neatly built houses, two and three stories in height; the population is estimated at 3,200, entirely sprung up in thirty-eight years.

Ship and boat-building, and the rope and sail-cloth manufactures are extensively carried on, but the fishery forms the staple trade of the place, so that fish-curing and cooper-work are carried on to a great extent. The average quantity of herrings caught annually, exceeds 60,000 barrels; and about 12,000 persons, chiefly strangers, are employed during the fishing season, which extends usually from the middle of July to the early part of September: about 600 fishing boats, each of 20 tons burthen, enter and depart from Pulteney-Town when the weather permits. The shipping frequenting the port in 1843, amounted to 53,952 register tons, of which 5,460 tons were in the foreign trade.

An increase of harbour space, and of depth of water, has been so eagerly sought after, recently, that the British Fisheries Society applied to the author for a plan, comprising a low-water harbour, which should be altogether free from sand, the entrance being in deep water and away from the influence of the river, while the pier heads should be so placed as to throw the sand past them, along with the sea, and at the same time be easy of access, which would be important for a refuge harbour. A slope of 750 feet in length, with an inclination of 1 in 12, for expending the force of the sea, would be required. The south harbour also required to be freed from sand, and deepened. This plan is shown in Fig. 1, and an Act of Parliament has recently been obtained for its execution.

The paper is illustrated by two drawings, (Nos. 3592 and 3593,) giving the general plan of the harbour, with the proposed improvements, and the sections of the pier walls, with the sea slopes and the method of constructing them.

No. 662. "Description of the Casks used for floating large stones, to construct Sea Walls in deep water." By James Bremner, M. Inst. C. E.

Casks for
floating
Stones.

The ordinary mode of conveying stones for harbour work, is by means of two large boats, with baulks of timber lashed across them, from which rope tackles are suspended. These tackles are hooked on to 'lewises' inserted into the stones, and tightened at low water. When the tide flows, the stone floats, and it can be conveyed to the spot where it is intended to be laid. Stones weighing 40 tons each, have been thus transported several miles, without difficulty, in good weather; but it has been found, that the boats were soon strained,

and became leaky, and on an exposed coast, when bad weather came on, they were liable to be destroyed; the author therefore devised the plan described in the paper, as a substitute for the united boats.

About eight years ago, the author was consulted as to the improvement of the harbour of Banff, and the repairs of the sea slope of the north pier, the foundations of which had partially failed. He found, that the previous attempts at preventing the destruction of the pier, by laying down stones of from 2 tons to 4 tons in weight, brought from a quarry in the neighbourhood, had been quite ineffectual, as such materials could not withstand the force of the waves. He had observed along the shore, at several miles westward of the harbour, in almost inaccessible situations, ranges of large rough stones of hard quality, weighing from 25 tons to 40 tons each, and he determined to use them for the repairs of the work. It would have been almost impossible to get the boats near them, so he resolved to use casks for the purpose, as he had formerly done, under somewhat similar circumstances, at Pulteney-Town harbour.

There was but little novelty in the construction of the casks (Figs. 1 & 2), which were of fir timber; the ends had each two cross boards inside, with four props fitted between them, and there was a slip feather at each joining of the end boards; there were also interior

Fig. 1.

Fig. 2.

hoops of timber, strutted from the centre by spokes, like those of a wheel, in the situation of the chains, by which the stone was borne; the whole was hooped outwardly with iron, and made in the strongest manner, consistent with lightness, to resist external pressure.

Where any of the stones were under low water, wooden frames were used in boring the holes for inserting the lewis. The casks were towed to the spot, and at low water were attached to the stone, by means of chains passing through the lewis rings and over the casks. At the top of each cask, the spindle of one end of the chain, was passed through the ring of the other, pulled tight, and fastened backward, by a small hempen line, to the chain. On the flowing of the tide, which rose at that spot from 10 feet to 15 feet, the casks and the stone floated together, and were towed away by means of a boat; the stone was then moored over the spot where it was intended to be laid, and at about half ebb, by means of a long-handled knife, the small lines, by which the chains were attached, were cut; the casks rose to the surface, and the stone, being guided into its position by boat-hooks, fell into its destined spot: the chains were then drawn away, and the casks were again fixed on, at low water, to the next stone to be floated.

