ANCIENT HYDRAULIC CLOCKS.*

The clocks of the ancients were based upon a uniformity in the velocity with which a liquid of constant level flows through an orifice. Heron, of Alexandria, composed a treatise (now lost) upon hydraulic clocks, and Philo, of Byzantium, in a recently discovered fragment of his Pneumatics, indicates several of the apparatus that were in use for obtaining a constancy in the level of the liquid motor in cases where there was not at one's disposal a continuous feed which permitted of employing the very simple waste pipe arrangement.

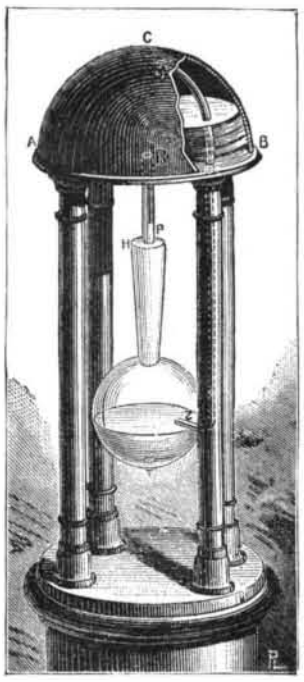

Fig. 1.—CONSTANT LEVEL APPARATUS.

Fig. 1 shows one of these apparatus. Let H T be the vessel, in which a constant level is to be obtained at the height, Z, despite the outflow that occurs at T. This vessel is surmounted with a reservoir, A C B, containing three apertures—one at C, for the introduction of the liquid; one at R, for the reception of a tube, R P, that serves to feed the vessel, H T; and one at B, for allowing of the passage of the tube, Q Z, which puts the upper part of the vessel in communication with the lower one at the level, Z.

The upper vessel is filled through the aperture, C, while the orifice, P, is closed, and then the former is closed and the latter opened. The liquid then flows into the vessel, H T, and the air enters through Z Q. If the discharge from R P is greater than that from the orifice, T, the liquid will then gradually rise in H T, until it reaches the level, Z. The apparatus will then be charged; since, as soon as the level of the water will have risen above Z, the air will no longer enter through R Q, and the flow from the upper vessel will stop, and will not begin again until the level, upon lowering, uncovers Z. This level will oscillate, then, between two very approximate limits until the upper reservoir is emptied.

I have selected the preceding arrangement from among the four given by the Greek author, because it is adapted to the production of one of those little prodigies that the ancients delighted in. It will be seen, in fact, that if the lower vessel be replaced by an urn with a wide mouth, and the bottom, A B, by a sieve, we might thus have a fanciful explanation of the action of Providence sending rain at periodical intervals to supply the sources of rivers.

Before the Greeks had thought of establishing constant levels, the Egyptians had devised clepsydras based upon the properties of the siphon. A Greek grammarian, named Horapollo, who taught belles-lettres at Alexandria in the fourth century of our era, has left a few details upon this subject which I can only quote in Latin:

"Rursus æquinoctia significantes idem animal Cynocephalum sedentem pingunt; duobus enim anni æquinoctiis, duodecies in die, per singulas nimirum horas urinam reddit; idemque noctie facit. Quare non immerito suis horologiis Ægyptii cynocephalum sedentem insculpunt, a cujus membro aqua difluat idque propterea quod duobus quas jam dixi, in quas æquinoctii tempore dies et noctes ex æquo dividentur, horas significet. Cœterum ne foramen illud acue artificioseque constructum, per quod in horologium aqua profluit et excernitur, aut latius fit, aut rursum auctius, remedium hoc excogitarunt, est quo quiquid pilorum est, ad caudam usque abradentes, pro hujus crassitudine ferream quondam fistulam in usum jam dictum fabricentur."

Fig. 2 gives the restoration proposed by F. Kircher, for the Egyptian clepsydra of Horapollo.

