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.

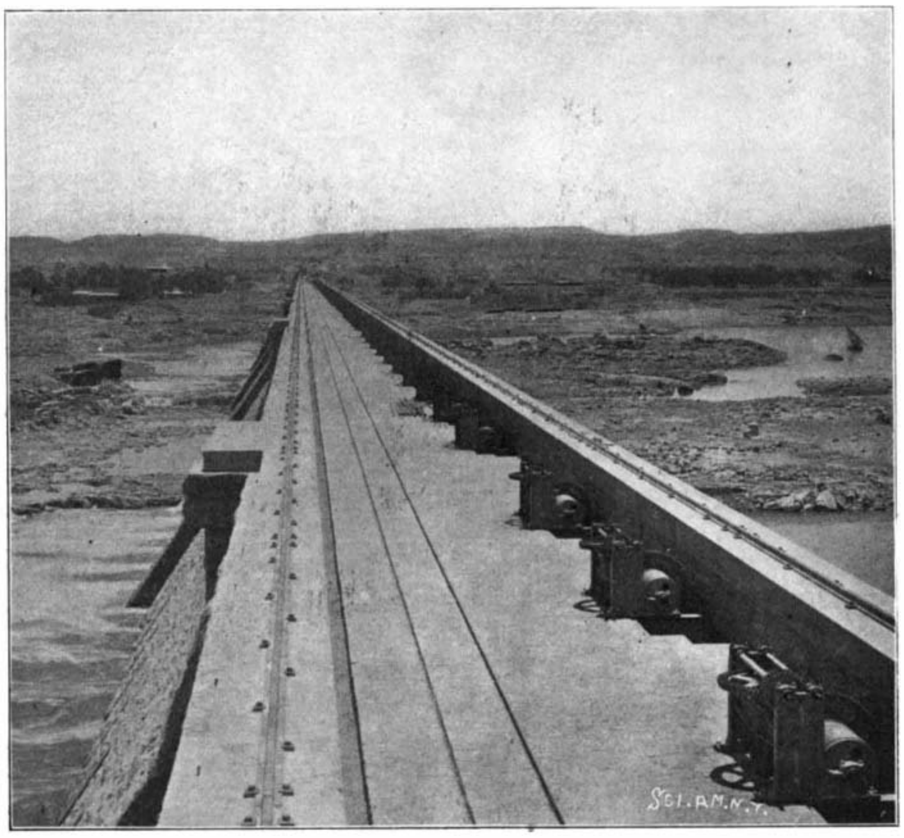
In discussing the results, the designer, Mr. Mosher, points out that the "Arrow" was drawing about 5 inches more than her designed normal draft of 3 feet 6 inches; that the boiler pressure, even at the starting point was forty pounds below the designed pressure; and that the vessel had not been out of 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.

