THE STEAM YACHT "ARROW"—THE FASTEST BOAT IN THE WORLD.

On the eastern shore of the Hudson River, near Ardsley and adjacent to the right of way of the New York Central Railroad, the government engineers some time ago placed certain stakes, which marked the beginning and the ending of an accurately-measured nautical mile or knot. This course was laid off for the purpose of testing torpedo boats before their acceptance by the United States government. The sighting marks consist at each point of two poles, set up 150 feet apart, one near the water's edge and the other about 150 feet back of the New York Central tracks. When the observer on a vessel that is under test brings the two poles in line he knows that he is exactly at the starting point of the mile. Similarly when the poles at the end of the track are in line he knows that he is crossing the finishing line.

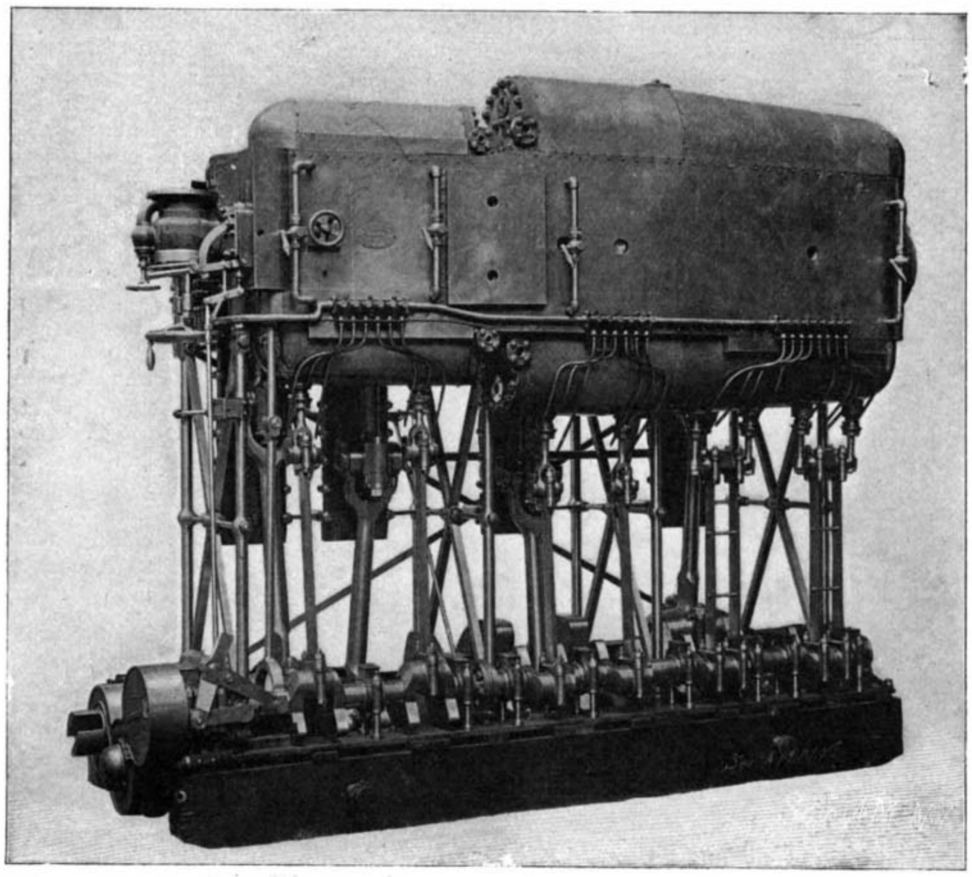
Over this course, and running at a distance of about 250 yards from the shore line, the steam yacht "Arrow" recently covered a nautical mile in exactly one minute and 32 seconds, or at the rate of 39.13 knots an hour. This is equivalent to 45.00 statute miles an hour and constitutes a new record for vessels of any kind whatsoever. The "Arrow" was designed by Charles D. Mosher, of this city, whose name is identified with the production of some of the fastest steam craft of the world, his "Ellide," a smaller vessel than the "Arrow," having steamed over the same measured mile at a rate of 34.73 knots an hour. Although the speed aimed at by the "Arrow" was extraordinarily high, namely 40 knots an hour, the uniform success which has attended the high speed trials of the Mosher boats, led those who have followed the performance of his craft, to expect that the designed speed would be reached.

