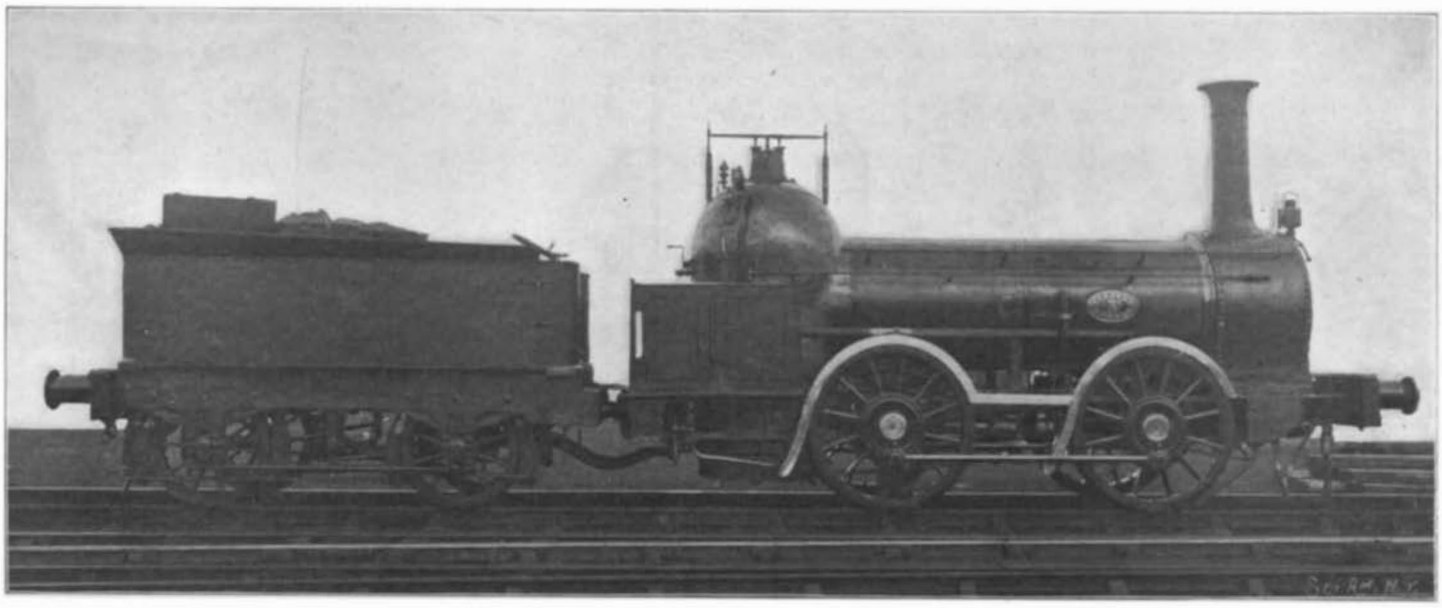
tween the jetties deposits of hardpan were met with; but the rotary cutter of the hydraulic dredger found no particular difficulty in breaking into this material. The hydraulic dredger used in late years measures 120 by 40 feet, with engines of 400 horse power and with a suction and discharge pipe 20 inches in diameter. Depending upon the character of material, its capacity ranges from 1,000 to 5,000 cubic yards per day.

On the east side of San Francisco Bay the shallows extend from the shore line fully two miles. Upon this flat the currents from the rivers discharging into the bay are driven by prevailing westerly winds. In time of flood, these river waters are full of sediment, which is deposited when the comparatively calm areas of the lower bay are reached. The ferry landings on the east shore are of great length. The Oakland pier is fully two miles in length, and the one at Alameda nearly twice as long. Both are of pile work, which suffers terribly from the destructive ravages of the teredo. Gradual progress has been made in filling in the trestles, especially on the Alameda pier, which runs directly on one side of the new channel. The material for filling is obtained by dredging from the estuary and utilized for making a solid roadbed for the railroad tracks. A space 9,000 feet long and 150 wide to a depth of 10 feet was recently filled in this way. A bulkhead was built on each side of the track, and into this space a pipe 20 inches in diameter, extending from the dredger, 5,700 feet distant, and supported by pontoons and piles, discharged a continuous stream of gravel and water, until the present solid roadbed of solid material was formed. The Oakland Harbor improvement has proved of even greater value than anticipated. The works are in charge of Col. H. E. Heuer, of the U. S. Corps of Engineers.



EARLY ENGLISH LOCOMOTIVE; IN SERVICE 1846 TO 1901.

CURIOUS LOCOMOTIVE EXPLOSION.