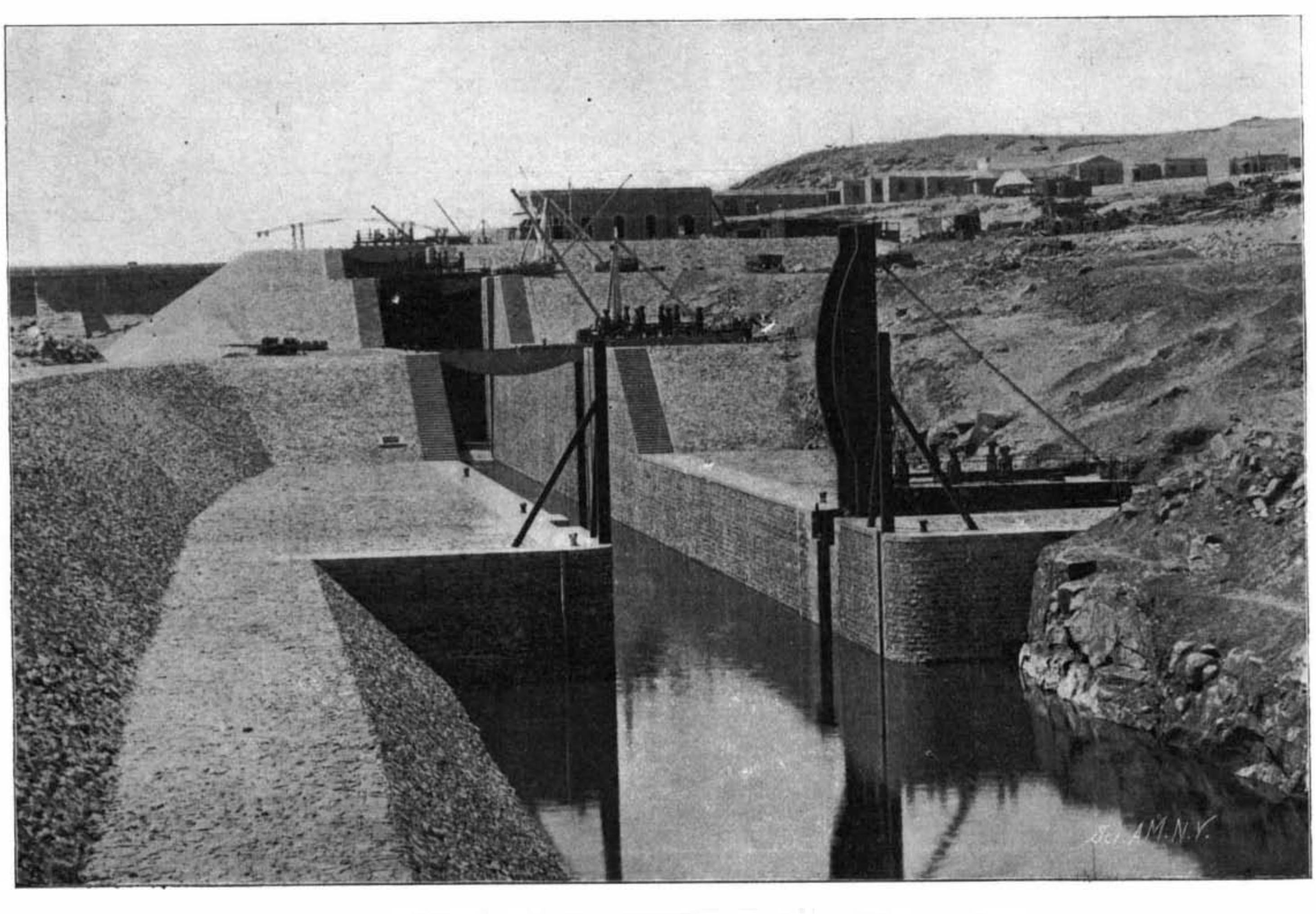


LOOKING TO THE EAST ALONG TOP OF DAM. REGULATING GEAR FOR SLUICES TO THE RIGHT.