The "Arrow" is a twin-screw yacht 130 feet 4 inches total length, 12 feet 6 inches beam, 3 feet 6 inches normal draft, with a displacement on that draft of 66 tons. In designing the vessel, particular attention was paid to the question of securing the greatest possible strength for the least weight of material; and the hull is unusually light considering the great power, 4,000 horse power, which is developed when the vessel is at full speed. The lines are similar to those with which we are familiar in the torpedo-boat destroyer, but they are greatly refined; and owing to the fact that the greatest beam lies well aft, and that this beam is continued out in the flat stern, the lines of the yacht are remarkably easy and well adapted to securing high speed results. The great sweetness of her model was shown in the fact that when the "Arrow" was steaming, in the earlier part of the mile trial, at a speed of over 40 knots an hour, she made remarkably little fuss, there being no lofty and crested bow wave, such as is seen at the high speed trials of torpedo boats.

The construction of the boat is composite in character, steel frames below the water line and aluminium above, except in the boiler and engine room spaces, where they are of steel throughout. Keelson, lower plates, reverse frames, bunkers, bulkheads, boiler saddles, engine foundations and other details are also of steel. The sides are double planked with mahogany, which is brought to a smooth fair surface and highly finished. Deck beams are aluminium bulb angles, while aluminium is used also for many other details. The vessel is strengthened longitudinally by diagonal strappings of steel plates.

The motive power consists of two Mosher water-tube boilers, containing a grate surface of 120 square feet and a heating surface of 5,540 square feet, the weight empty of each boiler being 6.43 tons. The boilers were designed to supply steam at 440 pounds to the square inch, although on the trial the pressure never exceeded 400 pounds to the square inch, that being the limit allowed by the inspectors. The twin-engines, of which we present an illustration, are of a type which has been specially designed for these high speed craft. They are quadruple expansion, with cylinders of 11, 17, 24, and 32 inches diameter by 15 inches stroke. The working pressure varies from 350 to 400 pounds per square inch and the revolutions from 540 to 600. The calculated power developed under 540 revolutions and 350 pounds pressure at the engine is 4,000 horse power. Both engines exhaust into one condenser with a cooling surface of 2,760 square feet. Between the steam cylinders there is installed a series of re-heaters, each one of which is capable of supplying the entire thermal equivalent of the work expended during the expansion, thus keeping the steam in a super-heated condition throughout its working cycle. These re-heaters dry the steam and prevent cylinder condensation.

The feed water before returning to the boilers is heated in four-stage feed-water heaters, being finally delivered to the boiler at a temperature of



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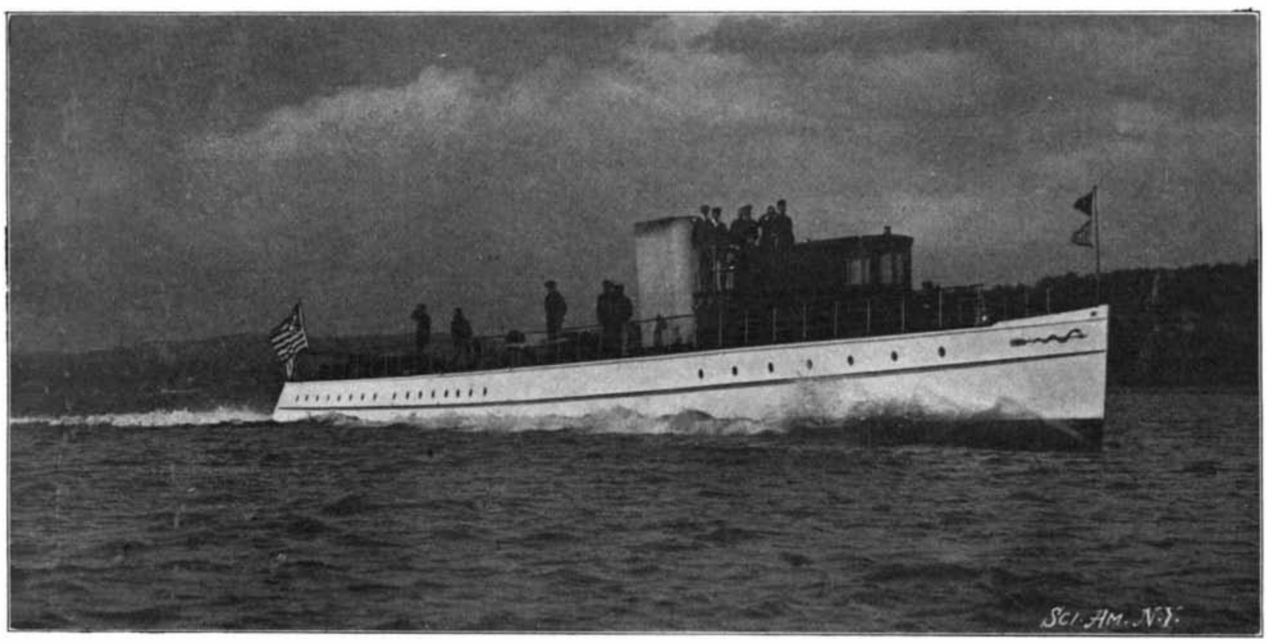
Twin-Screw, Quadruple Expansion Engines of the "Arrow." Horse Power, 4,000.