The accompanying illustrations are reproduced from photographs of an unusual railroad wreck which occurred to a local passenger train on the Denver & Rio Grande Railway, between La Veta and Cuchara, Colo. The disaster was due to the rupture of the boiler at the junction of the barrel and the firebox. The train consisted of a locomotive, ten freight cars, and a passenger coach at the rear, in which were some twenty-five passengers. The explosion occurred when the train was about one mile distant from La Veta station. The engineer and the fireman were instantly killed, and the concussion was so violent that buildings a mile distant from the track were severely shaken, and the noise of the explosion was heard at points twenty miles away, where it was supposed that an exceptionally heavy mining blast had been set off. The body of the engineer was found between 500 and 600 feet distant from the track and mutilated beyond recognition. The engine, as will be seen from the illustration, was completely wrecked. The upper sheet of the firebox was torn entirely loose from the boiler, and thrown a distance of over 600 feet to the right, landing on ground which was about 50 feet above the level of the track. The force of the explosion was sufficient to strip the boiler entirely from its seating, and the barrel was driven forward with a rocket-like action along the ground, plowing a deep furrow at the left of the track for a distance of 125 feet. The blast was also sufficient to tear the body of the tender loose from its frame and throw it around at right angles to the track, as shown in the accompanying illustration. The first car behind the tender was overturned and landed bottom up, to the left of the track, while the second and third cars were thrown over to the right. One of our illustrations shows the point at which rupture took place in the boiler. It will be seen that the firebox is entirely gone and the tube-sheet and tubes are exposed, showing the staybolts either ruptured or pulled out. Several staybolts, we are informed by our correspondent, were found to be eaten through and others almost through by the action of the alkali in the water.

The Wrecked Boiler.

View from Front of Train.

LOCOMOTIVE EXPLOSION AT LA VETA, COLORADO.

A LOCOMOTIVE CURIOSITY.

There has just been withdrawn from service in England one of the oldest locomotives in existence. Up to a few weeks ago this engine, which was constructed in 1846, was regularly employed for hauling mineral traffic upon the Barrow-in-Furness Railroad, which was one of the first railroads in England, having been opened for traffic for considerably more than half a century. The total length of this railroad is only 170½ miles, yet it is one of the most profitable lines in the United Kingdom, a fact due to a large extent to the heavy mineral traffic that it carries.

This engine, officially known as "Number 3," but familiarly styled "Old Coppernob," from its curious firebox, which is built of copper and is dome-shaped, is the survivor of three similar engines that were built in the early '40's for this railroad, though the two previous engines were somewhat smaller. The cylinders are 14 inches in diameter, with a 24-inch stroke. The steam pressure was 120 pounds per square inch. The heating surface of the tubes is 805 square feet, and of the firebox 49 square feet. The total weight of the engine and tender in working order was 32 tons 8 hundredweight. The wheels are four coupled, 4 feet 9 inches in diameter on the tread, and the engine frames are of the frame type with upper and lower members. The axle boxes are made of gun-metal and the motion is of the curved link type. The boiler is 11 feet 2 inches long and 3 feet 6 inches in diameter. The boiler plates are made of Low Moor iron throughout with the exception of the firebox, the barrel being made up of three rings.

A curious feature of the tender of the engine is that the under frame is constructed entirely of oak. The tender has a water capacity of 1,000 gallons. Although this old locomotive has been regularly running for over 53 years, when withdrawn from service it was found to be thoroughly strong and perfect in every respect. The working parts were in first-class condition. Although old-fashioned in design and pattern, it was a very serviceable engine, and an idea of the serviceableness of this type of locomotive may be gathered from the fact that the same company has several other similar "coppernobs," though of a more recent date, still running upon its system.

Now that it has been withdrawn from active service the locomotive is to be placed in a well-merited place of honor. The railroad company are having a special glass-covered case erected in a prominent position at their Barrow terminus to accommodate the relic, and it will constitute an interesting memento of the early days of the railway era and also form a striking contrast with the fleeter and more powerful locomotives of to-day.

Use of Old Wooden Paving Blocks.

An ingenious use has been found for the discarded wood blocks with which the London streets are paved. The woods employed for this purpose are the karri and jarrah woods of Australia, which, owing to their density of grain and extreme hardness, are peculiarly adapted for paving purposes. This wood, owing to these characteristics, is familiarly styled "ironbark." Hitherto when a street was renewed the old wood blocks were sold at a low figure to the poorer classes, and in some instances were given away to those who cared to carry them away. They are, however, now being put to a new use. The wood blocks are in reality only surface damaged. The inside is as hard and as durable as it was when first laid down. Realizing this feature, several toy manufacturers throughout the country approached the authorities, and now purchase all those blocks which are not damaged in the process of being torn up, for the purpose of making the cheap toys out of them. The wood is bought at a low figure, and by means of special machinery that has been laid down the outside is trimmed off and the remaining portion converted into small toys. The wood, owing to its strong nature, is excellently suited for this purpose; and owing to the fact that the raw material is purchased so cheaply the home manufacturers are in a position to undersell considerably 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.