### 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.

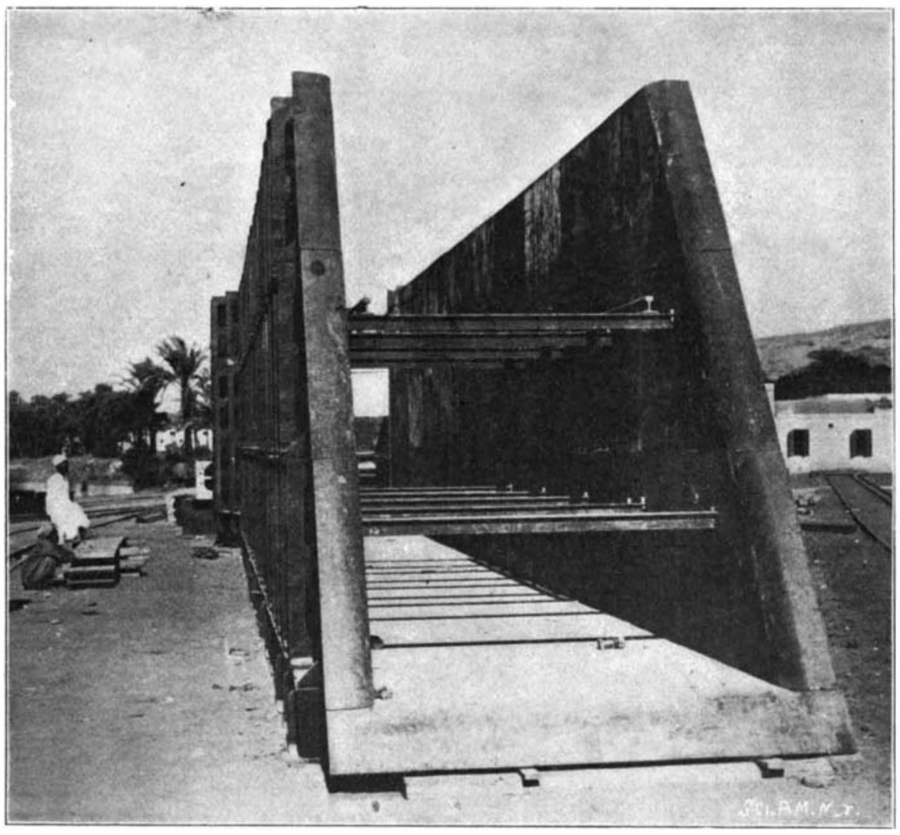
*By the Special London Correspondent of the SCIENTIFIC AMERICAN. From information supplied by Sir Benjamin Baker, K.C.M.G., F.R.S., Engineer-in-Chief, entirely closed by iron sluices during the summer months, thus heading up the water some 15 feet and throwing it at a high level into the six main irrigation canals below Cairo. In the summer months the whole flow of the Nile is arrested and thrown into the aforesaid canals. The old Barrage was constructed under great difficulties by French engineers, subject to the passing whims of their oriental chiefs. About fifteen years elapsed between the commencement of the work and the closing of all the sluices, and another twenty years before the structure was sufficiently strengthened by British engineers to fulfill the duties for which it was originally designed. Forced labor was largely employed in its construction, and at one time 12,000 soldiers, 3,000 marines, 2,000 laborers, and 1,000 masons were at work at the old Barrage.

In connection with the Nile reservoir, subsidiary weirs have been constructed below the old Barrage to reduce the stress on that structure. The system adopted was a novel one, devised by Major Brown, Inspector-General of Irrigation in Lower Egypt. His aim was to dispense almost entirely with plant and skilled labor; and so, without attempting to dry the bed of the river, he made solid masonry blocks under water by grouting rubble dropped by natives into a movable timber caisson. Both branches of the Nile were thus dammed in three seasons, at a cost, including navigation locks, of about $2,500,000. Many other subsidiary works have been and will be constructed, including regulators, such as that on the Bahr Yusuf canal.

By far the most important of the works constructed to enable the water stored up in the great reservoir to be utilized to the greatest advantage is the Barrage across the Nile at Assiout about 250 miles above Cairo, which was commenced by Sir John Aird & Company in the winter of 1898, and completed a few months ago. In general principle this work resembles the old Barrage at the apex of the delta; but in details of construction there is no similarity, nor in material, as the old work is of brick and the new one is of stone.

The total length of the structure is 2,750 feet, or rather more than half a mile, and it includes 111 arched openings of 16 feet 4 inch span, capable of being closed by steel sluice gates 16 feet in height. The object of the work is to improve the present perennial irrigation of lands in Middle Egypt and the Fayoum, and to bring an additional area of about 300,000 acres under such irrigation, by throwing more water at a higher level into the great Ibrahimich canal, the intake of which is immediately above the Barrage.

On the Nile the conditions are very special, and in some respects advantageous for the construction of dams and barrages. At Assiout the mode of procedure was to inclose the site of the proposed season's work by temporary dams or sudds of sandbags and earthwork, then to pump out and keep the water down by powerful centrifugal pumps, crowd on the men, excavate, drive the cast iron sheet piling, build the masonry platform and piers, lay the aprons of puddle clay and pitching, and get the work some height above low Nile level before the end of June, so that the temporary dams should not require reconstruction after being swept away by the flood. The busiest months were May and June, when in the year 1900 the average daily number of workmen was 13,000.



