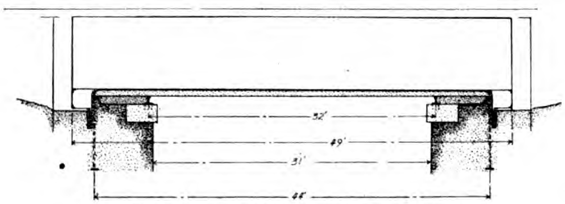
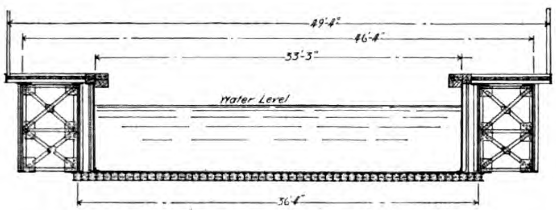
bedded in the masonry. The construction thus does away with the necessity for a center support and enables the use of the thinnest possible floor, which constitutes a saving of considerable importance in view of the scant amount of head room. The comparative room given in the old tunnel and in the new



ELEVATION OF TANK, TOLEDO AQUEDUCT.

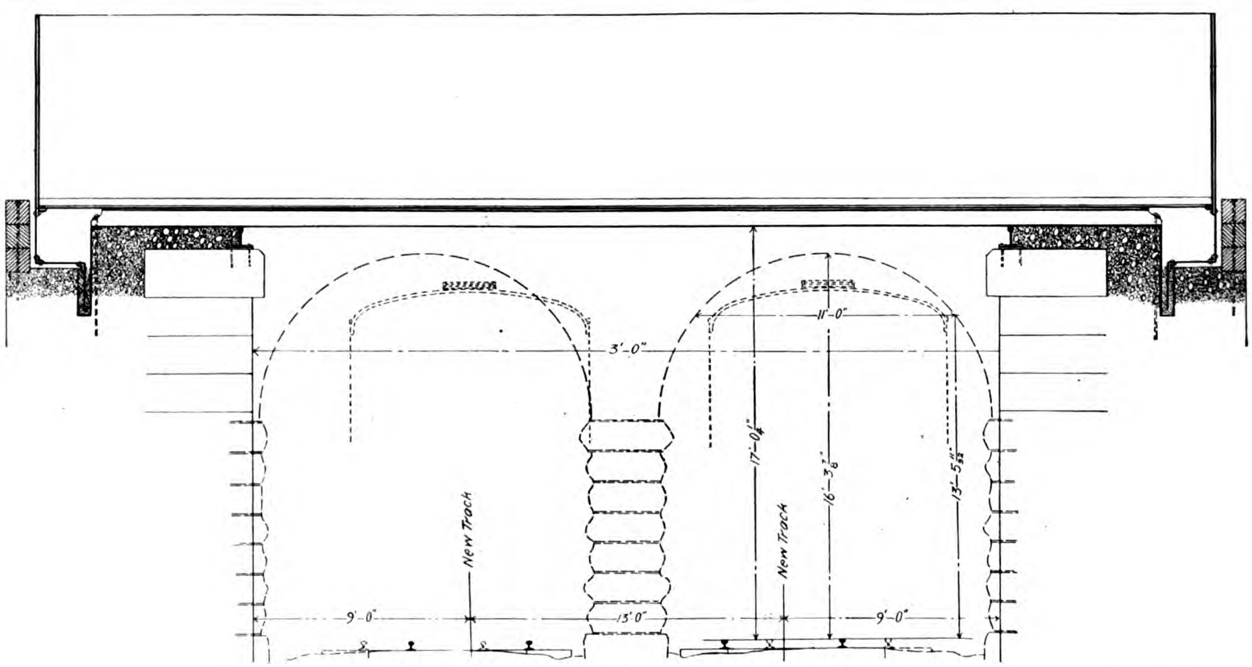
subway is shown in one of the line engravings herewith. The old masonry was of limestone and not especially well built. It has shown signs for many years of being badly shattered by frosts and some years ago was backed up with concrete, which latter was found to be now about all that did not have to be



SECTION OF TANK, TOLEDO AQUEDUCT.

removed. The removal of the old masonry has given the extra width required for the increased size of rolling stock previously referred to.

