ably the foreign competitors. Hitherto Germany has enjoyed a monopoly in the English toy market. Even cheap labor cannot place the toys upon the market at the same price at which the English manufacturer is selling his products, and at a highly satisfactory profit to himself.

ROLLING LIFT BRIDGES.

BY WALDON FAWCETT.

The rolling lift bridges which have been constructed during the past few years in Chicago and at other points in the United States constitute so distinct an advance over the types of movable structures heretofore utilized in spanning navigable waterways as to have aroused deep interest abroad; and the favorable verdict upon their claims for superiority indicated by the arrangements for the installation of similar bridges abroad is particularly significant in view of the fact that the most distinguished European engineers have for more than half a century wrestled with the problem of accommodating the highway traffic over congested waterways such as the Thames River.

The essential requirements of a movable bridge are many in number; a fact which, of course, lends interest to the solution of the engineering problems involved. In the first place, the bridge must be absolutely safe for all traffic crossing it and for traffic using the navigable gateway, and its mode of operation must be such as to cause the least possible delay both to the traffic crossing it and that using the waterway. Then there are other considerations, such as the desirability of providing the widest possible navigable channel, the non-encroachment on the dock space adjacent to the bridge, and, finally, the matter of economy of operation.

The original movable bridges which are of any interest from an engineering standpoint are what are known as the mediæval pivot or trunnion bascule bridges, which were used to span the moats surrounding fortresses or castles and which, when closed effectually, shut off communication. These bridges either revolved upon hinge pivots or trunnions in a vertical direction or were counterbalanced on the principle of the seesaw. During the first half of the century which has just closed a number of pivot bascule bridges were built, the spans ranging from 20 to 50 feet. The year 1869 saw the completion at Copenhagen, Denmark, of the largest bascule bridge which had, up to that time, been constructed. The bridge, which had a total width of 31 feet, consisted of two movable leaves operated by hydraulic power and gave a clear channel of nearly 57 feet. Some nine years later the honor of ranking as the largest bridge of this type passed to a structure erected at Rotterdam, Holland, which had a total width of 34 feet and gave a clear channel of over 75 feet. This continued to be the largest pivot bascule bridge until the erection of the Tower Bridge at London.

The development of the pivot bascule bridge led directly up to the invention of the rolling lift bridge, the latter type having been devised just as the Tower Bridge at London was nearly completion. The famous London structure was commenced in 1885 and completed in 1894. It provides a waterway 200 feet in width, and cost, all told, more than $4,000,000. The advance which has been made in movable bridges of late years could not, perhaps, be better illustrated than by comparing the Tower structure with a rolling lift bridge of even greater span at the entrance to the Grand Central Station at Chicago. The weight of the iron and steel in the London bridge is 14,000 tons, while that in the Chicago bridge is but 2,250 tons, and the entire cost of the latter was $126,000, less than the cost of the operating machinery alone of the Tower Bridge.

Only three types of movable bridges have been extensively used: First, the hinged, pivot or trunnion bascule bridge; second, the rolling lift or bascule bridge, the newest type; and, third, the swing bridge, commonly denominated "drawbridge," which has been in general use for years past by railroads all over the country. The invention of the rolling lift bridge grew out of the requirements of the Metropolitan West Side Elevated Railroad, which sought a way to carry the traffic of their four tracks across the Chicago River so as to enter the business center of Chicago. Various obstacles prevented the erection of a swing bridge and objections equally insurmountable precluded the possibility of operating satisfactorily a pivot bascule bridge patterned after the Tower structure in London. When it became apparent that the problem was to prove a grave one, William Scherzer set to work upon it and ultimately evolved the idea of the present rolling lift bridge.

The mode of operation of the rolling lift bridges is, as will be seen from the accompanying illustrations, extremely simple. Upon the approach of a boat the bridge seemingly splits across the middle and each half rears itself upright on the bank on which its shore end is resting. The two great advantages claimed for the rolling bridges, aside from economic considerations, are found in the fact that since no center pier is necessary for the support of the structure the entire navigable channel is available and is unobstructed for the passage of vessels, and in the form of construction which enables the rolling lift bridge to act as a barrier when opened for the passage of vessels, thus closing the roadway and preventing the accidents which have been caused in years past by trains running into open "draws."