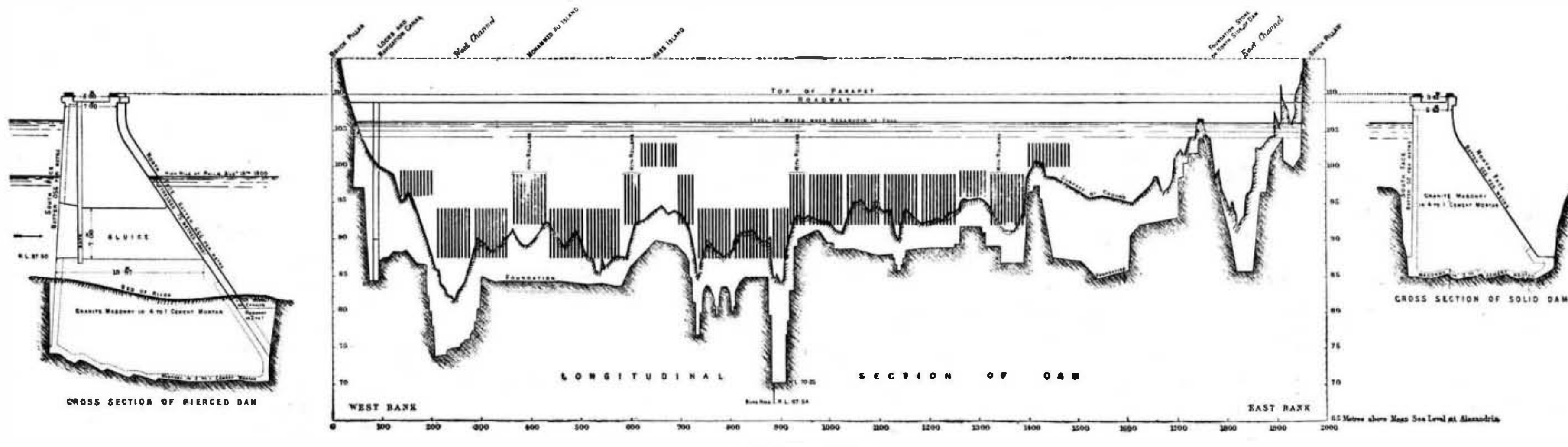
CAST IRON LINING FOR ONE OF THE SLUICES.

Assiout, as already observed, is about 250 miles above Cairo. The great dam at Assouan is 600 miles above the same point. Between Assiout and Assouan the remains of many temples exist, of far greater interest and importance than those at Philæ. The latter ruins, however, have attracted more attention in recent days, because, being situated immediately above the dam, the filling of the reservoir will partially flood Philæ Island during the tourist season. It would be idle to speculate as to who first thought of constructing a reservoir in the Nile Valley, or who first arrived at the conclusion that the site of the present dam above Assouan was the best one. Mr. Willcocks, one of the ablest engineers of the Public Works Department of Egypt, who was instructed by Sir William Garstin to survey various suggested sites for a dam between Cairo and Wady Halfa, unhesitatingly decided that the Assouan site was the best, and the majority of the International Committee, who visited the site in 1894, came to the same conclusion. This conclusion had, however, been anticipated by Sir Samuel Baker more than forty years ago, from mere inspection of the site without surveys. This single dam proposed by Sir Samuel Baker forty years ago is in effect the one which is practically now completed. The Assouan dam is not a solid wall, but is pierced with sluice openings of sufficient area for the flood discharge of the river, which may amount to 15,000 tons of water per second. There are 180 such openings, mostly 23 feet high by 6 feet 6 inches wide; and where subject to heavy pressure when being moved they are of the well-known Stoney roller pattern.

