counterweights were suspended over spiral sheaves. As the leaf rose and less weight was required to balance it, the spirals revolved to such a position that the counterweights hung over a smaller radius than when the leaf was down. Derché evolved easy methods for determining the exact form of these spirals, and on the spiral axes he placed sprocket wheels with hand chains, by means of which the leaf was operated. Overhead balance levers of the Dutch portal type were also installed in some cases, so the movement could be affected either by chain or lever. Movable hinged struts bracing back diagonally to the abutments, and revolving in against the shore as the platform was lifted, were sometimes placed beneath the leaves. This method of counterbalancing the leaves in all positions was so simple that it became quite popular in France and other parts of Europe.

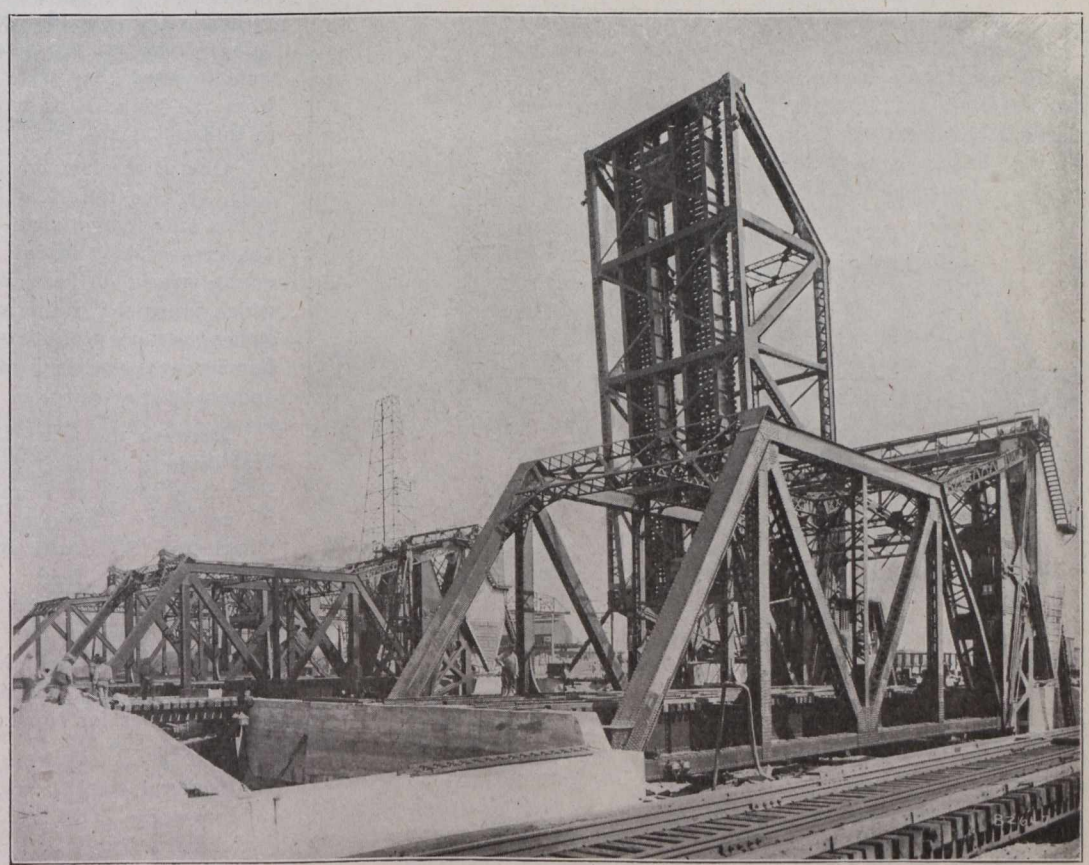
A bridge with varying counterweights had previously been proposed by Colonel Bergére, who intended using weights immersed in water, but his method was not greatly favored.

A modification of the Derché type was used some years ago in San Domingo. At the foot of the shore tower was a conical drum, to the small end of which was attached the balance chain from the outer end of the platform, while to the larger end of the drum was fastened the chain from the counterweight. Two applications of the Derché principle have recently appeared in America, the first of them being proposed in 1901 for the 95th Street bridge at Chicago. The plans showed a double leaf bridge with a clear opening of 140 feet. The leaves act as a three-hinged arch when closed, and are united by centre locks driven by a five-horse-power electric motor. The arch ribs are drawn up by cables passing over two 24-foot drums at the tops of towers, which are 80 feet high, and between these drums and on the same axle are spirals from which the counterweights are suspended. The spiral radius decreases from 12 to 3 feet. The total weight of each leaf is 120 tons.

Another design involving the Derché principle was invented and patented in 1904 by Mr. Wilbur J. Watson. In this design the cables are attached to fixed points on the trusses, and pass around sheaves of the proper diameter to which they are securely fastened, and on which they wind up upon themselves as the bridge rises. The counterweights are carried by chains built up of steel plates and pins. These chains pass around, and are wound from spiral sheaves mounted upon the same shafts as the first-mentioned ones. Chains are used instead of cables for hanging the counterweights because chains can be wound around drums of a smaller diameter. The counterweights are claimed to be less than half of those ordinarily used on bascule bridges, and the stresses in the structure, machinery and foundations are proportionately reduced.

The Poncelet System.—The other two types of bridges with compensating counterweights were invented in France by Poncelet prior to 1840. In one case, the leaves are supported by cables passing over fixed pulleys on shore, and over sheaves behind them, from which counterweights of heavy chain links are suspended, the lower ends of the chains being fastened to the shore structure. As the leaf rises and the chain links descend a greater part of the chain weight is transferred to the lower support, and less to the cables which pass over the sheaves to the bridge. The counterweight is self-acting and extremely simple, and it has, therefore, been extensively used. Small bridges thus equipped can be worked by a sprocket chain and wheel. The principle has been used to some extent in recent moving bridges of other types, as on the Halsted Street vertical lift bridge at Chicago.

A design for counterweight which is a modification of that described above, appeared in 1896 in the competition for a bridge over Newton Creek, the work of J. D. Wilkins and



Bridges at Indiana Harbor, Michigan.

R. W. Creuzbaur. The clear opening of 100 feet was crossed by a single leaf which was drawn up by ropes passing over sheaves on a symmetrical tower on one shore, and it was balanced by a metal box 21 feet long filled with pig iron, and compensated with chain, the whole being described as "the Wilkins system of counterweight." A somewhat similar regulating system was, as previously stated, used on the Halsted Street bridge.

Revolving Arch With Bascule Floor.—An unusual design for a bascule bridge appeared at the Newton Creek competition, the work of Mr. W. H. Breithaupt, a Toronto engineer, a patent for which was recorded July 3, 1896. It consisted of movable ribs meeting when closed above the channel centre and forming a three-hinged arch with suspended bascule floor leaves beneath. It was somewhat similar to a bridge previously erected at Liverpool, where the lower bascule leaves are suspended from double swing spans on