XLV. Description of the different methods of blowing up rocks under water

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sideration of the Imperial Parliament, which, after examining various documents, and hearing the testimony of several professional men of the first eminence, acknowledged the value of the discovery by voting a reward of 10,000*l.* to Dr. Jenner.

XLV. *Description of the different Methods of blowing up Rocks under Water.* By A. BAILLET, Inspector of Mines*.

THE operation of blowing up rocks, which the French call *tirage des mines*, is not in general attended with much difficulty, when the hole of the mine is pierced in dry compact ground without any fissure or cavity. When the ground is cavernous or hollow, or when water oozes through its pores, it becomes more troublesome, and requires particular care. When it is necessary to blow up rocks at the bottom of the water the difficulties are increased. In that case the usual processes must be abandoned, and others must be resorted to.

2d, The method of blowing up rocks in the latter case is little known, and not much practised: it may, however, be of great utility in many cases, not only in the working of mines, but in the execution of public works of importance. These motives have induced me to give a description of the three principal methods of blowing up mines under water.

The first is that used in the mines in the northern part of the republic: it is proper to be resorted to when the depth of the water which covers the ground intended to be blown up is not above 15 or 18 decimetres.

The second has a great resemblance to the process usual in mines when the ground suffers the water to ooze through it. It is simpler and less expensive than the preceding, and appears to me to be very proper for cases when there are only a few decimetres of water above the ground.

The third is suited to great depths of water, such as 4, 5, or 6 metres: it is that employed at Carlsrona. It is very ingenious, and seems hitherto to have been unknown to the French miners.

3d, But, before I begin to describe these methods, it may be of some use to mention here an interesting memoir, printed in the *Journal de Physique* for the year 1779, on the construction of air-boats proper for facilitating the execution of all sorts of works under water, without employing pump-

* From the *Journal des Mines*, No. 56.

ing. C. Coulomb, the author of this memoir, after describing the method of constructing the air-boat, shows in what manner it is to be used. He points out the means by which it may be made to sink at pleasure, of placing the workmen under the box, of continually renewing the air, of removing the rubbish and laying a foundation of mason-work at the bottom of deep water. He then calculates the time necessary for removing a metre in height from the bank of Quillebœuf, which interrupts the navigation of the Seine; and foreseeing the cases in which mattocks or pick-axes would be insufficient for clearing obstructions from the bottom of the water, and where the hardness of the rock might require the use of gun-powder, he proposes two methods of blowing up rocks under water.

In one, the workman placed under the box bores the rock, and introduces into the bottom of the hole a box of tin plate filled with gun-powder, to which is soldered a small tube, also of tin plate, which rises above the water at ebb-tides, and which is stopped with some greasy matter, after having been filled with a very weak composition to serve as a train. The sea, as it rises, makes the air-boat float; and when its lower edge has risen higher than the extremity of the tube it is then removed, and when the ebb-tide uncovers that extremity a person goes in a boat and sets fire to it.

In the other method, which the author proposes for the Mediterranean, and rivers where the assistance of the tide cannot be employed, the tube of tin plate which contains the train rises only 3 decimetres above the rock, but is terminated by a leather pipe covered on the outside with some water-proof substance, and in the inside with an incombustible varnish, and secured from the pressure of the water by a spiral winding made of wire. Its extremity must be carefully closed, and a buoy attached to it carries it to the surface of the water when the air-boat is afloat.

4th, I shall say nothing further of these methods, which suppose, as may be seen, the assistance of the air-boat. I only wished to point them out, because they may be useful in many cases, and may, besides, give rise to new ideas, and serve to modify the three particular methods which are the object of this memoir.

I. Method of blowing up Rocks at the Depth of 15 or 18 Centimetres under Water.

5th, This method consists in the following operations;

First, bore the hole at the bottom of the water by the help of borers, and instruments of proper length.

Then

Then place in the hole a tube of tin plate closed at the lower extremity. The exterior diameter of this tube is of such a size that, when introduced into the bore, it may fill it; and its length must be such as that it shall rise some centimetres above the surface of the water.

Then send down to the bottom of this tube the cartridge filled with powder; introduce the priming rod, and ram round it clay or plaster according to the usual process, and only to the height corresponding to the summit of the hole.

In the last place, draw the priming rod and introduce the train, and set fire to it with all the necessary precautions, that the workmen may be sheltered from danger at the time of explosion.

Observation.

6th, This method has been often employed with advantage in several mines of the republic: it may serve either for deepening wells, or making other excavations, when the means used for keeping the ground and bottom of wells constantly dry are insufficient.

II. Method proposed for blowing up Rocks some Decimetres below Water.

7th, When the ground or rock to be blown up is covered only by some decimetres of water, the miner can see the rock which he bores, and the hole to be loaded, with as much ease as if there were no water, and can work with the same facility. In this case, to save expense, the tube of tin plate may be omitted, and a cartridge of pitched cloth, such as that employed in ground through which the water oozes in every part, may be employed, adapting to it a rod of hollow wood * destined to contain the train that conveys the fire to the powder. The diameter of the aperture of this rod may be only a few millimetres, and its length must exceed the upper level by some centimetres.

8th, If this method be adopted, first construct a cylindric cartridge of cloth or pasteboard, and fill it with gunpowder; insert into it the rod, which must descend to the middle of the length of the cartridge without approaching the interior surface of the wrapper; pinch closely the upper part of the cartridge around the rod, and cover the cartridge and whole rod with pitch or some kind of varnish †. Then send down the cartridge furnished with its rod into the hole of the rock,

* This rod might be made of the elder or honeyfuckle.

† A solution of Spanish wax in alcohol is attended with the advantage of drying speedily, and of remaining water-proof for a long time.

and

and drive in strongly two plugs of dry wood to serve as wadding. These plugs must have a longitudinal groove, that they may glide along the rod and suffer the water to escape.