The total length of the dam is about 1¼ miles; the maximum height from foundation, about 130 feet; the difference of level water above and below, 67 feet; and the total weight of masonry over one million tons. Navigation is provided for by a "ladder" of four locks, each 260 feet long by 32 feet wide. As remarked in the case of Assiout, the difficulties in dam construction are not in design, but in the carrying out of the works. When the "rotten rock" in the bed was discovered Sir Benjamin Baker reported to Lord Cromer frankly that he could not say what the extra cost or time involved by this and other unforeseen conditions would be, and that all that could be said was that, however bad the conditions, the job could be done. Lord Cromer replied that the dam had to be completed whatever the time and cost. The contract was let to Sir John Aird & Company, of London, with Messrs. Ransomes & Rapier, of London, as sub-contractors for the steel work, in February, 1898. Two months after signing the contract the permanent works were commenced, and before the end of the year thousands of native laborers and hundreds of Italian granite masons were hard at work. On February 12, 1899, the foundation stone of the dam was laid by the Duke of Connaught. Many plans were considered by the engineers and contractors for putting in the foundations of the dam across the roaring cataract channels, and it was finally decided to form temporary rubble dams across three of the channels below the site of the great dam, so as to break the force of the torrent and get a pond of comparatively still water up stream to work in. Stones of from 1 ton to 12 tons in weight were tipped into the cataract and this was persevered with until finally a rubble mound appeared above the surface of the water. The first channel was successfully closed on May 17, 1899, the depth being about 30 feet and the velocity of current nearly 15 miles an hour. In the case of another channel the closing had to be helped by tipping in railway wagons themselves, loaded with heavy stones and bound together with wire ropes, making a mass of about 50 tons, the great mass being necessary to resist displacement by the torrent.

These rubble dams were well tested when the high Nile ran over them; and on work being resumed in November, after the fall of the river, water-tight sandbag dams, or sudds, were made around the site of the dam foundation in the still waters above the rubble dams and pumps were fixed to lay dry the bed of the river. This was the most exciting time in the old stage of the operations, for no one could predict whether it would be possible to dry the bed, or whether the water would not pour through the fissured rock in altogether overwhelming volumes. Twenty-four 12-inch centrifugal pumps were provided to deal if necessary with one small channel; but happily the sandbags and gravel and sand embankments stanched the fissures in the rock and interstices between the great bowlders covering the bottom of this channel, and a couple of 12-inch pumps sufficed.

The masonry of the dam is of local granite, set in British Portland cement mortar. The interior is of rubble set by hand with about 40 per cent of the bulk in cement mortar, four of sand to one of cement. All the face work is of coursed rock faced ashlar, except the sluice linings, which are finely dressed. This was steam crane and Italian masons' work. There was a great pressure at times to get a section completed before the inevitable rise of the Nile, and as much as 3,600 tons of masonry was executed per day, chiefly at one point in the dam. A triple line of railway and numerous trucks and locomotives were provided to convey the materials from quarries and stores to every part of the work. The maximum number of men employed was 11,000, of whom 1,000




LONGITUDINAL AND CROSS SECTIONS OF THE ASSOUAN DAM.

were European masons and other skilled men. Mr. Wilfred Stokes, chief engineer and managing director of Messrs. Ransomes & Rapier, was responsible for the detailed designing and manufacture of the sluices and lock gates; 140 of the sluices are 23 feet high by 6 feet 6 inches wide, and 40 of them half that height; 130 of the sluices are on the "Stoney" principle with rollers, and the remainder move on sliding surfaces. The larger of the Stoney sluices weigh 14 tons, and are capable of being moved by hand under a head of water producing a pressure of 450 tons against the sluice.

There are five lock gates, 32 feet wide, and varying in height up to 60 feet. They are of an entirely different type from ordinary folding lock gates, being hung from the top on rollers, and moving like a sliding coach house door. This arrangement was adopted for safety, as 1,000,000,000 tons of water are stored up above the lock gates, and each of the two upper gates is made strong enough to hold up the water, assuming the four other gates were destroyed.

When the river is rising the sluices will all be open, and the red water will pass freely through, without depositing the fertilizing silt. After the flood when the water has become clear, and the discharge of the Nile has fallen to about 2,000 tons per second, the gates without rollers will be closed, and then some of those with rollers; so that, between December and March the reservoir will be gradually filled. The reopening of the sluices will take place between May and July, according to the state of the Nile and the requirements of the crops.

