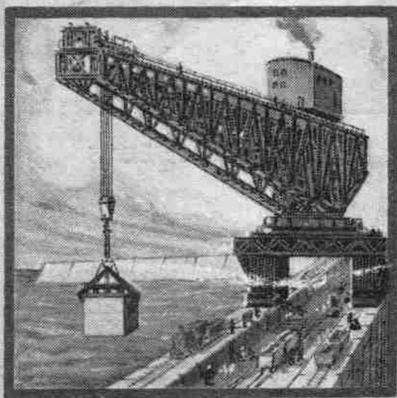

Giant Block-Setting Cranes

Their Work in Constructing Harbours and Breakwaters

One of the most interesting of all the branches of Engineering is that concerned with the construction of harbours, breakwaters and other structures connected with the sea. This branch of the profession offers splendid opportunities to those who are prepared to work hard and who gain that special knowledge that experience alone can give. It has been said that in its struggle with the sea, modern engineering is seen at its best.

HARBOURS are of great importance to all countries that have any shipping, not only to shelter their ships from the fury of the waves and to enable them to land their cargoes in quiet waters, but also to protect shipping from hostile attack in the case of war.

It is a curious fact that almost every country with a sea coast seems to have at least one natural harbour, and in many cases these are sufficiently large to accommodate large fleets of ships. One of the largest of these natural harbours is the Bay of Rio de Janeiro, which runs in a northerly direction for 15 miles with a width varying from two to seven miles. Surrounded by high mountains, with an entrance less than a mile in width, it is protected on each side by bold headlands. In Great Britain, Milford Haven in Wales, stretching inland for some 10 miles, is unequalled as a sheltered harbour.

Other natural harbours are formed by the mouths of rivers, such as the Thames, Mersey, Humber, Forth, and the Seine, but their efficiency is somewhat diminished by the " bar " that forms where the outflowing current of the river is checked by the sea.

Although such natural harbours as these continue to be useful, the requirements of modern times have made it necessary to augment their number, either by improving some natural feature—such as a bay or an inlet—or by constructing more elaborate works and enclosing large areas of the sea by harbour walls or breakwaters.

Our Fleet in Queen Elizabeth's Time

Britain has not always held the proud title of " Mistress of the Seas "—indeed, our supremacy in this direction is of comparatively recent growth. For instance, we were almost entirely without a fleet at the time when Spain, Holland, and France were great sea-powers. When the Spanish Armada rode the seas, the Royal Navy consisted of only twenty-three ships, eight of which were under 120 tons! At this time, however, the Republic of Venice possessed a fleet of over 3,000 vessels carrying more than 36,000 sailors.

Turning to the mercantile marine, we find that in 1540 there were only four vessels of 120 tons burden registered in the Thames. In Queen Elizabeth's time the shipping of Liverpool amounted to only 223 tons, the largest vessel being of 40 tons burden. How different are things to-day, when the shipping of the Thames and the Mersey runs into almost unbelievable figures, and London and Liverpool between them handle the greater part of the country's trade.

Without entering into further details, we see that even a few hundred years ago neither the Royal Navy nor the mercantile marine was of sufficient importance to require more harbour accommodation than that provided by natural inlets and sheltered bays. On the south coast these were found at such places as Portsmouth, Plymouth, Weymouth, Falmouth and Dartmouth.

The Progress of Harbour Construction

With the growth of our Navy and the increase in our national shipping, greater harbour accommodation became a necessity, and engineers were called upon to design and construct sea-works of one kind or another.

At first these took the form of rough breakwaters, which served to break the full force of the waves, and so protected some natural inlet, converting it into a comparatively safe harbour. The first breakwaters were constructed by floating large stones by means of casks to the places required. The stones were sunk between strong oak piles that had previously been driven into the sea floor at the place where the breakwater was required (Fig. 1). The ancient pier at Lyme Regis was so successfully constructed in this way that Queen Mary ordered the workmen to be sent to Dover to build a similar breakwater there.

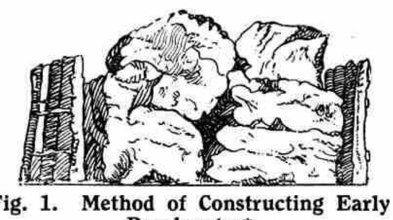

Fig. 1. Method of Constructing Early Breakwater*

* Figs. 1 and 2 are reproduced from "*Engineering for Boys*" by permission of Messrs. T. C. & E. C. Jack Ltd.

As was only to be expected, these early breakwaters did not long withstand the fury of the waves, but sooner or later were broken up and washed away.

