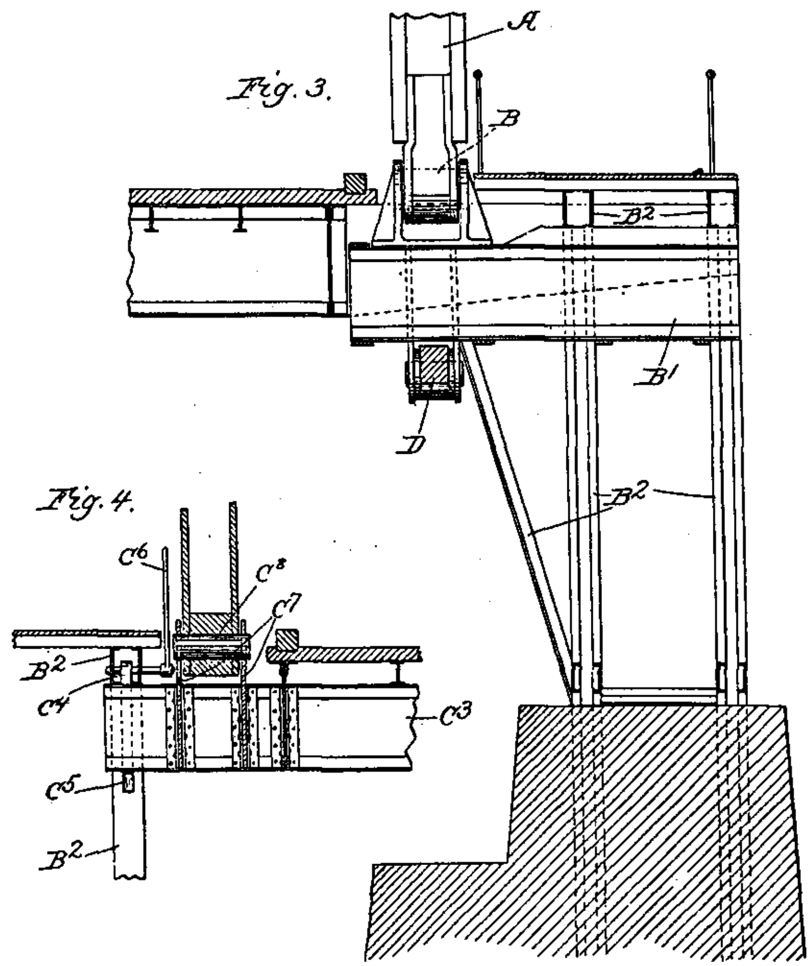
APPLICATION FILED DEC. 19, 1902.

NO MODEL. 6 SHEETS—SHEET 3.

Fig. 3.



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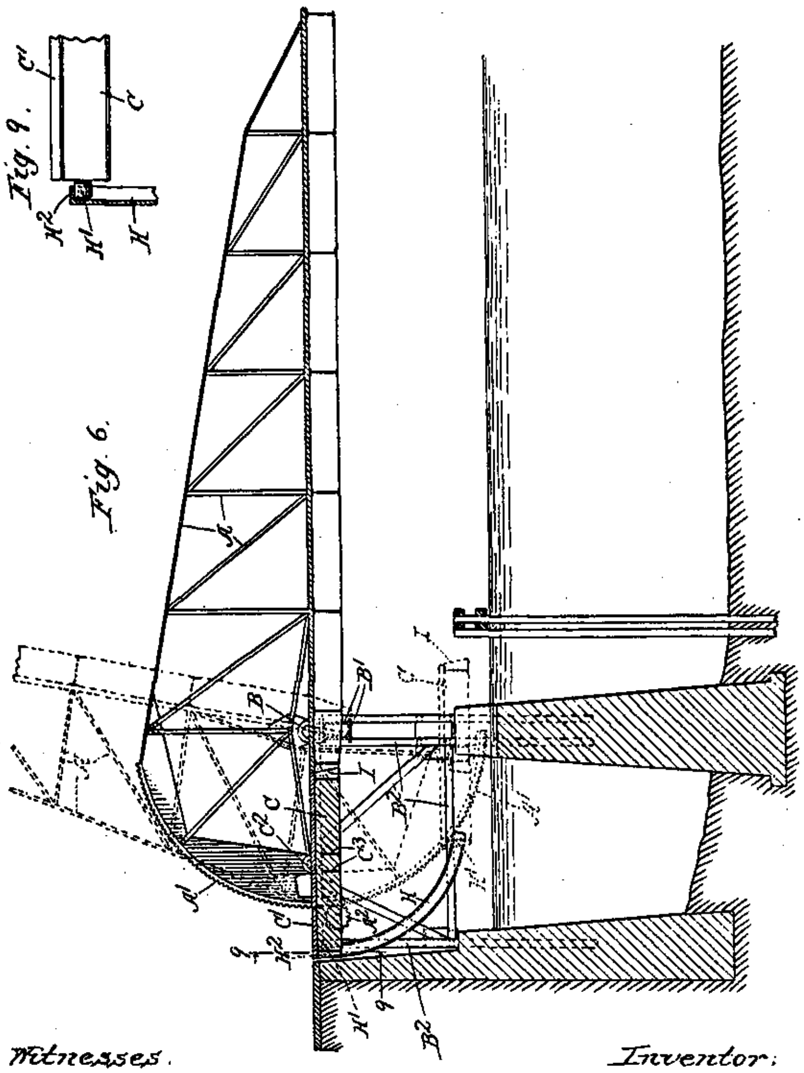
BRIDGE.

APPLICATION FILED DEC. 19, 1902.

NO MODEL. 6 SHEETS—SHEET 4.



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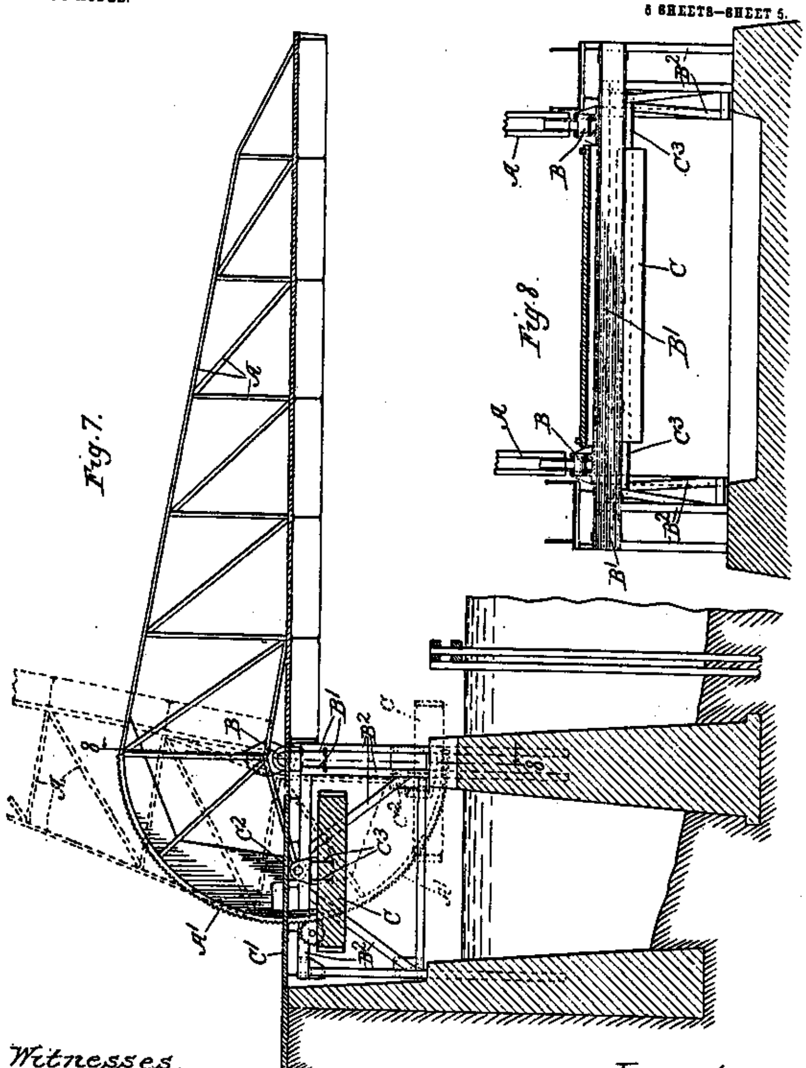
No. 738,954. PATENTED SEPT. 15, 1903.

J. B. STRAUSS.

BRIDGE.

APPLICATION FILED DEC. 19, 1902.

NO MODEL. 6 SHEETS—SHEET 5.



Witnesses.
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No. 738,954. Patented September 15, 1903.

UNITED STATES PATENT OFFICE.

