

passage as low as they can be made for the rocks, or to low water mark. The cross wall H. I. instead of being carried from H. to I. must be turned round at L. so as to leave open the space M. of its natural depth. That the tunnels may be freely supplied, the present little pier shewn by dotted lines at N. should be totally removed, and the rock at O. should be levelled with the rest surrounding it, and the whole so reduced as to give all freedom of water-way possible through the tunnels, and in this state of things, if the pier E. had occasion to be carried out still further, it would bring the tide more forcibly through the tunnels.

The means above-mentioned, by promoting a more free circulation of water through the harbour, would tend to keep down the bank of mud at A. ; but I cannot think it would effectually keep it clear ; but I apprehend when this is once done by the help of men, as before, by a more judicious disposition and application of sluices upon the present basin, the whole harbour may be kept in a great measure free. In the first place, I apprehend the water-ways of the sluices are much too small, for though the basin itself is much smaller than were to be wished, yet the letting the water go off in a small body though continued a longer time is not making the best use of it : a certain power of water will move that very expeditiously, which applied in a less degree will let the subject remain at rest. Consequently, the water being discharged from the basin in a large body, will do that in five minutes, which would remain undone, if the capacity of the opening were reduced so as to play a quarter of an hour ; for this reason I would advise the sluices to be full three feet square in the orifice, and to be laid rather lower than the bottom of the basin. The sluice D. may still remain the place for one of them, but instead of the sluice C. I would advise two upon that line at P. and Q. of the dimensions aforesaid : That at P. will more directly tend to scour the face of the pier R. than in its present position C. and also to keep down the growth of the mud at A. and more especially if a passage be first opened for it, to vent its water by the opening S. ; but the sluice P. being so much nearer the pier R. it will be so much farther from the east pier ; to keep the face whereof clear, it will be proper to have the other sluice mentioned at Q. which will also serve a secondary use ; for as the basin itself is liable to fill with mud, which I suppose it is a considerable expense to remove, this may be prevented by building a cross wall according to the dotted lines, with a sluice upon it at T. of equal size or rather larger than the others, constructed so as to pen the water either way ; this sluice may therefore be made use of by penning the water in one half of the basin to scour the other, and so alternately ; and when open suffers the whole basin to act by any of the interior sluices ; to avoid loss of water, it will be proper to have all the sluices, particularly those at Q. P. and D. executed in the most substantial manner. I cannot



cannot advise the doors to be cut, in order to make a valve to let the water in, but rather to set one of them open by hand; and to prevent accidents by neglect, a small tunnel with a valve in part to let in and effectually to keep in the water, may be fixed in the present opening at C. This I think will be the most effectual way of applying the water of the bafon without the use of men, and I think it would also add, if to the opening in the east pier, which if I remember right is there already, there were another added, not less than 25 feet wide, so that they may be nearly in the position V V. By these means, I expect the harbour may, when once cleared, be kept clear, or so nearly so, that with a little help from men occasionally, to direct the water to particular places, it may be effected in the most easy manner that the situation will admit of.

J. SMEATON.

N. B. To prevent loss of room in the bafon by the cross wall, it may be a strong stone wall, well built with lime, and aisled on the two outsidess.

## DUNBAR HARBOUR.

(See the Plan, Plate 4. Fig. 2.)

The REPORT of JOHN SMEATON, Engineer, upon the Harbour of Dunbar.