One of the most recent demonstrations of the utility of the rolling lift type of bridge is found in the evidence that a number of contiguous railroad tracks may be carried across a waterway by the construction of single or double track bridges placed side by side. These bridges may be coupled together when it is desired to operate them as one bridge, or each bridge may be equipped so as to be operated separately. The first six-track movable bridge ever constructed was completed in 1899 at the South Terminal Station in Boston, the largest terminal station in the world. The Boston bridge consists of three double-track spans, which may be operated jointly or as one span. Still more remarkable is the eight-track bridge which has been but lately completed to form a crossing at Campbell Avenue, in Chicago, over the Chicago Drainage and Ship Canal, which is to form a connecting link in a navigable waterway between the Great Lakes and the Gulf of Mexico.

Electric power is used in the operation of rolling lift bridges, but the force required is surprisingly light in view of the fact that the movable spans are perfectly counterbalanced and roll or rock with a minimum amount of friction. Trials have proved that less than twenty seconds is required for the complete operation of opening and closing the spans of one of the largest bridges. In the case of the large bridge at Boston, previously mentioned, each double-track span is operated by means of a 50 horse power electric motor, and the bridge is usually opened or closed in less than 30 seconds, including the time required for locking or unlocking. Moreover, the entire bridge is operated by one man.

A most interesting record is that of the Rush Street Bridge, at Chicago, said to be the most active movable bridge in the world. During an average season of lake navigation comprising a little over eight months this bridge is opened between 10,000 and 11,000 times, or fully forty times every twenty-four hours. Yet the power expense for the operation of this bridge by electricity does not exceed 67 cents a day. Over another rolling lift bridge in Chicago the passage of trains aggregates 1,200 daily.

A novel plan has been followed in order to make the rolling lift bridges more rapid in movement and to insure absolute safety of the working parts, even in the event of an accident to the operating machinery. The movable leaves comprising a bridge are so counterweighted that they are at rest when opened at an inclination of about 40 degrees instead of in the horizontal position which they occupy when closed. Thus, as soon as the locks are withdrawn the leaves will, without the application of any power whatever, roll back and upward and open a channel of sufficient width for the passage of vessels.

The rolling lift bridge moves by means of a large circular wheel rocking upon a perfectly smooth and level track, and, in localities where the waterway to be crossed is comparatively narrow, bridges have been constructed with but a single leaf or span. It is claimed that one of these rolling lift bridges when open is more stable against wind pressure than the Eiffel Tower or the Park Row building in New York city. The engineers admit that larger stresses are safely carried by the substructures of the Forth Bridge and the Brooklyn Bridge than will ever in all probability have to be carried by the substructure of the longest span rolling lift bridge which is likely to be constructed, but they contend that were a span longer than either of the above required, sufficient substructure, counterweight and machinery could be provided to open or close the span. With a view to developing the artistic and monumental possibilities of rolling lift bridges some very handsome designs have lately been prepared. In such structures the counterweight and operating machinery will be inclosed and protected by monumental masonry.

The first International Congress of Petroleum was held in Paris in 1900, and the second has been fixed for 1902, at Bucharest. The permanent commission which was formed at the Congress of 1900 has its seat at Paris, and is constituted as follows: President, M. Ed. Lippmann, former president of the Société des Ingénieurs Civils of France; vice-president, M. Van Zuylen; general secretary, M. P. Dvorkowitz; assistant secretary, M. Neuburger, 37 rue Scheffer, Paris, to whom communications may be addressed. M. Dvorkowitz has lately founded at London a petroleum institute. This new establishment is designed for the uniting and studying of all matters relating to the geology, extraction, chemistry and manipulation of petroleum and its derivatives.

Correspondence.

The Design of Propellers.

