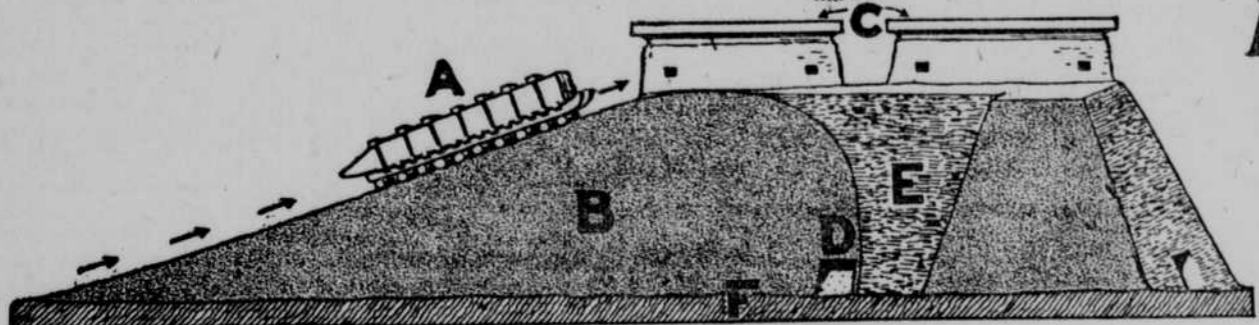
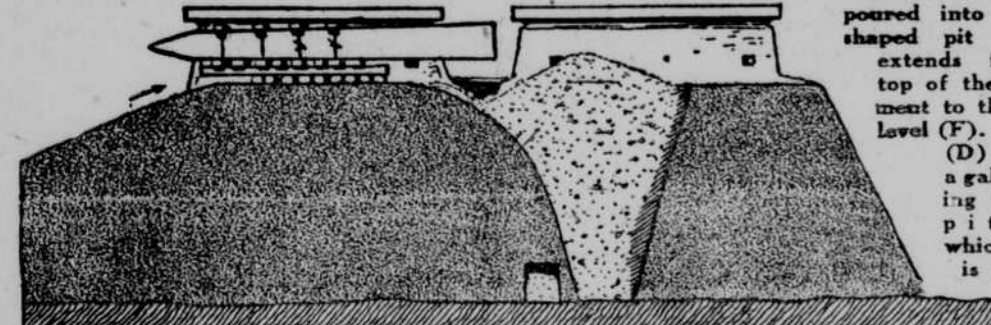


Puzzle Of Egypt's Obelisks Solved At Last

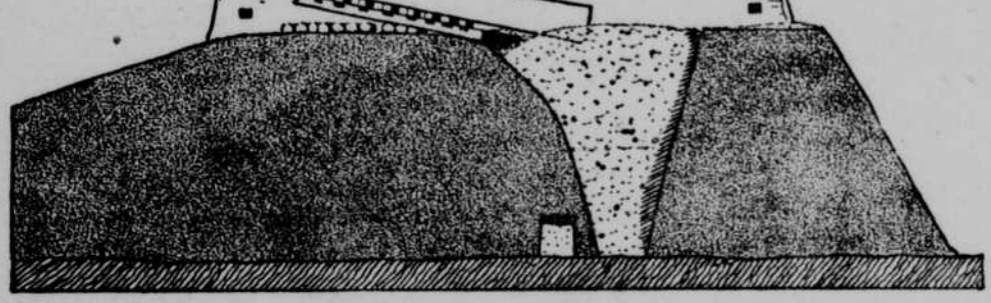
How the Pharaohs' Slaves With Their Primitive Tools Set Up the Great Columns of Stone Which Tax the Ingenuity of Our Modern Engineers



