

designed to handle 12,000 tons of stores and 2,500 vehicles each day, for the first ninety days of the invasion.

It was, therefore, plain that something more than merely extraordinary was required of our engineers. The three main elements in the design of the synthetic harbours were—

- (1) Reinforced-concrete caissons weighing up to 6,000 tons each, which could be towed across the Channel and sunk to form an inner breakwater;
- (2) Huge steel floats which could be moored in deep water to form an outer breakwater;
- (3) Floating steel piers hundreds of feet long that would reach from the beaches to ship-side and rise and fall with the tide.

For the total project, something like 100,000 tons of steel and 600,000 tons of concrete were employed. The plan also involved the earmarking and preparing of sixty old warships and merchant vessels, twenty-two of which were American. These were to be sailed to France, and there sunk in pre-arranged positions to form additional breakwater protection some 24,000 ft. long.

One hundred and forty-six concrete caissons were built in specially excavated tidal basins. The caissons resembled roofless arks, and were built in six sizes, of which the largest had a displacement of 6,044 tons. In shape they resembled an inverted T, with the interior divided into compartments. The T construction was designed to give stability to the "ark" while afloat. Valves in the outer walls served as seacocks. A 40 mm. Bofors gun was mounted on a steel platform on top of each caisson, and decked in

quarters provided for the gun crew during the tow across the Channel. Few members of the crews had any leisure to take a snooze during the trip. These guns, with those on the decks of the sunken blockships, were a vital part of the harbour defences.

The steel floats which were to form the outer breakwater were built in sections weighing 15,000 tons each, and made ready for towage across the Channel. The floats of the portable pier equipment which was to be towed across in 480 ft. lengths were designed to cope with a 21 ft. tide, and were therefore able to sit down on rock or sand as the tide receded.

Each pierhead consisted of a steel barge-like platform about 200ft. long by 60ft. wide partially supported by hollow-steel columns. The columns sustained only enough of the load to anchor and steady the structure. The columns extended above the pierhead, and a most ingenious arrangement of sheaves, cables, and power-driven winches raised or lowered the whole structure with the tide.

## Fruition

On "D" day, the synthetic harbours started moving—in pieces—across the 100-odd miles of rough water to Normandy. This meant using eighty-five British and American tugs to tow 13 miles of piers, causeways, and breakwaters weighing in all far over 1,000,000 tons, besides the 500,000 tons of doomed vessels—to be used as blockships—staggering along under their own power.

Late in the afternoon of "D" day the first block ships arrived, and by nightfall twelve of them were sitting neatly on the bottom in line, some four hundred yards offshore. With the tide at its highest, waves only just broke over their decks, leaving smooth water inshore suitable for landings from the smallest of craft.

The sunken blockships, by the way, were the cause of the Nazis putting out jubilant claims of "dozens of Allied ships sunk" in the early stages of the landing. Sunk they cer-

