A

DESCRIPTIVE AND HISTORICAL ACCOUNT

OF

HYDRAULIC AND OTHER MACHINES

FOR

RAISING WATER,

Ancient and Modern:

WITH OBSERVATIONS ON VARIOUS SUBJECTS

CONNECTED WITH THE

MECHANIC ARTS:

INCLUDING THE PROGRESSIVE DEVELOPMENT OF

THE STEAM ENGINE:

DESCRIPTIONS OF EVERY VARIETY OF BELLOWS, PISTON, AND ROTARY PUMPS—FIRE ENGINES—WATER RAMS—PRESSURE ENGINES—AIR MACHINES—EOLIPILES, &C. REMARKS ON ANCIENT WELLS—AIR BEDS—COG WHEELS—BLOWPIPES—BELLOWS OF VARIOUS PEOPLE—MAGIC GOBLETS—STEAM IDOLS, AND OTHER MACHINERY OF ANCIENT TEMPLES. TO WHICH ARE ADDED EXPERIMENTS ON BLOWING AND SPOUTING TUBES, AND OTHER ORIGINAL DEVICES—NATURE'S MODES AND MACHINERY FOR RAISING WATER. HISTORICAL NOTICES RESPECTING SIPHONS, FOUNTAINS, WATER ORGANS, CLEPSYDRÆ, PIPES, VALVES, COCKS, &C.

IN FIVE BOOKS.

ILLUSTRATED BY NEARLY THREE HUNDRED ENGRAVINGS.

SECOND EDITION,

REVISED AND CORRECTED—TO WHICH IS ADDED, A SUPPLEMENT.

BY THOMAS EWBANK.

It is a cruel mortification in searching for what is instructive in the history of past times, to find the exploits of conquerors who have desolated the earth, and the freaks of tyrants who have rendered nations unhappy, are recorded with minute and often disgusting accuracy—while the discovery of useful arts, and the progress of the most beneficial branches of commerce, are passed over in silence, and suffered to sink into oblivion. *Robertson's India.*

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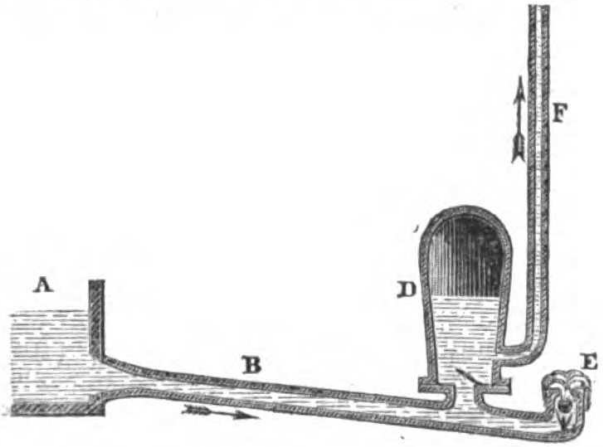
out with the liquid from the lateral pipes. Notwithstanding the advantages derived from such an apparatus, under circumstances similar to those indicated by the figure, it does not appear to have elicited the attention of engineers, nor does Whitehurst himself seem to have been aware of its adaptation as a substitute for forcing pumps, in locations where the water drawn from the cock was not required, or could not be used. Had he pursued the subject, it is probable the idea of opening and closing the cock (by means of the water that escaped) with some such apparatus as figured in No. 160, would have occurred to him, and then his machine being made self-acting, would have been applicable in a thousand locations. But these additions were not made, and the consequence was, that the invention was neglected, and but for the one next to be described, it would most likely have passed into oblivion, like the steam machines of Branca, Kircher, and Decaus, till called forth by the application of the same principle in more recent devices.

Whenever we peruse accounts of the labors of ingenious men, in search of new discoveries in science or the arts, sympathy leads us to rejoice at their success and to grieve at their failure: like the readers of a well written novel who enter into the views, feelings and hopes of the hero; realize his disappointments, partake of his pleasures, and become interested in his fate; hence something like regret comes over us, when an industrious experimenter, led by his researches to the verge of an important discovery, is, by some circumstance diverted (perhaps temporarily) from it; and a more fortunate or more sagacious rival steps in and bears off the prize from his grasp—a prize, which a few steps more would have put him in possession of. Thus Whitehurst with the water-ram, like Papin with the steam-engine, discontinued his researches at the most interesting point—at the very turning of the tide that would have carried him to the goal; and hence the fruit of both their labors has contributed but to enhance the glory of their successors.

