Heavy Movable Structures, Inc.

SIXTH BIENNIAL SYMPOSIUM

October 30 - November 1, 1996

Doubletree Resort Surfside
Clearwater Beach, Florida

A Century of Progress with Scherzer Rolling Lift Bascule Bridges, Historical Development of Movable Bridges, Part II

by

John A. Schultz Jr., S.E. and Jeffrey D. Routson, P.E., S.E., Hazelet & Erdal

A CENTURY OF PROGRESS WITH SCHERZER ROLLING LIFT BASCULE BRIDGES

HISTORICAL DEVELOPMENT OF MOVABLE BRIDGES, PART II

Prepared for:
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HAZELET & ERDAL
A DAMES & MOORE COMPANY
547 West Jackson Blvd.
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Wm Scherzer

DEFINITION

All "Bascule Bridges", by definition, pivot about a horizontal axis to rotate one or more bridge leafs in a vertical plane, for the purpose of providing specified channel clearances, both horizontally and vertically, for navigation. The rolling lift type bascule bridge is unique in that it both pivots and translates away from the navigation channel as the bridge leaf rolls open. This results, typically, in unlimited vertical clearance being attainable with less span from bearing to bearing being required in order to provide the same channel width, as a Trunnion Bascule Bridge.

One form of a rolling lift bascule bridge was first built around the year 1825 in France. The concept was originally developed for use on canals, so that both the navigation channel and the tow path were cleared by the bridge as it opened, as reported in Part I, Page 6.

PREFACE

"Remember the Past to Inspire the Future; Historical Development of Movable Bridges" which was presented in 1994 will be referred to as Part I.

"A Century of Progress, Scherzer Rolling Lift Bascule Bridges; Historical Development of Movable Bridges, Part II". This presentation will relate the culmination of events that precipitated the explosion of new developments that began in Chicago circa 1890. It will then focus on the development of the Scherzer Rolling Lift Bascule Bridge including the special features that are being used on current projects.
"The Selection and Evolution of the Chicago Type Trunnion Bascule Bridges; Historical Development of Movable Bridges - Part III", pertains to another presentation being introduced this year.

WHY CHICAGO?

When the glaciers came down from northern Canada to form the Great Lakes, pushing and gouging straight south for over four hundred miles to thrust Lake Michigan into the heartland of the North American continent, the stage was set for Chicago to become the "Hub of the Continent". It is difficult for today's generation to realize the extreme importance of travel by waterways that was experienced by people 100 to 200 years ago. Ships from every part of the Great Lakes traveled to Chicago to exchange their cargos for products of the farmlands. The schooners of yesterday have now been replaced by the 18 wheelers of today.

By the last decade of the 19th century, Chicago had become a major metropolitan center. Its location at the foot of Lake Michigan and the mouth of the Chicago River made it an obvious terminus for both water-borne transportation and rail transportation. You might say it was a precursor to today's intermodal transportation. Scores of wharfs were located along the North and South Branches of the Chicago River as well as between the confluence and the mouth. This resulted in a tremendous volume of navigational traffic along the river. Chicago's population was growing at a very rapid rate at the time and was expanding north, west, and south from the mouth of the river. This growing population generated a tremendous volume of wheel, foot, and hoof traffic that needed to cross the three branches of the Chicago River. The result of this, of course, was a vast array of movable bridges across the river. Virtually all of the bridges were swing bridges. In fact, there were so many that one could have nearly walked down the middle of the river, if they had all been open at the same time.

However, as the use of the river increased, so did the problem of contamination. Pollution of the river was widespread and as the river flowed into Lake Michigan, the city's drinking water became affected. Epidemics such as cholera, yellow fever, and meningitis were just a few of the dreaded diseases that were byproducts of contaminated drinking water. These periodic epidemics created a crisis for the city fathers. Nature must have had this problem in mind when it provided the continental divide just a few miles west of the lake shore.

The civil engineers realized that a canal could be dug from the south branch of the Chicago River to the DesPlaines River which flowed south. They would take the water that had been flowing out into the lake and eventually into the Atlantic Ocean, and change its direction so it would flow down the Mississippi

River system into the Gulf of Mexico. The solution was twofold as revealed by its name "The Sanitary and Ship Canal".

A navigation channel in the center of the river was greatly needed because the numerous swing bridges had caused such a bottleneck in the narrow Chicago River. The center pivot piers with their fenders extending up and down the river to protect the swingspan in the open position, prevented the full length of the river banks from providing docking facilities. This bottleneck also restricted the cross-sectional area of the river for sanitary flow. Again, a dual problem was presented to the engineers for solution. Bridges were needed that would stay within the street right-of-ways while opening up the center of the river for shipping and also increasing the sanitary flow area of the river.

HISTORICAL DEVELOPMENT

Metropolitan West Side Elevated Railroad Bridge

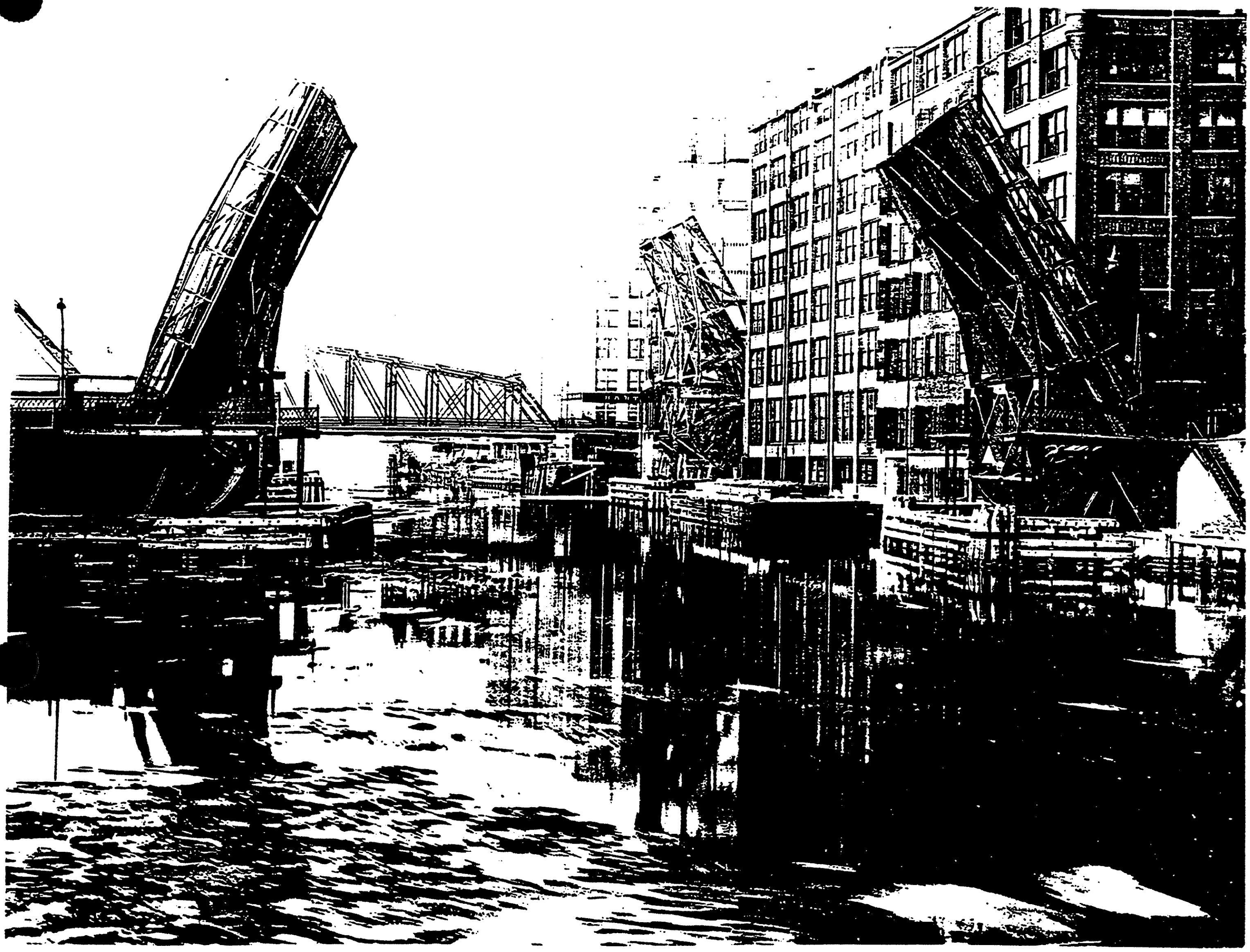
In 1893, the Metropolitan West Side Elevated Railroad Company was building an elevated line from the west suburbs to the "Chicago Downtown" east of the south branch of the Chicago River. The most difficult problem that confronted the management and engineers was the question of how to carry the traffic of their four tracks across the Chicago River. They wanted to have their terminal in the business center of Chicago where they could also tranfer on the same platform to the Chicago "L" system. Their "right of way" permitted a crossing between Jackson Street and Van Buren Street swing bridges, but these two bridges were so close together that it was impractical to build a third swing bridge between them.

A number of bridge engineers were consulted as to the best type of bridge to meet the difficulties, and a number of new schemes were submitted, none of them, however, fulfilling the requirements. One of the ablest American bridge engineers submitted to the management a pivot or trunnion bascule bridge design, similar to the Tower trunnion bascule bridge at London, which was then under construction, and it seemed to be the only feasible solution of the difficulties, and detailed plans were prepared for the construction of the bridge. In working out the detailed plans, objectionable features became more apparent and William Scherzer, C.E., was consulted by the management of the Metropolitan Company in reference to overcoming some of these objectionable features and the execution of the design. After devoting a great deal of time and study to this problem, he became convinced that it was impossible to eliminate the objectionable features of the pivot or trunnion type of bascule bridge. As the elevated railroad was then rapidly nearing completion, the bridge problem became very critical and induced William Scherzer to endeavor to solve the problem on entirely new lines, and after very extensive studies, ultimately led to his invention of the type of bridge known as the Scherzer Rolling Lift Bridge. A design for a four-track rolling lift bridge (twin-two track bridges) was prepared by him and submitted, and after a careful investigation of its merits as compared with those of other types of bridges, it was decided by the management of the Metropolitian West Side Elevated Railroad Company to adopt this design, and William Scherzer was entrusted with the preparation of the detailed plans.

The Metropolitan West Side Elevated Railroad Company then proposed to the City of Chicago that this type of bridge be also used at Van Buren Street in place of the old swing bridge, which was inadequate. This proposition was accepted by the City of Chicago. The plans for both of these bridges were completed and the patent for a rolling lift bridge was applied for shortly before the death of William Scherzer on July 20, 1893. The Secretary of War approved the plans on November 16, 1893. The patent covering both of these bridges was issued on December 26, 1893. Both bridges were completed in 1895, Van Buren Street in January and the railroad bridge in May, as reported in Part I, Page 18. (See Picture, with Van Buren Street in foreground, Metropolitan West Side Elevated Railroad Bridge beyond, and the Jackson Boulevard Swing Bridge in the background).

The Metropolitan West Side Elevated Railroad Bridge was composed of two similar or duplicate bridges, placed side by side, each carrying two railroad tracks. The two bridges were firmly coupled together so as to operate as one bridge, but when desired could be uncoupled in less than ten minutes and be operated separately, thus insuring a crossing for railroad trains. The movable span of this bridge was 114' center to center of bearings, and the channel between masonry piers was 108'. It was designed to act either as a three hinged arch or as a cantilever bridge. When acting as a cantilever, the live load was supported by the tail girders, which are locked under the projecting approach spans, the approach spans being firmly anchored into the masonry.

The center of gravity of the moving leaf was located so that, upon opening the tail and center locks, it rolled part way open to an angle of about 30°. This would require a minimum of power to operate, and only requiring the application of electric motive power when it was desired to open the bridge more completely or to close it. The bridge was usually opened or closed within 30 seconds, and was ready to receive trains in less than one minute from the time it started to close.



Completed January, 1895.

DIMENSIONS:

Span C. to C. of bearings, 115 feet.
Channel between piers, 109 feet.
Width cf Bridge, 59 feet.

SCHERZER ROLLING LIFT BRIDGE

Across Chicago River at Van Buren Street,
Chicago, Illinois.

View showing Bridge Opened, with entite channel available for navigation.

Highway Bridge.
Operated by electric power.

Invented and Designed by
WILLIAM SCHERZER, C. E.

Patented.