JOSEPH B. STRAUSS, OF CHICAGO, ILLINOIS.

BRIDGE.

SPECIFICATION forming part of Letters Patent No. 738,954, dated September 15, 1903.

Application filed December 19, 1902. Serial No. 135,889. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH B. STRAUSS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Bridges, of which the following is a specification.

My invention relates to bridges, and has for its object to provide a new and improved bridge, of which the following is a description, reference being had to the accompanying drawings, wherein—

Figure 1 is a plan view with parts omitted of one end of a bridge embodying my invention. Fig. 2 is a vertical section therethrough. Fig. 3 is a section on line 3 3, Fig. 1. Fig. 4 is a section on line 4 4, Fig. 1. Fig. 5 is a section on line 5 5, Fig. 1. Fig. 6 is a vertical sectional view showing a modified construction. Fig. 7 is a similar view showing a further modified construction. Fig. 8 is a section on line 8 8, Fig. 7. Fig. 9 is a detail section on line 9 9, Fig. 6.

Like letters refer to like parts throughout the several figures.

Referring now to Figs. 1 to 5, inclusive, I have shown a construction comprising a main span carried by trusses A A, which are mounted upon trunnions B, carried by a trunnion-supporting piece B', supported by the frame B^2. There is one of these frames B^2 associated with each of the main trusses. It will be noted that these frames are at one side of the main trusses and that the trunnion-supporting piece projects out over the frame, so that the space beneath the trusses and the main span is free and unobstructed. This is shown clearly in Fig. 3. These frames B^2 may be made in any desired manner. As herein shown, they consist of two frame-pieces, as illustrated in Fig. 5, connected together by suitable cross-pieces and anchored to the masonry. These frames support the controlling mechanism for the main span—such as the electric motor B^3. There is preferably a motor for each truss. The trusses A are provided with the curved racks A', adapted to be engaged by gears A^2 on the shafts A^3, operatively connected with the electric motors. The counterweight for the main span is pivotally connected thereto at a suitable point, so as to maintain a substantially horizontal position as the main span is raised and lowered, thus very materially shortening the structure and permitting a suitable movement of the counterweight without necessitating the use of a tail-pit, or at least greatly reducing the depth of such tail-pit. As shown in Fig. 2, the counterweight C is connected directly to the approach span C', and the counterweight and approach span are pivoted to the main trusses at C^2. It is of course evident that any suitable construction may be used for this purpose. As herein shown, the counterweight extends entirely across the floor between the two main trusses, and there is provided a bumping-girder C^3, which extends entirely across between the trusses, the ends projecting beneath the said anchor-frames B^2, as shown in Fig. 4, so that when in their up position further movement is prevented by these frames and the parts are held in position. When the counterweight is attached to the approach span, so that the approach span itself acts either partially or wholly as a counterweight for the main span, I provide a suitable lock for the approach span, so as to hold it in proper position and prevent accidental movement. As herein shown, this locking device consists of a movable locking-arm C^4, attached to the frame B^2 and provided with a beveled face C^5. This locking device is adapted to be engaged by the bumping-girder as it moves up, so as to be moved to one side, and then falls back into position, so as to engage the bumping-girder, and thus holds the approach span in position. This locking device is controlled by means of a lever C^6. The counterweight or the approach span, or both, when they are combined may be pivoted to the trusses in any desired manner. As herein shown, the bumping-girder is provided with projecting parts C^7, which come into proximity to the trusses, and there is a pin C^8 passing through the truss and these projecting parts, as shown in Fig 4, thus securely pivoting them together. As shown in Fig. 2, I have indicated a means for providing an additional increment of efficiency in the counterweight during movement from the open to the closed position of the main span without increasing the short-end lever-arm of the main span, which consists in pivoting it at one side of its center and then connecting to it the struts D, said struts being connected at their other end to a fixed part—as, for example, the trunnion-supporting piece B'—as shown in Fig. 3. It will be seen that by this construction the counterweight may be projected beyond the pivotal point to any degree desired and the parts balanced by the struts D, and thus the leverage of the counterweight increased so as to multiply its effect and at the same time keep it in a substantially horizontal position during the movement of the main span. It will be seen that in this construction when the main span is lifted by means of the operating mechanism the counterweight and the approach span when a part thereof will move down and will keep in a substantially horizontal position, so as to take the position shown in dotted lines in Fig. 2 when the main span is completely open. As ordinarily used the counterweight would be in a substantially vertical position when the main span is open, and the end would thus tip down below the water or into the ordinary tail-pit. By my construction the tail-pit is entirely done away with, or, if used at all, may be very small, and the great cost of the ordinary masonry is thus avoided.

In Fig. 6 I have shown a construction where the approach span acts as a counterweight, and in this construction the approach span is pivotally supported at its center or at or near its center of gravity to the main span, thus giving the entire counterweight the arm equal to the distance between the pivots of the main span and the pivots of the counterweight. With this construction, if the parts are properly made, the counterweight and the approach span will retain a substantially horizontal position during the movement of the main truss and will take the position shown in dotted lines. It will be seen that in this construction the counterweight when the bridge is open projects beneath, or, perhaps, more properly speaking, past, the points of support of the main span, and this necessitates a clear way under the span, which is secured by the construction herein shown and which also may be secured by various other constructions. If desirable, suitable means may be provided for insuring the substantially horizontal position of the counterweight or approach span during all of its positions.

In Fig. 7 I have shown a construction where the counterweight and approach span are separate, the approach span being fixed. In this case the counterweight is pivoted to the main trusses substantially the same as in the other constructions, but is pivoted at its middle or at or near its center of gravity. The counterweight therefore maintains a substantially horizontal position as the main span moves, taking the position shown in dotted lines when the bridge is open. In this construction the trunnion-supporting piece B' extends entirely across between the frames B². In this construction I secure the beneficial effects of the pivoted counterweight in connection with a bridge having a stationary or fixed approach span.

The construction embodying my present invention provides a bridge where all the moving parts are kept out of the water and where the tail-pit may be eliminated or reduced to very small proportions. The extreme length of the bridge is also very much reduced, and the elimination of the tail-pit in addition to reducing the cost of the structure gives a greater waterway, and thus the bridge does not obstruct the waterway in any material degree.

I have omitted the minor details of the iron construction in the figures in order to simplify the drawings and the drawings are therefore more or less diagrammatic.

I have described in detail particular constructions embodying my invention; but it is of course evident that the parts may be greatly varied in form, construction, and arrangement and that some of the parts may be omitted and others used with parts not herein shown without departing from the spirit of my invention. I do not, therefore, limit myself to the particular construction shown.

It will be seen that by this construction I am enabled to use a short tail end to the main span and that when the main span is closed the counterweight has a part which projects beyond the tail end, this projecting part being varied when the main span rises. In other words, this construction permits me to use a comparatively short tail end and yet to secure a comparatively long lever-arm for the counterweight, the projecting part of the counterweight being withdrawn toward the pivotal point of the main span or toward or within the boundary of the main span as it is lowered, thus permitting me to partially or wholly eliminate the tail-pit.

When the counterweight is provided with the retaining-strut D, it will of course be held in a substantially horizontal position at all times and will not be moved about its pivot due to its unbalanced condition, for with this form of my device the counterweight is always suspended at one side of its center. When the counterweight is suspended in the center, it will ordinarily move down in the proper position; but, if desired, it may be provided with a suitable guide, such as the guide H in Fig. 6. In this construction the counterweight is provided with one or more rollers H', said rollers working in guideways in the guide H. It will be seen that neither these rollers nor the guide have any strain, for their only function is to keep the counterweight in its balanced position.

When the construction shown in Fig. 2 is used, the struts D hold the approach span in proper position and keep it from tipping when the load passes therealong. When the construction shown, for example, in Fig. 6 is used, it is necessary to provide some means to prevent the approach span from being tipped by the load. This may be accomplished in any desired manner. As shown in said figuro, the ends of the main approach epans at the break in the floor ere beveled or inclined, as shown at I, so that the approach spau cannot be moved up past the level of tho floor of tho main span. At the other end any suitable device may be used, such as the etop H^2 on the guide H, against which the roller H' strikes when the approsch epan roaches the limit of its upward movement.

It will be noted that the upward movement of the tail end of the main girders is limited by the engagement of the humping-girder C^3 with the frames B^2, and hence the uplift ie carried by these frames. The greater part of the load ie then transferred by the diagonal pieces B^3 (see Fig. 5) to the end pieces B^5, to which is connected the beam or girder B^6, upon which is mounted the trunnions of the main span. It will thus be seen that thie uplift is opposed by the load on the trunnions, and anchorage is therefore necessary. The smaller portion of the load is transforred to the abutment, and the only anchorage necessary is that required to take caro of this part of the load. It will be seen that by this construction the tail end of the main span when in its normal position eagages a part which is connected to the part csrrying the load on the main trunnions, and it is this construction which avoids the necessity of providing anchorage for the greater part of the load duo to the uplift.