To the Editor of the SCIENTIFIC AMERICAN:

Your comments on the design of propellers in issue of September 7 correctly sums up the present situation of the subject.

Years ago, when Rankine enunciated the theory of propulsion that a vessel was made to move forward by the propeller moving a mass of water in the opposite direction, and the larger this mass and the slower its velocity, the more economical would be the performance of the propeller, it became the custom to use propellers of large diameter and small pitch ratios. But experience taught that for a given case it was just as easy to have a propeller too large as too small in diameter, and that very small pitch ratios were extravagant in the use of power. When this fact was becoming recognized the writer pointed out that there was another factor which entered largely into the matter of propulsion, and which made the subject even more complicated and difficult to comprehend—it is that of the inertia of the water acted upon, or its resistance to being put in motion by the propeller.

The notion of a propeller churning the water, when revolving at a high speed, when properly designed and applied, should be exploded by this time, because it will not do so even when the vessel is made fast; but in this latter case it will simply act as a pump receiving the supply water at its forward end and discharging at the opposite. The only time when there is any likelihood of churning is when it is so situated that it cannot receive an adequate supply of water at its forward end.

Experience with propellers taught contrary to general belief at one time that very long screws were not efficient. In the case of propeller pumps it was found that by dividing a long screw into several shorter ones and situating them some little distance apart on the shaft that a better performance was secured. Here, then, we have some explanation of the good performance of the propellers of turbine vessels. They are favorably situated to receive their supply water and each separate propeller on the shaft acts as an independent one.

The field for improvement in screw propellers by any change in their configuration is extremely limited. But there is one direction in which a promising opportunity is presented for improvement in propulsion, and it is somewhat surprising that it has not received more attention than it has.

It is to utilize the energy in the water discharged by the propeller which is now allowed to go to waste.

A great many persons, even some fairly informed in marine engineering, cannot comprehend how any considerable loss takes place in this particular.

Let it be understood that the action of a screw propeller in driving a vessel is the reverse of a turbine wheel in driving a mill. In the case of the latter the object to be accomplished is to transmit through the shaft the power contained in the water flowing to the wheel and to have it absorbed in moving the machinery of the mill. In doing this a mass of water flows to the wheel with a velocity according to its gravitation and is discharged with a much less velocity. The energy due to this difference is that available for the work of the mill.

In the case of a propeller driving a ship, eliminating the factor of inertia before referred to, the water which it acts upon is at rest and it is necessary to give the water motion in order that the reactionary effect may furnish the thrust to move the vessel. To accomplish this the power developed by the engines is transmitted through the shaft to the screw which operates on the water, then discharges it with an accelerated velocity, action and reaction being equal; it is the reaction of this discharged water that furnishes the thrust to drive the ship. Now it is evident that energy is absorbed in moving the vessel and there must of necessity be energy in the water discharged by the propeller.

Hence the power of the engines is divided between moving the vessel in one direction and a mass of water in the opposite direction.

I. MCKIM CHASE.

Washington, D. C., September 16, 1901.

Work on the by-product coke ovens at the Maryland Steel Company's Sparrow Point plant has begun. They are of a new type, and cause a saving of the tar, ammonia, and gas which is thrown off during the process of roasting the coal from which the coke is made. Coke for use in the furnaces of the company will be furnished by the ovens and will probably also supply coal gas for the use of the city of Baltimore. Illuminating gas from by-product coke ovens has been used at Everett, Mass., where a large coke plant has been in operation for some time. It is necessary to treat the gas after it comes from the coke. Cheaper grades of coal can be used in these new ovens.