The advantages gained by these means were obvious. The coast was too rugged and dangerous, to admit of a crane-lighter being used, and if it could have been worked, the stones were much too

heavy to be lifted on deck, and even then, there would have been some difficulty in moving a lighter such a distance. The stone displacing its own bulk of water, left not quite 13 cwt. per ton for the casks to lift; the specific weight of water, and of the stone being 36 cubic feet, and 13 cubic feet respectively to the ton. Each cask weighed 25 cwt., and displaced 445 cubic feet of water; so that two casks lifted a gross weight of $34\frac{1}{2}$ tons of stone, the displacement of water caused by which, was equivalent to lifting $12\frac{1}{4}$ tons. When rough weather came on, the casks were easily disengaged, and were rolled to above high water-mark, without the least injury. Even in a heavy surf, stones have been buoyed out, by means of a long towing-line fastened to the casks. The strength and tightness of the casks were very remarkable; after being used for 24 hours, scarcely a gallon of water was found in each cask. This must, in some measure, be attributed to the swelling of the wood.

Four casks were used, and with them a length of 400 feet of the foundation was effectually secured, in the course of a few months, and not a stone has since been removed.

To ensure still further the stability of the stones when laid, the author proposed to have a chain cable passed through a lewis in each stone, and permanently fastened to the pier, so as to connect the whole together.

The application of these casks has not been confined to floating stones. In Banff, as well as in Macduff Harbour, great inconvenience was felt, from the want of a sufficient depth of water. In case of a vessel being fully loaded up in the harbour, and the depth of water being insufficient, four of these casks were attached, by means of chains previously passed under the vessel's keel; with the flowing tide, a lift equal to 44 tons, was given by the casks, which were afterwards easily disengaged, when the vessel was outside, in deep water. To a vessel of 100 tons register, a deficiency of 15 inches in her draught of water, has been supplied by these means, the want of which water would otherwise have occasioned detention and loss.

The author believes, that casks would be found equally efficacious, in removing stones from the beds of rivers, &c.,* as from dangerous and exposed parts of the sea-coast.

The cost of each of the casks was £8, and they were not at all injured by the work they were used upon. The charge for labour, in making lewis holes, fixing on the casks, and removing the stones 3 miles, was only 1s. 6d. per ton, which included lowering them into

* Vide Subjects for Telford and Walker Premiums, No. 10, Minutes of Proceedings, 1844, page 22.

their proper places and towing back the casks; in short every expense, except that of finding casks and lewises.

The lewises used (Fig. 3), were of the simplest kind, the shank

Fig. 3.

part inserted was 2 inches in diameter at the bottom, tapering to $1\frac{1}{4}$ inch at the top, where a ring was welded into an eye; into this ring, the chains were fastened, before letting in the lewis, which was done by means of two guide rods of iron, close to the mouth of the jumper-hole; the wedge was then inserted, by means of a pair of long-handled tongs; a punch bar of iron being set on its top to hammer it down. Although the lewis-holes were perfectly cylindrical, not a single instance occurred of the lewis being drawn out, even when raising the heaviest stones.

The author thinks, that the slope of Banff Harbour, which is 3 horizontal to 1 perpendicular, is much too flat, as no superincumbent weight being added to the foundation course (on which the whole slope abutted), the stones were liable to be moved outward, by the heavy recoil of the receding waves, acting at low water on their surface and on the inner bed joints. This was the case with the new pier at Banff, which was designed by the late Mr. Telford, and has also been found, in many other harbours, to be a cause of constant outlay for repairs. The author suggests, that a curved slope of 1 to 1, reckoning from the top of the parapet to the foundation, should be used, and he has found that even a less slope than 1 to 1 answers very well, even in very exposed situations, if the foundation can be let into the rock.

The paper is illustrated by a drawing (No. 3591), showing the construction and the mode of using the casks, and by marginal sketches of the lewis and other details.