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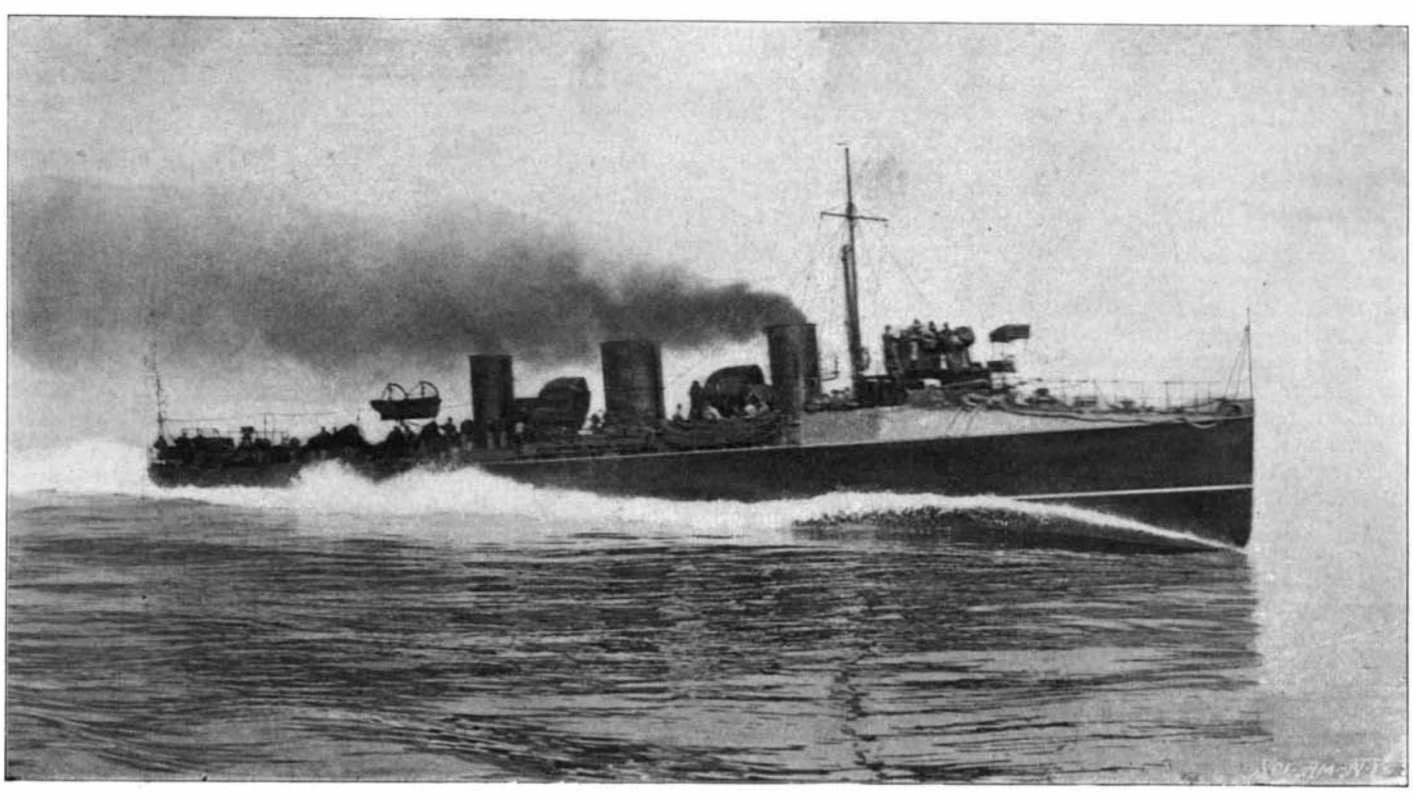
STEAM YACHT "ARROW." FASTEST CRAFT IN THE WORLD. SPEED ON TRIAL, 39.13 KNOTS.