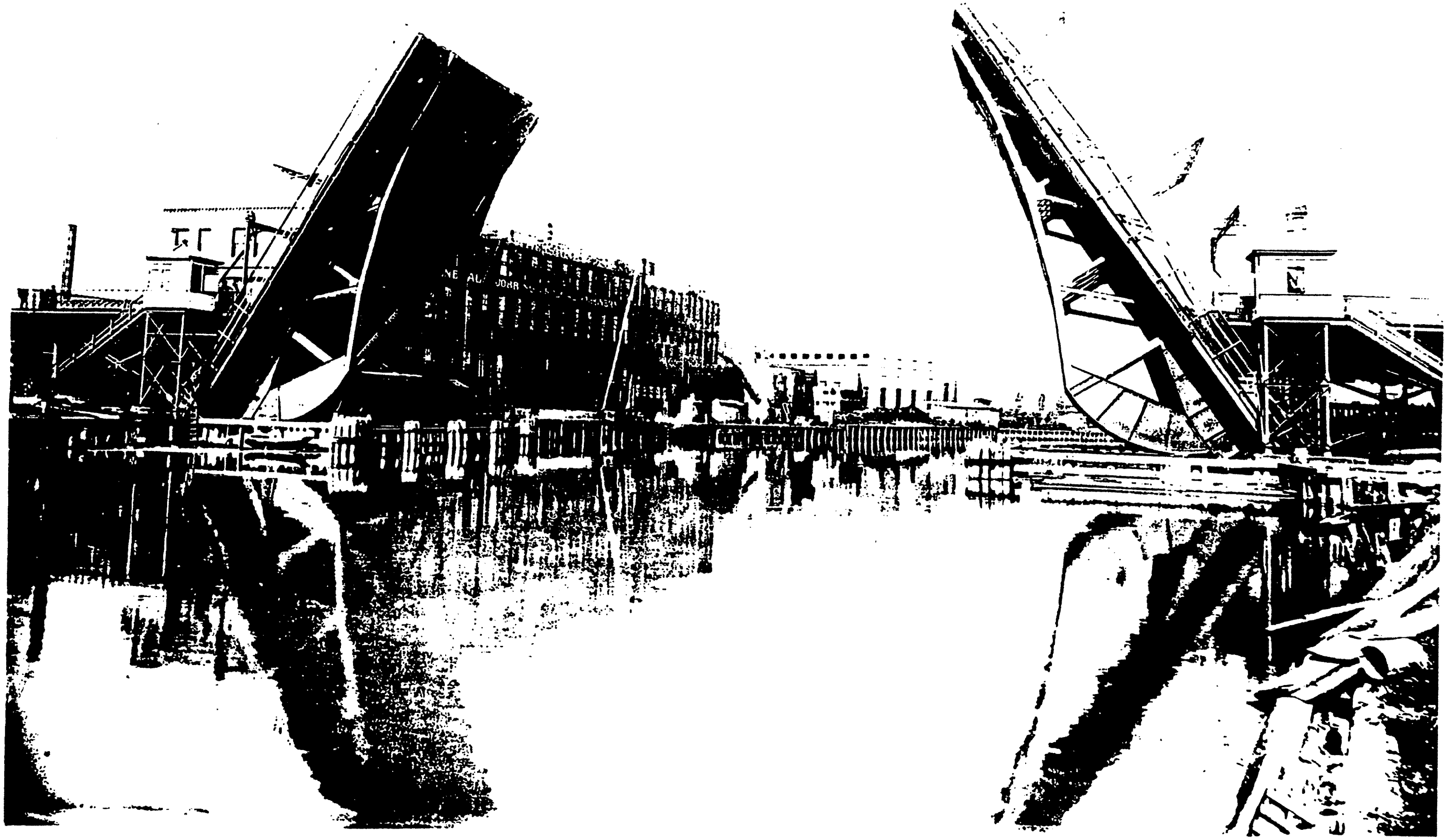
1,200 trains cross bridge daily; bridge rigid; moves rapidly, very little power; no depreciation.

Mr. W. E. Baker, General Manager of the Metropolitan West Side Elevated Railroad Company, in a letter (circa 1900) referring to this bridge states:

> *It was completed some time before May 6th, 1895, at which date the road was opened and the bridge placed in active service, since which time it has operated continously and has, of itself, caused no delays to trains, of which there are and have been since shortly after the date opening the road, about 1,200 trains daily crossing the bridge.*
>
> *The bridge may be said not to have required any repairs, except the inter-locking machinery, and only then in the early days of operation, when it was not well understood.*
>
> *We do not make any charge for motive power for operating the bridge; it is too small to be considered. The bridge is operated, as you know, by motors using the current with which we operate the trains.*
>
> *The bridge has proven rigid; it is rapid to open and shut; has never shown signs of failure. It requires little power to move it, shows no evidences of depreciation, and we are satisfied with it.*

North Halsted Street

Some time later, the City Engineer of Chicago, Mr. L. B. Jackson and his staff together with Mr. William Hughes, C.E., who designed the superstructure, apparently modifed William Scherzer's design of Van Buren Street for an increase in span length center to center of bearings from 115' to 127' and a reduced width from 59' to 50'. They undoubtedly paid a royalty to Albert Scherzer, William's brother, who owned the patents. The construction was completed in February, 1897. (See Picture)



SCHERZER ROLLING LIFT BRIDGE.

Completed February, 1897.

DIMENSIONS:

Span C. to C. of bearings, 127 feet.
Channel between piers, 121 feet.
Width of Bridge, 50 feet.

Across Chicago River at North Halsted Street,
Chicago, Illinois.

PARTLY OPENED.

Highway Bridge.
Operated by electric power.
Superstructure designed by
W. M. Hughes, C. E.
L. B. Jackson, City Engineer.
Patented.

Founding of the Scherzer Rolling Lift Bridge Company

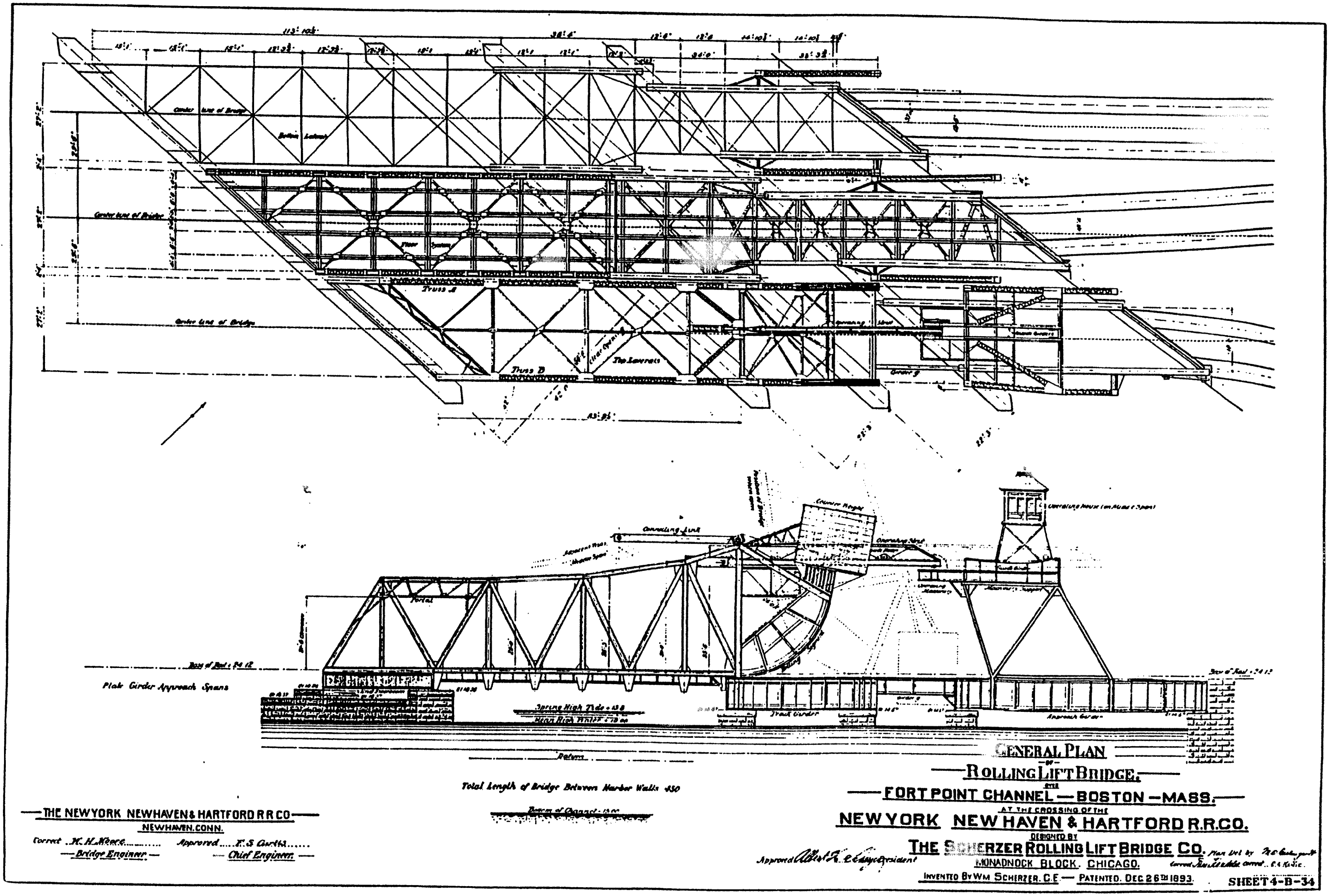
After the construction of William Scherzer's two bridge designs and the City of Chicago's design and construction of North Halsted Street bridge, Albert Scherzer realized the value of his brother's patent for this new type of bridge. He then founded the Scherzer Rolling Lift Bridge Company and established his new company in the Monadnock Building located at 53 West Jackson Blvd. in the Chicago Loop on July 1, 1897. His first two studies in July, 1897, were for the Sanitary District of Chicago (SD of C) to investigate the feasibility of carrying the existing 8 railroad tracks across the proposed Sanitary and Ship Canal near Campbell Avenue on the south side of Chicago. The first study was for a Through Cantilever Truss and the second study was for a Through Arch Truss design to provide a 150' clear channel. A third study increased the channel width to a 170' clear. The results of these studies were used as the basis for Scherzer's later proposal to the Sanitary District of Chicago.

Six Track Railroad Bridge, Fort Point Channel, Boston, Mass.

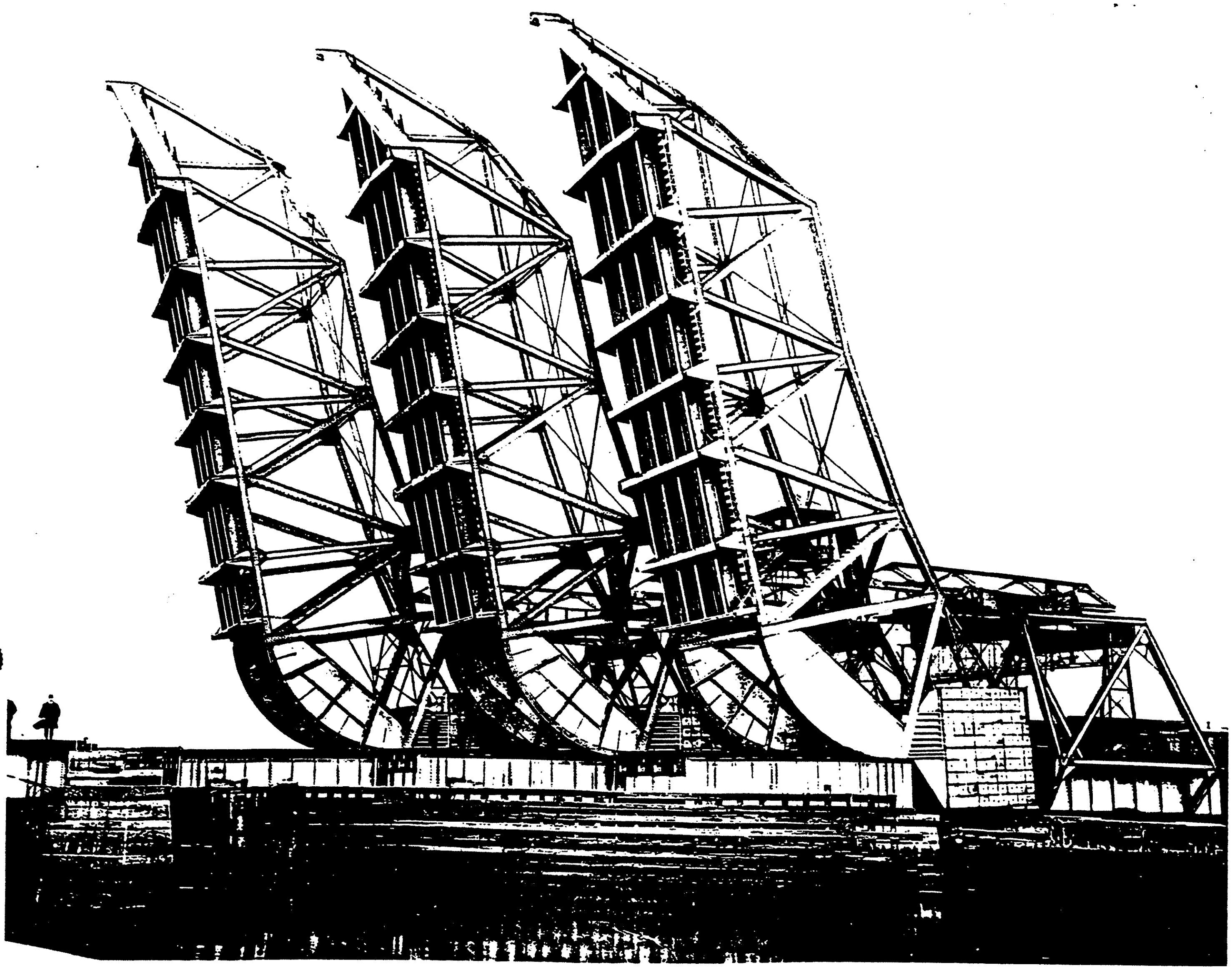
The South Terminal Station at Boston, Massachusetts was to be the largest terminal station in the world, and the problem of a proper bridge across Fort Point Channel to reach the station was of corresponding importance. All of the through and most of the suburban railroad traffic entering and leaving the station had to cross Fort Point Channel, and was to be concentrated at the crossing of the channel on six tracks. Owing to the close proximity of other movable bridges, the acute angle at which the bridge had to cross the channel, the impossibility of spreading the tracks, and the very slight elevation of the tracks above highwater, together with other complications, the engineers of the railroad company made an exhaustive study of movable bridges to meet these exceptional requirements, and concluded that the Scherzer Rolling Lift Bridge was the only known type of bridge that would fulfill every requirement of the situation. It was therefore decided by the management of the railroad company to build a six-track Scherzer Rolling Lift Bridge.

Albert Scherzer submitted a proposal which was accepted in 1897 and he obtained his first contract with the New York, New Haven & Hartford Railroad Company. He designed a 6-track Scherzer Rolling Lift bridge consisting of 3 adjacent Scherzer bridges each with 2 tracks over the Fort Point Channel at the South Terminal Station in Boston, Massachusetts. The bridges were on a 42° skew with the channel so the three bridges were offset longitudinally to each other. The clear channel width was only 42' but due to the skew, the span length was 114' center of center bearings. Each double track span is operated by means of a 50 horse-power electric motor, and the bridges are usually opened or closed in 30 seconds, including the time required for locking or unlocking. Each bridge was operated individually, using struts to roll the bridges open, but all three were controlled by one man. (See Picture). These bridges were completed in 1899, and it was the first time that 6 adjacent tracks could be carried across a navigational waterway at one location. (See Picture).