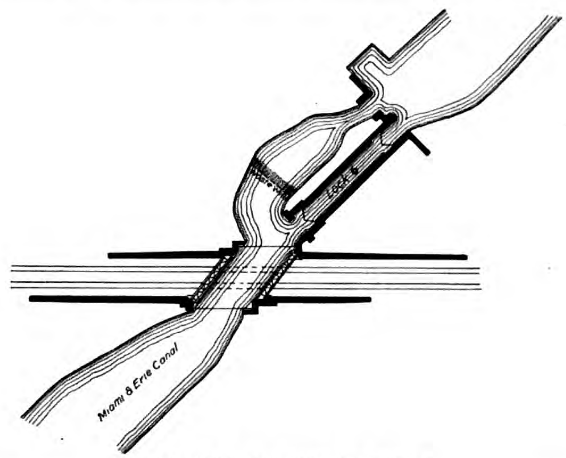
The detail of the steel structure was worked up by A. Lucius of New York, and the material is being furnished by the Toledo Bridge Company. We are indebted to Mr. Samuel Rockwell, principal assistant engineer of the Lake Shore & Michigan Southern, for the data given herein and for blue prints from which the accompanying engravings have been made.



COMPARATIVE SECTIONS OF TUNNEL AND SUBWAY, TOLEDO AQUEDUCT.

THE UTILITY OF THE BASCULE BRIDGE.

Movable bridges are becoming of greater importance each year to railroad companies because of increased railroad traffic, increased number and speed of trains, and the ever increasing number of tracks required and also because of the increased number and size of vessels to be accommodated. It is imperative that delays or obstructions from this source should be reduced to a minimum. The horizontal draw or swing bridge was evolved and came into extensive use because the more primitive form of movable bridge—the hinged pivot or trunnion bascule bridge, which was the more scientific in principle—



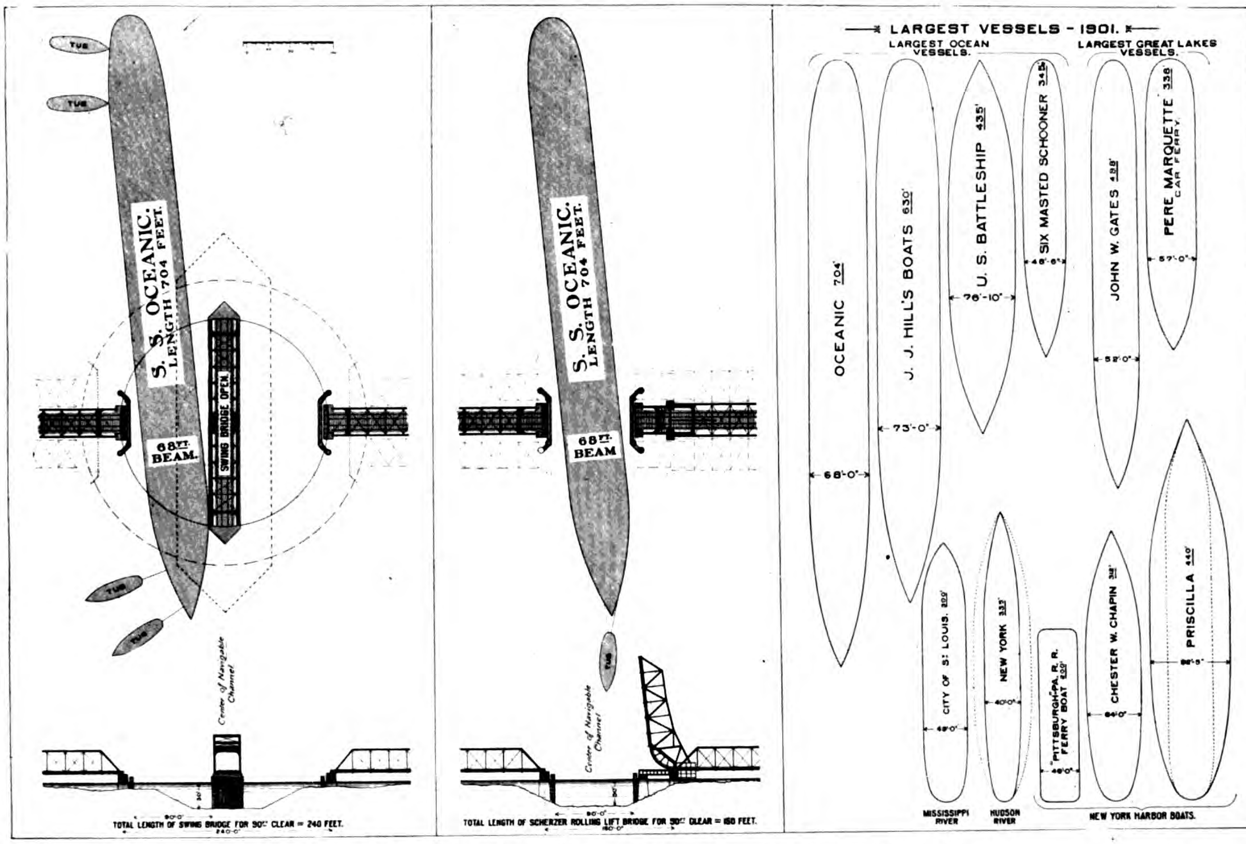
NEW CANAL AQUEDUCT AT TOLEDO.