Length, 130 feet 4 inches; beam, 12 feet 6 inches; draft, 3 feet 6 inches; displacement, 66 tons; horsepower, 4,000.



"VELOX," FASTEST DESTROYER AFLOAT. SPEED, 33.64 KNOTS.

Fitted with reciprocating engines for cruising and with turbines for full speed. Length, 210 feet; beam, 21 feet; draft, 7 feet; displacement, 315 tons; horse power, 10,000.

about 350 degrees. From what we have said it will be seen that the development of power is very high for the weights involved. Thus the weight of the boilers per square foot of heating surface, when they are full of water, is 6.3 pounds. The indicated horse power per square foot of grate surface is 33, while the weight in pounds per horse power of engines, boilers, including water, and all auxiliaries, is only 17.78 pounds.

Points which make for high economy, and hence for a large return of power per pound of boiler and pound of coal may be summarized as follows: Great initial pressure (from 100 to 150 pounds greater than the common practice in high speed boats); the considerable wire-drawing from the boiler to the engine, tending to dry and superheat the steam and reduce the condensation, results which are also enhanced by the action of the re-heaters on the cylinders; and the reduction of the cylinder clearances in the engine to a very low value.

With regard to the results actually obtained, if we would estimate them in their full value, we must bear in mind that the designer, who has always superintended the speed trials of the earlier vessels, was absent on this occasion. There were, moreover, certain untoward circumstances connected with the trial which undoubtedly prevented the attainment of the fullest speed of the vessel. Judging from the fact that provision had been made by those in charge of the trial, for instantly opening the four safety valves on the two boilers, it would seem that there was a certain measure of nervousness in the engine room force which, in itself, would not conduce to securing the highest results. Cords had been tied to the safety valves and an engineer placed so that he could instantly open all four valves. The craft came down to the line at a speed which must have been something over 40 knots an hour and had proceeded, under a boiler pressure of 400 pounds per square inch, over about one-quarter of the mile course, when one of the safety valves lifted. At this instant the engineer told off to watch the valves, pulled the rope and released the other three, so that the "Arrow" completed the remaining three-fourths of the course with an enormous volume of steam blowing from her boilers. As a consequence the pressure ran down to 250 pounds, at which pressure it stood when the mile was completed. There was, in consequence, a visible falling off of the speed; but in spite of this the estimated speed of 40 knots an hour was closely approximated, the actual speed being 39.13 knots an hour. The sighting of the marks was done by one observer and the stop watch was held by another, the result being carefully checked by several watches on board, all of which agreed with the result given out by the time-keeper.

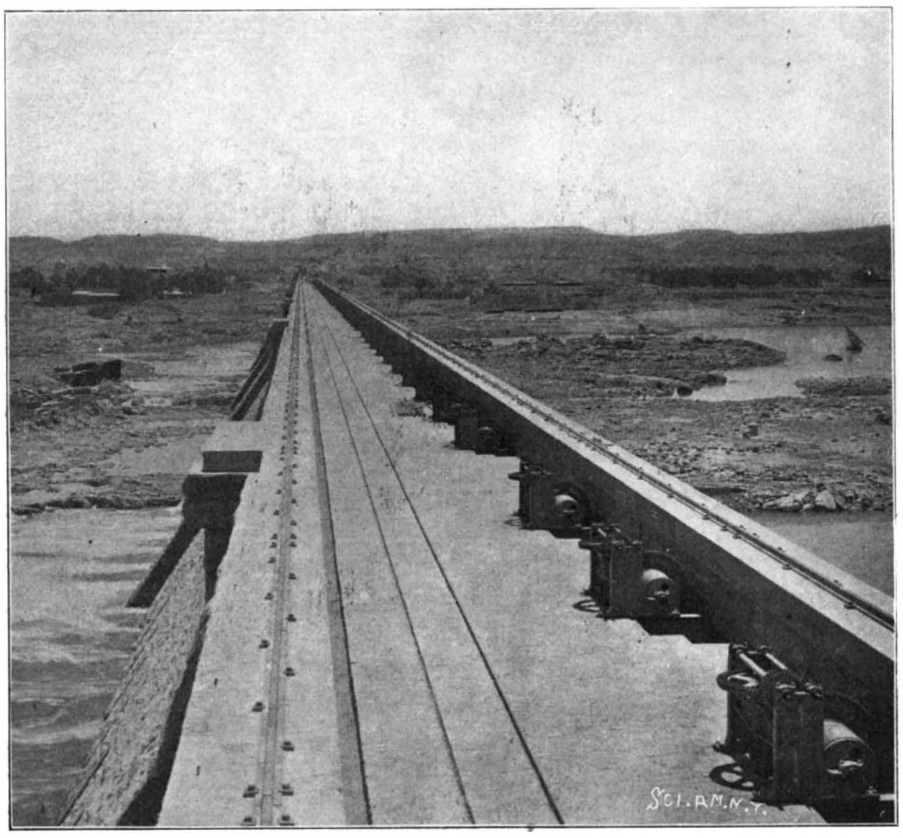
In discussing the results, the designer, Mr. Mosher, points out that the "Arrow" was drawing about 5 inches more than her designed normal draft of 3 feet 6 inches; that the boiler pressure, even at the starting point was forty pounds below the designed pressure; and that the vessel had not been out of the water for several months and, therefore, her bottom was not as clean as could be desired for a speed trial. These considerations would seem to justify the belief that when steaming on her designed lines and with a perfectly clean bottom, the "Arrow" would make, and probably somewhat exceed, a speed of 40 knots an hour.

