CHAPTER 19

THE SEAGOING HOPPER DREDGE

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The scope of this paper is generally limited to a brief history of dredging, and to a description of the seagoing hopper dredge and its cycle of operations.

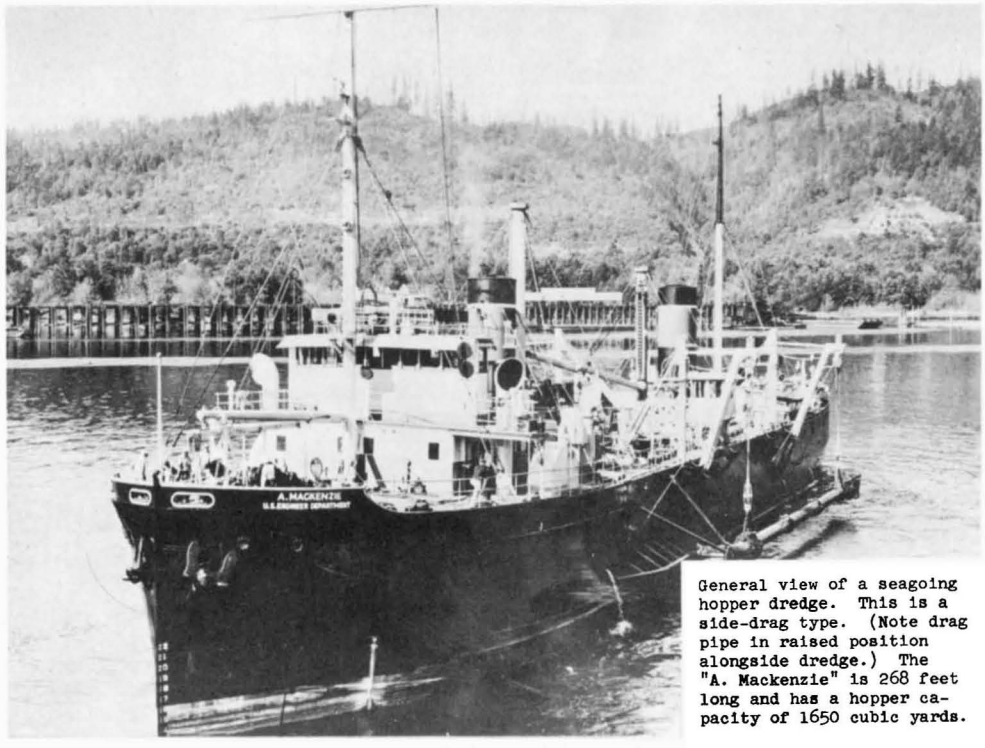
One reason for this limitation in scope is to avoid repetition of material presented by Mr. Berkeley Blackman in Chapter 18. In his paper, Mr. Blackman discusses the special problems of dredging at inlets; the types of plant used, together with their advantages and disadvantages; the methods necessary in making a cut through a sandy beach; and the precautions to be taken in disposing of materia from inlet dredging operation. He covers other particular phases of such dredging and concisely summarizes the subject with an illustrative example of the special aspects of dredging at tidal inlets and of the points which should be considered in the performance of the work. All but a few of the hopper dredges in the United States are operated by the Corps of Engineers. Therefore, this paper may be of interest to those not familiar with dredging operations of that agency.

Dredging is a special type of excavation involving the removal of material from under water. Several thousand years ago the Chinese and the Assyrians employed the primitive spoon-and-bag dredger to clean and maintain their canals. This apparatus consisted of a bag manipulated from a boat by means of a pole attached to a yoke or hoop at the mouth of the bag which was dragged along the canal bottom. When full, the bag was lifted and dumped into the boat. The method of disposal of the material is not clear, but it must be assumed that it was lifted ashore or dumped overboard, all probably by hand. Little improvement over this spoon-and-bag method of dredging was made until the advent of the industrial era in the eighteenth century. The method was then developed into a chain of buckets moving on a ladder.

Only during the past one hundred years has dredging been lifted to one of the most important methods of excavation known to engineers. During this period, hydraulic dredging was developed. Hydraulic dredging is the term applied to the method wherein material is conveyed by water through pipes as distinguished from the self-explanatory term of bucket dredging. The centrifugal pump is usually the prime mover of the mixture of material and water.