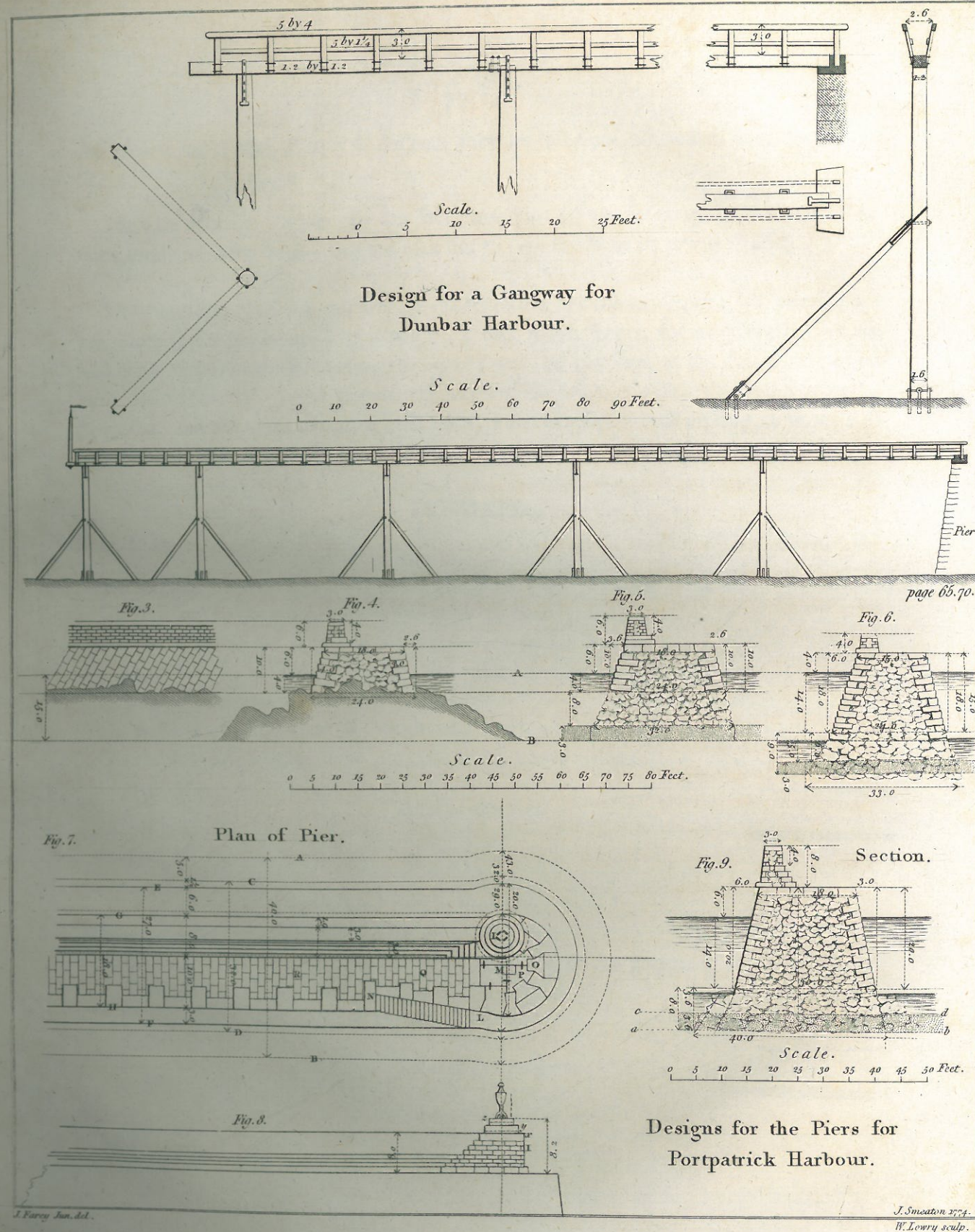
THE harbour of Dunbar appears from its form to be well adapted for the security of vessels lying therein, and as it is situated in the bottom of a bay, exclusive of the trade that is usually carried on there, it becomes of consequence to the security of vessels trading on this coast; and its principal deficiency in both these views is the want of a good access, particularly in going into it; and this is not owing to an improper course or direction of the entry from the bay, but from the narrowness of the passage, which is rendered in effect still narrower from the sloping form of the rocks on the starboard or N. W. side going in, to avoid which, vessels are obliged in prudence to keep nearer to the pier than they otherwise would do, and by this means, by the recoil of the sea from the rocks, are often driven against the pier, or upon the sloping rocks that are sunken and hid. To remedy this inconvenience as much as possible, it has been very properly proposed to cut off a certain part of the slope of the rocks, down even with the bottom of the rest of the passage, and to build the face up above high water mark, (as shewn at A A. in the plan), by which means, as the passage will not only be actually widened full five yards in the narrowest place, but by giving opportunity to vessels to see every thing that can hurt them, they may safely keep several yards further from the pier than they could otherwise have done; the passage thereby in the narrowest part being rendered from about 45 to 60 feet wide; at the same time the sea being prevented from breaking upon the sloping rocks, it will recoil with less force than at present, and the vessels will be less subject to be carried from side to side for want of sufficient way through the water. Lastly, this new pier or facing to the side of the entry being carried up sufficiently above high water mark, it will enable assistance to be given by throwing a rope on board from the most projecting point thereof, so as to tow in vessels when they do not come in with sufficient fresh way, to keep them clear of either side of the entry.