greatly increased in difficulty and cost of construction with each increase in the length of span required to accommodate the increasing width and length of vessels. The swing bridge type differed fundamentally from the bascule bridge in that the main supporting pier occupied the center or the best part of the navigable channel, and divided the waterway into two passages, instead of providing one adequate passage in the center of the channel. Where only one channel for navigation is required, the swing bridge must be made of double length and the channel is divided into two parts by the center pier and swing protection which occupy the center and most efficient part of the navigable waterway.

The swing bridge in moving swings outside of the roadway over land, water and docks, instead of moving entirely within the roadway, as is the case with the bascule bridge. These were not serious objections to the swing bridge in the early days of railroad construction and development, because vessels were comparatively small and infrequent. The delay to the railroad traffic was of no consequence, as the traffic was light, trains were few in number and single tracks were sufficient. As vessels increased in size and number, the old swing bridges were discarded and new ones built with longer spans, without departing from the original forms of the swing bridge type. This type of bridge became so common that it was regarded as the only feasible type of movable bridge for railroad and highway traffic across navigable waterways. Its many limitations and anomalous character in the science of engineering were not fully recognized until the increased railroad and water traffic in the United States produced conditions which the swing bridge type was wholly inadequate to meet and which conditions led to the invention and use of the Scherzer rolling lift or bascule bridge type. With this type of bridge the engineer is not compelled to lengthen the movable span and bridge the total length of the movable bridge required. It shows the center of the channel unobstructed, giving a wide angle of movement for the passing vessel, enabling it to pass the bridge rapidly and causing the least possible delay and obstruction to railroad traffic. It also shows that any number of additional railroad tracks can be carried across the channel without discarding or removing the existing bridge, the approaches or the piers, and also without disturbing or delaying the existing railroad traffic. The additional spans can be erected on the piers in an upright position, rapidly and without interference with navigation.

The diagram also illustrates the extreme safety of the bridge in the open position against wind pressure, the bulk of the weight being in the counterweight and segments near or below the tracks. It is, therefore, safer than any high modern office building.

The swing bridge served its early purpose well, but it is no longer adequate, efficient or economical, or the best movable bridge to meet the expanding tendencies of modern railroad



COMPARISON OF WIDTH OF OPENING REQUIRED WITH BASCULE AND SWING BRIDGES.

two channels where only one is required; he is not compelled to obstruct the center and best part of the navigable channel by a centerpier and by a long and wide protection pier, the construction and especially maintenance of which are expensive. The diagram presented herewith shows a swing bridge open and a large vessel passing through the draw, and forcibly illustrates the obstructive character of the swing bridge protection and the delay which is caused to railroad traffic by the slow passage of vessels on account of the swing protection. It also shows that any increase of railroad traffic requiring an increase in the number of tracks across the channel compels the discarding and removal of the existing swing bridge also the approach spans and piers. Additional tracks always compel the construction of a new, longer and wider swing bridge, with a larger and more obstructive center swing protection. Many swing bridges have been discarded for this reason only, and have been replaced by new and large swing bridges, which will in turn have to be discarded as the traffic of the railroad increases. It also necessitates the building of a temporary movable bridge and the diversion of the traffic around the new swing bridge. These expensive and wasteful processes are not necessary with the rolling lift bridge.

Another diagram shows a Scherzer rolling lift bridge on a similar scale for similar conditions. It clearly shows that a single channel can be provided of any width desired without bridging two channels, thus enabling a considerable saving in traffic, due to enormously increasing population and production, because:

1. Constantly increasing railroad traffic demands an ever increasing number of parallel railroad tracks, especially at cities and harbor terminals.

2. Increased water traffic has called into service a large increase in number, and also longer and wider vessels.

3. The increased width of vessels has required wider channels, and necessitates the construction of longer spans for movable bridges.

4. The increased number of vessels requires more frequent openings of movable bridges, and consequently causes more frequent delays to trains and traffic.

5. The increased length of vessels increases the time of delay to railroad traffic during the passage of each vessel.

6. The channels of waterways and harbors are being deepened and improved, docks, land and water right are greatly increased in value and are rapidly becoming more valuable.

The cost of a movable bridge increases with each increase in the width of the clear channel spanned. It is, therefore, desirable and most economical for the engineer to provide only one channel of a minimum width, but ample to rapidly pass the largest vessels likely to use the channel. The above diagrams show the length and width of the largest vessels likely to use the waterways and harbors of the United States, for some years to come.