

# EXPLANATION of the Designs for the Diving Machine for Hexham Bridge.

(See Plate 13.)

To Mr. Pickernell.

Sir,

Aufthorpe, 16th September 1778.

IF the cafes would have enabled us to reduce the water so low as to be even with the very bottoms of the caissons of each pier, I take for granted you would have thought it no difficulty with broken rubble, beton, stones, and short blocks of wood cut a little wedge-ways, to have crammed and wedged full the cavity underwashed, under the wooden bottoms; so as to have been equally resisting, and capable of bearing a weight with the original gravel, and particularly when this new body of matter is supported, and even jambed tighter into its place, by filling up the vacancy between the pier and the case, a little above the wooden bottom with rubble, and then driving it tight down by a sett with the ram. It therefore now remains, that I describe, and make you master of a piece of machinery, that will put you nearly into the same condition, as if the water could have been reduced to the caisson's bottoms as before mentioned; and this is by means of an air chest or diving vessel, which being let down will exclude the water down to the very bottom of the river, if you please; and therefore as low as the underside of the wooden bottom, which in the present case is as low as will be necessary or useful; and the chest or vessel being large enough to give liberty for a man to work therein; being furnished with a pair of boots, he will at mid-leg deep in water, do his business with almost as much facility as if the water were pumped out to the same level.

The principal part of this machine will consist of a strong chest, suppose three feet six inches in length, about four and a half feet depth or height, and as wide as to give free leave for its going down between the cases and the piers, which I suppose will be about two feet wide inside measure, as the other measures are also supposed to be. Now you know very well, that if you push a drinking glass, or any other similar vessel with its mouth downwards into the water; that it will exclude the water, leaving the vessel full of air, as it was before it was thrust into the water; in like manner, if this chest, being loaded with a sufficient weight, be let down into the water mouth downwards, the air will exclude the water to the bottom skirt of the chest, and if let down so as to rest upon the bottom of the river, a man may stand dry therein, and do any kind of business, the same as he could do in the same space in the open air. But to continue this for any length of time, two things are obviously necessary, and those are light, and a circulation of fresh air. The former might on occasion be supplied by a candle; but here we may have the advantage of

of day-light, by putting in two or three strong round panes of glass into the bottom of the chest, which will in its inverted situation in use be the top; a sufficiency of light will enter, this top of the chest being supported above water.

Respecting air, you will conceive that any quantity might be forced in by a strong pair of bellows; but these made of leather, would be cumbersome and unhandy. I therefore substitute a kind of forcing air-pump, made of thin hammered copper, that will throw in a gallon at a stroke; which will not only continually refresh the workman within, but whatever air escapes out through the joints or pores of the air-chest, will be replenished, and the overplus go out at the bottom or skirt of the chest, and boil up on the outside.

The quantity of weight that will sink it mouth downwards, will be the same as placed therein (bottom downward) would sink it the same depth, and as this chest I propose to be suspended by a tackle, and to go down by its own weight, I compute that it will take 16 pigs of lead to sink it to the bottom of the river, and keep it steady; I propose that the lead may be as much out of the way as possible, to place them upon the ends of the chest, endways upward, that is, four in a row below, and four above, and the same at the other end; making in the whole 16 pigs, which are to be fastened on with screws, either by cleats screwed on, or punching a hole through each end of each pig.

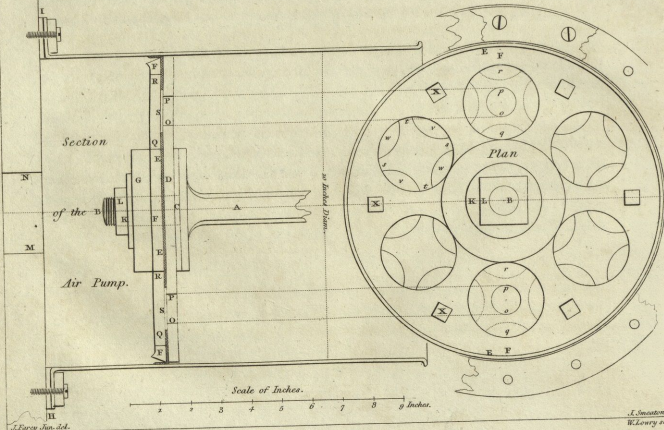
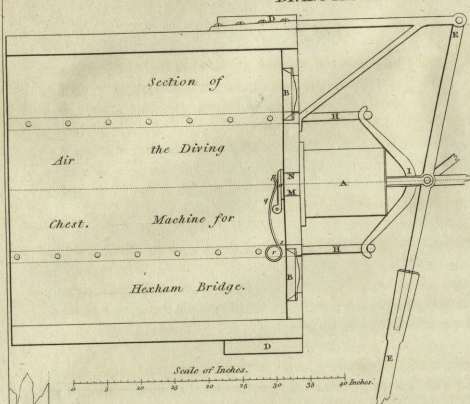
At one end of the chest there is to be a board fixed across for the man to sit upon, and a cleat nailed on each side, to set each of his feet upon, so that while the machine is letting down or hoisting, he is totally dry, and when let down low enough, he stands upon the bottom of the river, without any more water than the height between the skirt of the chest, and the bottom of the river, which may be more or less as is found convenient, I suppose never more than a foot deep; because wherever the ground is taken out more than one foot below the under-side of the caisson's bottom, I would propose to fill it up with rubble previously to that height or depth; nor can it be of use to let down the skirt of the chest much below the caisson bottom, because the side of the chest will then diminish the room you will have, to get the matter for underpinning under the caisson bottom.