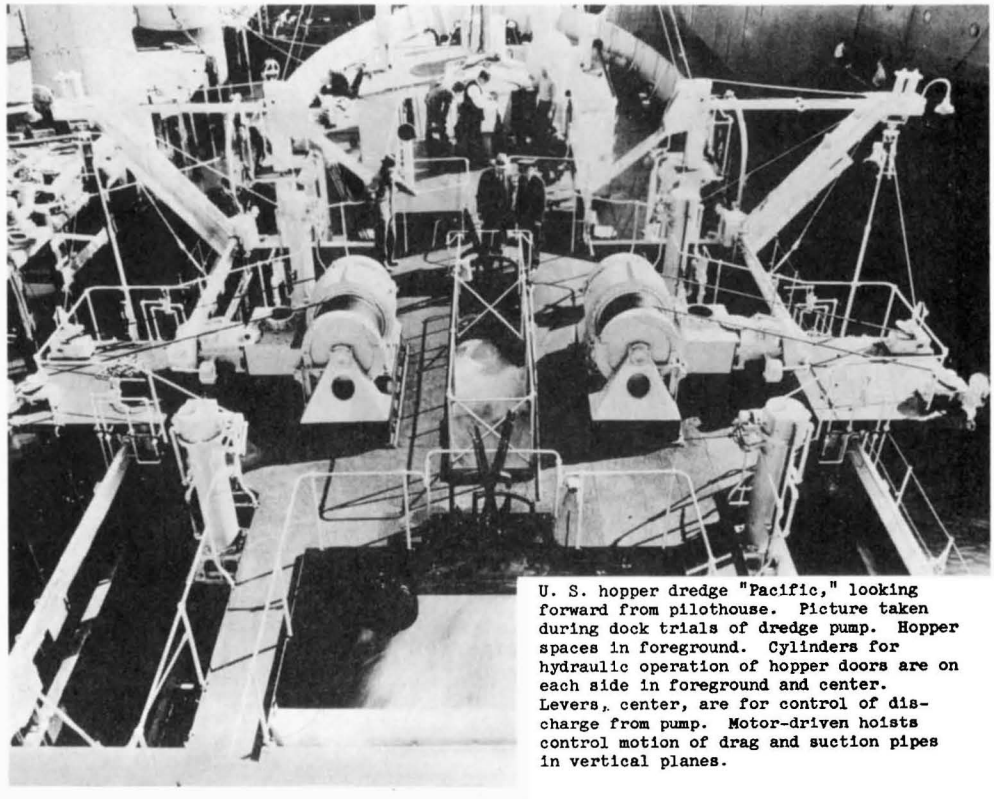
The two principal types of hydraulic dredging machines are the pipe-line dredge and the hopper dredge. In pipe-line dredges the material is discharged through floating and/or shore pipes to the disposal area, or, in rare instances, to barges which transport it to the disposal area. Hopper dredges, on the other hand carry the excavated material in bins, or hoppers, within the hold of the ship Another principal difference between the two types is that the hopper dredge is self-propelled while the pipe-line dredge is not and must be towed from job to job.

The modern seagoing hopper dredge is basically a self-propelled vessel with the molded hull of an ocean freighter or tanker, but fitted with hoppers to retain and transport material instead of holds for cargo or tanks for oil. Photographs showing some of essential features of this type of dredge are shown in Figs. 1 - 4. The seagoing hopper dredge has been developed primarily for the dredging of bars and entrance channels at coastal inlets, in other exposed locations, or where the excavated material must be carried a considerable distance for disposal. It excavates, transports, and disposes of material without anchoring and without the assistance of any auxiliary plant or equipment. Its operations do not interfere with, or obstruct, navigation of other craft as it moves along a waterway under propulsion and steerage control similar to any other vessel. Therefore, its use is also favored in busy harbors.



General view of a seagoing hopper dredge. This is a side-drag type. (Note drag pipe in raised position alongside dredge.) The "A. Mackenzie" is 268 feet long and has a hopper capacity of 1650 cubic yards.