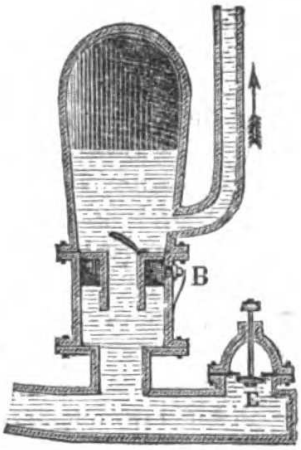
The *Bèlier hydraulique* of Montgolfier was invented in 1796. (Its author was a French paper maker, and the same gentleman who, in conjunction with his brother, invented balloons in 1782.) Although it is on the principle of Whitehurst's machine, its invention is believed to have been entirely independent of the latter. But if it were even admitted that Montgolfier was acquainted with what Whitehurst had done, still he has, by his improvements, made the ram entirely his own. He found it a comparatively useless device, and he rendered it one of the most efficient —it was neglected or forgotten, and he not only revived it, but gave it a permanent place among hydraulic machines, and actually made it the most interesting of them all. It was, previous to his time, but an embryo; when, like another Prometheus, he not only wrought it into shape and beauty, but imparted to it, as it were, a principle of life, that rendered its movements *self-acting;* for it requires neither the attendance of man, nor any thing else, to keep it in play, but the momentum of the water it is employed to elevate. Like the organization of animal life, and the mechanism by which the blood circulates, the pulsations of this admirable machine incessantly continue day and night, for months and years; while nothing but a deficiency of the liquid, or defects in the apparatus can induce it to stop. It is, compared to Whitehurst's, what the steam-engine of Watt is to that of Savary or Newcomen.

Montgolfier positively denied having borrowed the idea from any one—he claimed the invention as wholly his own, and there is no reason whatever to question his veracity. The same discoveries have often been, and still are, made in the same and in distant countries, independently of each

other. It is a common occurrence, and from the constitution of the human mind will always be one. A patent was taken out in England for self-acting rams in 1797 by Mr. Boulton, the partner of Watt, and as no reference was made in the specification to Montgolfier, many persons imagined them to be of English origin, a circumstance that elicited some remarks from their author. "Cette invention (says Montgolfier) n'est point d'origine Anglaise, elle appartient toute entière à la France; je déclare que j'en suis le seul inventeur, et que l'idée ne m'en a été fournie par personne; il est vrai qu'un de mes amis a fait passer, avec mon agrément, a MM. Watt et Boulton, copie de plusieurs dessins que j'avais faits de cette machine, avec un mémoire détaillé sur ses applications. Ce sont *ces mêmes dessins* qui ont été fidèlement copiés dans la patente prise par M. Boulton à Londres, en date du 13 Décembre 1797; ce qui est une vérité dont il est bien éloigné de disconvenir, ainsi que le respectable M. Watt." We have inserted this extract from Hachette, because we really supposed on reading the specification of Boulton's patent in the Repertory of Arts, (for 1798, vol. ix,) that the various modifications of the ram there described were the invention of that gentleman. The patent was granted to "Matthew Boulton, for *his* invention of improved apparatus and methods for raising water and other fluids."



No. 168. Montgolfier's Ram.



No. 169. The same.

No. 168 represents a simple form of Montgolfier's ram. The motive column descends from a spring or brook A through the pipe B, near the end of which an air chamber D, and rising main F, are attached to it as shown in the cut. At the extreme end of B, the orifice is opened and closed by a valve E, instead of the cock in No. 167. This valve opens downwards and may either be a spherical one as in No. 168, or a common spindle one as in No. 169. It is the play of this valve that renders the machine self-acting. To accomplish this, the valve is made of, or loaded with, such a weight as just to open when the water in B is at rest; *i. e.* it must be so heavy as to overcome the pressure against its under side when closed, as represented at No. 169. Now suppose this valve open as in No. 168, the water flowing through B soon acquires an additional force that carries up the valve against its seat; then, as in shutting the cock of Whitehurst's machine, a portion of the water will enter and rise in F, the valve of the air chamber preventing its return. When this has taken place the water in B has been brought to rest, and as in that state its pressure is insufficient to sustain the weight of the valve, E opens; (descends) the water in B is again put in motion, and again it closes E as before, when another portion is driven into the air vessel and pipe F; and thus the

operation is continued, as long as the spring affords a sufficient supply and the apparatus remains in order.

The surface of the water in the spring or source should always be kept at the same elevation, so that its pressure against the valve E may always be uniform—otherwise the weight of E would have to be altered as the surface of the spring rose and fell.

This beautiful machine may be adapted to numerous locations in every country. When the perpendicular fall from the spring to the valve E is but a few feet, and the water is required to be raised to a considerable height through F, then, the *length* of the ram or pipe B, must be increased, and to such an extent that the water in it is not forced back into the spring when E closes, which will always be the case if B is not of sufficient length. Mr. Millington, who erected several in England, justly observes that a very insignificant pressing column is capable of raising a very high ascending one, so that a sufficient fall of water may be obtained in almost every running brook, by damming the upper end to produce the reservoir, and carrying the pipe down the natural channel of the stream until a sufficient fall is obtained. In this way a ram has been made to raise one hundred hogsheads of water in twenty-four hours to a perpendicular height of one hundred and thirty-four feet, by a fall of only four feet and a half. M. Fischer of Schaffhausen, constructed a water-ram in the form of a beautiful antique altar, nearly in the style of that of Esculapius, as represented in various engravings. A basin about six inches in depth, and from eighteen to twenty inches in diameter, received the water that formed the motive column. This water flowed through pipes three inches in diameter that descended in a spiral form into the base of the altar; on the valve opening a third of the water escaped, and the rest was forced up to a castle several hundred feet above the level of the Rhine.