The cynocephalus, M, contains a brass vessel which serves as a reservoir for the water whose flow is to measure the hours. C D is a glass cylinder whose bottom contains an aperture for the passage of a tube, K, that forms a siphon with the hell, E F. It will be seen that the water that flows from the cynocephalus' body into the cylinder, C D, will rise in the latter until its level reaches the upper orifice of the tube, I K. At this moment the siphon will become primed, and the water will flow into the vessel, G H. If the discharge from K is sufficiently great with respect to that from the cynocephalus, the vessel, C D, will empty entirely at the end of a certain time. Between the contents and discharges of the cynocephalus and the vessel, C D, ratios may be so established that the cynocephalus shall supply the clock for 24 hours, and that the cylinder shall fill up in 12 hours and likewise empty in 12 hours. It will then only be necessary to mark upon the cylinders, C D, and E F, divisions that shall correspond to these hours. The ascending divisions on the cylinder, C D, will represent, for example, the 12 hours of the day, and the descending ones on E F, those of the night. These divisions will not all be exactly at the same distance, since the velocity of the flow varies

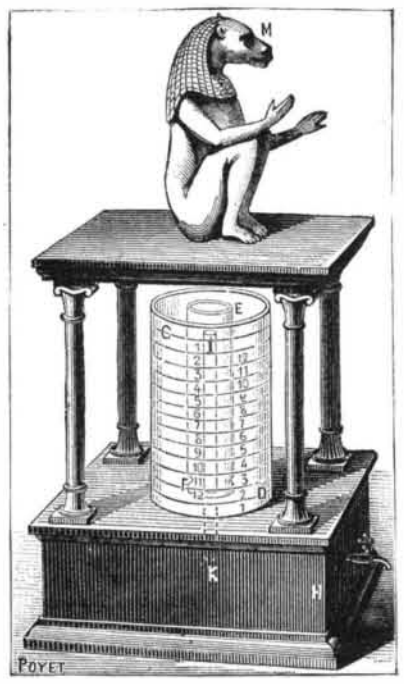

Fig. 2.—EGYPTIAN HYDRAULIC CLOCK.

with the height of the liquid above the orifice through which it runs.

One might, by daily modifying the discharge from the cynocephalus, by means of cocks, succeed in having the cylinder, C D, fill during the time that elapses between sunrise and sun set, and in having it empty between sunset and sunrise; but the operation would be a very delicate one, and the ancients solved the problem in another way—by the aid of curves analogous to those that serve for the equation of time in sun dials.

In the clock that I have just described, the cynocephalus is supposed to be filled with water every twelve hours. In order to surmount such an inconvenience, it is only necessary to cause water to flow from a fountain, A, into a basin provided at its upper part, for the overflow, with a cock for keeping the level constant, and at its lower with a siphon for leading the water into the large cylindrical vessel.

Kircher asserts that he has read in Heron's treatise upon hydraulic clocks that the Egyptians had apparatus of this kind that began to work automatically at sunrise. For this purpose there was employed as upper reservoir a very thin glass or metal globe, which was provided internally with a siphon, D E, rising to a little above the center. Through an orifice, A, water was poured into the globe nearly up to the siphon's curve, and then the aperture was hermetically closed. It will be seen that the first rays of the sun

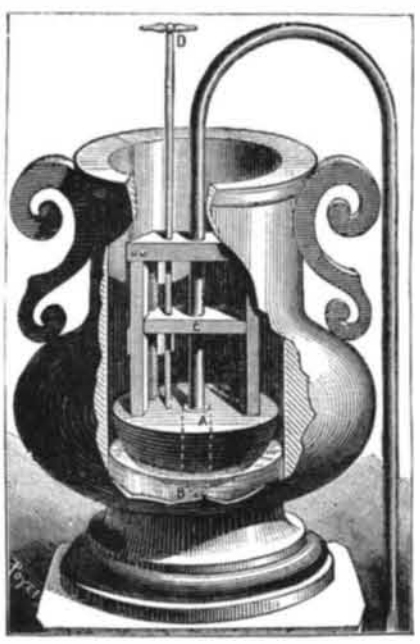

Fig. 4.—HERON'S CONSTANT DISCHARGE SIPHON.

that struck the globe expanded the air, and, causing the water to rise in the siphon, primed the latter. The discharge then continued until the globe was empty. With two clocks of this kind running alternately it was unnecessary to rise at daybreak unless the sky was cloudy—an occurrence that seldom happens in Egypt.