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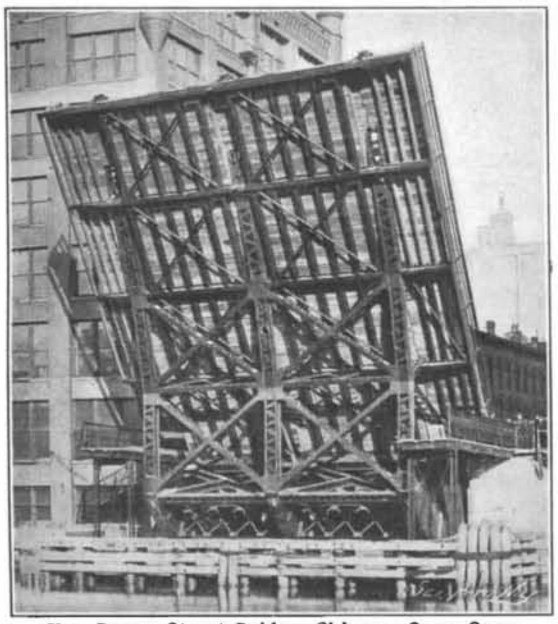
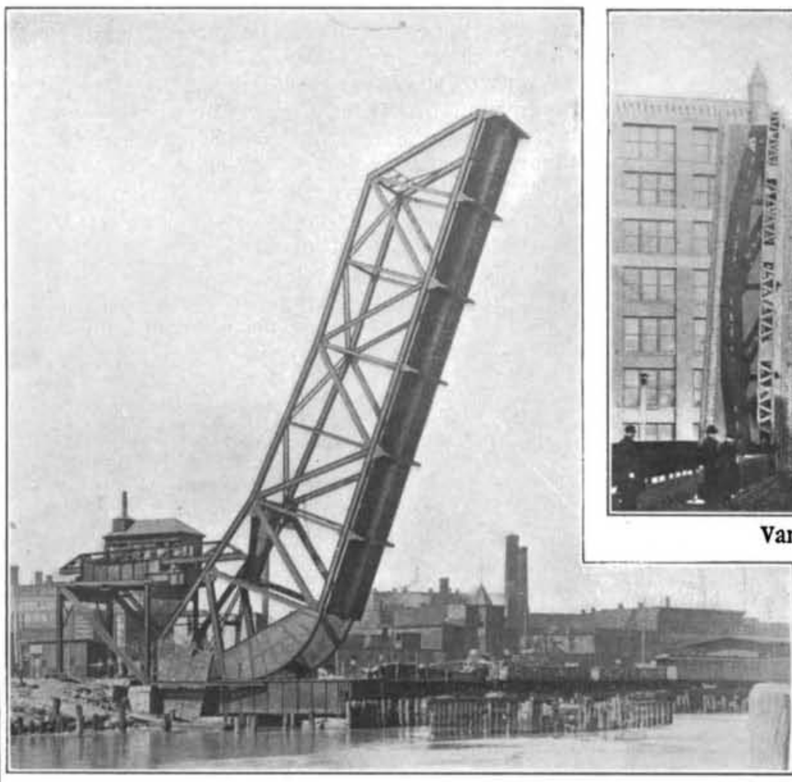
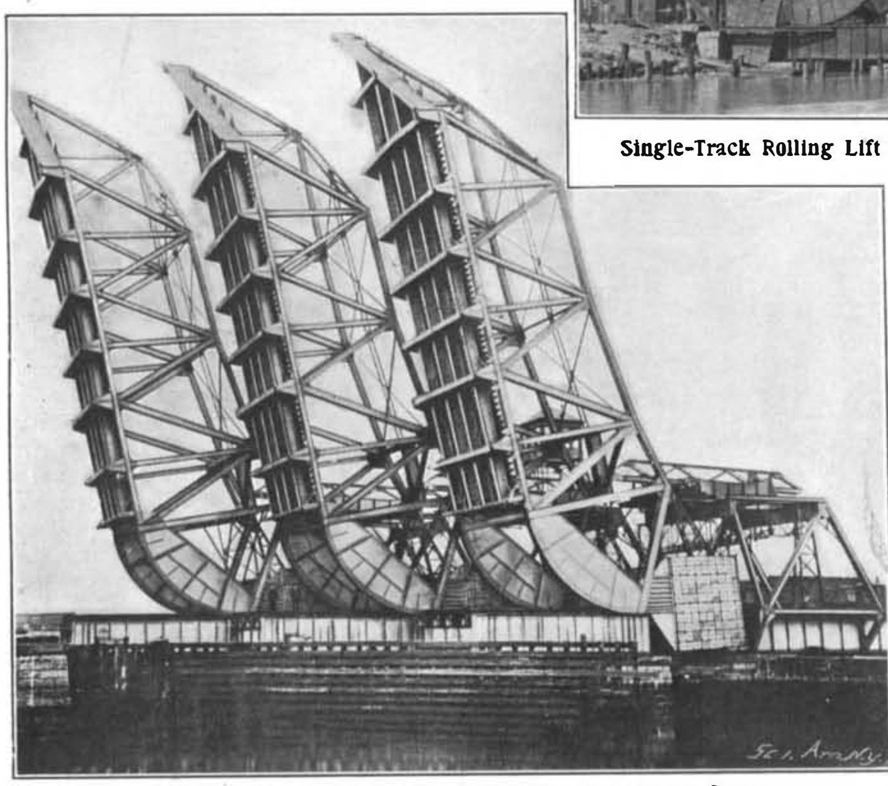