I claim—

1. A bridge comprising n main span, a counterweight therefor pivotally connected to the main span, end means for limiting the movement of the counterweight about its pivot.

2. A bridge comprising a main span, a counterweight connected thereto, and means providing an additional increment of efficiency in the counterweight during movement from the open to the closed position of the main span without increasing the short-end lever-arm.

3. A bridge comprising a main span, pivotally supported between its ends, a horizontally-disposed counterweight movably connected with the short end of tho main span, and an engaging device for holding said counterweight in a substantially horizontal position during the movement of the main span.

4. A bridge comprising a main span, mounted upon trunnions, supporting parts for said trunnions, an open way between said supporting parts, a horizontally-disposed counterweight connected with sald main epan, a portion of said countorweight passing by the trunnion-supports when the main span is open.

5. A bridge comprising a main span, provided with a series of main trusses, a beam or girder extending across the space between at least two of them, and a counterweight for said main span extending across between at least two of said main trussee and connected to said beam or girder.

6. A bridge comprising a main span, provided with a series of main trusses, and a counterweight for said main spaa extending across between at least two of said main trusses, said counterweight pivotally connected to said trussee.

7. A bridge comprising n main span, provided with a series of main trueses, a beam or girder at the tail end of said trusses extending across the space between them and pivotally connected thereto, and a counterweight attached to said beam or girder.

8. A bridge comprising a main epan, provided with a series of main trusses, a beam or girder at the tail end of said trusses extending acroes the space between them and pivotally connected thereto, a counterweight attached to said beam or girdor, and means for keeping said counterweight in substantially the same relative position during all the positions of the main span.

9. A bridge comprising a main span, a counterweight movably connected to said main epan at one side of its center, and means for preventing movement of the counterweight due to its unbalanced condition.

10. A bridge comprieing s pivotally-supported main span, a counterweight pivoted at one side of its center to said main span, so ss to be in an unbalanced condition, and a retaining-strut connected to the short arm of the counterweight and to a fixed part eo as to prevent displacement due to the unbalanced condition, whereby the effect of the counterweight is incressed.

11. A bridge comprising a main span, supporting parts therefor, a counterweight attached to said main span, and an open way between the supports for the main span whereby the counterweight may pass between said supports.

12. A bridge comprising a main epan, an approach span pivotally connected to said main span so as to move therewith, said approach span acting partislly or wholly as the counterweight for the main span.

13. A bridge comprising a main span, an approach span pivotally connected to said main span so as to move therewith, said approach span acting partinlly or wholly as the counterweight for the main span, and a fixed engaging part adapted to engage said approach epan so as to limit its upward movement.

14. A bridge comprising a main span, aa approach span pivotally connected to saul main span so as to move therewith, said approach spaa acting partially or wholly as the counterweight for the main span, and a locking device for locking the parts in their normal position.

15. A bridge comprieing a main span, provided with main trusses, n cross-piece pivtally connected to the tail end of said main trusses, and an approach span carried by eaid croee-pieco so as to move with the main span.

16. A bridge comprising a main spau, sup-

ports for said main span located outside of the boundary of the main span so that the space between said supports is free.

17. A bridge comprising a main span, supports for said main span located outside of the boundary of the main span so that the space between said supports is free, and a horizontally-disposed counterweight pivotally connected to the tail end of said main span and adapted to pass between said supports when the main span is lifted.

18. A bridge comprising a pivoted main span having a tail end, a comparatively thin horizontally-extending counterweight attached thereto, and having a part which projects beyond said tail end, and means for varying the length of this projecting part as the main span rises.

19. A bridge comprising a comparatively thin horizontally-extending counterweight which projects beyond the tail end of the main span when the bridge is closed, and means for drawing the projecting end of said counterweight toward the pivotal point of the main span as the span is raised.

20. A bridge comprising a main span, a support therefor, a part for limiting the upward movement of the tail end of the main span and which receives the uplift, said part connected with the support for the main span whereby a portion of the uplift is counteracted by the main load.

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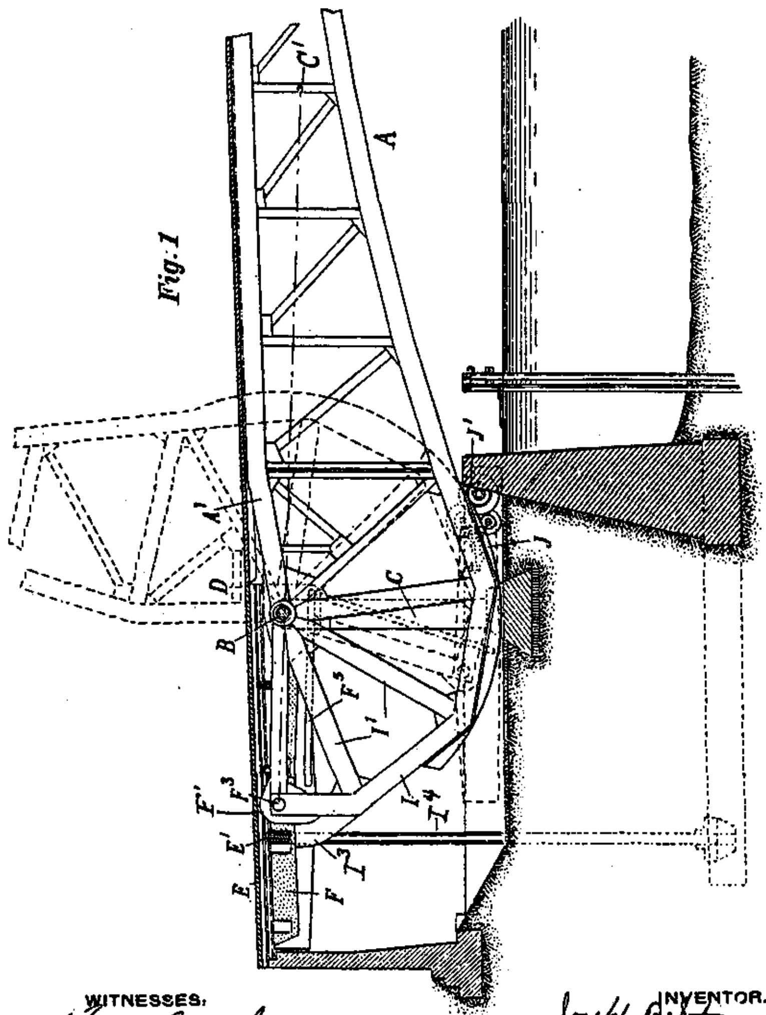
EDWARD T. WRAY.

APPENDIX B

Strauss Bascule Bridge Patent No. 1,124,356

J. B. STRAUSS.
BASCULE BRIDGE.
APPLICATION FILED FEB. 19, 1906.

1,124,356. Patented Jan. 12, 1915.
4 SHEETS—SHEET 1.



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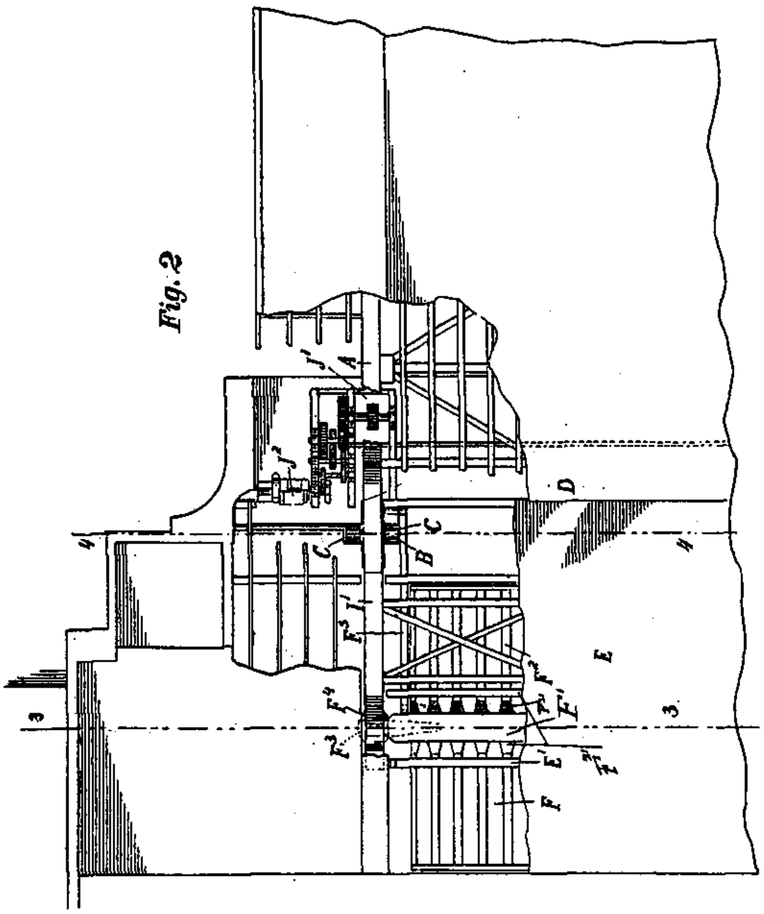
BASCULE BRIDGE.
APPLICATION FILED FEB. 10, 1906.