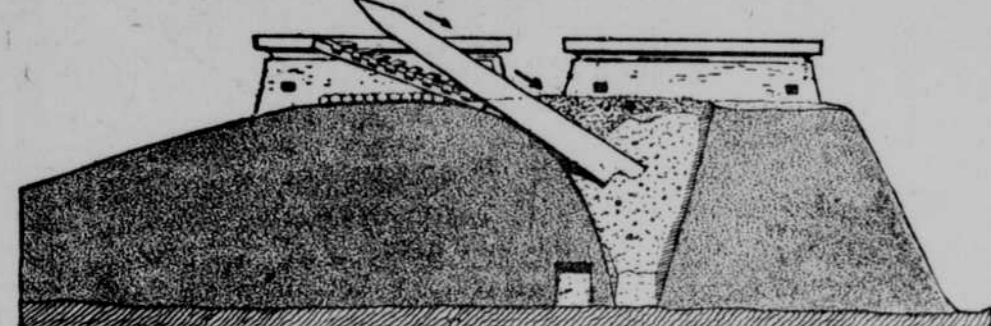
1—Sectional working model of the Egyptians' method of erecting an obelisk weighing hundreds of tons. The obelisk (A) being hauled on a sled up the artificial embankment (B). The buildings (C) are where sand is sifted and poured into the funnel-shaped pit (E), which extends from the top of the embankment to the ground level (F). The door (D) leads to a gallery opening into the pit through which the sand is removed.



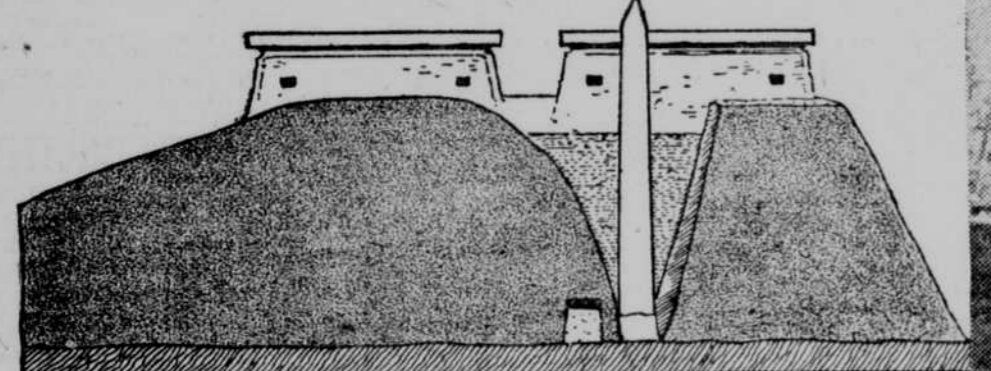
2—The pit filled with sand and the obelisk ready to be pushed over on it, base downward. The pedestal on which the obelisk is to stand is on the ground level at the very bottom of the pile of sand.



3—The obelisk, with all the lashings released and its base sinking into the sand, which prevents it from dropping too fast and being broken.



4—The obelisk when enough of the sand has been removed to permit it sinking half way down the funnel-shaped pit.



5—As the obelisk looks after the last of the sand has been removed from its base and it has been pulled upright, resting squarely on its pedestal. Now all that remains to be done is to remove the surrounding embankment.

AMONG the most remarkable of the monuments left by the ancient Egyptians for us to marvel at are the obelisks—imposing columns consisting of a single piece of stone, often rising to a height of more than one hundred feet and sometimes weighing more than five hundred tons.

How the toiling slaves of the Pharaohs ever managed to quarry such huge stones, transport them over long stretches of land and water and finally set them up on pedestals where they have stood firmly for centuries has long been a puzzle to science.

On the obelisks themselves and in the tombs of some of their architects there have been found no end of facts about the builders' pride in these monuments, the men and gods in whose honor they were raised and, in some cases, the length of time it took to set them up. But there is yet to be discovered any description of the methods of quarrying and transporting one of them and finally lifting it into an upright position on its pedestal.

With all their lack of the engineering knowledge and appliances which we possess, the Egyptians apparently did not think the erection of an obelisk such a difficult task. It was "all in the day's work" and the details were not thought important enough to bother history with.

Yet it was a task that makes the modern world marvel at the patience and ingenuity of the Egyptians.