Van Buren Street Bridge, Chicago, Span Open.

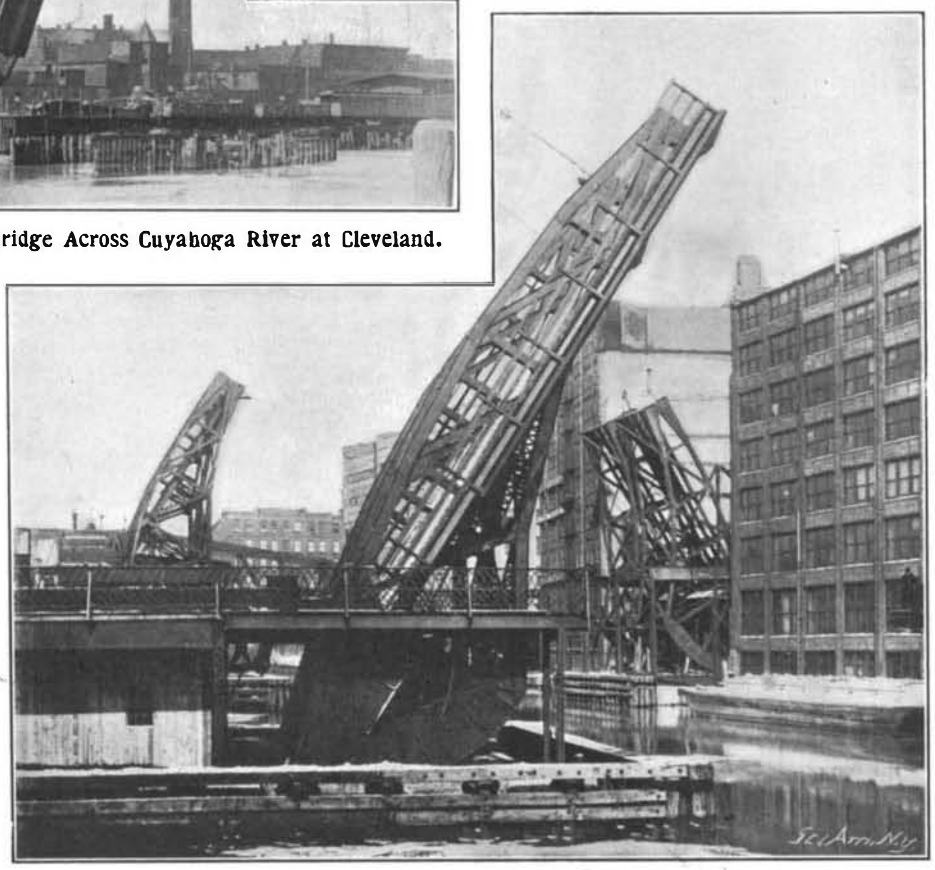


Single-Track Rolling Lift Bridge Across Cuyahoga River at Cleveland.