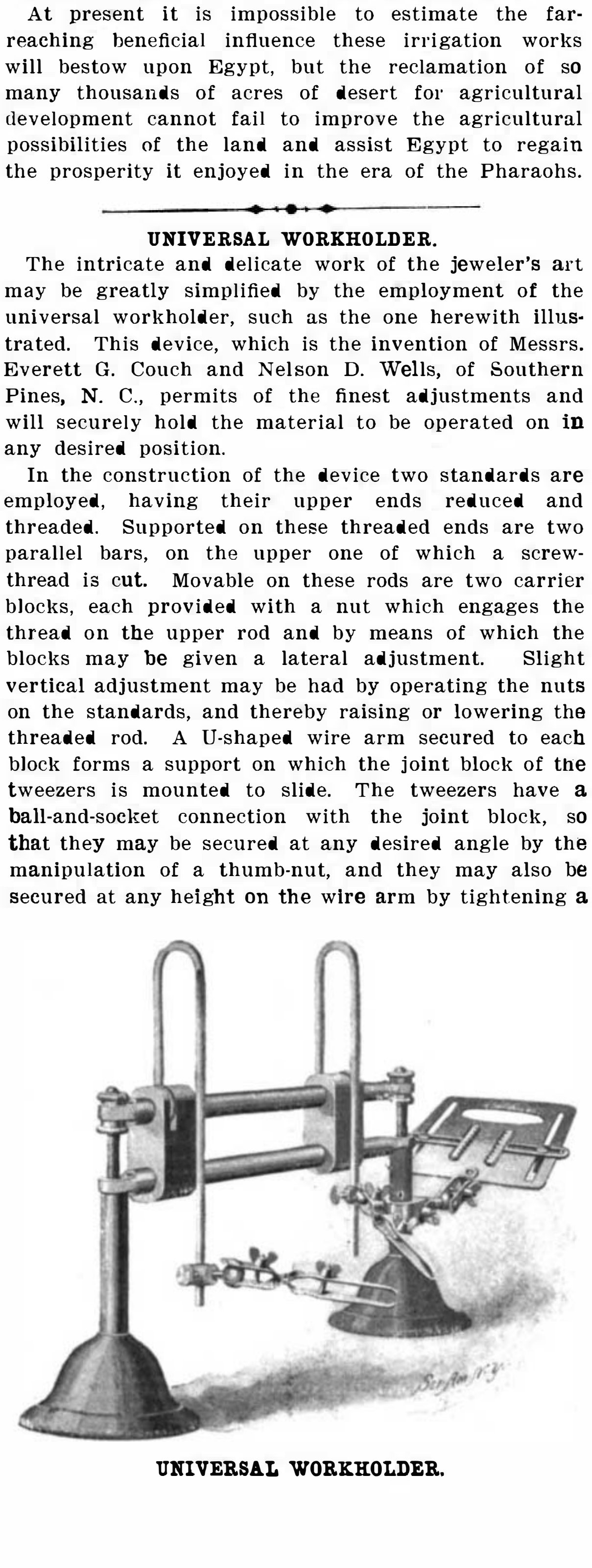
Between December and May, when the reservoir is full, the island of Philæ will in places be slightly flooded. As the temples are founded party on loose silt and sand, the saturation of the hitherto dry soil would cause settlements and no doubt injury to the ruins. To obviate this risk, all the important parts, including the well-known Kiosk, or "Pharaoh's bed," have been either carried on steel girders or underpinned down to rock; or, failing that, to the present saturation level. It need hardly be said that, having regard to the shattered condition of the columns and entablatures, the friability of the stone, and the running sand foundation, the process of underpinning was an exceptionally difficult and anxious task.

At present it is impossible to estimate the far-reaching beneficial influence these irrigation works will bestow upon Egypt, but the reclamation of so many thousands of acres of desert for agricultural development cannot fail to improve the agricultural possibilities of the land and assist Egypt to regain the prosperity it enjoyed in the era of the Pharaohs.

## UNIVERSAL WORKHOLDER.

The intricate and delicate work of the jeweler's art may be greatly simplified by the employment of the universal workholder, such as the one herewith illustrated. This device, which is the invention of Messrs. Everett G. Couch and Nelson D. Wells, of Southern Pines, N. C., permits of the finest adjustments and will securely hold the material to be operated on in any desired position.