See Photogravure Plates.



General Plan of 6=Track Scherzer Rolling Lift Bridge, Boston, Mass.



Completed January, 1900.

The N. Y., N. H. & H. R. R. Co

F. S. Curtis, Chief Engineer.

W. H. Moore, Engineer of Bridges.

THE SIX TRACK SCHERZER ROLLING LIFT BRIDGE

across Fort Point Channel, Boston, Mass., at the South Terminal Station, for the New York, New Haven & Hartford Railroad Company.

THREE SPANS OPEN.

Designed by
THE SCHERZER
ROLLING LIFT BRIDGE CO.
Monadnock Block, Chicago.

Invented by
William Scherzer, C. E.

Patented.

The Eight Track Railroad Bridge

The Chicago Sanitary and Ship Canal was to form a connecting link in a navigable waterway between the Great Lakes and the Gulf of Mexico, capable of carrying the largest modern lake or ocean vessel or war ship in operation at that period in time. This made it necessary that the bridges over the canal should be movable and provide a large clear channel for navigation.

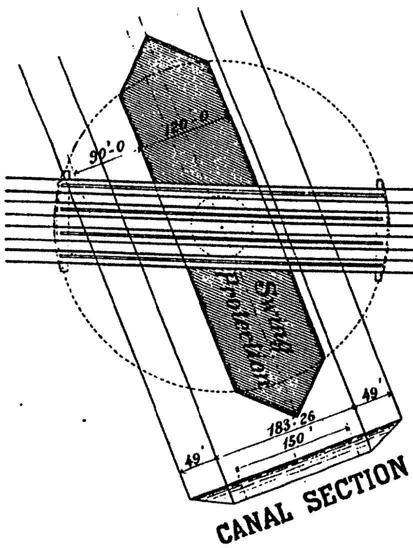
At Campbell Avenue, in the City of Chicago, near the junction between the Sanitary and Ship Canal and the Chicago River, eight railroad tracks, side by side, crossed the site of the proposed Canal. The Pittsburgh, Cincinnati, Chicago & St. Louis Railway Company owned four of the tracks. The Chicago Terminal Transfer Railroad Company had two tracks and the Chicago Junction Railroad Company had two tracks. An agreement was made between the railroad companies interested and the Board of Trustees of the Sanitary District of Chicago, under which the Sanitary District agreed to build and pay for a satisfactory movable bridge to be provided for the railroad companies, and also agreed to pay to the railroad companies a sum of money, which put at interest, would provide an income sufficient to perpetually maintain and operate this bridge. No eight-track movable bridge had ever been built.

In order to assist in determining the most satisfactory and economical bridge to be built, the Sanitary District of Chicago prepared complete plans for an eight-track swing bridge. The bridge was to be 399', $2^5/_8$" long, 116' wide with four main trusses 29' 6" apart, center to center, with extension of the floor beams carrying a single track outside of each outer truss. The turn table drum was to be 78' 7" in diameter. (See Picture).

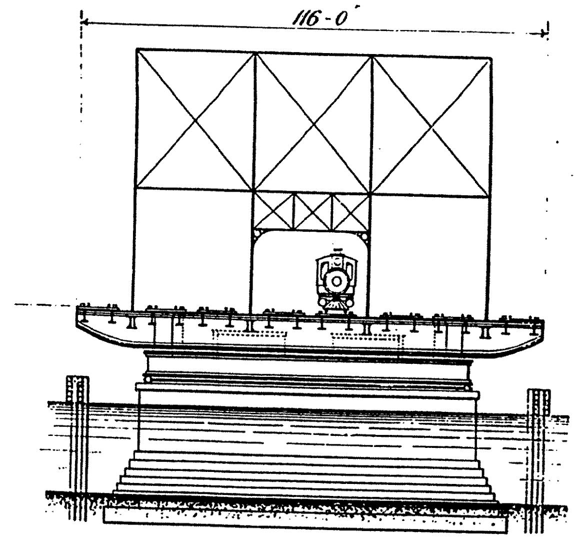
After bids for the construction of this bridge were received, the plans were submitted to the railroad companies for approval, but were rejected by them for the following and other reasons:

1. When all the tracks are placed on one structure, traffic would be completely blocked in the event of any disablement of the bridge or its machinery, as this would necessitate its being kept open until repairs were made, or in case of any obstruction in the channel which might prevent its being closed.

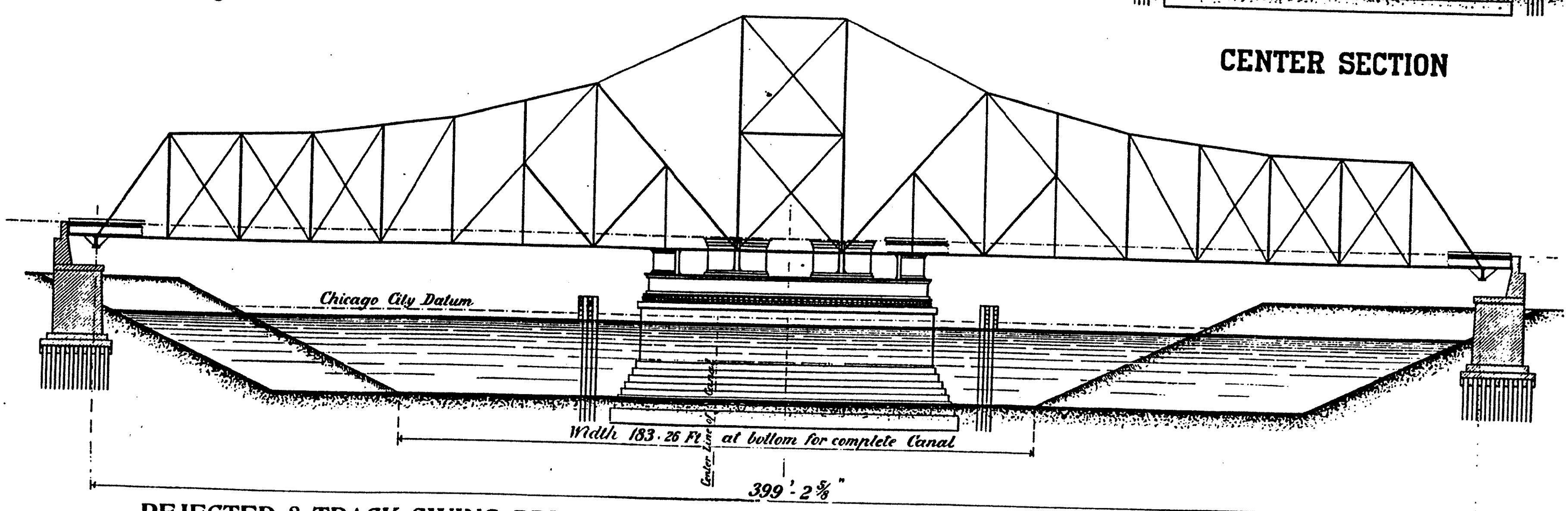
Diagrams Showing Some Disadvantages of the Swing Bridge Type.



PLAN OF
8 R.R. TRACK
SWING BRIDGE



CENTER SECTION



REJECTED 8 TRACK SWING BRIDGE, PROPOSED ACROSS SANITARY AND SHIP CANAL CHICAGO.

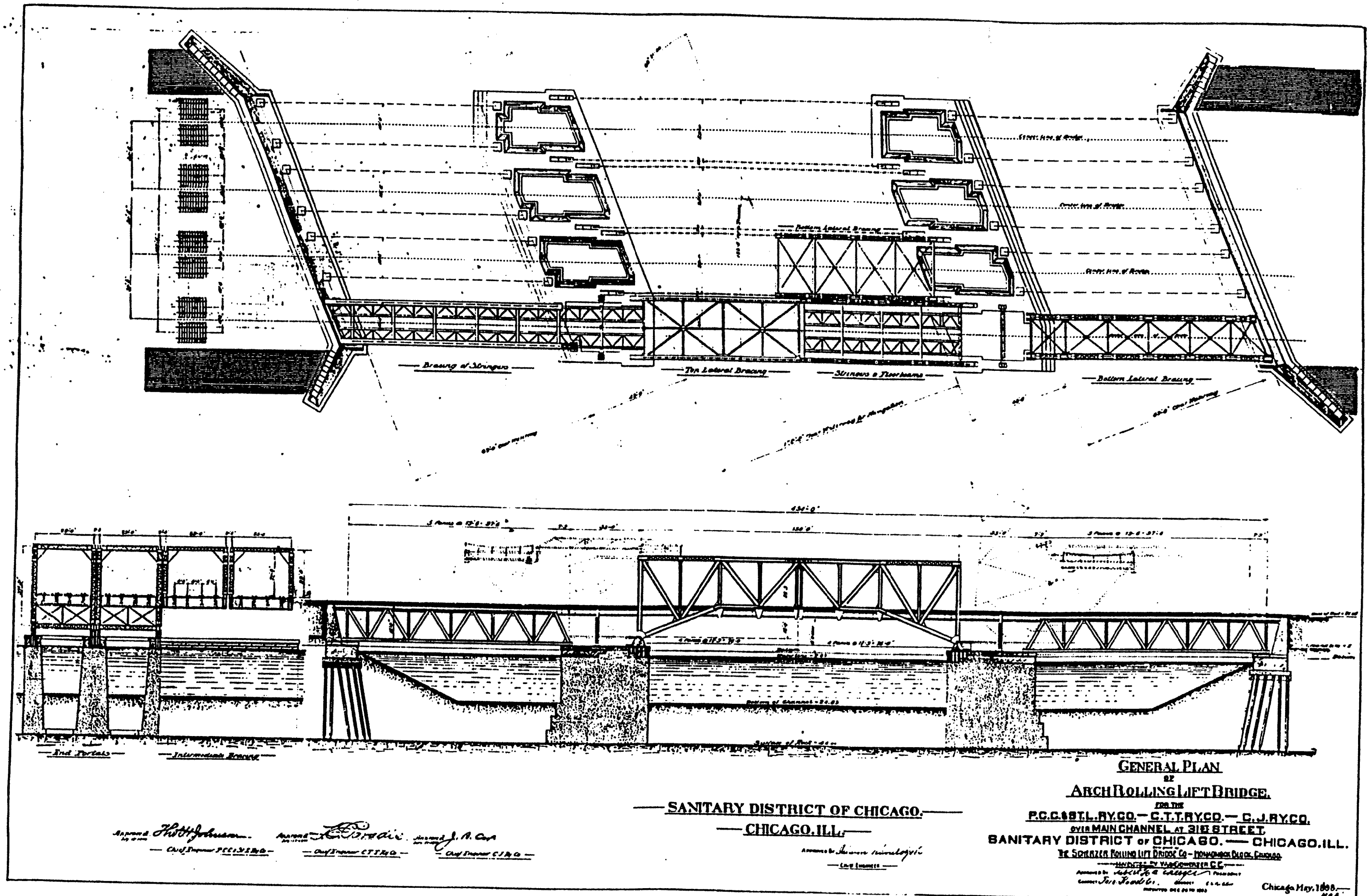
2. The wide center pier and protection pier would leave two comparatively narrow channels, through which vessels would have to pass slowly and carefully, thus increasing the delay to the railroad traffic.

New designs and bids thereon to meet the requirements were invited by the Sanitary District through extensive advertisements, and seven designs were submitted.

The design of the Scherzer Rolling Lift Bridge Company was selected for construction, and approved by the engineers of the Sanitary District and by the engineers of all the railroad companies interested. On April 8, 1898, the contract with the SD of C was a result of the first three studies for bridges to carry the 8 railroad tracks over the Sanitary and Ship Canal near Campbell Avenue in Chicago. The 120' clear channel was on a 68°22' skew which required a 150' span, center of center bearing.
The entire contract for the construction of the substructure and superstructure of this bridge was awarded to the Scherzer Rolling Lift Bridge Company. Under this contract the bridge was first built as a fixed structure. (See Picture). The contract price of the substructure, complete, was $166,575, and superstructure was $175,565, the total contract price being $342,140. A contract was also made with the Scherzer Company, to act as supervising engineers of the above work, and also of the future work of fabrication and erecting the additional parts, providing the operating machinery, electrical equipment, etc. required to complete the structure as a movable bridge.

As shown by the illustrations, this eight-track Scherzer Rolling Lift Bridge is rapidly nearing completion as a fixed bridge, and is already carrying some of the railroad tracks. The operating machinery and electric equipment was added in order to make the bridge movable before the Canal was opened for navigation.