1,124,356.

Patented Jan. 12, 1915.
4 SHEETS—SHEET 2.

Fig. 2



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BASCULE BRIDGE.
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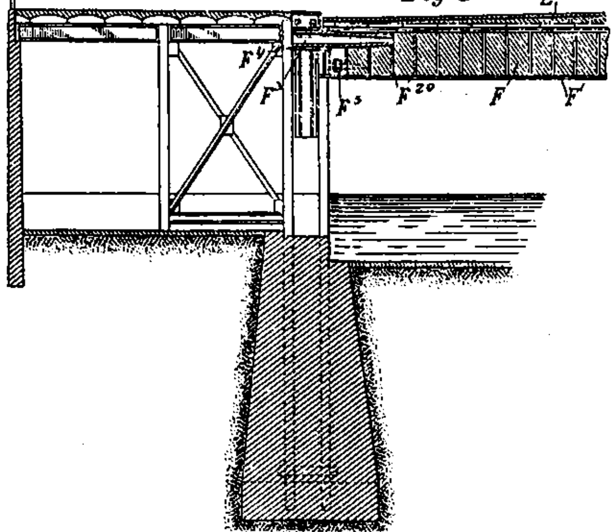
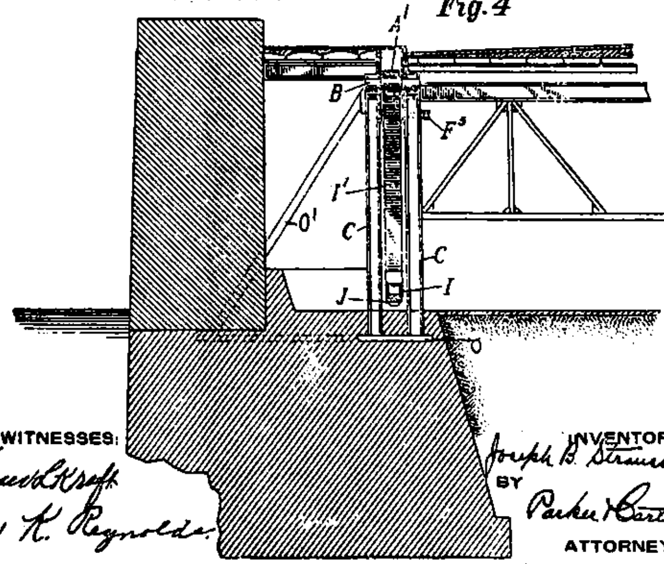
4 SHEETS—SHEET 3.





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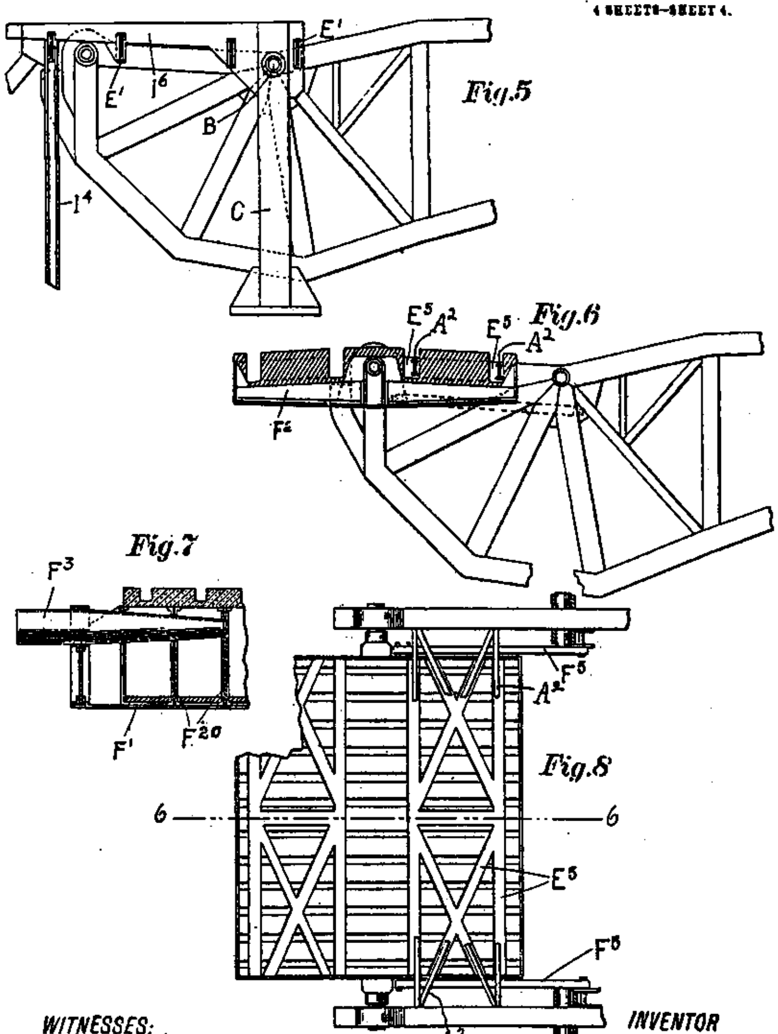
1,124,356.

Patented Jan. 12, 1915.
4 SHEETS—SHEET 4.



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UNITED STATES PATENT OFFICE.

JOSEPH B. STRAUSS, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE STRAUSS BASCULE AND CONCRETE BRIDGE COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

BASCULE-BRIDGE.

1,124,356. Specification of Letters Patent. Patented Jan. 12, 1915.

Application filed February 19, 1906. Serial No. 301,773.

To all whom it may concern:

Be it known that I, JOSEPH B. STRAUSS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Bascule-Bridges, of which the following is a specification.

My invention relates to bascule bridges, and has for its object to provide a new and improved bridge of this description.

My invention is illustrated in the accompanying drawings, wherein—

Figure 1 is a side elevation in part section illustrating my invention; Figure 2 is a plan view with parts broken away; Fig. 3 is a sectional view taken on line 3—3 of Fig. 2; Fig. 4 is a sectional view on line 4—4 of Fig. 2. Fig. 5 is a view showing the support for the main span illustrating the members for the upward and downward forces. Fig. 6 is a sectional view through the counterweight taken on line 6—6 of Fig. 8 showing the grooves of the counterweight material. Fig. 7 is a sectional view through that part of the counterweight where the counterweight pin is located. Fig. 8 is a plan view of the counterweight.

Like letters refer to like parts throughout the several figures.

This invention has among other objects to provide what may be called an underneath type of structure wherein the bridge, counterweight and the operating mechanism are all beneath the roadway.

In the drawings I have shown one span of the bridge. It is, of course, evident that the bridge may be a single span bridge or there may be two spans, one on each side of the stream, the two connected together at the middle when in their operative position.

As shown in the drawings, a main span A comprising suitable trusses A^1 is mounted upon suitable trunnions, or projecting pins B which work in bearings in the supporting posts C, C, said trusses passing in between said supporting posts as shown. The trusses A^1 are connected together by the cross pieces A^2. (See Fig. 4.) By this arrangement it will be seen that the supporting posts are symmetrically disposed with relation to the trunnions. There is also suitable bracing for said posts. The floor D of the main span does not extend all the way along said main span, but stops at the point at one side of the trunnions. The rest of the floor E back to the abutment wall is fixed. The counterweight F is located beneath the roadway floor E and may be made up in any desired manner. As herein shown it consists of a main central cross girder F^1 and longitudinal girders F^2 (see Fig. 2). The main cross girder is a box girder having interior webs or diaphragms F^{20} (see Fig. 7) at right angles to the axis of the girder. The longitudinal girders are divided into two sections, the ends of which abut the cross girders and which are fastened thereto by the plates F^{21}. At each side of the counterweight there is a counterweight pin F^3 cantalivered in the main cross girder (see Figs. 2 and 7) said pin passing through holes in the diaphragms F^{20} and connecting to a plurality of said diaphragms so that the pin reactions are transmitted to the main cross girder. These pins project beyond the counterweight into suitable bearings F^4 in the trusses. (See Fig. 3.) It will be seen that by this construction the counterweight is, as it were, concentrated at the points where the pins are connected with the main cross girder and is free to move with relation to the trusses so that the counterweight can keep its horizontal position. The counterweight pin and the trunnion of the main span are in line with the center of gravity of the main span. This will be seen in Fig. 1 where the center of gravity is diagrammatically represented at C^1. A suitable floor is preferably associated with the counterweight girders. The counterweight is preferably cut away so as to receive the cross beams or stringers E^1 of the roadway floor when the bridge is down so that there would be no interference between the roadway floor and the counterweight. This is illustrated more clearly in Figs. 6 and 8 wherein the counterweight is shown as provided with cut away portions or grooves E^5, the beams or stringers being omitted in Fig. 8 to show these grooves. By this construction the counterweight extends toward the roadway floor between the stringers supporting said floor. Connected with the counterweight is a counterweight link F^5 which is pivoted to the counterweight and to the fixed support. This keeps the counterweight in a proper horizontal position during all the various positions of the main span.