In the construction of the device two standards are employed, having their upper ends reduced and threaded. Supported on these threaded ends are two parallel bars, on the upper one of which a screw-thread is cut. Movable on these rods are two carrier blocks, each provided with a nut which engages the thread on the upper rod and by means of which the blocks may be given a lateral adjustment. Slight vertical adjustment may be had by operating the nuts on the standards, and thereby raising or lowering the threaded rod. A U-shaped wire arm secured to each block forms a support on which the joint block of the tweezers is mounted to slide. The tweezers have a ball-and-socket connection with the joint block, so that they may be secured at any desired angle by the manipulation of a thumb-nut, and they may also be secured at any height on the wire arm by tightening a thumb-screw in the joint block; thus an unlimited variety of angles may be obtained.



UNIVERSAL WORKHOLDER.

The value of the device will be readily appreciated by the jeweler. The delicate horizontal adjustment permits a joint when made to be opened for the insertion of solder and closed again without the slightest variation. If desired, the tweezers may be moved apart sufficiently to be swung in line with each other, so that a successful butt-end joint of the smallest gold wire can be made. Additional tweezers may be easily mounted where required.

Adjustable on one of the standards is a clamping block to which a plate is secured by a ball-and-socket joint. Near its outer end this plate is provided with an opening in which a small receptacle may be placed for heating water, a lamp being situated underneath the same. Since the plate is attached to the standard by a universal joint, it will be found useful for holding charcoal, against which the work held by the tweezers may be placed while soldering. The charcoal is held between toothed jaws having slotted shanks which permit adjustment for the varying widths of charcoal, while the same may be secured at any desired position along the slots at each side of the plate. The entire device is characterized by its simplicity of construction which, nevertheless, does not detract from its efficiency for the most varied requirements.

## AN IMPROVED KNIFE.

A patent has recently been granted to Mr. Newton E. Putney, of Southbridge, Mass., for an improvement in tools, such as knives, awls and the like having slidable blades or sheaths. The invention provides a tool of this type which can be readily manipulated with one hand to bring the blade into active cutting position or to conceal the same against possible injury to persons coming into contact with it.

IMPROVED KNIFE.

Our illustration shows a knife having this improved construction. The handle of the knife contains a longitudinally-extending recess in which a metal lining, *C*, is fitted. This lining, which is tubular in shape, is contracted at the inner end so as to be engaged by a transverse pin, *G*, secured in the handle. This pin also engages the inner end of the shank, *A*, of the knife blade. The knife blade is normally concealed within a sheath, *E*, having a tubular extension mounted to slide within the lining, *C*. A shoulder is formed on the inner end of this extension against which one end of the coil spring, *D*, presses, the other end resting against the bottom of the lining. The spring serves to move the sheath to its outermost position, concealing the knife blade. When, however, it is desired to use the knife the sheath is moved back and held in this position by a spring catch, *B*, riveted at one end to the knife blade and at the other end engaging the sheath through an opening in the same. A finger piece is provided on the sheath to enable one more easily to uncover the blade; while the spring-catch is so arranged that by slight pressure of the finger it will be disengaged and the sheath will be moved out under spring tension to conceal the blade. The knife will be found very serviceable for use in stores to cut twine, or for use by carpenters and other mechanics; for it may be safely carried in the pocket without danger of cutting the same, and yet may be readily and quickly brought into cutting position.

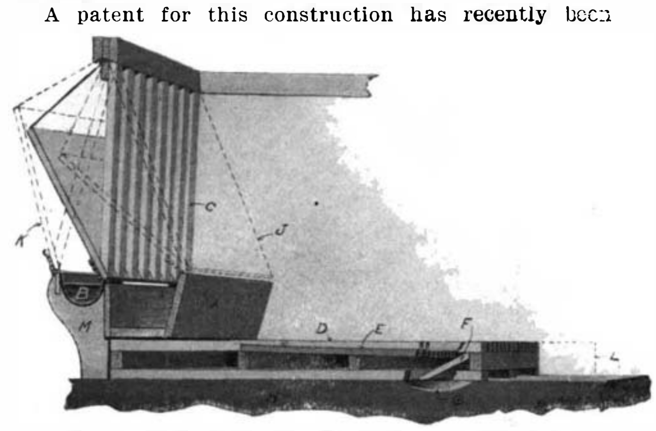
## A STALL FOR HORSES OR CATTLE.