Fig. 1



U. S. hopper dredge "Pacific," looking forward from pilothouse. Picture taken during dock trials of dredge pump. Hopper spaces in foreground. Cylinders for hydraulic operation of hopper doors are on each side in foreground and center. Levers, center, are for control of discharge from pump. Motor-driven hoists control motion of drag and suction pipes in vertical planes.

Fig. 2

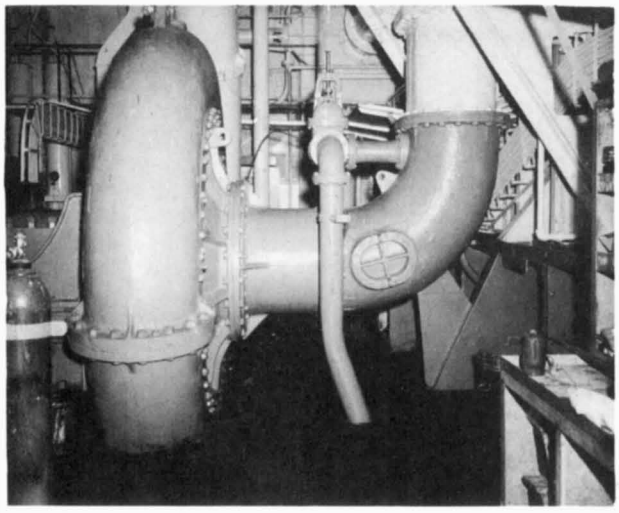


Fig. 3
Dredge pump of seagoing hopper dredge ("A. Mackenzie"). Impeller is 6 feet 9 inches in diameter. Discharge pipe (left in photo) has inside diameter of 26 inches. Pump driven by 900 H.P. electric motor at 150 R.P.M. Pump capacity 52,000 G.P.M.

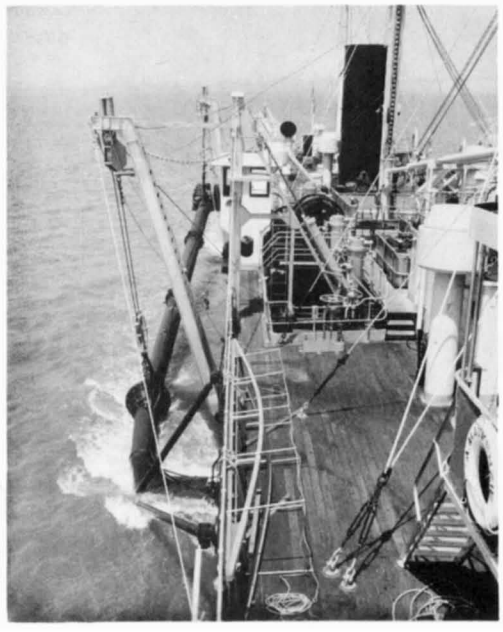


Fig. 4
General view from pilothouse of starboard side of seagoing hopper dredge ("A. Mackenzie"). Drag pipe in raised position.

Seagoing hopper dredges vary in size and capacity in accordance with the type of projects on which they are designed to be used. Small shallow-draft dredges of 500-cubic-yard capacity are about 180 ft. long; those of 1200- to 1600-cubic-yard capacity are about 280 ft. long; 3000-cubic-yard dredges are about 350 ft. long; and the largest dredge, of 8000-cubic-yard capacity, is 525 ft. long. All of the dredges have quarters and mess accommodations for crews for three-shift 24-hour-per-day operation.

Because of its principal use in dredging in exposed localities where other types of dredging equipment cannot be used, and in order that it may travel between such localities, the seagoing hopper dredge is designed to be seaworthy in all respects. The dredges are built to meet the U.S. Coast Guard requirements for "Ocean" classification and carry all prescribed navigation equipment including radio communication, lifeboats, and firefighting apparatus. Personnel are licensed or certified in accordance with U.S. Coast Guard regulations. Some of the dredging equipment is unique to the type of dredge, and warrants special discussion. The principal elements of dredging equipment are the drag-pipe assembly, the drag hoist, the pump, and the hoppers. The drag-pipe assembly is that portion of the pump suction line carried outside of the hull. One end of the assembly is hinged to the hull by a swivel-ell connection. The other carries the draghead, which is a large steel casting with a grate on the lower face, so designed and hung that it rides on the channel bottom when the drag is lowered. When operating, the hopper dredge moves along the channel at slow speed (1 to 3 knots) with its dragheads lowered in contact with the channel bottom. The mixture of bottom material is lifted hydraulically through the suction line by the pump, thence through discharge pipes to the hoppers.