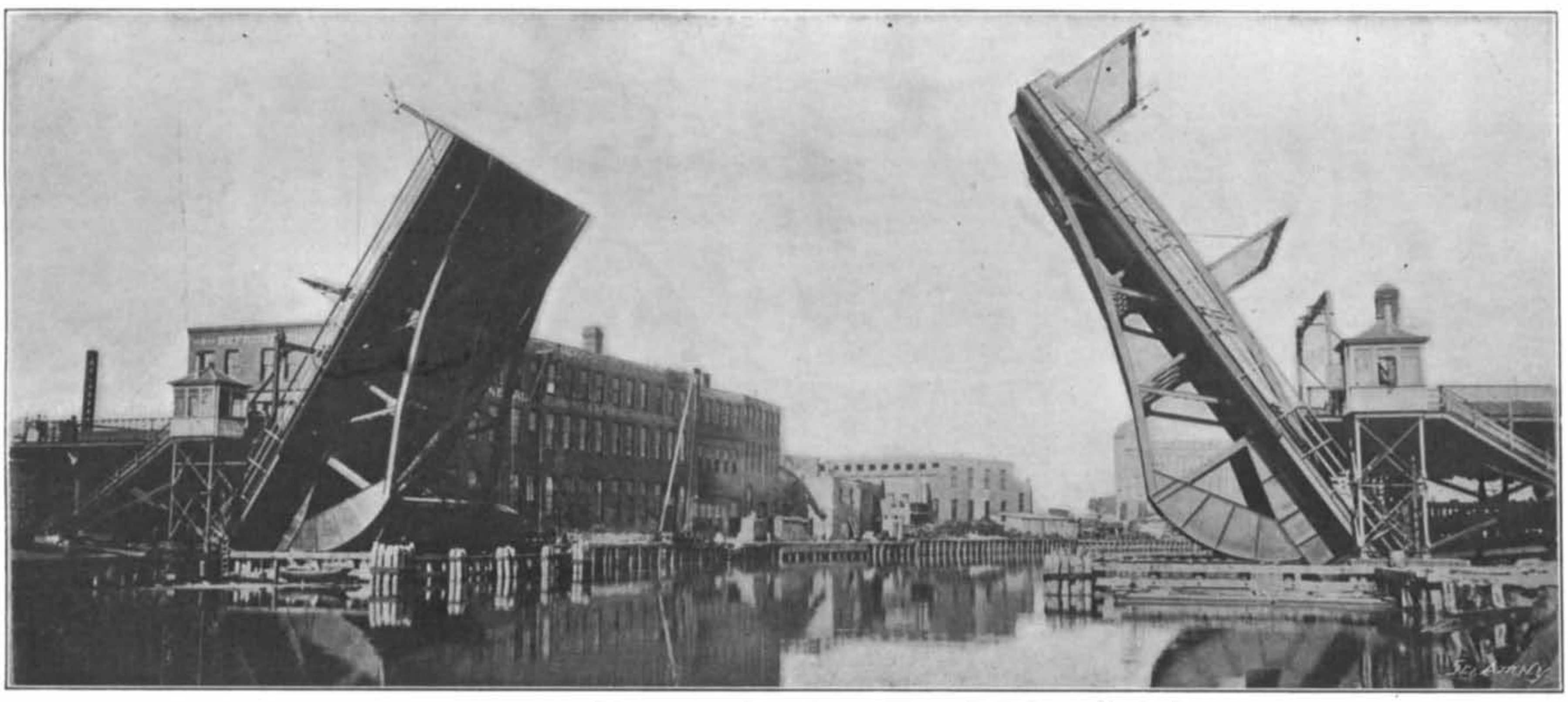
Van Buren Street Bridge, Chicago.



Six-Track Rolling Lift Bridge at South Terminal Station, Boston.



Rolling Lift Bridge Over Chicago River at Van Buren Street.



Electrically Operated Highway Bridge Across the Chicago River at North Halsted Street, Chicago.

ROLLING LIFT BRIDGES.—[See page 198.]