In the accompanying illustration we show a new form of stall for horses and cattle which embodies a number of important features. The stall is provided with a movable floor whereby it may be adjusted for animals of different sizes; it is further provided with an adjustable feed-rack mounted to swing over a water-trough and feed-trough so as to cut out one or both of the troughs and permit an attendant to fill them without entering the stall.

The construction of the stall is as follows: The feed-trough, *A*, and water-trough, *B*, are both supported by brackets, *M*. The feed-rack, *C*, which is adapted to hold hay or like food, is swung on pivots in the side walls of the stall and is arranged to just clear the top edges of the troughs. A bolt at the bottom of the rack serves to lock the same in its different positions. The normal position, which is shown in full lines in the engraving, affords the animal free access to the feed-trough, but cuts out the water-trough. When it is desired to fill the feed-trough the rack, *C*, is moved into position, *J*, indicated by dotted line. In order to water the animals the rack, *C*, is moved back into position, *K*.

Resting on the stable floor, *H*, are the floor sections, *B*, which may be moved back into position, *L*, when necessary to accommodate larger animals. These floor sections are provided with channels into which are fitted the strips, *E*, for directing the drainage against the deflector boards, *F*, and thence into a conduit, *G*, formed in the stable floor, *H*. The deflector boards are required more particularly when the floor sections are drawn outward to position, *L*. When it is desired to clean the stable floor the stall floor sections may be wholly removed and thorough cleansing will thus be permitted.

A patent for this construction has recently been granted to Mr. Richard Smith, of Fort William, Ontario, Canada.



ADJUSTABLE STALL FOR HORSES OR CATTLE.

## A NEW TYPE OF WATER COOLER.

In these days of sanitary precautions there is an increasing demand for pure drinking water. Physicians have succeeded in teaching the general public the evils of the ordinary ice water cooler, and, as a consequence, a number of improved coolers have been put on the market. Among these is one invented by Mr. Charles F. Conover, of 406-420 East 53d Street, New York city. This cooler is more particularly designed for cooling distilled aerated mineral waters and other liquids contained in large glass bottles. The construction permits of conveniently drawing off the liquid and cooling the same without bringing it into direct contact with the cooling medium. The cooler is provided with a bracket, *F*, extending upward, on which the water bottle or demijohn is supported. The stopper of this bottle is provided with an air-vent pipe, *A*, and a siphon pipe, *B*, the latter being connected by a flexible tube with the outer end of the coil, *C*, resting on the bottom of the cooler. The inner end of this coil leads to a faucet, *G*, through which the water may be drawn off into a tumbler, supported on the drip-pan, *D*. Ice is placed on the coil, *C*, to cool off the water circulating therein. The cooler is provided with a bottom pan, into which the drainage from the ice and from the drip-pan, *D*, flows. The faucet, *E*, connects with this pan and affords the means through which the waste water may be drained off. The flexible connection on tube, *B*, is preferably provided with a device by which it may be closed whenever it is disconnected from the siphon-pipe at the time an empty bottle is being replaced by a filled one. As soon as proper connection with the coil has been made, the siphon action begins; for the level of the liquid in the bottle is above the highest point of the siphon pipe.

This form of water cooler embodies many excellent advantages. Primarily, of course, the water is cooled without being contaminated by contact with the ice. Again, only a small amount of water is cooled at a time, so that when a fresh bottle has been connected up, one does not need to wait until its entire contents have been cooled before obtaining a glassful of cold water. Mr. Conover's cooler will further be found very economical in its consumption of ice. Aside from these, other advantages which our limited space prevents us from enumerating, will readily suggest themselves to our readers.

A NEW FORM OF WATER COOLER.