With the same view it would be well if a pier could also be carried out upon a ledge of rocks (which are dry at low water) on the S. E. side of the entry from the north angle



of the present pier, to the Beacon Rock. This would not only defend the passage from the surge of the sea, but by its projection also enable assistance to be given by throwing a rope on board on the larboard side of the ship, of which there is always an equal chance of its being preferable, by its being nearest; and still more effectual when it can be done on both sides. To this however may reasonably be objected the great expense that must necessarily attend the execution of a pier of sufficient bulk and strength to stand in this place the full stroke of the sea: however, to take advantage of that part of the utility of a S. E. pier, which consists in giving assistance by a rope, I have contrived a gang-way to extend itself in the same direction as far as the Beacon Rock, as shewn by the dotted lines in the plan, whereby any competent number of men will be able to give the same assistance by heaving a rope on board, as could be done from a stone pier, and which is contrived on principles so simple that it may be executed at a very moderate expense. This will be sufficiently explained by a design on purpose, (see Plate 5.) shewing how the same is to be executed, and indeed, had I not a good deal of experience in the of fixing temporary utensils in the building of the Eddystone Lighthouse, I should have been very dubious in proposing a structure seemingly so slight to stand the violence of the sea. But there I learnt, that where the force of the sea is to be rather eluded than resisted, the less matter is opposed to its action the better, provided that this be but fixed in the firmest manner. I believe the whole of the design will occur from the plan, save the manner of fixing the iron bolts into the rocks, which are not proposed to be done with lead, as that is perpetually working loose, but in the following manner:—Round holes about 18 inches into the rock more or less, according to the firmness thereof, are to be bored with a jumper of  $1\frac{1}{2}$  inch diameter; to these the eye-bolts are to be forged a very small matter taper, and larger so as to drive tight to their proper depth, with an iron maul; if they happen to be a small matter too small, then strips of plate iron put in along with them will make them to drive firm, and the rust will fix them from drawing.

Respecting the proposed pier or wharf (A A in the plan), as it will receive the full stroke of the sea, with a S. easterly wind, it will be necessary to be built very firm, and I believe it will not fully answer the end if the ordinary seas break over it; I therefore propose it to be raised nine feet above high water at spring tides, that is 22 feet above the low water line at the pier head, but it may decline in height as it runs S. westwards towards the land. This height will carry it considerably above the rocks where it is built, and therefore instead of so large a quantity of backing as will be necessary to make the whole good to that level with the land, I have proposed it to be built upon the back side as per section, Fig. 3. The rocks b. at the foot of the pier, are to be taken away as above shewn, before the





the pier is built; and when it is finished, they are to be cut off smooth according to the line a.

The bare stones of the pier (see the face view, Fig. 4.) are not proposed to be all on the same level, as there shewn, but the rock cut to give the stone its proper bearing.

The face (Fig. 4.) if you can procure the free-stone at a moderate price, will be best done according to the specimen; but if you work with rough stones, the more nearly they are laid conformable to the same idea, the better; and the platform at top should be laid on with the best mortar. As I cannot well judge of the prices at which the materials can be procured, and the work executed at Dunbar, I content myself with making an estimate of quantities as follows, which may be fitted up after proper workmen &c. are consulted.

# ESTIMATES.

## THE PIER.

£. s. d.

To cutting the rock according to the line in the plan 786 cube yards at -

To building in the whole pier 2,770 cube yards at -

To free-stone in the face and platform, reckoned at a medium  $2\frac{1}{2}$  feet in thickness, reckoned extra in its value in the solid of the pier

26,250 cube feet at -

To posts of wood or stone (if thought necessary), as also for lime &c. -

To contingent expenses at 10 per cent on the above articles -

Total of the pier

£

## THE GANGWAY.

To fir timber 942 say measured neat in place 1000 cube feet at -

To iron work 19 $\frac{1}{2}$  cwt. say one ton at -

To a large stone for fixing the end of the gangway to the parapet of the present pier, 30 cube feet at -

Contingencies on the above at 10 per cent. -

Total of the gangway

£

Aufhorpe,  
25th June 1772.

J. SMEATON.



# PORT PATRICK HARBOUR.

The REPORT of JOHN SMEATON, Engineer, upon the Harbour of Port Patrick, in the Shire of Galloway, with a Projection of Piers for rendering the same safe and commodious for Vessels of eight feet draft of water.