"Cleopatra's Needle," which now stands in New York's Central Park, is not one of the tallest and heaviest of the obelisks. It is a few inches less than seventy feet in height and weighs 193 tons.

But to bring this column from Egypt, to load it on the ship and unload it, to drag it through New York's streets and finally set it up where it now stands was a job that taxed the skill of some of the world's best engineers. They would hardly have known how to accomplish it without the aid of steam hoisting engines and the most approved cranes, derricks, winches and jacks—all things which are

believed to have been quite unknown in ancient Egypt.

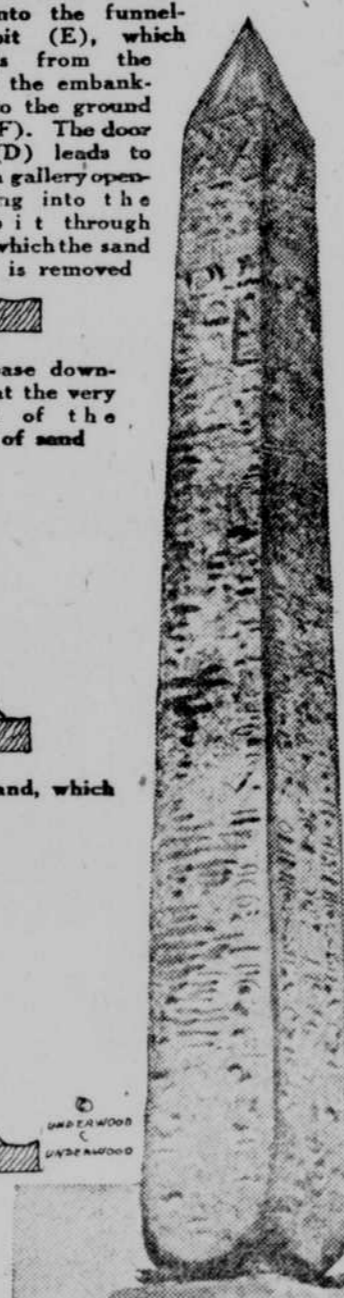
The most plausible theory of the way the obelisks were quarried and transported long distances and set up is that just given to the world by R. Engelbach, chief inspector of antiquities for Upper Egypt. It is based on his study of the unfinished obelisk in the quarry at Aswan, from which many of these monuments came.

This unfinished one is larger than any of those which we know to have been set up. It is 137 feet long and weighs 1,168 tons. Work on it seems to have been stopped because of an unexpected fissure in the rock.

Professor Engelbach patiently cleared away the debris of centuries that covered this abandoned monument and carefully studied the methods that had been followed in quarrying it. When these were settled he proceeded to reconstruct the plan he believes would have been followed in lifting the obelisk out of its resting place in the quarry, carrying it to the site selected for it and rearing its huge bulk on its pedestal.

Preliminary shafts first were sunk, Mr. Engelbach thinks, to ascertain if the rock was of the proper quality for an obelisk of the size desired. After the surface stone had been removed by burning and by prying it off with wedges the outline of the proposed obelisk was marked out and the digging of a trench clear around it begun.

