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DESCRIPTION
Of Montgolfier's Hydraulic Ram.

(With an Engraving.)

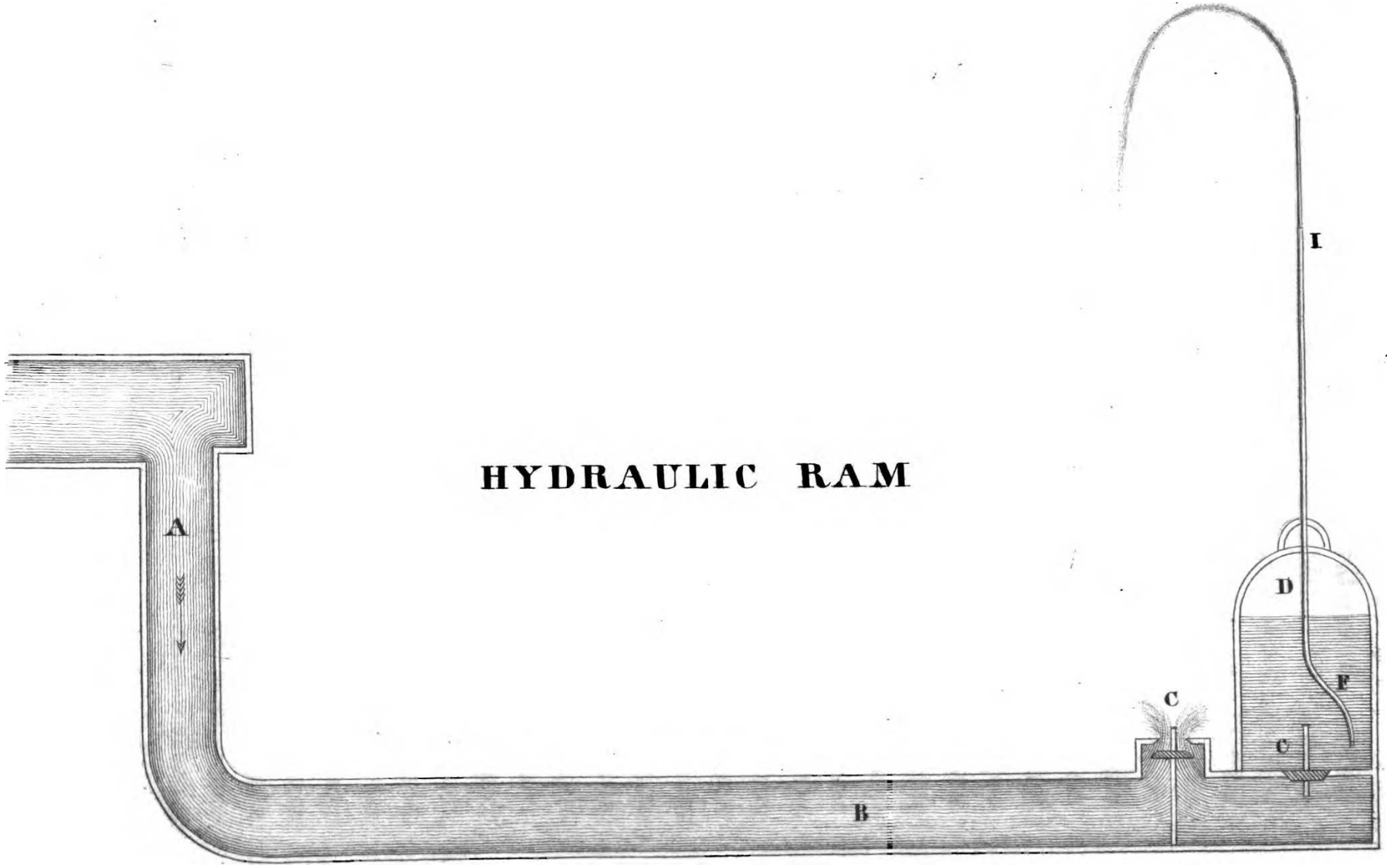
By E. C. GENET, Esq.

Read before the Society, March 15, 1819.

THE celebrated Montgolfier, who having submitted fire and air to the power of man, invented ærostation, or the art of navigating in the air, has also discovered the art of raising water above its level, without any other agents, but the pressure of its fall combined with the elasticity of air. The ingenious machine, by the means of which, that problem has been solved, has been called by that great man, an hydraulic ram, on account, it is supposed, of its mode of acting, similar in some respects, to the operation of another instrument, also called a ram, in architecture, and used to drive piles by the fall of a heavy weight.

Montgolfier had established a large paper-mill and paper hanging manufactory, on the banks of a stream, which had but little fall, and he undertook to raise the water of that stream to the summit of his building to move certain machinery. The various hydraulic machines in use, in 1800, the time at which the inventor was preparing his new discovery, appeared to him to be too expensive or too complicated, and economy being his object, he discarded pumps and wheels moved by water, steam, or animal strength: nature alone, stript of an useless apparatus of mechanical encumbrances, was consulted

HYDRAULIC RAM



by him; he studied her laws and obtained what he wanted.