The rear end of the main span instead of being made up of curved members is composed of a series of straight members or chords of a circle I and radial members I^1

from the trunnion to the intersecting points of said chords (see Fig. 1).

Any suitable operating mechanism may be used for raising and lowering the main span. As herein shown the main span is provided with a toothed rack J which is engaged by a gear wheel J^1 connected by suitable reducing gears to a motor J^2. This rack and the operating mechanism are beneath the roadway floor so as to be out of the way. When the bridge is in its operative position the parts are as shown in full lines in Fig. 1. When it is desired to lift the bridge the operating mechanism is started and the main span moved about the trunnions as pivots. The counterweight moves down with the rear end of the main span, said rear end moving away from the fixed roadway floor, the counterweight keeping in a horizontal position and assuming the position shown in dotted lines when the bridge is up. When the bridge is again lowered the parts take the position shown in full lines. It will be seen by this construction that all the parts and operating mechanism are beneath the roadway so that there are no upwardly projecting parts or mechanism.

It will be noticed that the fixed floor, the fixed support, the rear end and the counterweight are all adapted to work in the limited space between the underside of the roadway and the water line. The various parts are therefore recessed and otherwise adapted to fit into and clear each other during the operation of the bridge.

The fixed supports on which the trunnions are mounted and which are arranged in pairs, are so arranged with relation to the counterweight that part of the counterweight passes by them and in front thereof when the bridge is open. Said fixed supports or supporting posts are mounted upon bolsters O, there being side braces O^1 for said supporting posts also connected with said bolsters, the supporting posts, braces and bolsters acting as a unit. The movable section of the bridge is provided with main trusses, said main trusses having the trunnions associated therewith and provided with radial members radiating from the trunnions in straight lines toward the front and rear. The main span is provided with what may be called a double rear end member consisting of a member upon which the counterweight pins are mounted and the member acting as a bumper, and the counterweight pin is in one line of action and the bumper I in the other, the bumper acting at the rear of the counterweight pin. This bumper stops the main span when it has reached its lowered position by engagement with the stringer E^1 anchored by the members I^4, and holds it in place. The pressure of this bumper is resisted by the members I^4 which are properly anchored in any desired manner. The fixed floor and the main span have a joint support, that is, they are supported upon the same device. The support for the main span embraces members for the upward and downward forces with suitable connections between them. These members and connections are shown in Figs. 1 and 5. The members for the upward and downward forces consist of the posts C and the members I^4. The connection between these members is obscured by the truss and counterweight in Fig. 1, but is clearly shown in Fig. 5, and consists of the connecting piece I^5, there being one of these at each side of the bridge.

The counterweight pins upon which the counterweight is supported are located in substantially the same horizontal plane as the center of gravity of the counterweight. The support for the main span embraces direct acting vertical supporting members for the upward and downward forces in a vertical plane with the trunnions and bumper and suitable horizontal bracing between them, the horizontal bracing consisting of the floor and floor beams at the top.

I claim:

1. A bascule bridge comprising a main span, two sections of floor, one attached to the main span, the other free therefrom but fixed in position and extending over the rear end of the main span, a counterweight attached to the rear end of the main span and disposed to fit between the cross supports of the fixed floor and beneath it.

2. A bascule bridge comprising a main span mounted upon trunnions, a counterweight therefor comprising cross and longitudinal girders, a floor associated with said girders carrying the counterweight material, counterweight pins cantalivered in the main cross girder and projecting beyond the counterweight, said pins working in bearings on the main span.

3. In a bascule bridge a fixed floor, a counterweight movable with relation to said fixed floor comprising a supporting frame, counterweight material supported in said frame and extending above said frame and toward the fixed floor, said counterweight material recessed to receive the supports of said floor.

4. In a bascule bridge a main span mounted upon supports so as to be opened and closed, a counterweight connected with said main span, a fixed roadway floor above the counterweight having a supporting floor system to receive said counterweight when the main span is in its closed position and arranged so that a part of the floor system and counterweight are in the same horizontal plane when the main span is closed.

5. A bascule bridge comprising a main span, a counterweight frame comprising a main cross girder and longitudinal girders,

said cross girder acting as a main support for the longitudinal girders and provided with a plurality of separated diaphragms and pins at the ends of said cross girder for connection with the main span, each of said pins having a bearing in a plurality of said diaphragms, said pins having bearing ends projecting beyond the cross girder.

6. In a bascule bridge a main cross girder provided with a plurality of separated diaphragms and having pins at its ends, each of said pins having a bearing in a plurality of said diaphragms, said pins having bearing ends which project from the girder.

JOSEPH B. STRAUSS.

Witnesses:
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EDNA K. REYNOLDS.

APPENDIX C

List of Personnel Associated with Construction

Fred Atwater	Chairman, Bridge Commission
Mr. Beardsley	Resident Engineer
Howard L. Beers	Assistant Engineer
Ralph Beers	Commissioner
F. William Behrens	Mayor of Bridgeport
William H. Burr	Consultant
George M. Coughlin	Former Director of Public Works
James Coulter	Commissioner
Mr. Dorner	Bridgeport Dredge & Dock Company
Francis Dunigan	Commission Secretary
William J. Lavery	Commissioner
Mr. Lyttel	Structural Engineer, Penn Bridge Co.
James A. McElroy	City Engineer
Richard Murphy	Commissioner
J. A. Northey	Director of Public Works
John Schwarz, Jr.	Commissioner
Joseph Strauss Bascule Bridge Company	
George W. Sunderland	Treasurer, Bridgeport Dredge and Dock Company
Paul Svihra	Foreman, stonework
Mr. Wagner	Structural Engineer, Penn Bridge Co.
Frank Wheeler	Commissioner