As engineers advanced in their knowledge of this particular class of work, these early types of breakwater gave place to stone piers. More recently these have been superseded by massive monoliths of concrete, such as the mole of Zeebrugge, and the harbour works at Wick, in the north of Scotland.

The largest artificial harbour to-day is that at Portland. It covers an area of over 2,000 acres at a depth of one fathom and 1,500 acres at a depth of five fathoms at low tide. The works were commenced in 1849 and it is interesting to know that they were carried out by convict-labour from Portland prison. The harbour was completed in 1872, but two large additional breakwaters have since been added so as to make the harbour of service in protecting warships from torpedo attack.

Fig. 2 shows a diagram of the scheme of construction of the breakwater at Portland Harbour. As will be seen it consists of a rubble mound, 285 ft. in diameter, just below low water level. Between low water level and high water level is a sloping buttress wall with a high sea wall of solid masonry rising above this.

Protecting our Coasts

Equally important in the branch of engineering under consideration is the designing and building of sea-walls. Sea-walls are very necessary, apart altogether from the fact that they often make delightful promenades from which we may enjoy the sea-air or cast our fishing lines when on our holidays! Unless strong sea-walls are constructed, the constant hammering of the waves soon undermines the cliffs, so that the sea encroaches upon the land and the coast line becomes completely altered.

Some people may be inclined to wonder at the statement that the sea can exert any destructive power upon our coasts, but we have only to notice how the waves lift

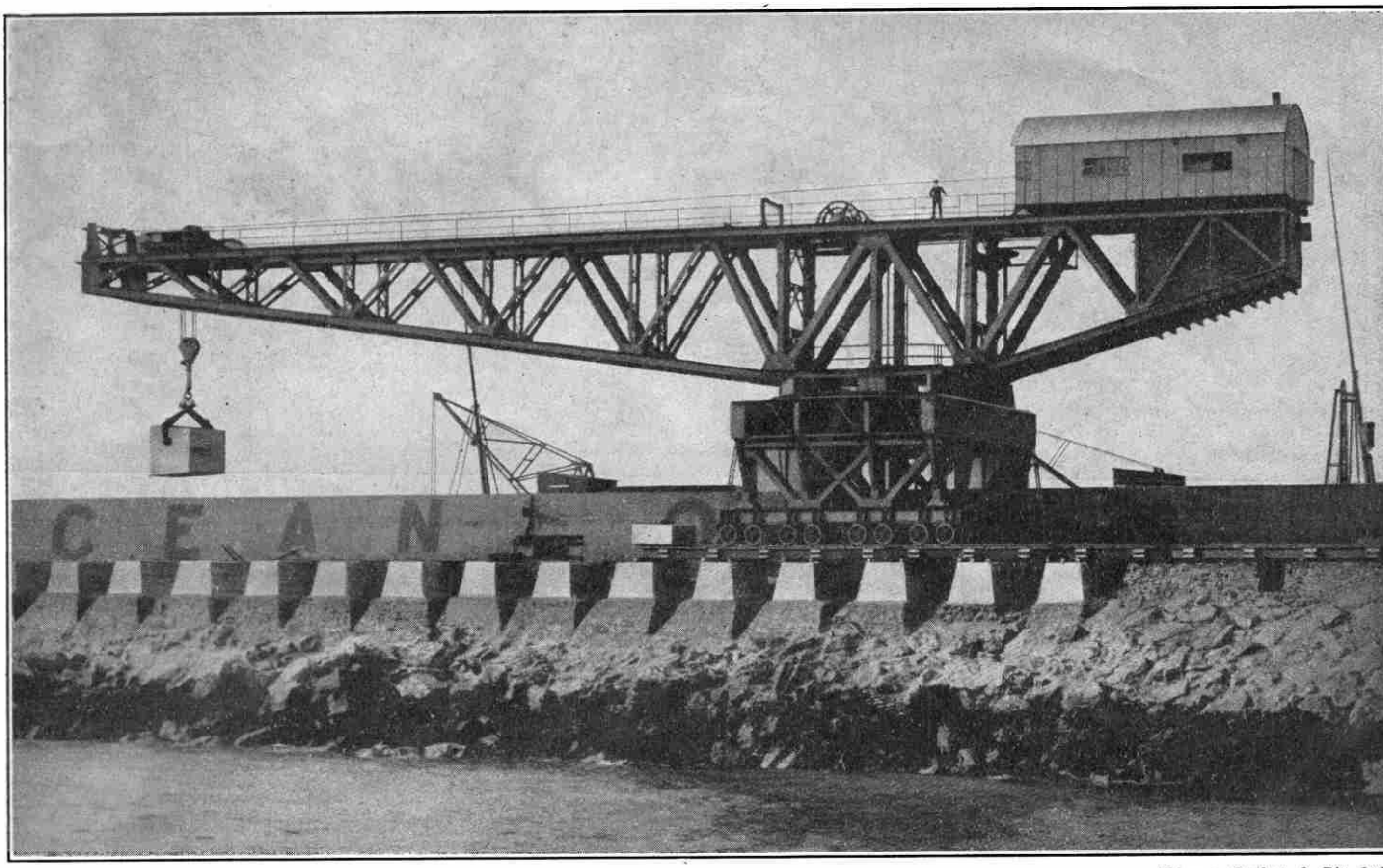

Photo courtesy] **A Giant Crane Setting Massive Concrete Blocks** [*Messrs. Stothert & Pitt Ltd.*