We also present illustrations of the fastest torpedo-boat destroyer, the "Velox" of the British navy. She was constructed by the same builders as the ill-fated "Viper" and "Cobra," and like them is driven by turbine engines. Mr. Parsons of turbine fame had found that the "Viper" and the "Cobra" were not so economical as could be wished when running at ordinary cruising speeds. Passenger steamers run always at their highest speed, but warships only require their full power occasionally, and in common with all steam engines, the steam turbine does not show high efficiency when working much below the power for which it is designed. The arrangement arrived at in the "Velox" is as follows:

The main propelling machinery consists of two independent sets of Parsons turbine engines, one high-pressure and one low-pressure engine being on each side of the vessel. This gives four turbines, each of which has its own line of shafting, and, as each shaft carries two propellers, there are eight propellers in all. The high-pressure turbines drive the outer shafts and the low-pressure turbines the inner ones. For going astern reversing turbines are incorporated in the exhaust casing of each of the low-pressure cylinders. A novel feature in this vessel is the introduction of ordinary reciprocating engines fitted in conjunction with steam turbines. These engines are of the triple-compound type, and are coupled direct to the main turbines and work in conjunction with them. They take steam directly from the boilers, and exhaust through the high-pressure turbine, the exhaust from the latter passing in turn through the low-pressure turbine, and from thence to the condensers. These reciprocating engines are for use at cruising speeds, when low power only is needed, and are therefore of comparatively small size. When higher powers than those needed for absolute cruising speeds, under ordinary conditions, are needed, steam will be admitted to the turbines direct from the boilers; and when the highest speed is needed, which would bring the rate of revolution beyond that permissible with reciprocating engines, steam will be entirely cut off from the latter, they being at the same time thrown out of gear, and the steam turbines alone will be used. With this arrangement the "Velox" will doubtless prove an exceptionally economical destroyer at cruising speeds.

The boilers are of the Yarrow type, and have been made by Messrs. Hawthorn.

The hull of the "Velox" has been built by Messrs. Hawthorn, Leslie & Co. She is 210 feet long, 21 feet wide and 12 feet 6 inches molded depth. The maximum speed made by the "Velox" up to the present is 33.64 knots.