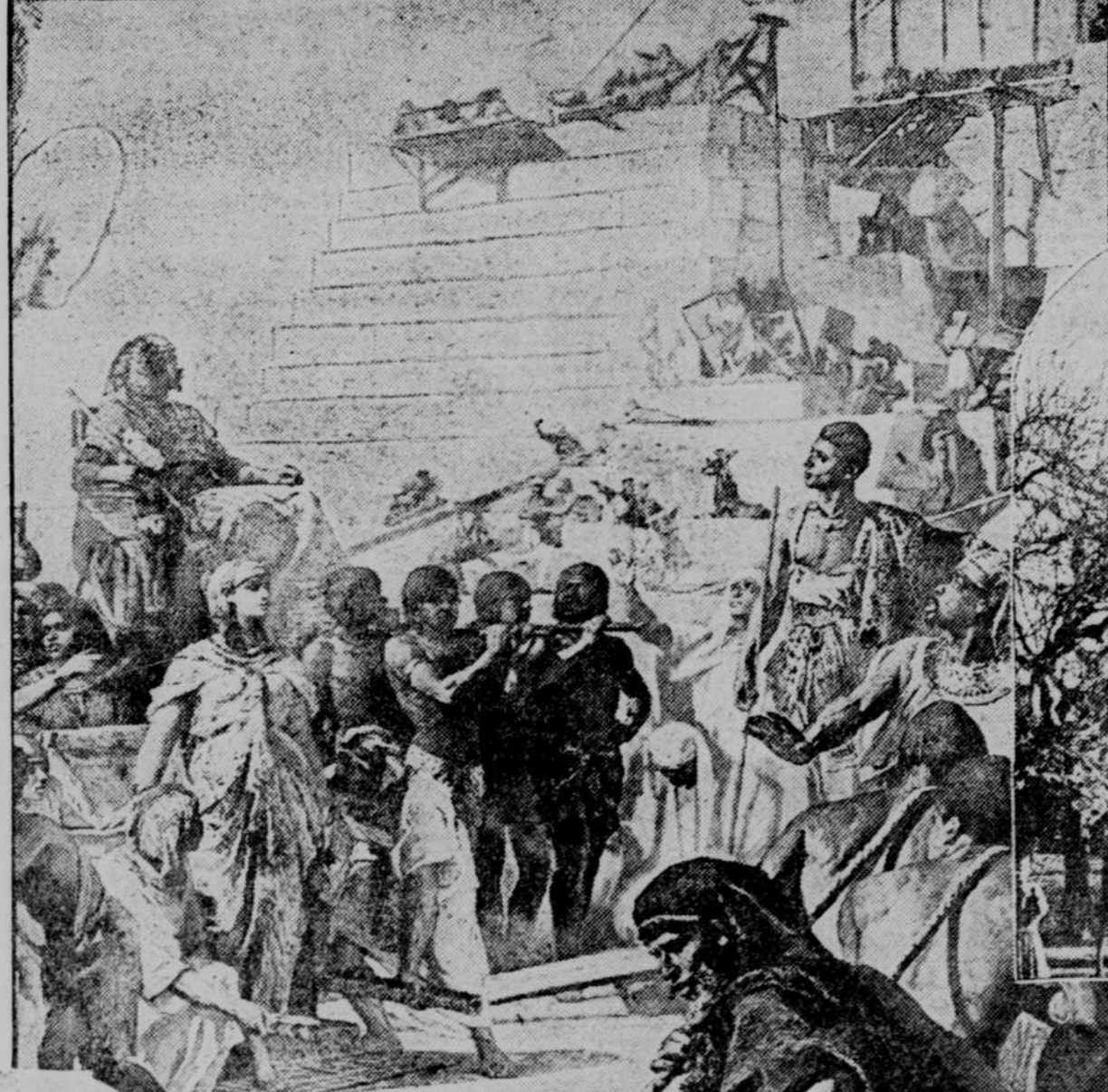
This trench probably was dug by pounding with rammers tamped with heavy round stones that crumbled the granite to dust. As they wielded these tools the toiling slaves sang chants very similar to those sung by the laborers of modern Egypt at their work.



Statue of Sennemut, architect of Queen Hatshepsut's obelisks, holding her little daughter, to whom he was tutor. Above—"Cleopatra's Needle," whose erection in New York's Central Park proved a difficult engineering problem.

While the trench around the obelisk grew deeper and deeper, other workmen attacked the surface of the obelisk that already had been exposed, and made it nicely smooth.

When the trench on both sides and either end had reached a point sufficiently deep, the work of removing the rock from the under side began. As the



The famous painting, "The Building of the Pyramids," showing some of the thousands who toiled for years to raise these amazing monuments to the genius of ancient Egypt's architects and engineers.

solid rock was crumbled away loose stones were put in its place along the middle of the obelisk so that it would not break in two of its own weight when the rest of the supporting granite was removed.