pebbles, or even large stones, and roll them along the shore. When we take a "header" through a breaker we sometimes feel these pebbles dashing against us with such force that they give us quite painful blows!

Not only are the waves able to lift pebbles in this way, but they can also lift huge rocks to a considerable height. A heavy sea easily moves rocks and boulders weighing many tons and even tosses them about like so many corks! Having raised them to heights of 40 ft. or more, it dashes them against the cliffs with the action of a giant battering-ram.

The Power of the Waves

Many well-known cases could be mentioned to illustrate the immense power of the sea. For instance, Sir William Mathews, the celebrated engineer, tells us that in 1898 a section of the Peterhead breakwater weighing 3,300 tons was moved bodily by the action of the waves.

In 1871 a harbour wall was built at Wick in Scotland. Composed of concrete blocks—each of which weighed 100 tons—it was capped by two tiers of 80-ton blocks. On top of all was a solid mass of cement weighing 800 tons. One might think that such a heavy structure would surely successfully withstand the action of the waves for many years, and so thought the engineers who built it. We may imagine their surprise, however, when it was found that the sea had not only moved the whole mass, but had actually turned it round and deposited it inside the harbour! As if to show that it could do even more than this when it wished, the sea scattered the 80-ton blocks in all directions. In due course the damage was repaired and the blocks were replaced. Determined to get the upper-hand, the engineers this time placed on top of the concrete blocks a superstructure weighing more than three times the weight of the original. Before this 2,600 ton superstructure had been in position two years a storm moved it and broke it in half!

A House Falls into the Sea

The sea has indeed, a terrible power and when this is exerted against the cliffs of an unprotected coast, the damage is very great and the sea rapidly encroaches on the land.

A few years ago some friends of mine had a house at Robin Hood's Bay, in Yorkshire, where they spent their summer holidays for many years. The house was delightfully situated, 50 or 60 ft. above the sea, on the top of the cliff overlooking the bay, with a roadway running between the garden and the edge of the cliff. Last summer when I visited Robin Hood's Bay again, I found that the sea had so encroached that not only had it claimed the roadway and the whole of the garden, but half the house also had been undermined by the sea. The old house was standing without the outer walls, which had fallen into the sea. All the rooms were open to the sea, and the whole building resembled a sectional view of a modern dwelling!

All along this part of the Yorkshire coast—from Whitby to Spurn Point—the sea is making great inroads, claiming many acres of land every year. At some parts of the coast substantial and heavily-built sea-walls have been erected to keep the sea back, but it is only a question of time before they too are attacked by the relentless action of the waves, so that constant repairs, or even rebuilding, becomes necessary.

Special Cranes Employed

In carrying out the construction of all sea works, cranes are particularly useful to the engineer. The type of crane used varies according to the nature of the work in hand, which in turn depends largely on local conditions and the special requirements arising therefrom. It is no exaggeration to say that without mechanical aid of this kind it would have been quite impossible to construct most of the great sea works of to-day.

Among the most useful cranes are those of the Giant Block-setting type, such as is illustrated on this page and on our coloured cover. For the loan of illustrations for both these, we are indebted to Messrs. Stothert & Pitt Ltd., of Bath, who specialize in this class of crane.

To enable us to understand the particular work in which these block-setting cranes are employed, we must learn something of the developments of harbour construction. In the first place it should be mentioned that no two breakwaters or harbours are exactly alike, and almost every harbour requires particular treatment. In one case a mound

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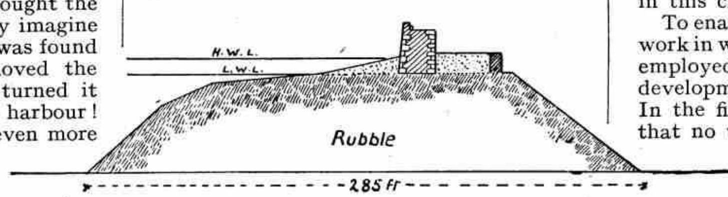

Fig. 2. Diagram of Section of Portland Breakwater