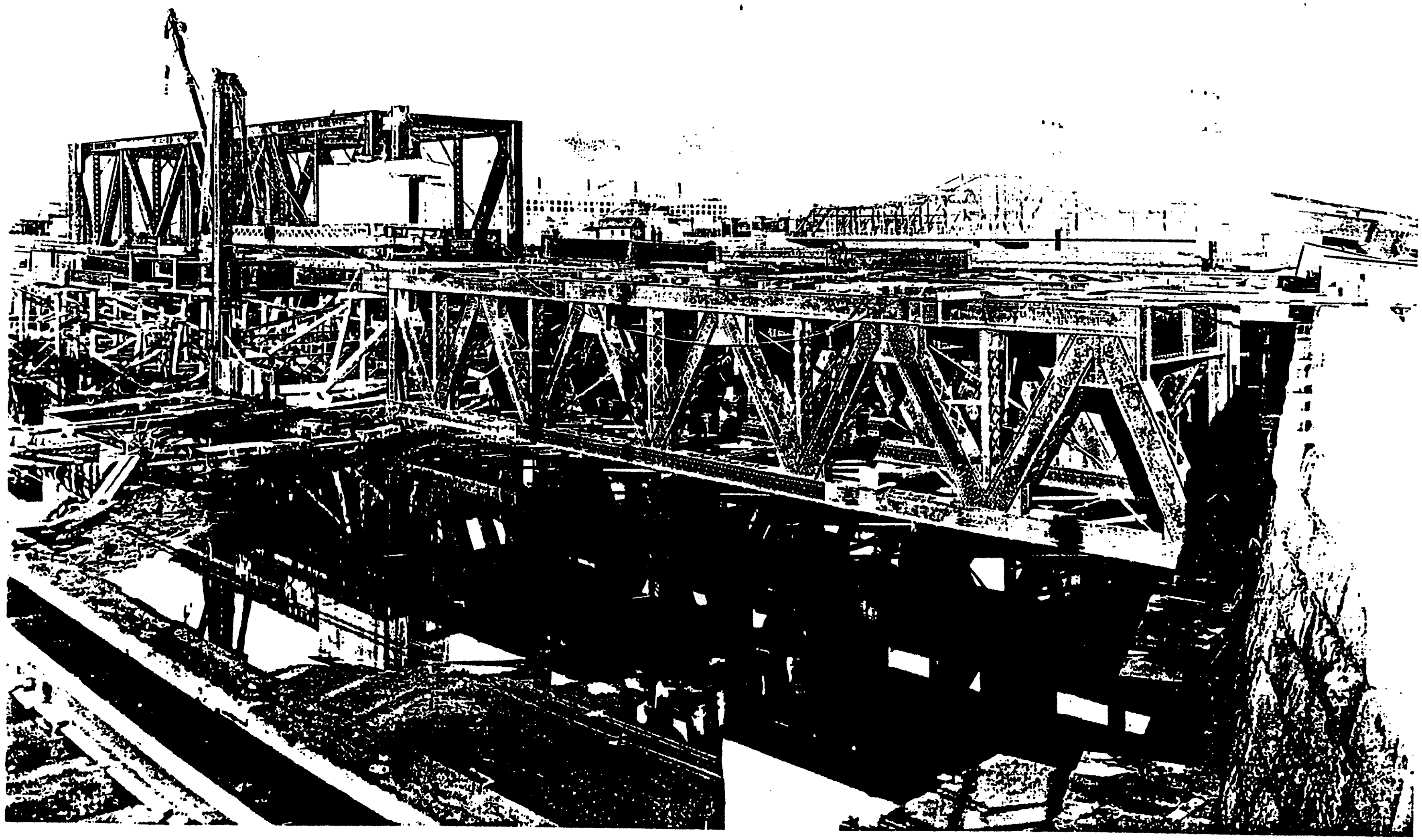
See Photogravure Plates.



THE OFFICIALLY APPROVED

General Plan of the 8-Track Scherzer Rolling Lift Bridge.

SHOWING THE STRUCTURE AS A FIXED BRIDGE.



Composed of Four Double-Track Railroad Bridges, to be operated by electric power as one bridge, or two bridges, or each bridge may be operated separately.

THE EIGHT TRACK SCHERZER ROLLING LIFT BRIDGE

across the Main Drainage and Ship Canal, Chicago, Illinois, for the Sanitary District of Chicago.

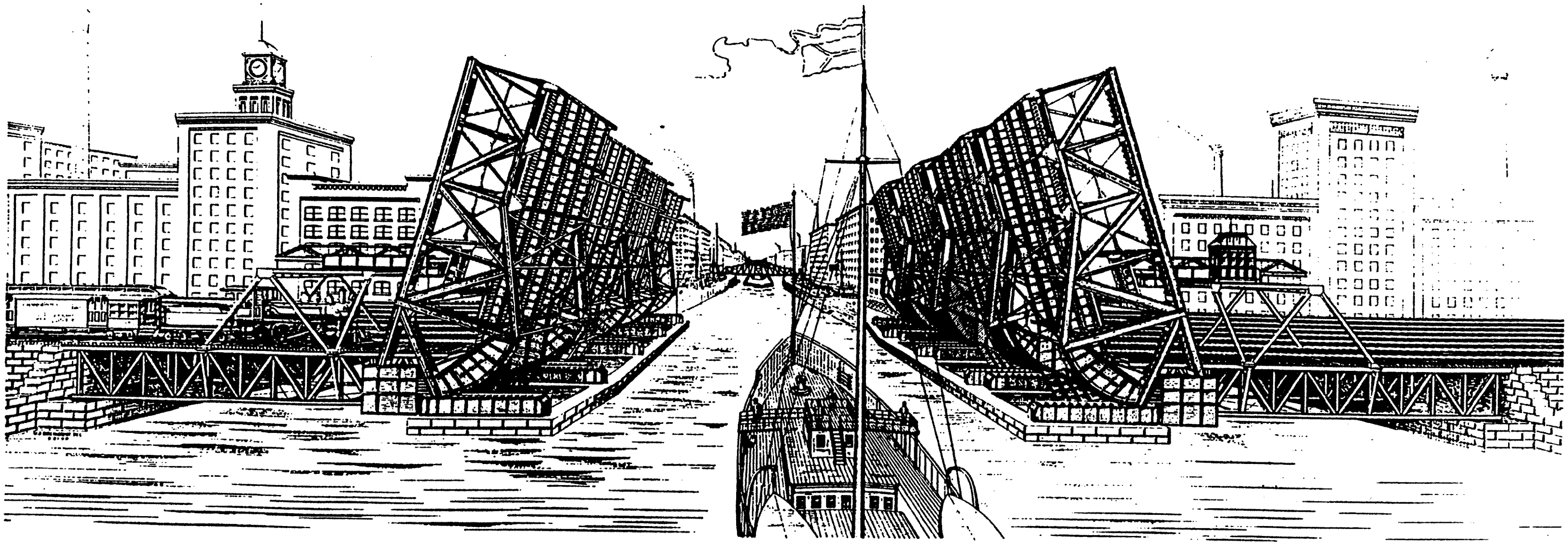
View shows progress of erection November 2, 1900.

One Double Track Span erected as a fixed bridge.

Designed by
THE SCHERZER
ROLLING LIFT BRIDGE CO.
Monadnock Block, Chicago.

Invented by
William Scherzer, C. E.

Patented.



THE EIGHT TRACK SCHERZER ROLLING LIFT BRIDGE

Across the Main Drainage and Ship Canal, Chicago, for the Sanitary District of Chicago,

For the use of

The Pittsburg, Cincinnati, Chicago & St. Louis Railway Co.,
The Chicago Terminal Transfer Railroad Co., and
The Chicago Junction Railway Co.

The Sanitary District of Chicago.
Isham Randolph, Chief Engineer.
W. M. Hughes, Engineer of Bridges.
The P. C. C. & St. L. Ry. Co.
Thos. H. Johnson, Chief Engineer.
The C. T. T. R. R. Co.
F. E. Paradis, Chief Engineer.
The C. J. Ry. Co.
J. B. Cox, Chief Engineer.
Ralph Modjeski, Consulting Engineer

Designed by
THE SCHERZER
ROLLING LIFT BRIDGE CO.
Monadnock Block, Chicago.

Invented by
William Scherzer, C. E.

Patented.

Chicago Terminal Tranfer Railroad Bridge, Chicago

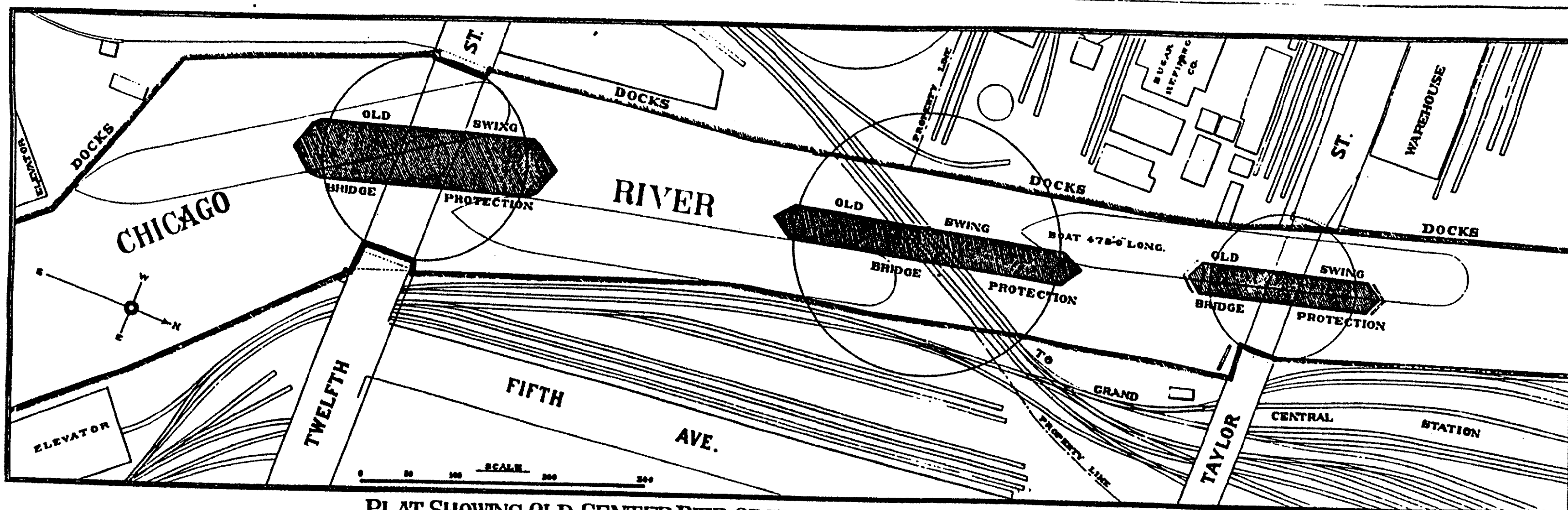
The first Scherzer Rolling Lift Bridge Company's design to be completed in Chicago was for the SD of C to carry four tracks of the Chicago Terminal Transfer Company northeast across the south branch of the Chicago River into the Grand Central Station. They were twin bridges each carrying two tracks which replaced a double-track swing bridge. The design for two double-track bridges, side by side, was operated either jointly or singley, as desired. Owing to the slight elevation of the base of rail above water, about 10', the bridge was designed as a through truss cantilever. It crossed the channel at the very acute angle of 36° 30', which necessitated a span of 275', center to center of bearings, in order to give a clear channel for navigation of 120', the minimum required by the United States War Department for the Chicago River. This was the longest double leaf bascule bridge in the world at the time it was built in 1901. The specifications of the Scherzer Rolling Lift Bridge Company were used and Cooper's Specifications for Railroad Bridges, 1896 Edition, controlled the design as far as applicable. The loading was 10,000 lbs. per lineal foot of bridge, with a concentrated load of 50,000 lbs. at any point of each track. The bridge was operated by electricity, and although provision was made for an operator on each side of the river, the machinery and electrical equipment was arranged that the bridge could be operated by one man from the operator's house on one side of the channel. The substructure was composed of Portland cement concrete and Bedford stone, and rests upon piles driven to rock and cut off 5' below the bottom of the channel.

The Official reports of the Sanitary District of Chicago, under date of August 6, 1898, contains the following statement by the Honorable Frank Wenter, past president of the Sanitary District of Chicago:

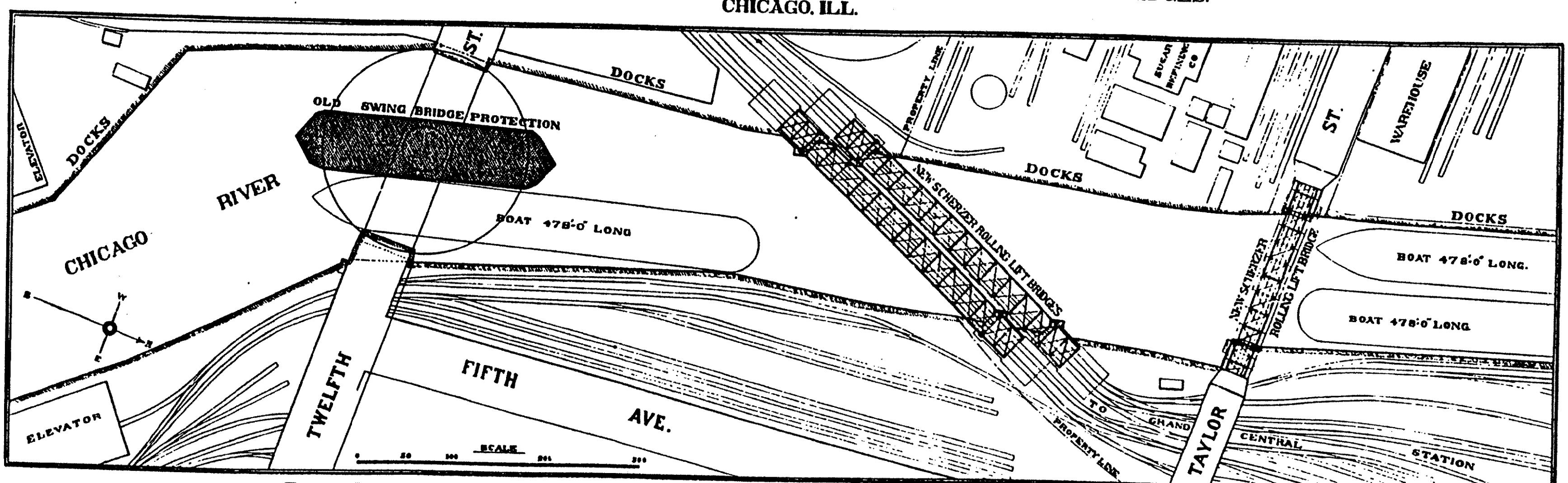
> The Scherzer type is the bridge of perfection; it is recognized by the engineering profession as the most perfect bascule bridge in existence; it is a monument to the inventor.

On November 23, 1898, the Sanitary District of Chicago signed another contract to design a replacement for the swing bridge at Taylor Street which was just north of the CTTRB railroad bridge. (See Picture).