Observation.

9th, Instead of a rod of hollow wood you may employ, with advantage, either a tube of tin plate about four millimetres in diameter, terminating at the lower extremity, which must be inserted in the cartridge in a truncated cone, and an orifice of two millimetres; or a leaden pipe drawn in the manner of wire-drawers, having the same dimensions as the above, and whose resistance may be sufficient, if you take care to introduce into it, while you drive in the wadding, a rod which may exactly fill the interior vacuity.

If you have at hand any kind of composition capable of acquiring hardness in a little time * at the bottom of the water, you may substitute for the rod and metallic tubes a flexible tube of cloth done over with pitch or gum. In this case, it will be necessary to introduce the priming rod into the tube, while you drive in the wadding to prevent its depression. The cloth of the tube, the upper extremity of which is destined to rise above the hole in the rock, must be sufficiently thick and strong that the pressure of the water, which I suppose to be some centimetres above the ground, may not flatten it, even if the liquid should introduce itself between the tube and the composition.

III. Method of blowing up Rocks under Water at any Depth.

10th, This method, on the first view, has a resemblance to that first described, since a tube of tin plate is employed in it; but it differs essentially from it in this respect, that instead of wadding above the charge, according to the usual method, you employ an inflexible flank charged with a weight at its upper extremity, and terminating at the lower in a segment of an iron cylinder, which performs the office of a wedge, and is applied exactly upon another similar wedge inverted and resting on the upper end of the cartridge.

The effect of this disposition, as may be readily conceived, is to force the wedge which adheres to the cartridge to ascend a little at the time of the explosion, and to squeeze itself closely against the upper wedge so as to close the hole in the rock.

11th, The description of this process may be seen in the

* A mixture of quicklime and plaster newly calcined would, perhaps, be of this kind.

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twelfth volume of the Memoirs of the Academy of Stockholm; I shall therefore give a literal translation of it*.

IV. *New Method of blowing up Rocks under Water, by Daniel Thunberg.*

A profile of the rock which has been bored, and into which the charge is introduced, is represented Pl. V. fig. 1.

The charge is contained in a tube of tin plate impermeable to water, a vertical section of which is represented in the same figure. The lower extremity of this tube must be adjusted properly to the hole which has been bored in the rock.

The charge consists of a paper cartridge filled with gunpowder, and attached to the iron wedge *b* with a thread such as that used for sewing sails.

To this first wedge *b* is applied another *c*, which adheres to an iron rod that rises above the tube.

On the plane face of these wedges is a groove made with a file which reaches to the powder: this groove is continued throughout the whole length of the tube of tin plate by means of a wooden rod *d*, hollow on the side turned towards the iron rod, to which it is made fast with strong packthread.

Before this rod is attached to the iron one, a match, which proceeds from the upper extremity and communicates with the interior of the cartridge, is placed in the groove.

e is a train applied to the end of the match.

B, C, are two rafts which enable the workmen to bore the rock and blow it up.

D is a weight which prevents the iron from being repelled too far when the explosion takes place.

EFGHI are different pieces necessary for charging. *E* is the cartridge furnished with its wedge, seen sideways; *F* the wedge seen in front; *G* the wooden rule and its groove; *H* the upper wedge and its iron rod; *I* the tube of tin plate.

When the rock has been bored according to the usual method by employing a borer pretty strong and of such a length as the depth of the water may require, introduce into it the tube into which the charge has been put; then apply the train *e*, and, having placed the weight *D* above the rod, set fire to it. The explosion will immediately take place: the wedge *b* would be expelled but for the wedge *c*, which cannot give way; and the two wedges being thus united confine the charge, the effect of which will never fail, as has been proved by experience.

* Details respecting this process may be found also in a large work entitled *Description des Travaux exécutés à Carlscrona, par Daniel Thunberg.*

Four feet of the tube and the lower wedge are in general lost; but the upper wedge may be employed for new charges, because it is never damaged.

Observation.

12th, This method, the success of which is proved, deserves, no doubt, to be known by all those engaged in great undertakings, and who have frequent occasion to apply it*. It is, perhaps, susceptible of being modified; and it appears to me that, without employing the impermeable tube, a varnished cartridge might be used, with a flexible tube proceeding from it, lodged in the groove between the two wedges, and then rising above the water.

Fire also might be conveyed to the powder below the water by means of a strong discharge of electricity; but little can be expected from this method in the hands of workmen.

In the last place, the lower wedge might be made of hard and very dry wood.

13th, But in whatever manner this method may be employed it will not require great expense, and it may be used with great advantage for deepening ports, rendering certain harbours more convenient and safe, and for freeing rivers and streams from those rocks which obstruct their course and impede the navigation of them.

XLVI. *Account of a North-East Storm, or Memorandums towards a Theory of the Winds in the Region between the Gulf-Stream and the Great Range of Mountains* †.

ON the Atlantic coast of America north-east storms begin in the south-west, and proceed thence to windward at the rate sometimes of about one hundred miles an hour. It has been remarked long ago by Dr. Franklin, that storms from the north-east, on the eastern side of this continent, begin in the opposite point, or to leeward. Whether this rule universally obtains may perhaps as yet admit of some doubt:

* M. Daniel Thunberg employed the same means to raise large blocks of stone from the bottom of the water. For this purpose a hole is bored in the block with a miner's borer to the depth of twenty or twenty-five centimetres. Two wedges are introduced into it, forming by their junction a cylinder so as to fill the hole. Several blows are then struck on the iron bar which adheres to the upper wedge: the two wedges are then closely squeezed together, and the block is raised out of the water by means of a windlass and a cord attached to a ring fixed in the lower wedge.

† Communicated by Dr. Mitchill.

but