A long tube laid along the edge of a rapid river, as the Niagara above the falls, or the Mississippi, might thus be used instead of pumps, water wheels, steam-engines and horses, to raise the water over the highest banks and supply inland towns, however elevated their location might be; and there is scarcely a farmer in the land but who might, in the absence of other sources, furnish his dwelling and barns with water in the same way, from a brook, creek, rivulet or pond.

If a ram of large dimensions, and made like No. 168, be used to raise water to a great elevation, it would be subject to an inconvenience that would soon destroy the beneficial effect of the air chamber. When speaking of the air vessels of fire-engines, in the third book, we observed that if air be subjected to great pressure in contact with water, it in time becomes incorporated with or absorbed by the latter. As might be supposed, the same thing occurs in water-rams; as these when used are incessantly at work both day and night. To remedy this, Montgolfier ingeniously adapted a very small valve (opening inwards) to the pipe beneath the air chamber, and which was opened and shut by the ordinary action of the machine. Thus, when the flow of the water through B is suddenly stopped by the valve E, a partial vacuum is produced immediately below the air chamber by the recoil of the water, at which instant the small valve opens and a portion of air enters and supplies that which the water absorbs. Sometimes this *snifting* valve, as it has been named, is adapted to another chamber immediately below that which forms the reservoir of air, as at B in No. 169. In small rams a sufficient supply is found to enter at the valve E.

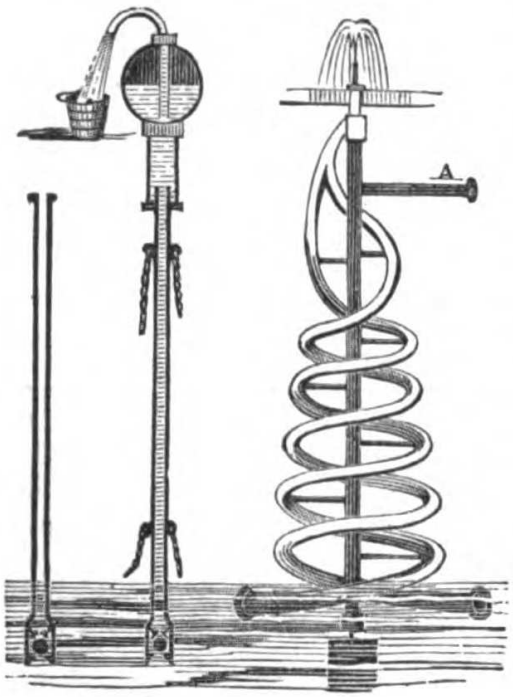
Although air chambers or vessels are not, strictly speaking, constituent elements of water-rams, they are indispensable to the permanent operation

of these machines. Without them, the pipes would soon be ruptured by the violent concussion consequent on the sudden stoppage of the efflux of the motive column. They perform a similar part to that of the bags of wool, &c. which the ancients, when besieged, interposed between their walls and the battering rams of the besiegers, in order to break the force of the blows.

The ram has also been used in a few cases to raise water by atmospheric pressure from a lower level, so as to discharge it at the same level with the motive column or even higher. See *Siphon Ram*, in next book.

The device by which Montgolfier made the ram self-acting, is one of the neatest imaginable. It is unique: there never was any thing like it in practical hydraulics, or in the whole range of the arts; and its simplicity is equal to its novelty, and useful effects. Perhaps it may be said that he only added a valve to Whitehurst's machine: be it so—but that simple valve instantly changed, as by magic, the whole character of the apparatus—like the mere change of the cap, which transformed the Leech Hakim into Saladin.[a] And the emotions of Cœur de Lion, upon finding his great adversary had been his physician in disguise, were not more exquisite than those, which an admirer of this department of philosophy experiences, when he contemplates for the first time the metamorphosis of the English machine by the French Savan. The name of Montgolfier will justly be associated with this admirable machine in future ages. When all political and ecclesiastical crusaders are forgotten, and the memories of all who have hewed a passage to notoriety merely by the sword, will be detested—the name of its inventor will be embalmed in the recollections of an admiring posterity.

The water cane, or *canne hydraulique*, raises water in a different manner from any apparatus yet described. A modification of it in miniature has long been employed in the lecture room, but it is seldom met with in descriptions of hydraulic machines. It is represented at No. 170; and consists of a vertical tube, in outward appearance like a walking cane, having a valve opening upwards at the bottom, and placed in the liquid to be raised. Suppose the lower end twelve or fifteen inches below the surface, the water of course would enter through the valve and stand at the same height within as without: now if the tube were raised quickly, but not entirely out of the water, the valve would close and the liquid within would be carried up with it; and if, when the tube was at the highest point of the stroke, its motion was *suddenly reversed* (by jerking it back) the liquid column within would still continue to ascend until the momentum imparted to it at the first was expended; hence a vacuity would be left in the lower part of the instrument into which a fresh portion of water would enter, and by repeating the operation the



No. 170 No. 171. No. 172.

[a] Walter Scott's Tales of the Crusaders.