Comparative Plats Showing Navigation Obstructed by Swing Bridges and Obstructions Removed by Using Scherzer Rolling Lift Bridges.

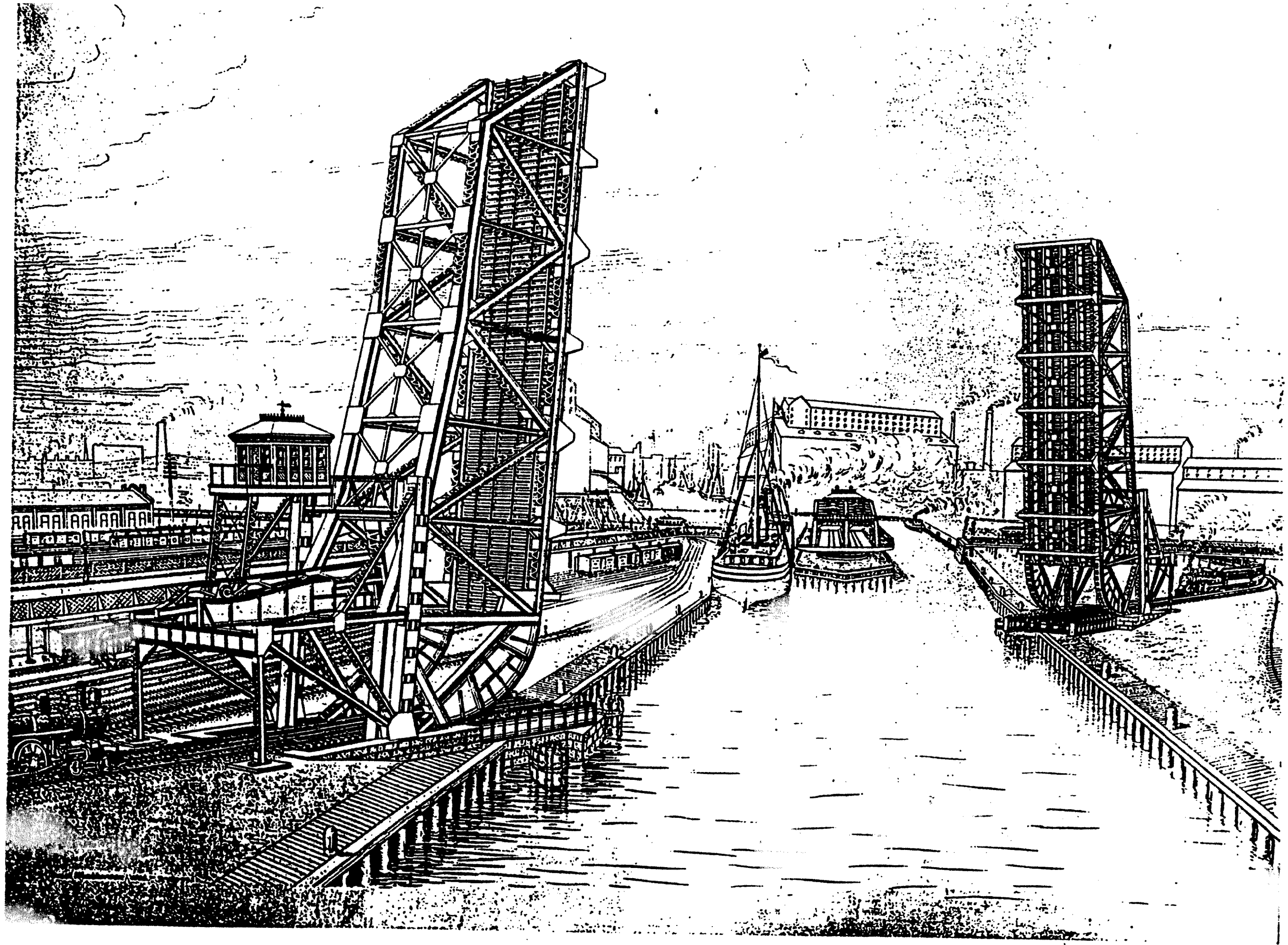


PLAT SHOWING OLD CENTER PIER OBSTRUCTIONS AT TAYLOR ST. & R.R. BRIDGES.
CHICAGO, ILL.



PLAT SHOWING PIER OBSTRUCTIONS REMOVED BY NEW SCHERZER ROLLING LIFT BRIDGES.
CHICAGO, ILL.

SCHERZER ROLLING LIFT BRIDGE CO.



The Sanitary District of Chicago.
Isham Randolph, Chief Engineer.
W. M. Hughes, Engineer of Bridges.

The Chicago Terminal Transfer Railroad Co.
F. E. Paradis, Chief Engineer.
Ralph Modjeski, Consulting Engineer for the C. T. T. R. R. Co.

THE 275-FOOT SPAN DOUBLE TRACK SCHERZER ROLLING LIFT BRIDGE

FORMING ONE-HALF OF THE FOUR TRACK SCHERZER ROLLING LIFT BRIDGE

Across the South Branch of the Chicago River at Grand Central Station, Chicago, Illinois.

Designed to add second Double Track Bridge and operate as one Four Track Bridge.

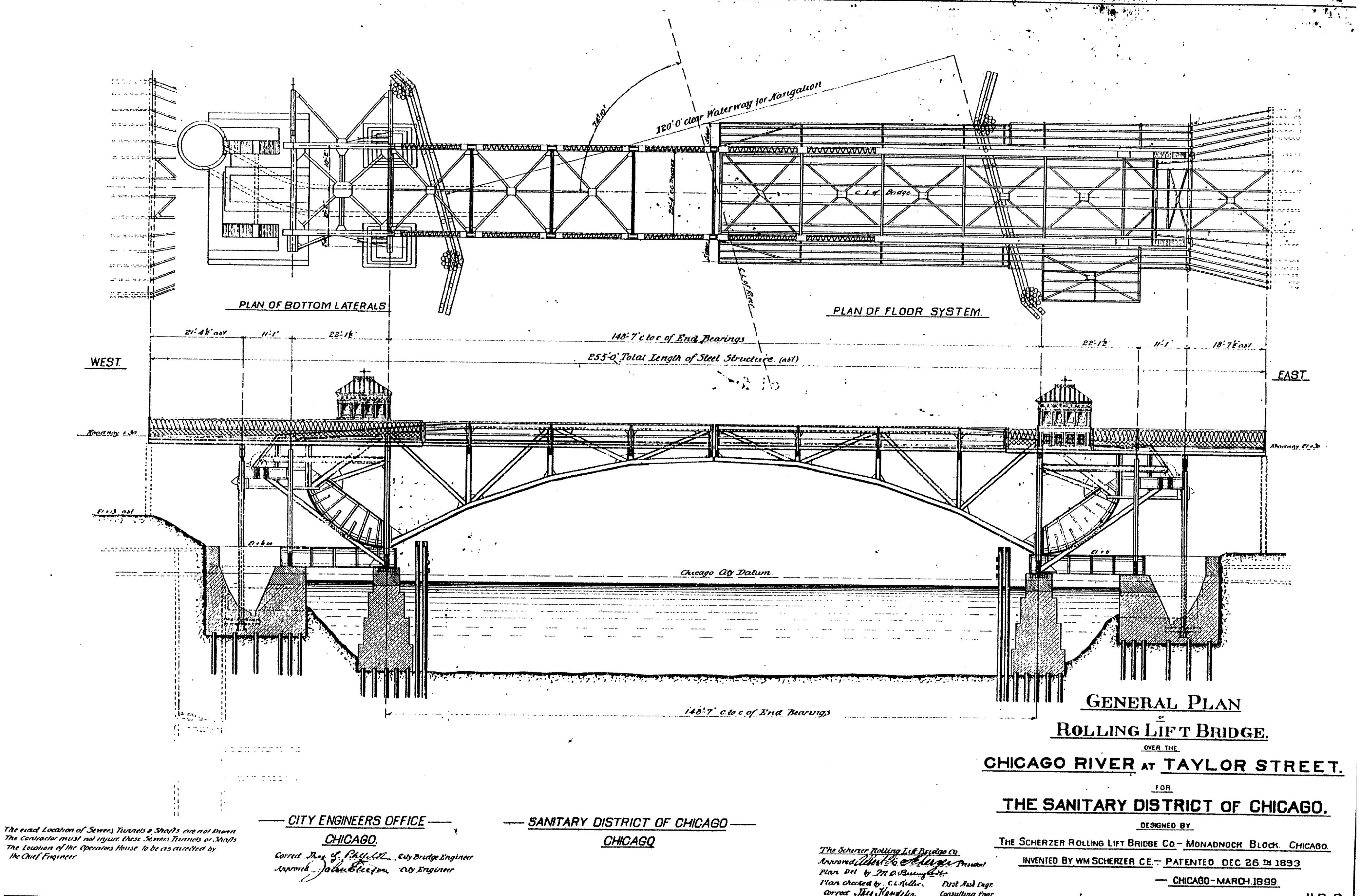
Also shows Channel obstructed by 12th Street Swing Bridge.

Designed by
THE SCHERZER ROLLING LIFT BRIDGE CO.
Monadnock Block, Chicago.

Invented by
William Scherzer, C. E.

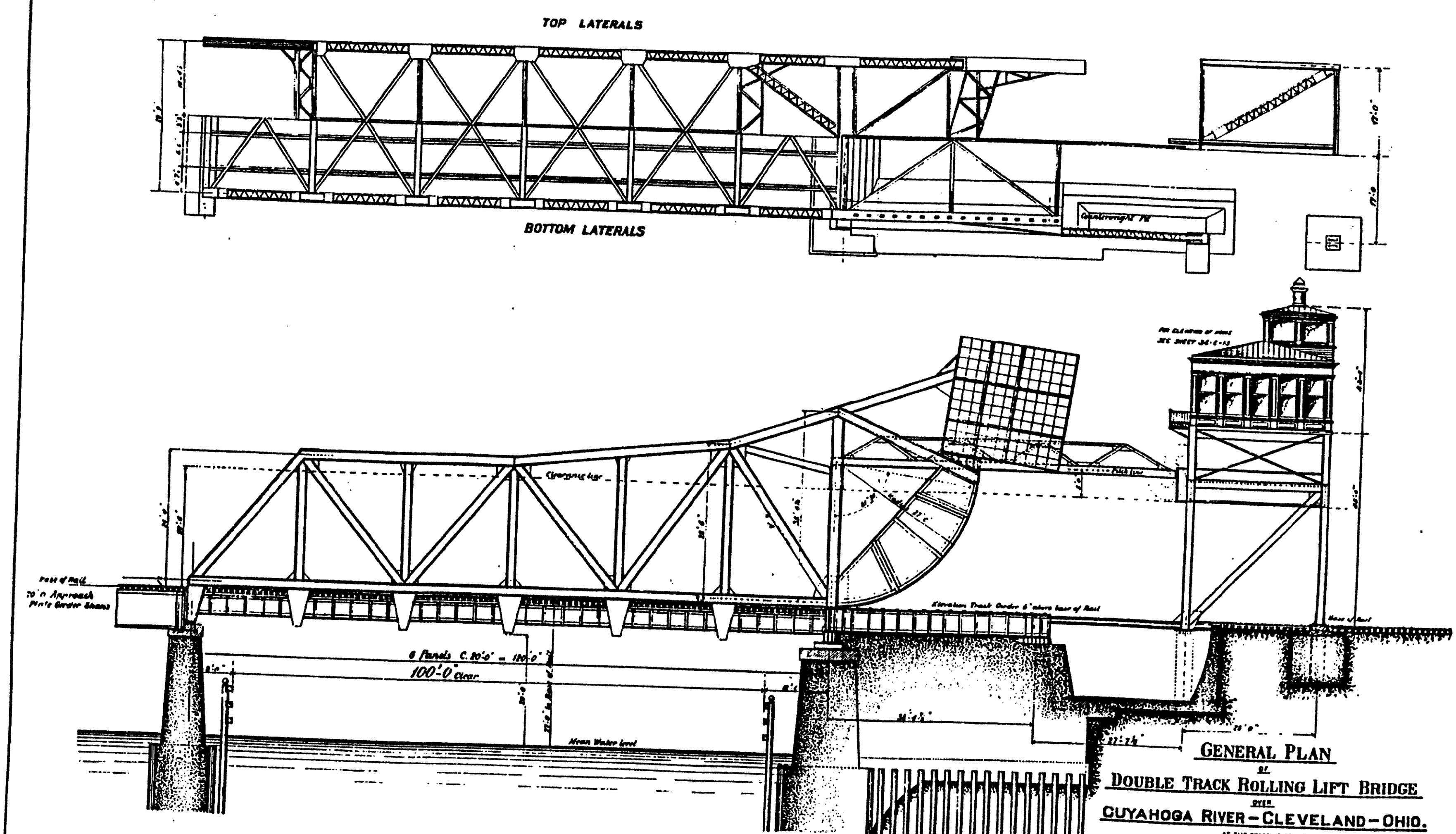
Patented.

See Photogravure Plates.



Railroad Bridge at Cleveland, Ohio and Others

The single-track Scherzer Rolling Lift Bridge across the Cuyahoga River, Cleveland, Ohio, for the Cleveland, Cincinnati, Chicago & St. Louis Railway Company, was completed in the year 1900 and replaced a swing bridge. It is composed of a single movable leaf, 125 feet in length, center to center of bearings, and provides a clear channel for navigation of 110 feet between pier protections. It is operated by the engines of the old swing bridge, but the machinery is also arranged so that the electric power may readily be substituted in the future. This bridge proved so satisfactory that the railroad company decided to remove their double-track swing bridge, carrying their main lines across the Cuyahoga River at Cleveland, and replace the same with a double-track Scherzer Rolling Lift Bridge. The authorities of the City of Cleveland were so favorably impressed by the merits of the completed bridge that they also decided to build a double-leaf Scherzer Rolling Lift Highway Bridge at Middle Seneca street, to replace a swing bridge. Construction was completed in 1900. (See Picture).