The foregoing will I believe be sufficient for explaining the general principles and outlines of the method I mean to pursue in underpinning, and re-supplying what is underwashed from the bases of the piers, and which I dare say you will now see to be entirely practicable.

What

## DIVING MACHINE

Plan





What you are therefore immediately to put in hand, is the air-chest, of or about the inside dimensions before mentioned; I believe the two flat fides will do very well, if of good red wood deal shot clean of sap, the two ends and bottom (or in use its top), it would be well if they could be got of single planks of elm, beach, or plain tree, as they would hold the nails better; I fancy  $1\frac{1}{2}$ , or  $1\frac{3}{4}$  thick for the fides, and  $2\frac{1}{2}$  or  $2\frac{3}{4}$  for the ends and bottom, will be sufficient; they should be well jointed, and put together with white lead and oil, and the inside joints stroked with white lead and oil, as the effort will not be of the water to enter, but of the air to escape from within.

Were I with you when it is put in use, I should be the first to go down in it, as there is no more danger (all your tackle being firmly fixed,) than being let down into a coal pit by a rope; and if it shall happen that all your mafons are too fine fingered, I fancy a couple of colliers to take turn and turn, will find it a very comfortable job; a particular encouragement must however I expect be given.

I will give you more particular directions in my next: as to the air-pump, all that will be wanted from the copper-smith will be a cylindrical pipe of copper, 10 inches diameter and 12 inches high, wired at top, and a flanch at bottom of about  $1\frac{1}{4}$  inch broad, by which it is screwed down upon the top of the air-chest; the copper to be about the thickness of a halfpenny; if you have no neat handed copper-smith, that can hammer it straight and smooth inside, it may on occasion be made of strong tin.

I am, Sir, your most humble servant,

J. SMEATON.

The materials will be got into the chest by letting them down in a shallow bucket or box, that will go under the skirt of the air-chest; which should be let down upon blocks to keep it steady, while the air pump is worked; you will do well to try it, first in shallow water, and deeper by degrees, from whence you will find the nature of its working.

#### Explanation of the Section of the Air Pump, Plate 13.

A—The piston shank and flanch terminating in

B—A screw by which the whole is compressed together.

C—Leather to keep the joint air tight.

D—The upper plate (to be made of boiler plate),  $\frac{1}{16}$  inch less in diameter than the copper barrel.

E—A flat middling piece of shoe upper leather, turned down upon the border to make a tight joint with the barrel, and which also composes the valves.

F—The under plate (also of boiler plate), the edge being a little raised round the border, and about  $\frac{3}{16}$  less than the barrel: the leather D being held tight between these two plates.

G—A piece of wood by way of butt or stop upon

HI—The upper surface of the plank of the air-chest's bottom, in its inverted situation.

K—An iron ring, and

L—The nut that fixes all fast.

MN—The opening through the plank, by which the air passes into the chest, and is shut by a valve or clack on the under side.

OP—Shews the opening through the upper plate.

QR—Ditto through the lower plate.

S—The solid part of the leather that shuts the hole OP when the piston is forced down, and gives leave, by means of its four arms, for the air to enter when it is drawn up.

#### Explanation of the Plan of the Air Pump.

FF—Shews the under plate, and under face of the piston.

EE—The leather.

q r—The holes through the fame.

o p—The holes through the upper plate, as they would appear if the leather were removed.

At *st, st*, the leather appears in place; and *vw, vw*, those spaces being cut away, give leave for the air to pass in going downward from above, while the piston is ascending; but not to escape from below upward, while the piston is forced down.

N. B. the rest of the letters marked upon the plan refer to the same things as the same letters refer to in the section.

XX—Shew the square heads of small screws tapped into the opposite plate, in order to hold the plates close together near the border, as the nutt and screw do in the middle: the heads, however, will be better above.

#### Explanation of the Plan of the Air Chest.

A—The air-pump.

B—The sky lights 6 inches diameter each, to be made of window glass knobs, if plate glass is not to be had.

C—Clamp plates of iron to confine the top and sides strongly together.

DD—Pigs of lead, end upward.

EE—The lever for working the pump.

GG—The axis and brace for steadying the lever.

HH—Two bows for hoisting the chest.

#### Explanation of the Section of the Air Chest.

The same letters referring to the same things as in the plan.

I—A strong crooked iron to lay hold of the bows to which the main rope or tackle is to be fixed.

MN—The opening from the pump to the air chest.

*op*—The valve; whereof *o* is leather, *p* wood; to be shut by a wire spring, *qrs*, a little more than sufficient to overcome the weight of the valve.