Figure 1
Location Map
Quadrangle: Bridgeport, Connecticut 1:24000

Figure 2
Location of "Noble's" Bridge
1888 Atlas of Bridgeport; Plate 6

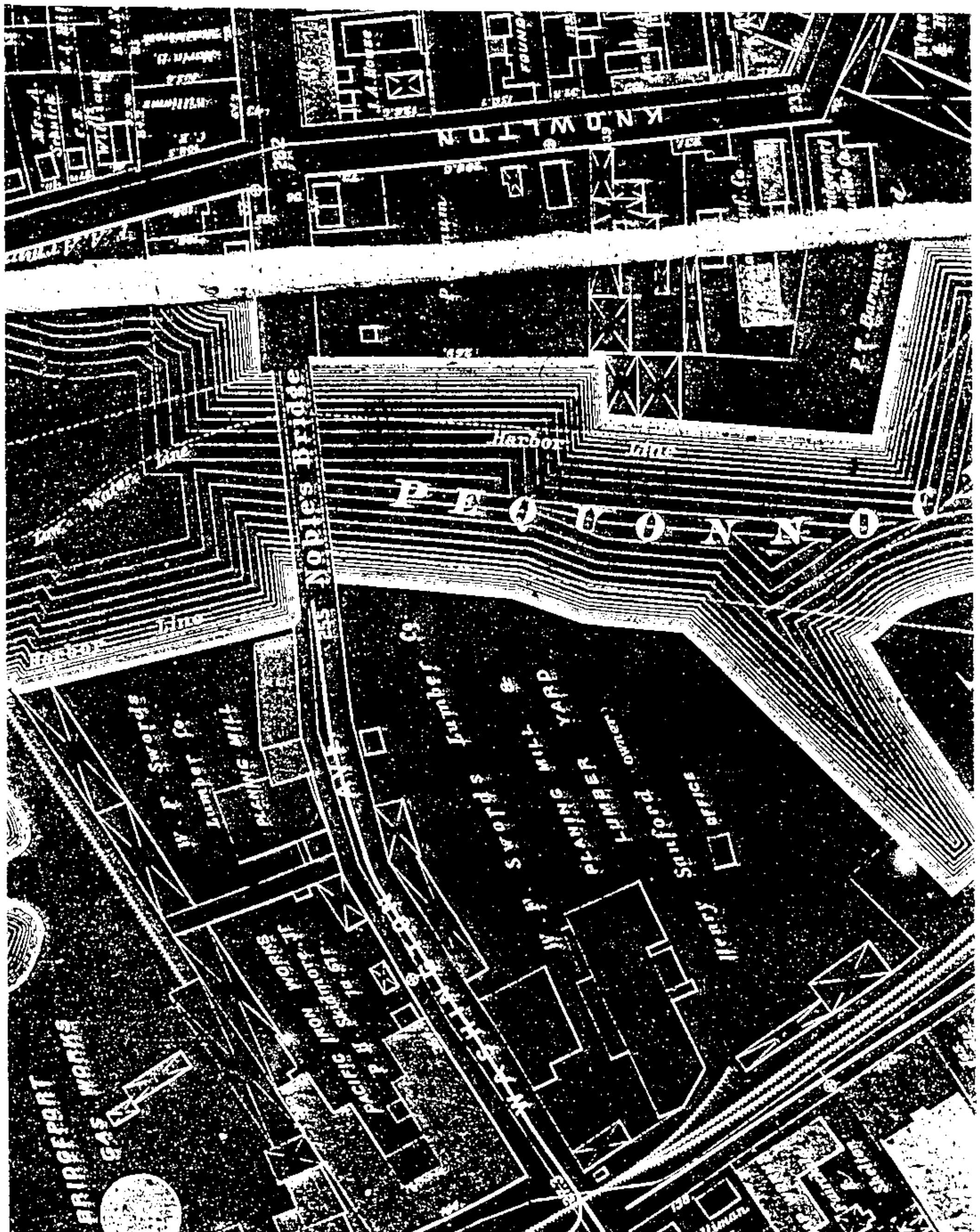


Figure 3
Barnum and Noble property in 1851.
Bridgeport Public Library

1851 Plan by
James C. Lane

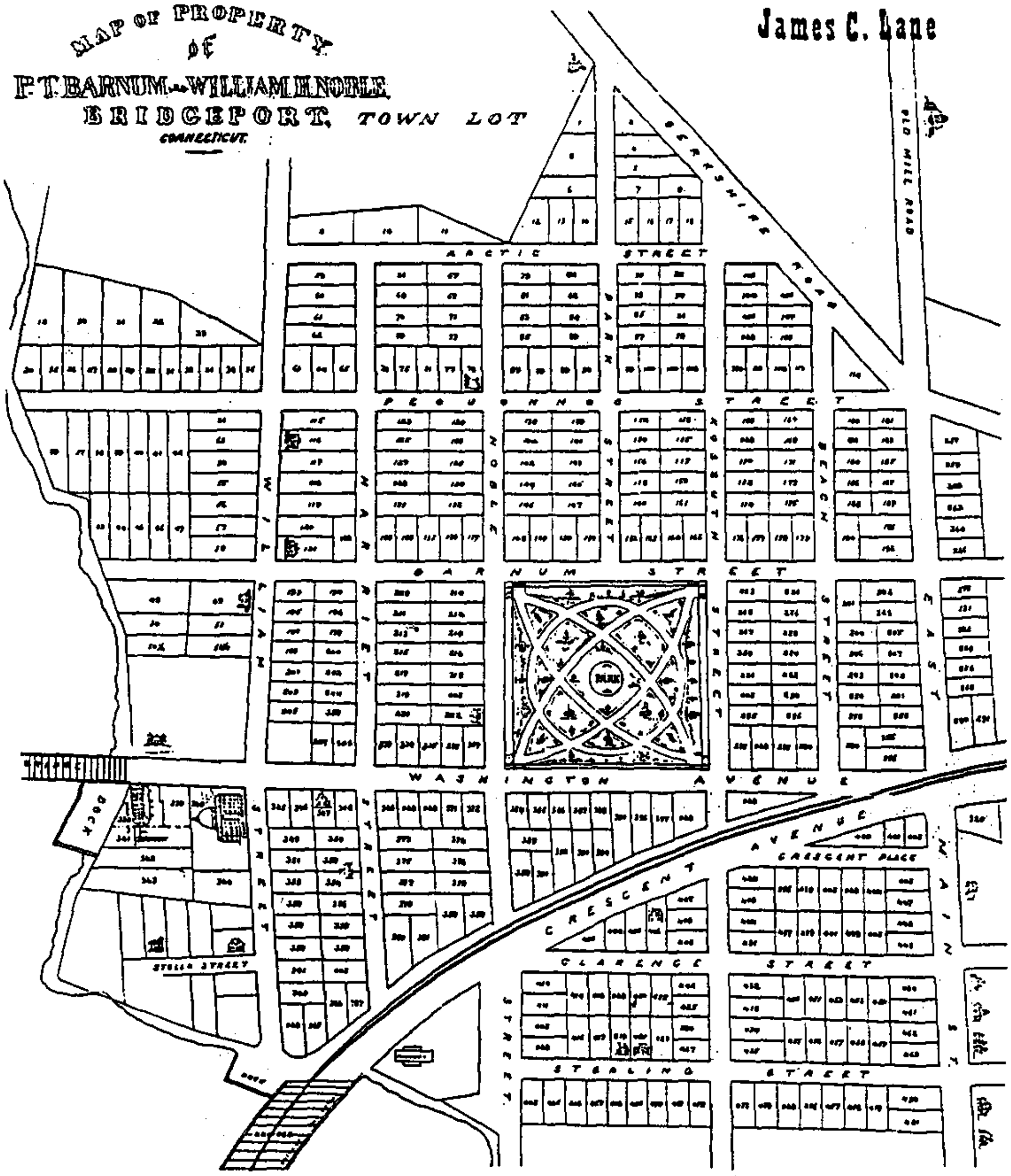


Figure 4
A "bird's eye" view of Pembroke in 1875.
Bridgeport Public Library

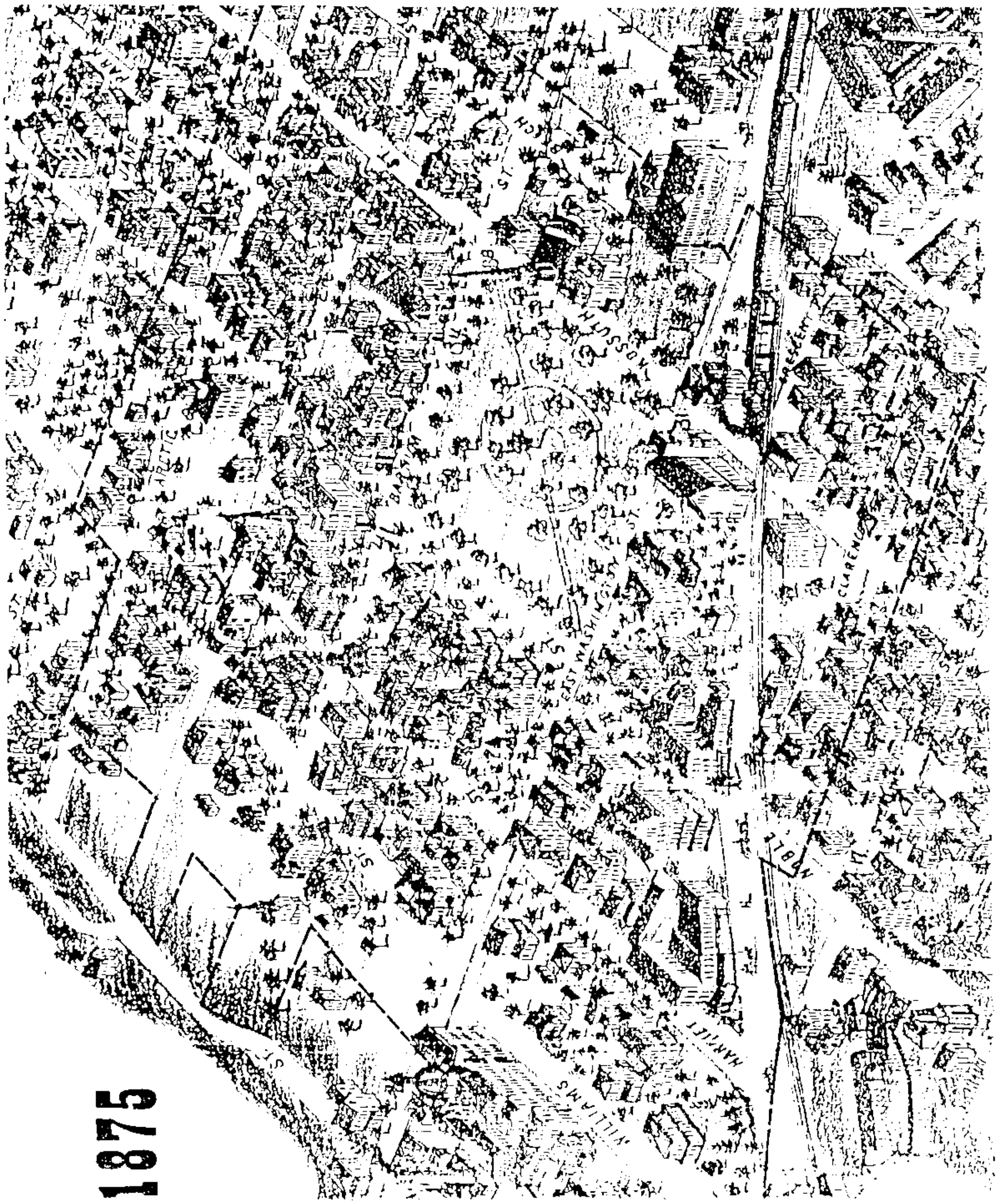
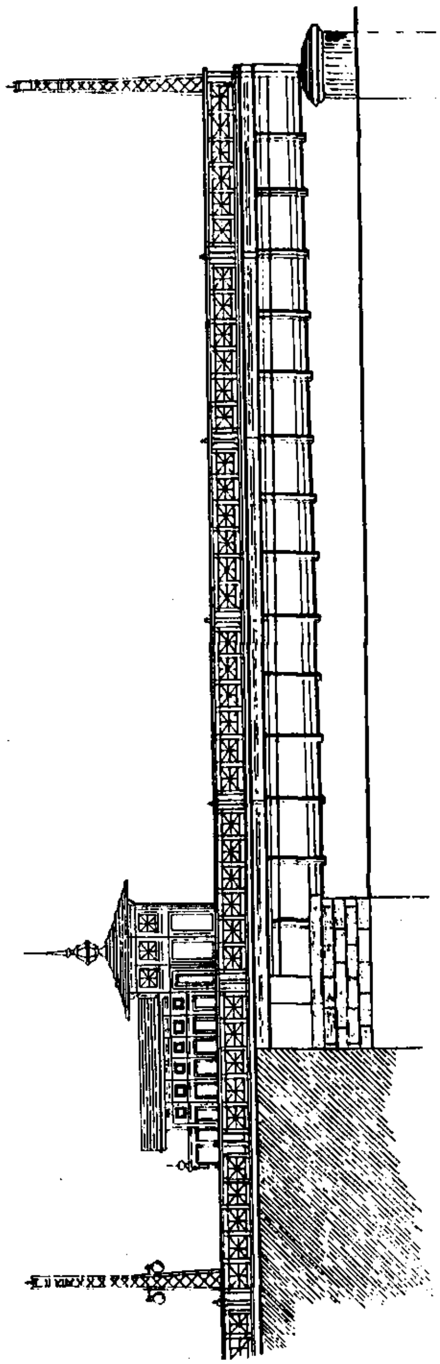