GENERAL PLAN
OF
DOUBLE TRACK ROLLING LIFT BRIDGE
OVER
CUYAHOGA RIVER – CLEVELAND – OHIO.
AT THE CROSSING OF THE
C.C.C.&ST.L.RY.
DESIGNED BY
THE SCHERZER ROLLING LIFT BRIDGE CO.
MONADNOCK BLOCK – CHICAGO
INVENTED BY WM. SCHERZER C.E. — PATENTED DEC. 26th 1893
CHICAGO SEPT 28th 1900

THE CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS R'Y. CO.
APPROVED Geo. W. Kittredge
CHIEF ENGINEER.

The Scherzer Rolling Lift Bridge Co.
APPROVED BY Albert H. Scherzer PRESIDENT
PLAN MADE BY S.T. [illegible]
PLAN CHECKED BY [illegible] FIRST ASST. ENG.
CORRECT Theo Thandelin CONSULTING ENG.

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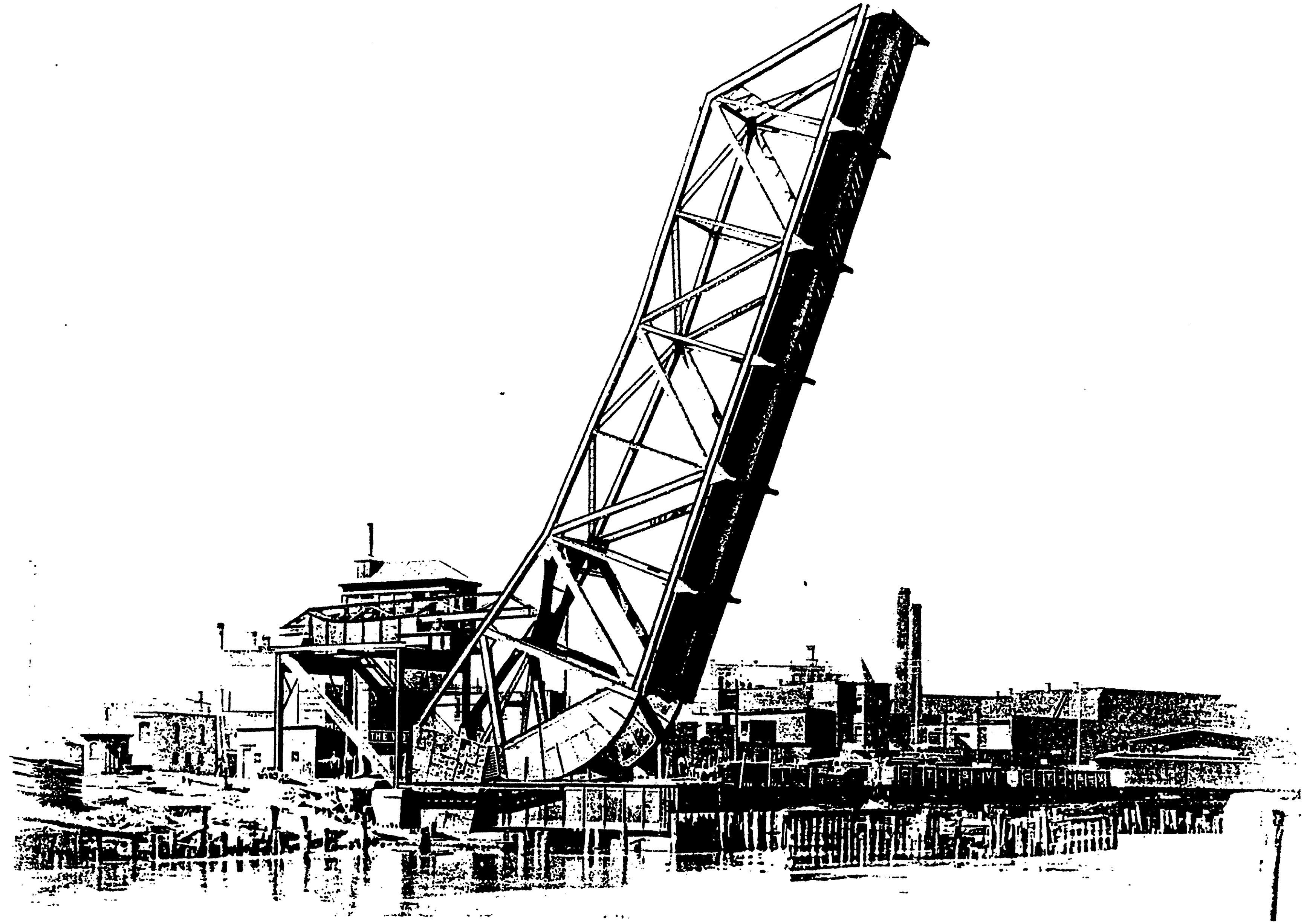


Completed August, 1900.

The C., C., C. & St. L. Ry. Co.

George W. Kittredge,
Chief Engineer.

SINGLE TRACK SCHERZER ROLLING LIFT BRIDGE

across the Cuyahoga River, Cleveland, Ohio, for the Cleveland, Cincinnati, Chicago & St. Louis Railway Company.

OPEN.

Designed by
THE SCHERZER
ROLLING LIFT BRIDGE CO.
Monadnock Block, Chicago.

Invented by
William Scherzer, C. E.

Patente

The following is a quoted from Albert H. Scherzer's January, 1901 Publication in Chicago, and titled "Scherzer Rolling Lift Bridges".

The Scherzer Rolling Lift Bridge fulfills every requirement essential to a movable bridge. Its introduction marked a new era in the progress of movable bridges. It eliminates the objectionable features of the pivot hinged or trunnion bascule bridge, the swing bridge and the direct lifting bridge. It spans navigable waters in the most simple, efficient and least expensive manner. It has been in extensive use for a number of years and has never trapped or killed a single victim, nor as yet has any vessel succeeded in damaging the bridge. In the collisions which have occurred, the vessels alone were damaged. The bridge is especially adapted to avoid collisions, because of its great rapidity in opening and moving out of all danger. The efficiency of the Scherzer Rolling Lift Bridge in accommodating both the largest land and water traffic and its superiority over former types of movable bridges has been demonstrated beyond question by the many large bridges of the Scherzer type now in successful operation in Chicago, Cleveland and Boston, and the further fact that it has been adopted, approved and used by the management and engineers of the largest and most progressive railroads in the United States, for the largest and most difficult movable railroad bridges ever built, and the further fact that the Scherzer bridge has been adopted and the Scherzer Company has completed plans for a number of large railroad and highway bridges now in the course of construction in various cities of the United States. The other types of movable bridges heretofore used are rapidly being replaced by the Scherzer Rolling Lift Bridge.

There have have been hundreds of Scherzer Rolling Lift Bascule bridges built since the Company was founded in July 1, 1897 to the present date. Many improvements were made and patents obtained by Albert Scherzer before his death in 1916. Mr. Charles Keller who was part of the orignal staff, was made President by Mrs. Scherzer who inherited the company from her husband. In 1922, she decided to have new leadership in the company and hired a University of Illinois professor named Craig Hazelet. In 1936, He along with another staff member, Mr. Ingolf Erdal purchased the company from Mrs. Albert Scherzer and formed the partnership of Hazelet + Erdal. On June 1, 1995, the firm became Hazelet & Erdal, A Dames & Moore Company. The rolling lift bridge is the best choice in most applications to meet all vehicular traffic and navigation requirements for the least initial cost and the most economical operating and maintenance cost.

H&E has been at the forefront of State of the Art design of movable bridges with the following innovative and cost saving features:

1. Introduction of new welding details.
2. Hydraulic cylinder operation.
3. Low Speed-High Torque Hydraulic Motor operation.
4, Automatic operation using Programmable Logic Controllers (PLC).
5. Data Acquistion System (DAS) with self diagnostic features.

So many other developments have been made during Scherzer Rolling Lift Bascule Bridge Company's forty years and Hazelet & Erdal's past sixty years that it would require more space to cover than is available in this presentation. **The thoughts to carry with you are, H&E will provide you with the best service on any type of movable bridge and unsurpassed service on any Rolling Lift Bridge.** Typical Features of Scherzer Rolling Lift Bascule Bridges are explained on the following pages.

END OF HISTORICAL DEVELOPMENT

An unfortunate misconception is that the Scherzer Rolling Lift Bascule Bridge is an old design that is no longer being used for new bridges. Eight new rolling lift bridges have been constructed during the past ten years that were designed by Hazelet & Erdal and a ninth will be constructed shortly. In addition a number of rolling lift bridges designed by other firms have been constructed. A list of these bridges is shown in Table 1 below.

Table 1

Rolling Lift Bridges Designed or Built during Past Ten Years
Bridges Designed by Hazelet & Erdal
10th Street over the Manitowoc River, Manitowoc WI
Indianapolis Boulevard over the Indiana Harbor Canal, East Chicago IN
US-10 over the St. Croix River, Prescott WI
Dickey Road over the Indiana Harbor Canal, East Chicago IN
Military Street over the Black River, Port Huron MI
Tayco Street over the US Canal, Menasha WI
CSX Bridge No. 11 over the East Pascagoula River, Pascagoula MS
8th Street over the Manitowoc River, Manitowoc WI
Canal Street over the Indiana Harbor Canal, East Chicago IN (est'd construction 1997)
Bridges Designed by others
Santa Fe Rwy Bridge over the ICWW, Galveston Bay TX
Veterans Memorial Bridge over the Saginaw River, Bay City MI
Main Street over the Root River, Racine WI
State Street over the Root River, Racine, WI
Main Street over the Fox River, Green Bay WI
Walnut Street over the Fox River, Green Bay, WI

TYPICAL FEATURES

A typical bridge can be either a single-leaf or a double-leaf structure with the leaves interlocked at mid-span. In either case, each leaf is composed of a channel arm and a counterweight arm. The channel arm cantilevers out over the navigation channel from its supporting pier (or abutment). The counterweight arm extends behind the supporting pier and supports a counterweight. The counterweight is generally constructed of steel or concrete or a combination of the two. Most bridges are either deck-girder or deck-truss structures or they are through-girder or through-truss structures. Generally, through-structures have overhead counterweights and deck-structures have counterweights located below the deck. (See Figure 4).

Segmental Treads and Tracks The defining characteristic of the Scherzer Rolling Lift bridge is the fundamental method of operation. Where the channel arm and counterweight arm join, the leaf contains segments of large wheels; each segment is affixed to one of the main girders or trusses. On any one leaf, the centers of rotation of these wheel segments are collinear, even for a skewed bridge. The collinear axis of the wheel segments is referred to as the "center of roll". It is also the location of the center of gravity of the leaf (in a vertical plane). Unlike the wheels on wagons which rotate on fixed axles or the wheels on railroad cars which are attached to axles which rotate in fixed bearings, the wheel segments on a Scherzer Rolling Lift Bridge do not rotate with respect to the leaf. Instead, the leaf and wheel segments roll together in a fashion similar to a rocking chair. In this manner, the leaf rolls open or rolls closed. The radii of these wheel segments can vary from approximately 3 feet for a small deck girder highway bridge to approximately 30 feet for a large through truss railway bridge. The actual bearing surface of the wheel segments are referred to as the "segmental treads" and may be fabricated from steel plates or steel castings. The segmental treads are attached to built-up sections called "segmental girders".

Each wheel segment rolls on a track, and all tracks are in a common horizontal plane. Typically, the tracks are supported directly by the substructure or they are supported by track girders. Track girders may be supported by two piers or supported by an adjacent span. When a leaf is in its "closed" position, the wheel segments rest upon the track ends nearest the navigation channel. When a leaf is in its "open" position, the wheel segments rest upon the track ends furthermost from the navigation channel. The distance between these two points is defined as the "length of roll". The angle between the deck in the closed position and the deck in the open position is referred to as the "angle of roll" or "angle of opening" and is equal to

$$\frac{\text{(length of roll)} * 360}{2 * \pi * \text{(radius of wheel segments)}} \quad \text{(in degrees).}$$

Generally, the angle of roll is between 70 and 80 degrees, although occasionally it may be outside of this range.

Jaw and Diaphragm For double leaf bridges, a unique feature of the Scherzer Rolling Lift Bridge is the absence of a mechanical centerlock. All double leaf bascule bridges require centerlocks to ensure that both leaves deflect equally when live loads travel across the leaves. Except in rare incidences, these centerlocks transfer only vertical shear forces between the two leaves; no longitudinal forces nor bending moments are transferred. All of the various trunnion style bascule bridges have mechanically operated centerlocks. In trunnion style bascule bridges, after both leaves have been rotated to their "closed" positions a locking device is driven between the two leaves where they meet at mid-channel.

A Scherzer Rolling Lift Bridge typically has a "Scherzer Shear Lock" for the center lock between leaves and is composed of a "Jaw" and "Diaphragm". Each main girder or truss on the leaf nearest to the operator has a Jaw detail, and each main girder or truss on the opposite leaf has a Diaphragm detail. This unique detail is possible due to the manner in which the Scherzer Rolling Lift Bridge moves. When the two leaves are closing, they are rotating downward, and they translating toward each other. As they reach the "nearly closed", position, the "Jaw" and "Diaphragm" begin to mate. As they reach the "fully closed" position, they become fully engaged. Once the Jaw and Diaphragm are fully engaged, the two leaves must deflect in unison. The Diaphragm easily slides within the Jaw to accommodate changes in the length of the leaves due to temperature changes. In addition to transferring vertical shear forces, the Jaw and Diaphragm detail is designed to align the two leaves laterally.

Concrete Supports For bascule leaves that are supported by enclosed piers there is a basic difference between the support system for a trunnion bascule compared to a rolling lift bascule.

Each main girder (or truss) of a trunnion style bascule leaf is supported by a large diameter trunnion, or shaft. This trunnion is located at the center of rotation of the leaf. The trunnion is, in turn, supported by a pair of large trunnion bearings. On many trunnion style bascule bridges the inside trunnion bearings (and sometimes the outside trunnion bearings as well) are supported on steel towers. These towers are usually supported by the floor of the counterweight pit. Since the pits are often wet, or at times may be flooded, it is common to find the trunnion towers in a deteriorated condition.