In the apparatus shown in Fig. 2, as well as in that in Fig. 1, the discharge from the upper vessel diminishes in measure as the level of the contained liquid lowers. Heron in his Pneumatics describes an arrangement which permits of rendering the discharge from a siphon constant, and even of causing the velocity with which this constant discharge flows to vary at will. In order to render the discharge constant, it is only necessary to affix the shorter leg of the siphon to a float (Fig. 4), when it will always preserve the same length over the surface of the water. The velocity of the outflow is made to vary by increasing or diminishing such length by means of a screw, D, that actuates a crosspiece, *c*, movable between the two uprights of a frame affixed to the float. The shorter leg of the siphon is fixed to this crosspiece, and its extremity slides with slight friction through a tube, A B, set into the float.

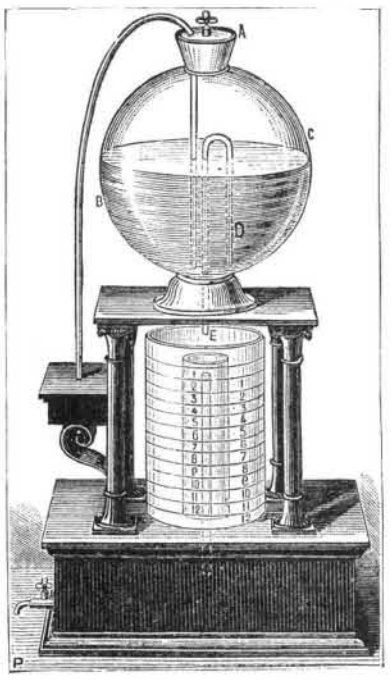

Fig. 3.—EGYPTIAN HYDRAULIC CLOCK SET IN ACTION BY THE SUN.

It will be seen that 200 B. C., the screw was already practically utilized; but the nut was not as yet manufactured, and it will be seen from the Alexandrian engineer's description that this device was replaced by a simple pin which was fixed to the crosspiece, and which engaged with the thread of the screw.

Fig Cultivation in Sicily.

There are several varieties of the fig tree in Sicily, some yielding a large, others a small fruit, and this fruit varies in its degree of sweetness, also in color from white to black. The fruit of some varieties ripens sooner than that of others. The trees grow equally well in poor and rich soil, and bear abundantly when planted on the mountain side and in the valleys. Consul Woodcock, on Catania, says that the favorite varieties of Sicilian figs are the *Sangiovannaro*, the *Sottuno*, the *Melinciano*, and *Ottalo*. The *Ottalo* has smooth leaves, the peduncle of the flower and fruit is longer, and the fruit is sweeter than that of the other varieties. The *Ottalo* fig is considered to be the best for drying. The fig is propagated from the suckers that spring up from the roots, cuttings from the tree being also used, and these are set in the months of February and March. In orchards the distance maintained between the trees is about twenty-six feet. The fig is long lived, as it is constantly being renewed by shoots that spring up from the roots taking the place of the main trunk when it becomes old and decayed. The soil is worked in the spring, and also in November following. The best varieties in Sicily are grafted, and also budded upon the stock of the wild fig, this operation being performed also upon healthy trees of the best varieties, and the time chosen for it in March, or when the trees are in blossom in June. Great care is exercised in the cultivation of the tree to remove all dead and diseased branches, and to avoid too much cutting and pruning. The fruit is dried in the following manner: It is gathered when partially ripe, that is, when the fruit is more green than ripe, and immediately plunged into boiling water, and allowed to remain only a very few minutes. It is then placed in a spot sheltered from the sun, and the next morning, at sunrise, spread upon a platform in order that it may be flooded with sunlight, care be taken not to place it upon the ground on account of its dampness. While drying, shallow willowwork baskets are used for holding the fruit, and these are never placed upon the ground, but kept in an erect position. At sundown the fruit is covered to protect it from the night dews or unexpected showers of rain, and this operation is continued for several days until the fruit becomes thoroughly dry. When dry it is placed in layers in small boxes or baskets, these layers being arranged very neatly and artistically, the fruit being pressed down firmly by hand until the box or basket is full, when they are securely covered and kept in a dry place ready for shipment.

A Poor Inventor Who Became Rich.

An inventory of the estate of the late Cyrus McCormick, the inventor of the harvester, has been filed in the Probate Court of Cook County, Ill. The total is not far from twenty million dollars. The executors of this colossal trust furnished a bond for thirty millions.

* A. De Rochas, in *La Nature*.