

displaced the air, a certain sound was produced, either by its expulsion through some small orifice, or by its escape between the sides of the case and the weight. This sound had probably remained unnoticed, like the ordinary creak of a door, perhaps for many years, until one day, as the barber's son was amusing himself in his father's shop, his attention was arrested by it. This boy's subsequent reflections induced him to investigate its cause, and from this simple circumstance he was led eventually either to invent or greatly to improve the hydraulic organ, the force pump, the air gun fire engine, &c. Now this barber's son was Ctesibius, of Alexandria, one of the most eminent mathematicians and mechanics of antiquity, and the teacher of Hero, of Alexandria, of whom I have previously spoken. No illustration of the pump of Ctesibius has survived, but from the descriptions handed down it is supposed to have been thus:—

A wheel having projections or float boards on its rim is placed in a stream; fixed upon the same shaft with the wheel, and therefore revolving with it, is a piece called a cam, which stands out more on one side of the shaft than the other. At each revolution this pushes down one end of a lever, to the other end of which is connected the pump rod, carrying a solid piston closely fitting the barrel of the pump. In the bottom of the pump is a suction valve and a pipe leading to the water, and in the side another pipe, terminated by a delivery valve at the bottom of an air vessel. Inserted in the air vessel is a delivery pipe, up which the water passes to its destination. The air vessel is in effect an elastic cushion, compressed during the stroke of the pump, and expanding during the return stroke, so that the water is forced up the delivery pipe in a continuous stream. In some cases there were two pumps worked by the same wheel and connected to the same air vessel to still further equalize the flow. No details are shown, but the mechanical arts must even at that time have arrived at some degree of perfection, for we are told that "the cylinders were made of brass, the pistons turned very smooth, and the valves hinged with very exact joints."

About the beginning of the Christian era, a Roman architect and engineer, named Vitruvius, wrote a treatise on those professions, and inserted a brief account of the hydraulic machines then in use.

It is an interesting circumstance in the history of this ancient engine that the air vessel should have been preserved through so many ages, when its use was not known. While its size was diminished, its form was retained. It is no wonder that the old copyists consider it an unsightly and unnecessary enlargement of the discharge pipe, and hence they removed it accordingly; certainly the fancy that could add the rectangular twist to the upper part, would not hesitate to remove the supposed deformity from the lower one. Some persons, deceived by the imperfect representation, have supposed that such engines were not used in the time of Heron, and that the figure and description were inserted in his work as mere hints for future mechanics to improve on, but the description sufficiently indicates that similar machines were in actual use. The materials and workmanship of the pumps—metallic pistons and spindle valves—with guards to prevent the latter from opening too far, the mode of forming the goose neck by a kind of swivel joint, somewhat like the union or coupling screw, the application of an air vessel, two pumps forcing water through one pipe, and both worked by a double

lever, are proofs that the machine described by Heron was neither an ideal one nor of recent origin or use. There are features in it that were very slowly developed by manufacturers in modern times. It is not at all improbable that ancient engines were equal in effect to the best of ours, but, whether they were or not, one thing is certain, that to the ancients belong the merit of discovering the principles employed in these machines, and of applying them to practice. It is remarkable, too, that fire engines made their first appearance in Egypt, thus adding another to the numerous obligations under which that wonderful country has placed civilized nations in all times to come.



FIRE APPLIANCES, LONDON, 1660.

Having noticed the use of pumps to extinguish fires, I may remark that they were also employed in the middle ages, if not before, to promote conflagrations, viz., to launch Greek fire. This mysterious substance is represented as a liquid. Beckman says it certainly was one, and so far from being quenched, its violence was augmented by contact with water. It was principally employed in naval combats, being enclosed in jars that were thrown into the hostile vessels. It was also blown through iron and copper tubes planted on the prows of galleys and fancifully shaped like the mouths of animals, which seemed to vomit streams of liquid fire. There is among the figures of war machines in the old German translation of Vegetius, one that (judging from the flames issuing from monstrous animals' mouths) seems to have been designed for projecting Greek fire, though it is difficult to see how it was done. Another mode of using this terrible material was by forcing it in jets "by means of large fire engines," and sometimes "the soldiers squirted it from hand engines." Its effects upon those on whom it was thrown seem to have been somewhat similar to those produced by the composition of alcohol and spirits of turpentine recently adopted as a substitute for oil in lamps, and which has occasioned so many fatal disasters, by the explosion of vessels containing it and its consequent dispersion over the persons of the sufferers. It was easy (says Beckman) to conceive the idea of discharging Greek fire by means of forcing pumps, because the application of them to extinguish fires was known long before its invention. It is supposed to have originated with Callinicus, a Syrian engineer of Balbec, in the 7th century. It may, however, have been known to the old Greeks and Romans, for they made use of similar devices for projecting fire. Monfaucon, in describing their marine combats, observes