Figure 5
South elevation of the bridge as designed.
Strauss Bascule Bridge Company



SOUTH ELEVATION - EAST WASHINGTON AVENUE BRIDGE

Delineated by Robert C. Stewart

Figure 6
Original Design - Operator's House
Strauss Bascule Bridge Company

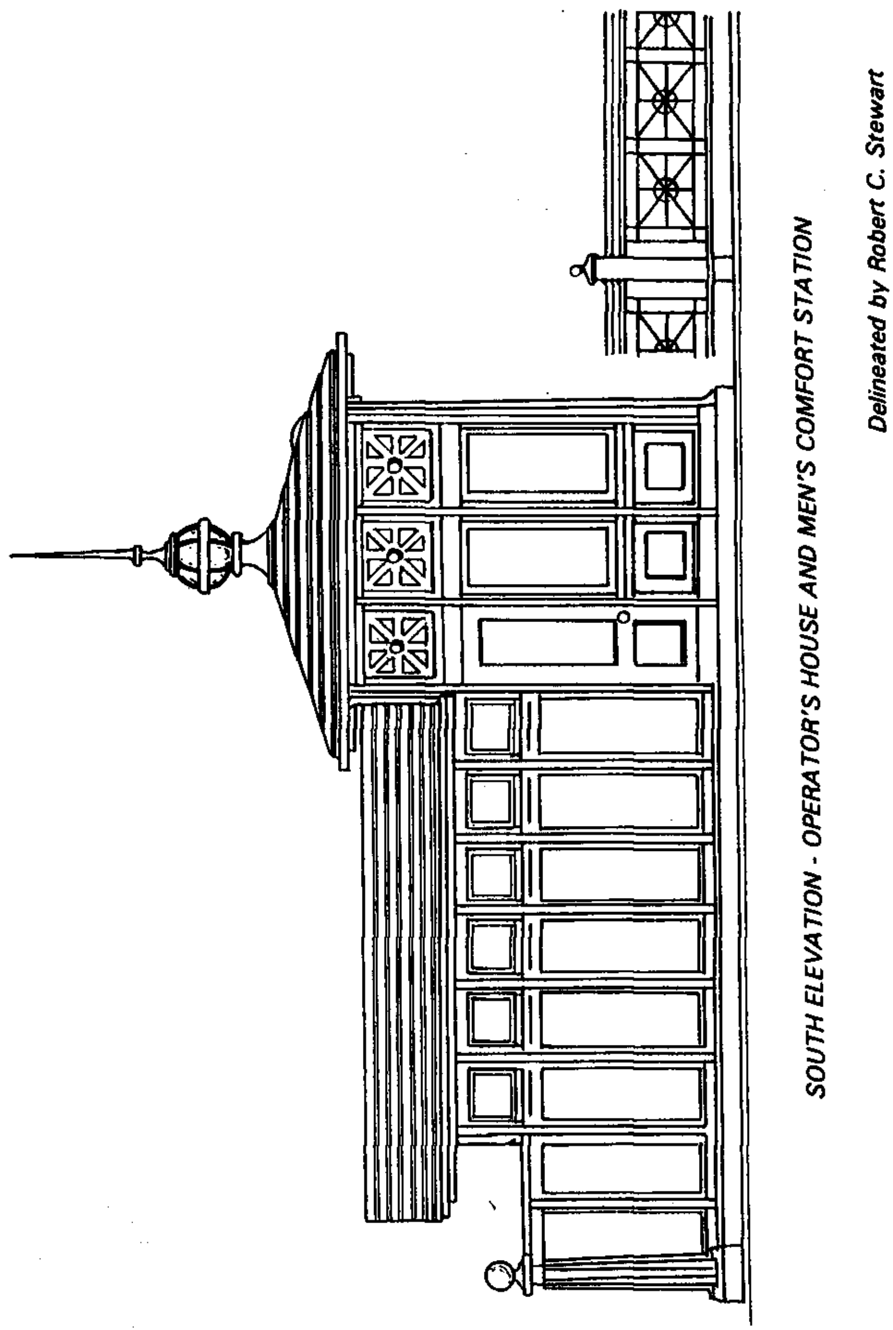


Figure 7
Link and Counterweight; Open position