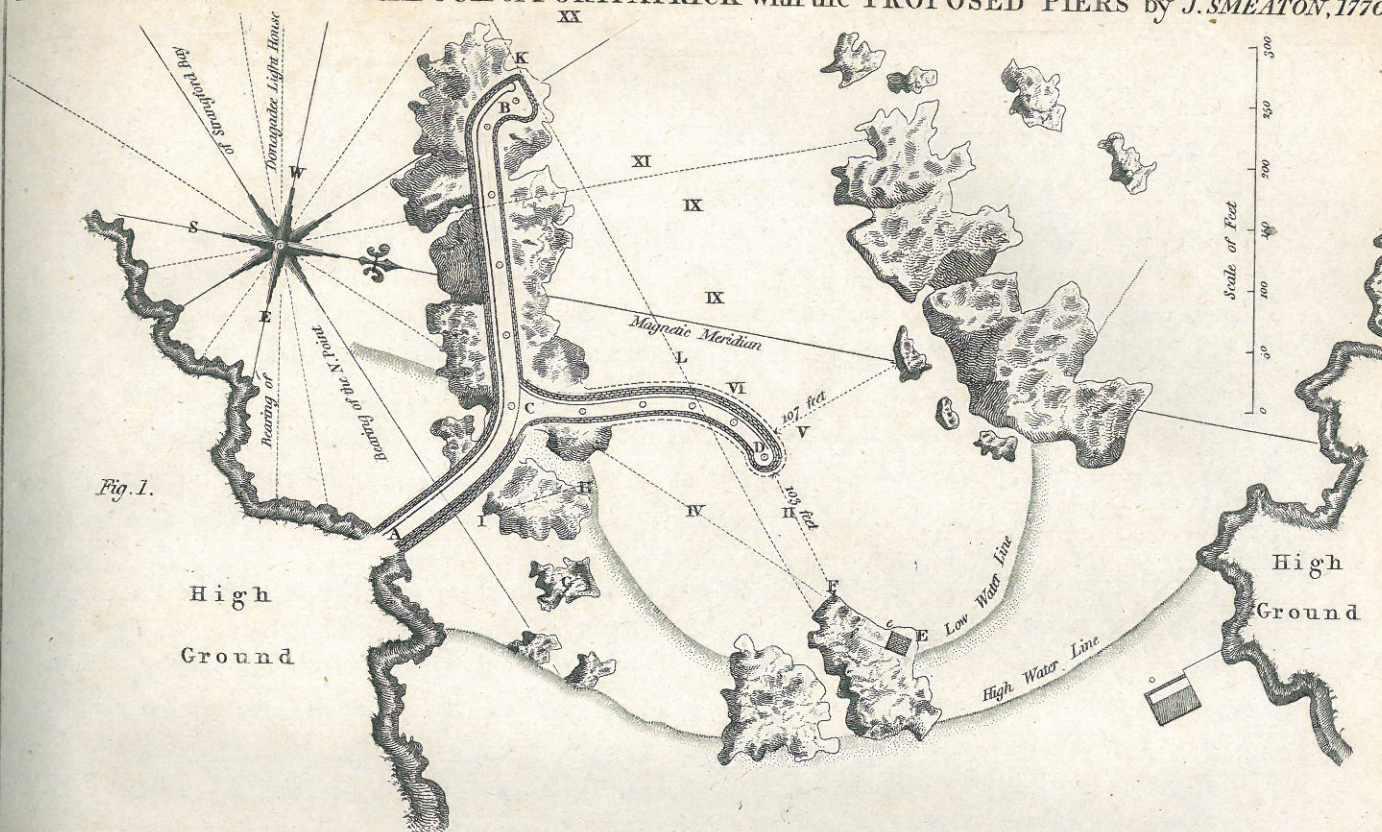
THE harbour of Port Patrick is generally esteemed the nearest port in Great Britain to Ireland, being, as it is said, but about seven leagues from the harbour of Donaghadee, upon the coast of Ireland, and which is almost right opposite: on account therefore of the shortness of the passage, it becomes a very desirable object that the harbour of Port Patrick should be rendered safe and commodious for such vessels as are best adapted to carry the packets, passengers, carriages, horses, cattle and goods between the two kingdoms; and on this head I am advised, that nothing less than vessels of 40 tons, drawing eight feet of water, and constructed upon proper principles for sailing, will be fully adequate to this purpose.

The harbour of Port Patrick is at present entirely in a state of nature, a small platform for the more commodious landing and shipping of passengers, &c. excepted; and indeed it has many natural advantages, being very easy of access, and of sufficient depth to ride the vessels proper to be employed afloat at low water, and to protect them from storms coming from seven-eighths of the whole compass; and had the remaining eighth been as well guarded as the rest, this harbour had been complete; but the want of protection from those points, necessarily obliges the vessels employed to be of such a construction as unfits them for the general purposes. Those defects it is the business of art to remedy, which is the object of the present proposition.

This harbour is formed by two ledges of rocks running out almost parallel from the shore, so as to form between them a small bay of about 220 feet clear width, and about 550 feet in depth, that is in and out. The bottom is a clean sand, and the soundings gradually increase from the shore to 20 feet at low water in the mouth of the bay, and leaving from 9 to 10 feet at dead low water mark in middle of the harbour.

The

PLAN of the NATURAL HARBOUR of PORTPATRICK with the PROPOSED PIERS by J. SMEATON, 1770.



PLAN of the HARBOUR, with the alterations now proposed.