Experience demonstrates, that a body placed at a small distance from the surface of the earth, and following without impediment the laws of gravitation, falls with a quickness increasing in the proportion of 30 feet in a second. The result is that the quickness of those bodies increases as their time and the distance described by them is as the square of their time. But if the fall of the same body is not free; that is to say, if it communicates a portion of its motion to other bodies in a state of rest, the quickness, as well as the distance described, diminish in proportion to the masses with which it has divided its motion. In pursuance of these two incontestible facts, Montgolfier, satisfied that the strength vested in a body cannot be destroyed, conceived the idea of raising, by the means of a given fall of water, a portion of that water to an indefinite height; proportioned, as to its quantity, to the elevation of their ascension, divided by the elevation of the fall, allowing for some loss occasioned by friction.—Supposing accordingly, that, in the figure annexed, corresponding with the model, the column A, 5 feet high, represents the fall of water which the local situation of the stream or brook has enabled to obtain, and that the conduit, or pipe B, is 15 feet long, the vertical column A, shall be called *active*, and the horizontal column B, in the said conduit or pipe, shall be called *passive*. Supposing also that the tube of ascension is prolonged to the elevation of 100 feet, where the bason intended to receive the water is

placed, and that an air reservoir is provided for inside of the balloon D. It will happen that if a sufficient quantity of water is poured into the superior bason to fill up the tube of ascension F I, the air contained in the reservoir or balloon D, shall be reduced to occupy less than one-fourth of the space which it occupied before its compression, and that the rest of the space shall be occupied by the water descended through the tube of ascension F I, and that the elasticity of the compressed air being equipoised by the pressure of the column of water, the whole shall remain in a perfect state of rest. Now, admitting that the two valves, to wit, the stopping valve C, and the ascending valve O, are shut up, it will follow of course, that the two columns, A and B, shall also be in a state of rest, and such will be the situation of the ram whenever it is not in action. But in order to rouse it from that state of stupor, if the valve C is abandoned to her own weight, it will descend into the water until the extremity of the stem running through it touches the base of the tube B. At that moment the active column A will begin to obey to her own force of gravitation, but not in a complete state of freedom, being prevented by the stupor of the passive column, which will divide her movement, so that the two columns will acquire an equal quickness. But inasmuch as the active column is but one third of the passive column, the said quickness shall not be more, after a given time, than the fourth of the quickness that the active column should have acquired, during the same time, had it been suffered to use freely its own gravity.

By the constant pressure of the air compressed in the air reservoir D, through the action of the two columns A and B, and by the constant re-action of the same mass of air on the same columns, the whole operation of the hydraulic ram is performed.

The practical application of that simple machine is very extensive; manufacture, agriculture, domestic accommodation and hydraulic architecture, may equally be benefited by it, and no machine offers greater *results*, with less expense.

In order to understand what is meant by the *result* of an hydraulic machine, it must be stated, that it is the produce of water raised in proportion to the power of water used to raise it. According to that definition, the most celebrated machines, such as the machine of Marly, erected at an enormous expense by Louis the XIVth, to convey water from the river Seine to his residence at Versailles, has in its primary establishment yielded only $\frac{1}{40}$ and latterly only $\frac{1}{200}$. Other machines have not offered more satisfactory results; but a well executed ram generally yields about $\frac{1}{50}$ of the power it uses, and accordingly its produce it greater than the produce of common hydraulic machines placed in the same circumstances. That instrument will prove to be of the greatest utility for agricultural purposes, and particularly for the irrigation of land. It may also be used with advantage in hydraulic architecture, to restore to canals a certain proportion of the water lost by the waste of the locks and evaporation, or to supply water to those destitute of sufficient feeders. Several cities might equally with the assistance

of that valuable machine, receive from adjoining rivers or streams, water of a good quality for culinary, domestic, or manufacturing purposes.

The expense will vary according to circumstances; but it may generally be said that it will be in proportion, 1st, of the quantity of water required; 2d, of the pitch of ascension; 3d, of the distance of the reservoir where it is to be carried, and that, finally, the greater the fall the cheaper it will be.

The following example, stated by Montgolfier in one of his memoirs, will give, on the expense attending the establishment of an hydraulic ram, a basis upon which comparative calculation may be made.

"It was requisite to elevate to 108 feet the greatest possible quantity of water, with a fall of only 5 feet 9 inches. A ram 4 inches diameter was applied, which employed daily 11,500 cubic feet of water, and delivered during the same time 240 cubic feet of water. The ram properly so called had cost in Paris 2400 livres, and all the accessaries and fixing amounted to as much, so that for 4800 livres (about 1000 dollars) at 108 feet elevation, a quantity of water has been raised amply sufficient for all the wants of a large family, the irrigation of an extensive garden, and the supply of a considerable stock of cattle and horses, &c."

The keeping of the machine is trifling, and requires nothing but cleaning after a freshet or a frost. It must be observed that the utility of the hydraulic ram is not confined to running water, and that by the construction of an artificial fall, it may be applied to draw water from low repositories or to drain

mines and deposits of stagnant waters, with as much facility as it is practised by the means of wheels, pumps, &c. and for these purposes the simplicity of the ram, will render it preferable to any other hydraulic machine.