The drag-pipe assembly may be hung from the vessel in any one of three ways. When in the center amidships so as to be raised and lowered in a well through the vessel, it is known as the "center-well" type. When suspended in a well at the stern, it is a "stern-well" type. When suspended from the side, it is a "side-drag" type. The latter has been adopted as a standard for the modern dredges which carry, and usually operate with, a drag on each side.

Dragheads are designed basically to secure the maximum percentage of material with minimum hydraulic losses and without admitting obstructions or choking the pump. Two general types have been evolved. The "New York," or fixed, type operates best in soft or free-flowing material while the "Pacific," or self-adjusting type, is most adaptable to dredging packed sand or other firm material. Because the drag bottom, or grate, is subject to wear through abrasive action, it is usually hard-surfaced and replaceable. Unlike most pipe-line dredges, which have cutters to loosen material, the hopper dredge depends upon "suction" and the motion of the draghead for loosening material. However, teeth have been attached to, or cast integral with, draghead grates in attempts to scarify or loosen firm material. These attempts have met with varying success.

The forward end of the drag-pipe assembly includes an elbow and is usually supported by a sponson with bearings which carry the pipe trunnions and act as pivots for angular movement of the drag in the vertical plane. A ball joint in the pipe between the elbow and drag permits minor angular movement in the transverse direction. The drag assembly is supported from davits by cables passing through sheaves to the drag-hoisting winches. The latter provide for the lowering and raising of the drag pipe. During dredging, each drag is continuously controlled by an operator called a dragtender. He must control the position of the drag in relation to the bottom in accordance with the type of material encountered and the depth of cut necessary, so as to obtain maximum dredging efficiency.

The dredging pump is usually located in the forward part of the ship and is especially designed for the type of operation involved. Like most dredging pumps, it must be constructed to resist abrasion and must be of high capacity at relatively small discharge head. The larger dredges have one pump for each drag, but several of the smaller dredges (500- to 1600-cubic-yard capacity) have one dredge pump with suction pipes from each drag uniting in a wye on the suction side of the pump.

The pump discharge pipes lead to the hoppers where suitable distribution boxes, or troughs, are equipped with gates, or valves, to regulate flow into the several hopper bins. The solid material settles in the hoppers while the water (carrying a small percentage of suspended material) flows over the top of the hoppers into troughs which carry it to overflow chutes which discharge it overboard. When the hoppers are filled with solids (or when, in the case of dredging material which tends to remain in suspension, the "economic pumping" limit has been reached) the pump is stopped, the drags are lifted, and the dredge runs at high speed to the dumping ground.

The hoppers are usually located amidships and extend from the main deck nearly to the bottom of the dredge. Their sloping bottoms are fitted with semi-watertight gates or doors for dumping material. On the modern dredges, these doors are operated by direct-acting hydraulic cylinders, the piston rods of which are connected to the door-operating rods. In keeping with the general safety precautions taken in the design and operation of the seagoing hopper dredges, the hoppers are usually located in watertight bulkheaded compartments. Necessary doors through such bulkheads are watertight, and those to engine rooms are equipped with remote controls for emergency purposes.

As with other modern vessels, the type of power plant for a seagoing hopper dredge is selected to give the most efficient performance under the design criteria of the vessel. The general types in use are turbo-electric, diesel-electric, and direct (steam or diesel engine) drive.

There are numerous other features of the seagoing hopper dredge which are unique to its type as a vessel and as a dredge. However, it is believed that the principal of these features have been mentioned herein. About 25 seagoing hopper dredges are operated by the Corps of Engineers, and this fleet moves approximately 70 million cubic yards of material annually to play an important role in maintaining harbor entrances and channels which are necessary for waterborne commerce.