When the obelisk was finally detached from the parent rock Mr. Engelbach thinks it was raised up some distance with levers and the rock in front of it brought down to the level of the obelisk's lower side by wedging and burning. A bank of sand was built on the rock and onto this the obelisk was tipped sideways. This sand was dug away and a new bank piled up to receive the obelisk with another tipping and this process was repeated over and over again until the edge of the quarry was reached.

There a huge sled was waiting, buried under quite a depth of sand. Onto this the obelisk was rolled, then the sand was dug away from beneath it and the sled was drawn, probably on huge rollers, to the bank of the Nile.

Loading onto a barge was accomplished by drawing the boat as close to the bank as possible, building an embankment around and over it and then letting the obelisk settle down into its place by digging out the filling from beneath it. The unloading was done by building another embankment, but in this case it had to reach only to the level of the rollers on which the granite column rested in the barge.

To make plain his novel theory of the ingenious method by which one of these huge and unwieldy pieces of stone was raised to its full height and set squarely on a pedestal Mr. Engelbach con-

structed—on a miniature scale, of course—a complete working model. On this page are given sectional views of this model showing five different stages in the erection of an obelisk.

As Mr. Engelbach explains in his recently published book, "The Problem of the Obelisks," he believes the Egyptians built over and around the pedestal an embankment of earth almost as high as the obelisk was to stand. This embankment sloped gently upward from the level of the ground at one side and up this incline the obelisk was hauled on a sled.

Directly over the pedestal a funnel-shaped pit was dug in the embankment, extending from top to bottom. This pit was filled with fine, soft sand and onto this sand the obelisk was tipped from the sled, bottom end first.

Workmen in galleries built in the lower part of the embankment then would begin to remove the sand, and as they did so the obelisk would start sliding automatically deeper and deeper into the pit.

At last, when all but a very little of the sand had been removed, the obelisk would be leaning against one side of the pit, in an almost upright position. As the remaining sand was taken away slaves would pull the obelisk into a perpendicular position and it would settle gently down on the pedestal, the notch in its base fitting nicely into the place prepared for it.

Then all that had to be done was to level the embankment of earth that had been thrown up and there the obelisk was, prepared to stand for untold ages

The obelisk of Senusert I at Mataria, near Cairo. It is a comparatively small one, 67 feet in height and weighing 121 tons.

unless covetous Europeans or Americans should take it down and carry it off.

"I have made several experiments in the slope of the sides of the funnel," says Mr. Engelbach, "and the form of the leading-in curve, and I find that a wide range of variation will produce the desired results. The only necessity appears to be that the left wall of the funnel must be straight until it is of a height of at least two-thirds the height of the balancing point of the obelisk before the curve begins.

"Many students have boldly affirmed that the Egyptians knew engines and forces of nature of which we are to-day ignorant. This is quite a wrong idea; it is, as a matter of fact, far easier to explain every step in the mechanics of a large obelisk to the non-technical reader than those of an iron bridge.

"Though modern research robs the Egyptians of the magical powers attributed to them, it makes them far more admirable in the eyes of the practical man, as it shows that they could do, with the most primitive tools, feats of engineering which we, with some 3,000 years of mechanical progress behind us, are barely able to copy.

"A study of the unfinished Aswan obelisk enables the visitor to look with different eyes on the finished monuments and to realize, not only the immense labor expended in transporting the giant blocks and the years of tedious extraction of stone in the quarries, but the heartbreaking failures which must sometimes have driven the old engineers to the verge of despair before a perfect monument could be presented by the king to his god.

"Nowadays, if anything gets out of position, a jack, a winch or a crane is called for, and the trouble is soon put right; in ancient times a colossus or an obelisk which came down badly onto its pedestal was something in the nature of a tragedy.

"The origin and religious significance of the obelisk are somewhat obscure. In the royal sanctuaries of the fifth dynasty kings on the margin of the western desert at Abusir, not far from the Pyramids of Gizeh, the obelisk took the place of the holy of holies of the later temples.

"The obelisks of Upper Egypt, on the other hand, had no very definite connection with sun-worship, their only function being an additional decoration to the pylons."