For a rolling lift bascule leaf, each track is supported directly on a widened portion of the concrete walls of the pier at an elevation well above the floor of the counterweight pit. This support method eliminates the need for a steel tower. The steel track is normally imbedded in the substructure concrete. Thus, the only maintenance that is generally required for the track is to occasionally sweep debris from its top surface.

CONTINUING DESIGN IMPROVEMENTS

Tracks & Segmental Treads The first rolling lift bridges were fabricated as riveted built-up sections. The tracks consisted of one or more rolled steel plates bolted to the top flanges of track girders. The segmental treads consisted of one or more rolled steel plates that were curved to a proper radius and bolted to the segmental girders. In order to maintain alignment when the bridge rolled open or closed, several pintles were mounted along the centerline of the tracks; matching holes were bored in the segmental tread plates. Initially, the track and segmental tread plates were relatively thin, approximately 1 inch. After several years of service, a number of bridges that had undergone numerous openings began to display a problem. Cracks began to appear in the segmental tread plates. These cracks were usually located near the holes for the pintles. Thicker plates and larger radii helped to preclude these cracks.

A significant improvement to the design of the tracks and segmental treads was to change from rolled steel plates to steel castings. Initially, the steel castings were cast in the shape of thick plates or slabs. The longitudinal edges had a reduced thickness so that when they were bolted to their respective girders, the bolt heads would not protrude above the rolling surface. The steel castings were significantly thicker than the plates had been and were better able to withstand and distribute the tremendous bearing loads to which they were subjected. Although these flat steel castings were a significant improvement over the rolled steel plates, they still did not eliminate all problems.

These cast steel tracks and segmental treads were redesigned to have an "I" or a double stem tee "Π" shape with very thick flanges and webs. The material strength was also increased (a typical casting now has a tensile strength of 90,000 psi and a yield strength of 60,000 psi).

On a typical highway bridge, these castings are usually mounted on single web girder sections. Therefore, the castings are in an **I** shape. Instead of round pintles and holes, rectangular lugs are used. The track casting has lugs, or teeth, along both edges that extend above the top surface. The segmental castings have notches along their edges into which the lugs mate as the segmental castings roll open or closed. (See Figure 1)

On a typical railway bridge, the castings are usually mounted on box girder sections. Therefore, the castings are in a **Π** shape. On these castings, pintles and holes are normally found along the centerlines of the sections. (See Figure 2)

Jaw and Diaphragm The Jaw and Diaphragm detail has undergone few changes over the years. The Jaw detail now has wear plates located on the upper and lower portions of the Jaw. The wear plates are bolted to the main material with shim packs placed behind the wear plates. Over the years, as wear occurs on the wear plates and the Diaphragm castings. The wear plates can be unbolted and additional shims inserted to compensate for the wear that has occurred. These shim packs can also be used to aid in the final alignment of the two leaves during the original construction of the bridge.

If the two leaves are being opened at the same rate of angular rotation, the tip of the Jaw tries to rotates upward faster than the Diaphragm casting which bears against it. This happens since the tip of the Jaw is slightly farther from its Center of Roll than the Diaphragm casting is from its Center of Roll. In the past this condition has been accommodated by letting the Jaw leaf push the Diaphragm leaf upward. When Programmable Logic Controllers (PLCs) were incorporated into bridges, the PLCs were programmed to rotate the Diaphragm leaf slightly faster than the Jaw leaf. (See Figure 3)

On recent bridges we have reshaped the wear plates so that their wear surfaces have contours to accommodate the travel path of the Diaphragm casting. This simplifies the programming of the PLC.

Operating Machinery The earliest rolling lift bridges were opened and closed by "operating struts" which were connected to each main truss at the Center of Roll location. These operating struts extended back toward the operating machinery which was located on the approach structures. The operating struts contained racks which engaged the main drive pinions of the operating machinery. As the main drive pinions rotated, the operating struts were either pulled or pushed to open or close the bridge, respectively.

Although the operating strut system functioned well, it had a drawback. The movement of the operating strut required a significant space behind the moving leaf. To overcome this drawback, the operating system was completely revised. The operating machinery was moved from its stationary location behind the moving leaf to a machinery room that was located directly on the moving leaf. The machinery room was located between the main bascule trusses or girders. Because of this location, the machinery room and all machinery rotated with the bascule leaf. Through a series of open gears, the machinery rotated a main pinion shaft that extended through the main trusses, or girders. The main pinion shafts were located at the Center of Roll. A main drive pinion was located on the outside end of each of these shafts. Each main pinion engaged a stationary rack that was located directly below the pinion and was supported by a rack frame. These rack frames were supported directly by the piers or they were a part of adjacent approach spans. As the main pinions turned, they travelled along the stationary racks, thus pulling the leaf open or closed.

This rack and pinion concept was improved when the stationary rack was inverted and moved to a location above the pinion. This orientation eliminated the tendency for ice and debris to collect in the rack teeth, which had been a cause of trouble on some bridges.

Later variations included replacing some or all of the open gearing with speed reducers. Some installations included a single speed reducer with two main motors attached to the two ends of the high-speed shaft. The two ends of the low-speed shaft were either connected directly to the main pinion shafts or connected to two sets of open gearing which drove the main pinions. Other installations included a set of three speed reducers. The two main motors were attached to the high-speed shaft of the primary speed reducer. The low-speed shaft of the primary speed reducer was coupled to the high-speed shafts of the two secondary speed reducers. The low-speed shafts of the secondary speed reducers were coupled directly to the main pinion shafts.

Beginning in the 1950s, some bridges utilized hydraulic cylinders instead of rotating machinery. On these bridges, two hydraulic cylinders were mounted outboard of the bascule girders. The cylinders were located well behind the Center of Roll and supported directly on the piers. The free end of the piston rod was connected to a bearing that was attached to the bascule girder at the Center of Roll. The piston rod was fully extended when the bascule leaf was in its fully closed position.

In the 1980s rolling lift bridges were being built which used low-speed high-torque (LSHT) hydraulic motors. These motors eliminated the need for multi-stage open gearing or speed reducers, although it is common to use one or two stages of open gearing. An advantage of these motors is that there is no drop-off in torque when they are operating at very low speeds. An advantage of using hydraulic systems is that the system can be designed to provide very positive control of the leaf. Hydraulic systems utilize check valves and/or blocking valves which can prevent the leaf from moving.

A variation in the use of a LSHT hydraulic motor system is the recently designed (by Parsons Brinckerhoff) Main Street Bridge in Green Bay, Wisconsin. This bridge will utilize LSHT hydraulic motors coupled to planetary gear sets which will be mounted directly on the main pinion shafts.

Machinery Brakes For many years these bridges, as with many other types, used thruster-released drum brakes mounted on the operating machinery. These brakes have a rotating drum and fixed shoes. Normally, the shoes are held tightly against the drum by heavy springs. This prevents the drum, and therefore the machinery, from rotating. An electric solenoid, or thruster, is attached to the shoes through a linkage mechanism. To release the brake, the solenoid is energized which spreads the shoes apart and allows the drum to rotate. A more recent variation of this style uses a self-contained hydraulic thruster instead of an electric solenoid. An electric motor, hydraulic pump and hydraulic cylinder are all contained within a single unit.

On bridges with low-speed high-torque hydraulic motors, another type of brake is typically found, hydraulically released disc brakes. Unlike drum brakes, hydraulically released disc brakes have no external moving parts. The housing is attached to a rigid support. The internal disc(s) is mounted on a shaft that is coupled to the rotating machinery. The brake pads are held against the disk by heavy springs. A release mechanism is operated by hydraulics that is connected to an outside source.

A hybrid of the above systems has been used on larger bridges. A large rotating disc is mounted to the operating machinery. A pair of thruster-released brakes are located 180° apart and straddle the disc. Each thruster-released brake has a pair of brake pads, one against each face of the disc. The brake pads are held tight against the disc by heavy springs. A self-contained hydraulically operated thruster is attached to the linkage system that hold the brake pads.