Strauss Bascule Bridge Company

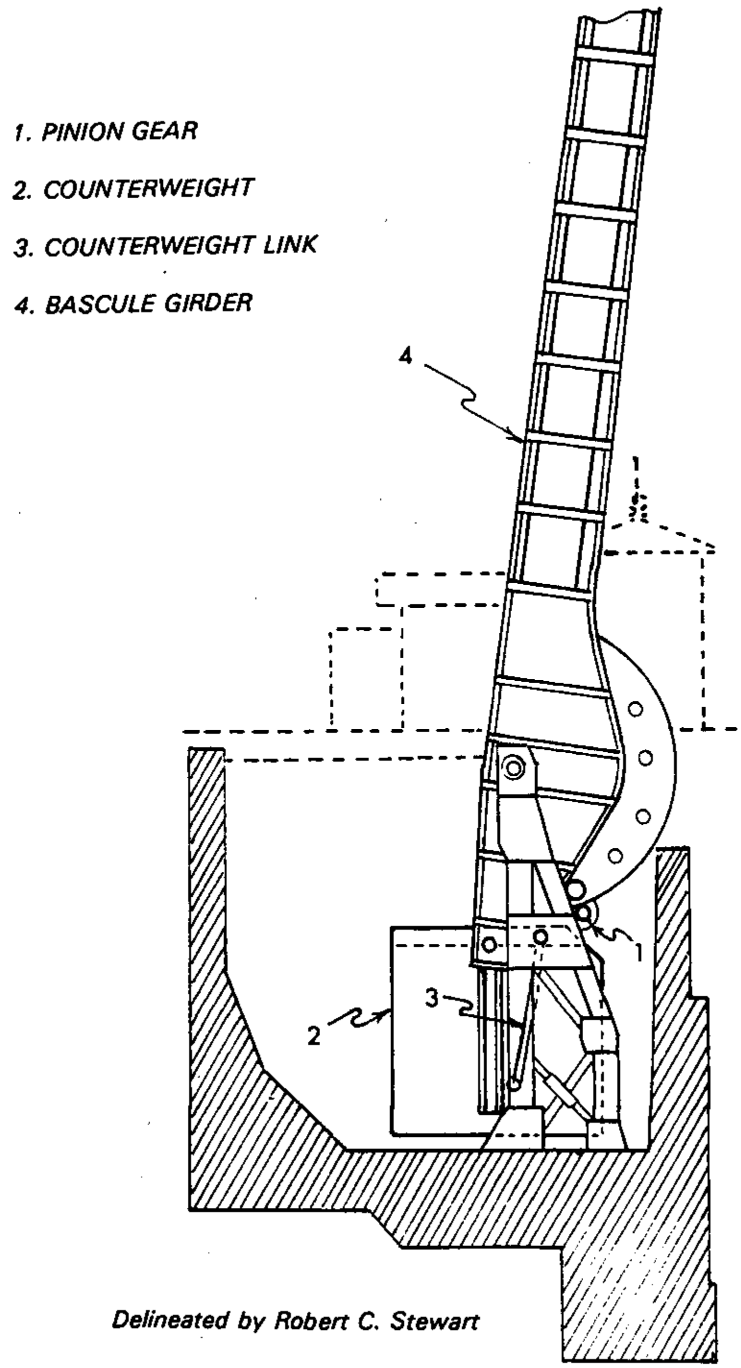


Figure 8
Link and Counterweight; Closed position
Strauss Bascule Bridge Company

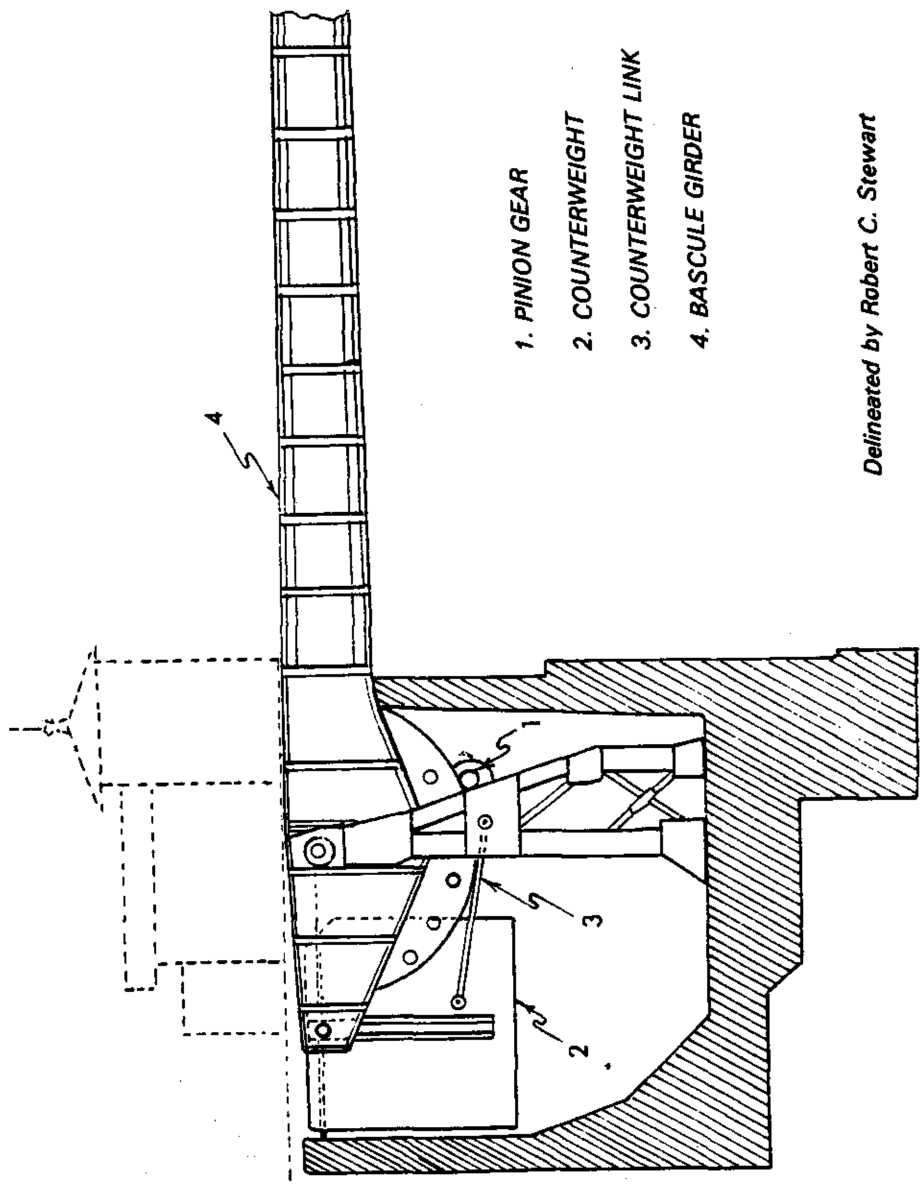
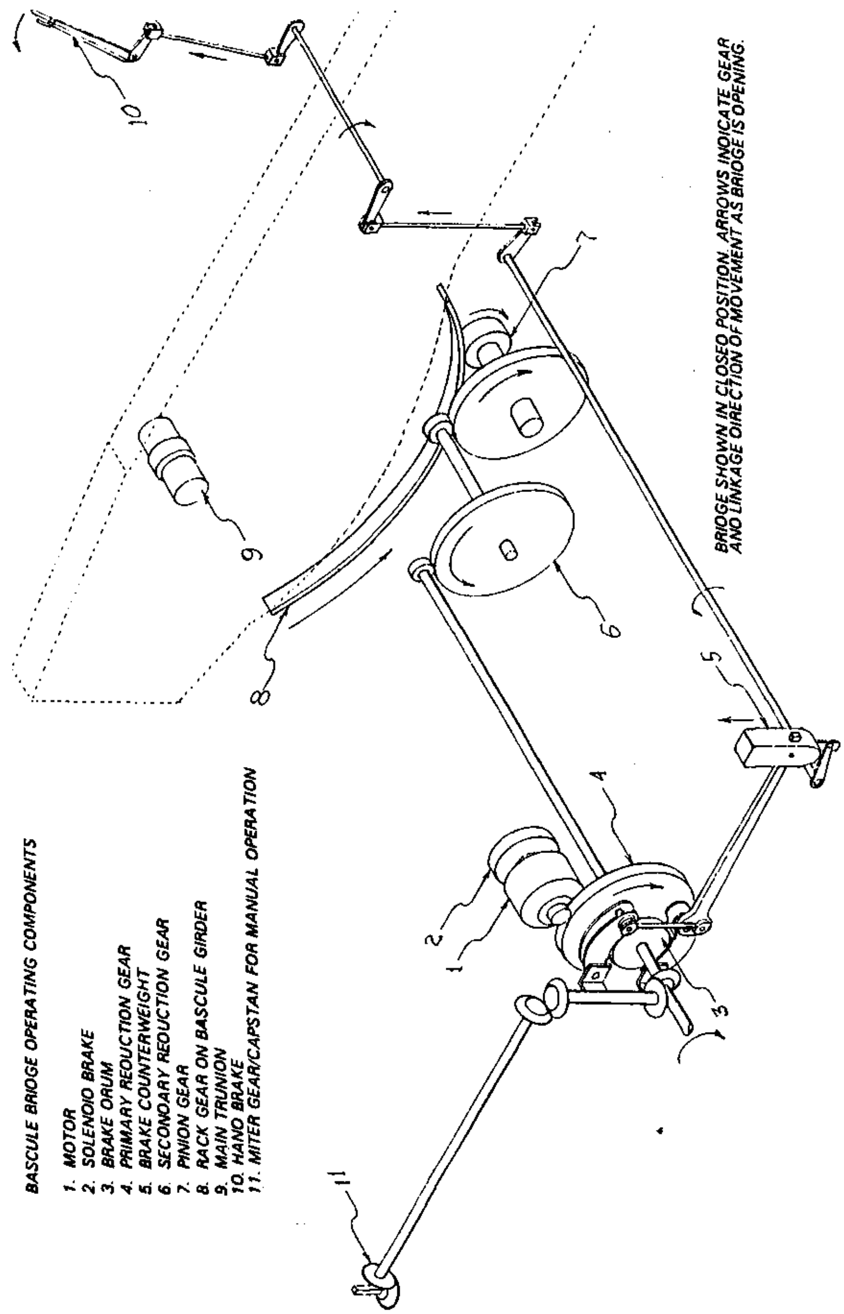


Figure 9
Gear and Brake Mechanism
Strauss Bascule Bridge Company



Delineated by Robert C. Stewart