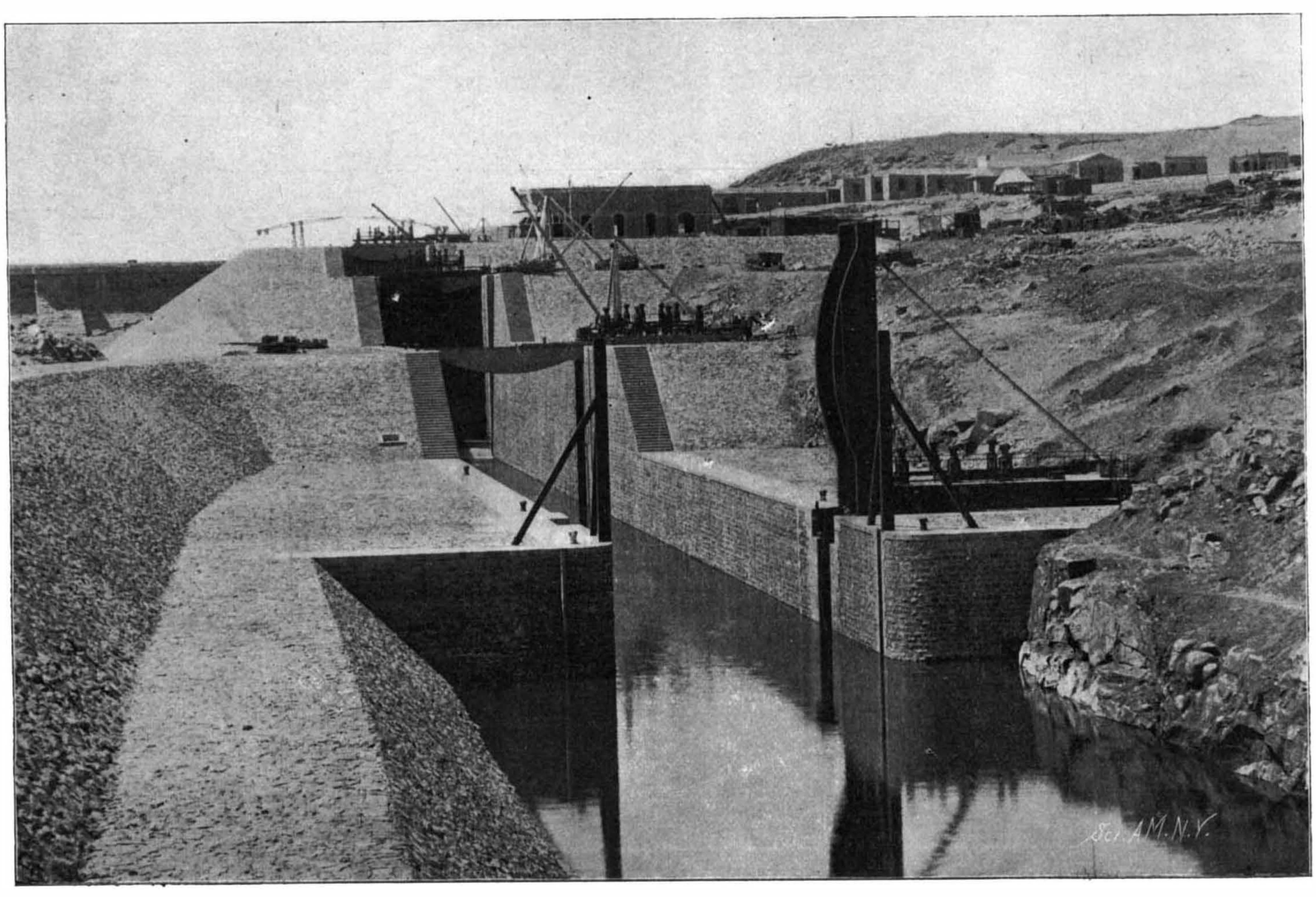


LOOKING TO THE EAST ALONG TOP OF DAM. REGULATING GEAR FOR SLUICES TO THE RIGHT.

THE NILE IRRIGATION WORKS.*

The monumental dam at Assouan, by far the greatest achievement of the kind in ancient or modern times, which will form a reservoir in the Nile Valley capable of storing 1,000,000,000 tons of water, will not only produce a revolution in the primitive and laborious methods of irrigation in Egypt, but will reclaim to the uses of the husbandman vast areas of land that hitherto have been accounted arid and worthless desert.

The old system of irrigation was little more than a high Nile flooding of different areas of land or basins surrounded by embankments. Less than a hundred years ago, perennial irrigation was first attempted to be introduced by cutting deep canals to convey the water to the lands when the Nile was at its low summer level. When the Nile rose, these canals had to be blocked by temporary earthen dams, or the current would have wrought destruction. As a result, they silted up, and had to be cleared of many millions of tons of mud each year by enforced labor, much misery and extortion resulting therefrom. About half a century ago the first serious attempt to improve matters was made by the construction of the celebrated Barrage at the apex of the Delta. This work consists, in effect, of two bricked arched viaducts crossing the Rosetta and Damietta branches of the Nile, having together 132 arches of 16 feet 4 inches span, which were



THE NAVIGATION CHANNEL—ENTRANCE TO LOCKS FROM THE NORTH.

*By the Special London Correspondent of the SCIENTIFIC AMERICAN. From information supplied by Sir Benjamin Baker, K.C.M.G., F.R.S., Engineer-in-Chief.