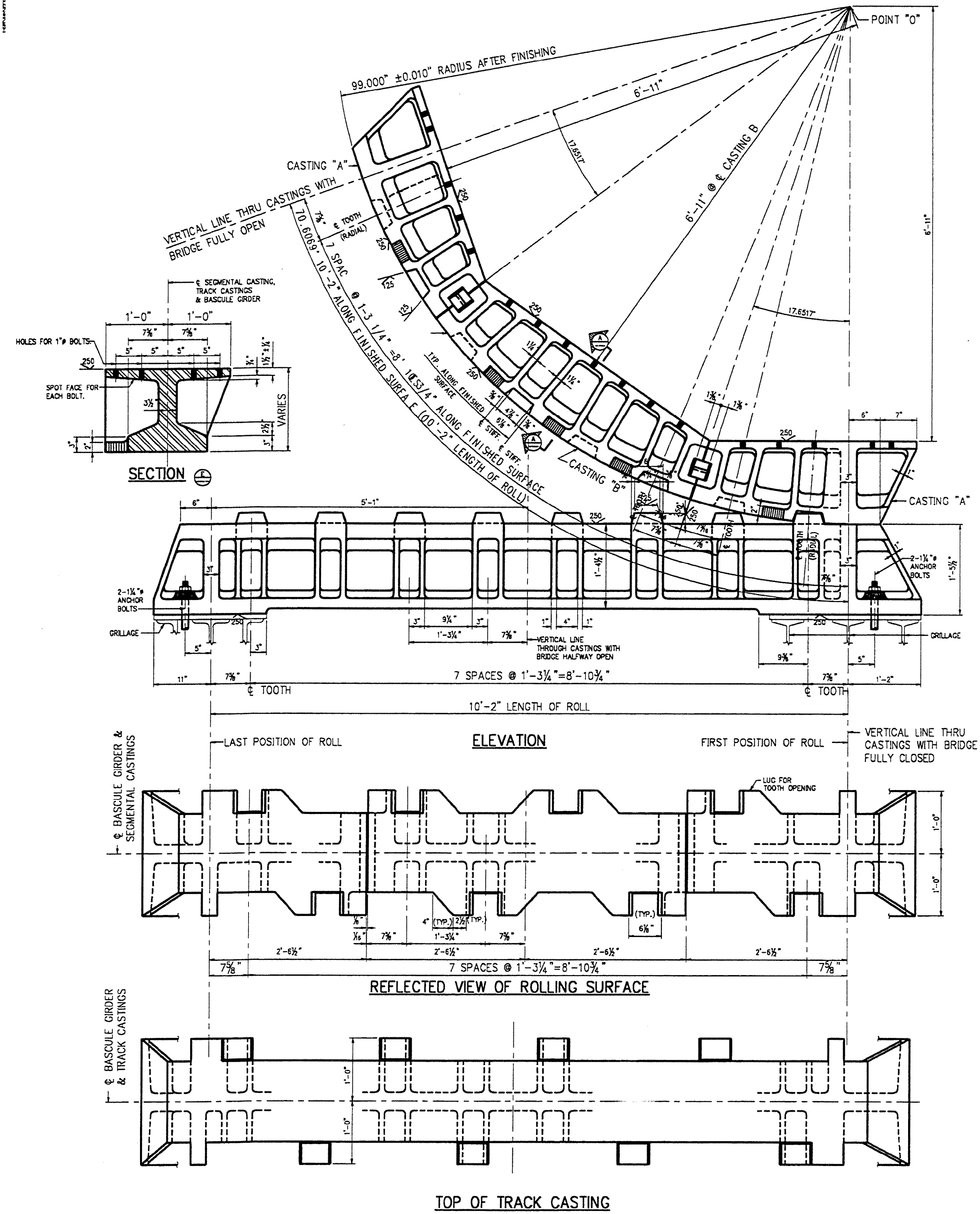


FIGURE 1 TYPICAL SEGMENTAL & TRACK CASTINGS FOR HIGHWAY ROLLING LIFT BRIDGE

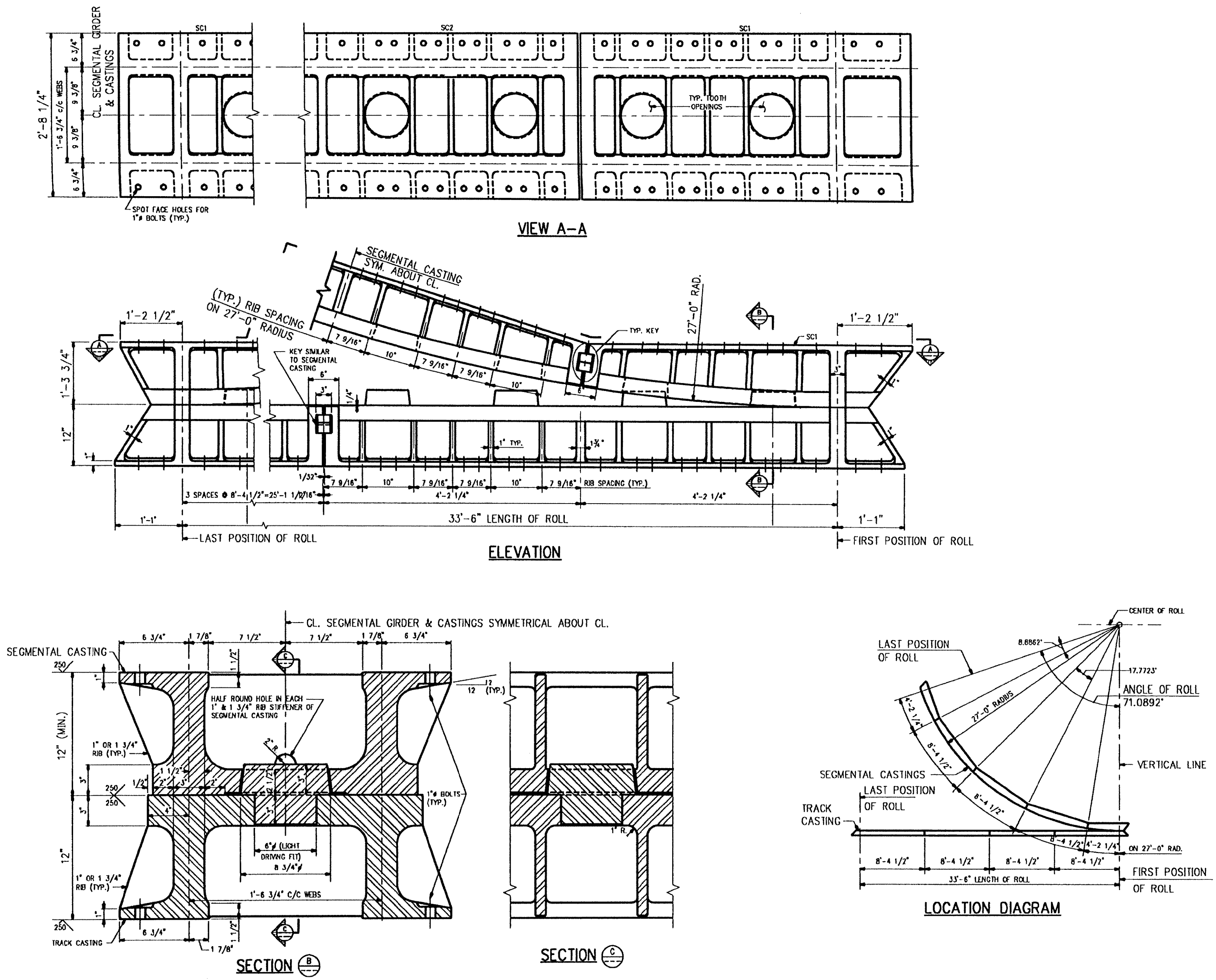


FIGURE 2 TYPICAL SEGMENTAL AND TRACK CASTING FOR RAILWAY ROLLING LIFT BRIDGE

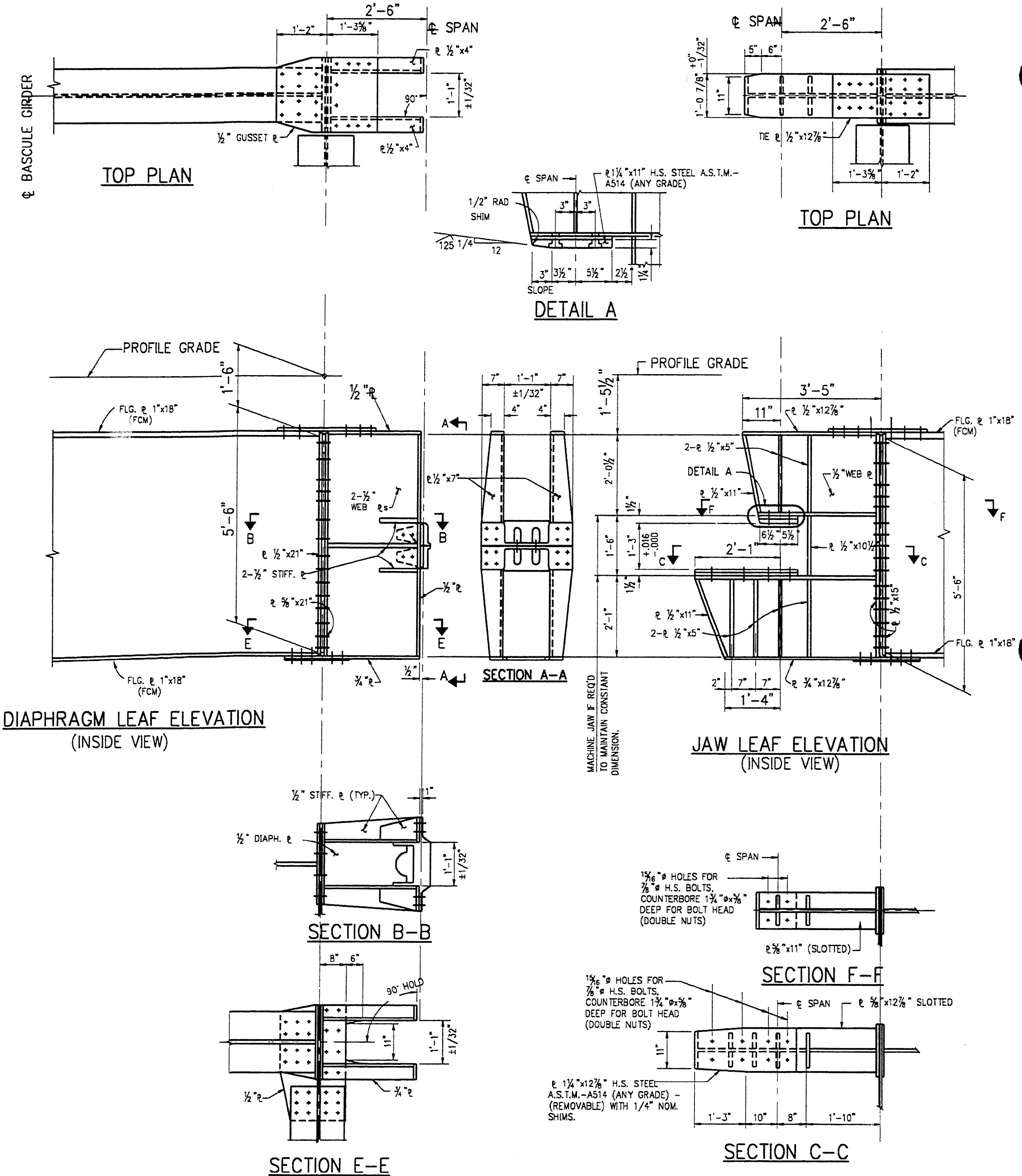
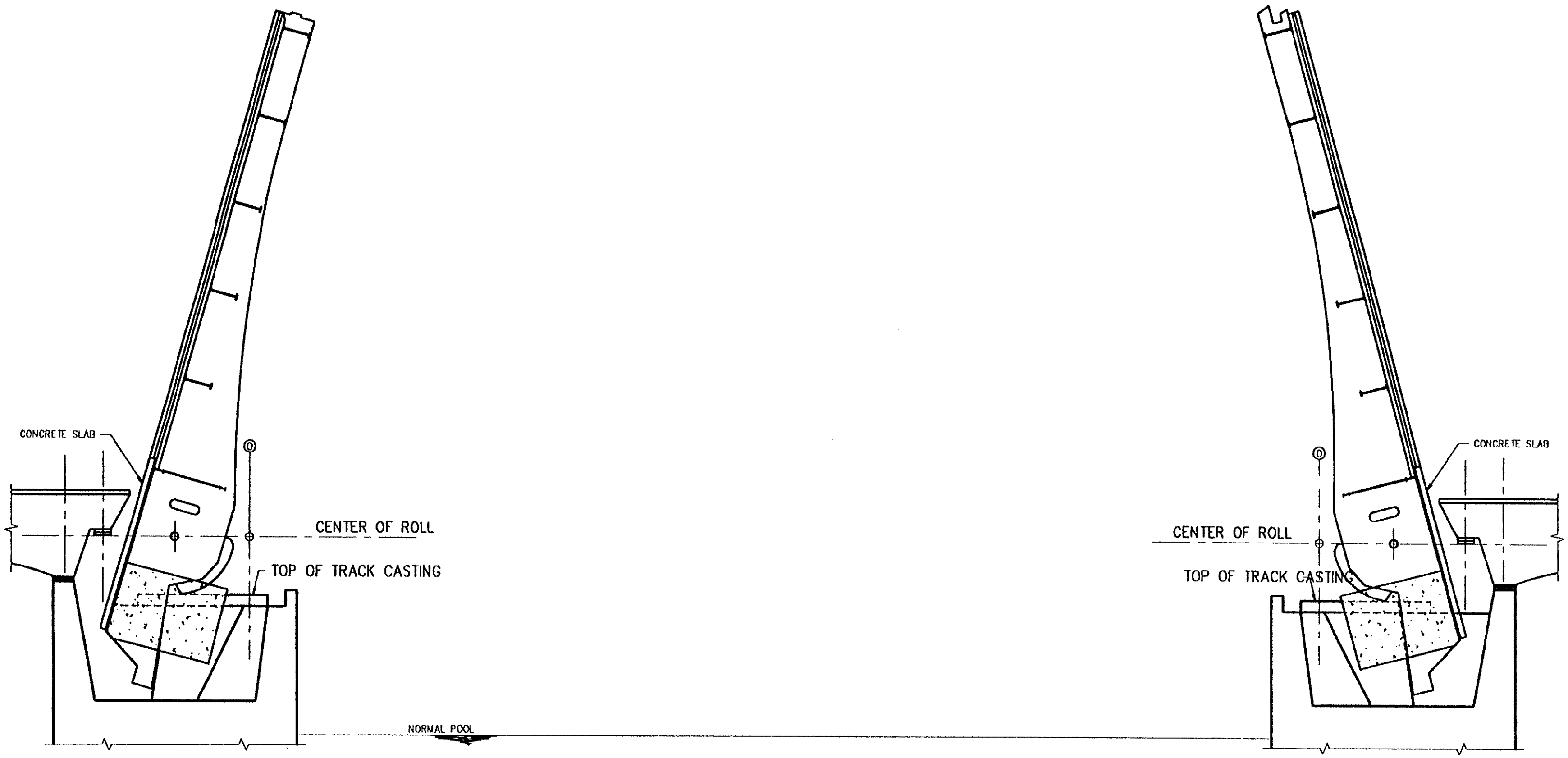
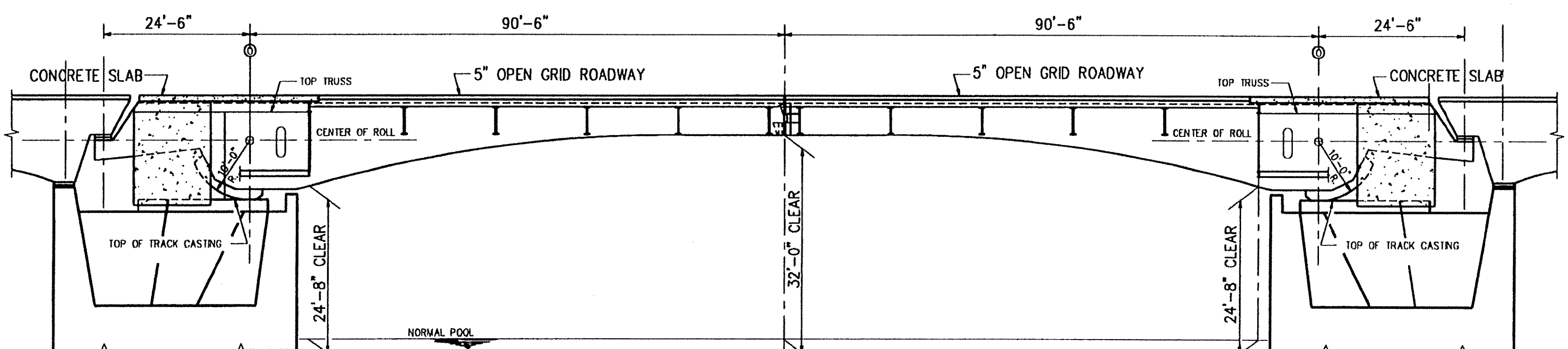


FIGURE 3 JAW AND DIAPHRAGM DETAILS



ELEVATION - BRIDGE OPEN



ELEVATION - BRIDGE CLOSED

FIGURE 4 TYPICAL HIGHWAY ROLLING LIFT BRIDGE

John A. Schultz, Jr.

Other Presentations and Publications

November, 1994 - Clearwater Beach, Florida - The Fifth International Biennial Symposium sponsored by Heavy Movable Structures, Inc. (HMS). Presentation delivered was entitled *Remember the Past to Inspire the Future - Historic Development of Movable Bridges.*
As Chairman of the Awards Committee, he presented 5 Certificates in Memoriam to Affiliated Companies of the individual recipients.

November, 1992 - Fort Lauderdale, Florida - The Fourth International Biennial Symposium and Exposition sponsored by HMS, held in Florida. A presentation entitled *PLCs Provide Complete Automatic Control of Movable Bridges* was given.

November, 1990 - St. Petersburg, Florida - The Third International Biennial Symposium sponsored by HMS. Presentations entitled: *The Self Destruction of a Strauss Trunnion Bridge*, and *Replace Electro-Mechanical Torque Control Drives with LSHT Hydraulic Speed Control System - Using Programmable Logic Controllers (PLC) and Providing Data Acquisition Systems (DAS).*

October, 1989 - Founded the "Movable Bridge Innovator's Hall of Fame" in Chicago, Illinois which is now sponsored by HMS/MB.

March, 1989 - Madison, Wisconsin - University of Wisconsin, College of Engineering, Department of Engineering Professional Development. Course on Effective Bridge Rehabilitation. Presented session on Movable Bridge Rehabilitation.

October, 1988 - Atlanta, Georgia - International Road and Bridge Maintenance/Rehabilitation Conference and Exposition. Presentations entitled: *Replace Electrical Torque Control Drive System With An Automatic Hydraulic Speed Control System* and *What Goes Up Does Not Always Come Down (Emergency Repairs of Amtrak's Vertical Lift Span over the South Branch of the Chicago River).*

November, 1987 - St. Petersburg, Florida - The Second International Biennial Symposium sponsored by HMS. Presentations entitled: *Low Speed-High Torque Fluid Drive On Movable Bridges* and *Data Acquisition System for Movable Bridges.*

November, 1985 - Tallahassee, Florida - The First International Biennial Symposium sponsored by HMS. Presentation entitled *The Development Of The Hydraulic Systems Designed From 1965 To The State-Of-The-Art Hydraulic Systems of Today.*

March, 1984 - River Grove, Illinois - Bridge Maintenance and Repair Seminar at Triton College. Presentation entitled *Maintenance and Repair of Movable Bridge Machinery.*