CHAPTER 30

DREDGING - PAST, PRESENT, AND FUTURE

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ABSTRACT

This paper traces the history of dredging from a primitive dredge invented by Leonardo da Vinci to the most modern and powerful equipment. Emphasis is given to the modern hopper dredge and recent development in connection with the use thereof. The possibility of application of hopper dredges to beach nourishment work is discussed with an account of current experiments being made in an effort to develop the practicability of such usage.

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Dredging is, of course, the science of excavating materials which are submerged underwater. As a matter of fact, Webster does not give the word the dignity of calling it a science. It has long been considered by the average person as a rather uninteresting, prosaic, unsophisticated, and perhaps dirty subject. I have no argument with the source of these feelings but, having been engaged in this subject for over 30 years, I must take the other side of the fence since dredging is actually a most challenging field in which we are dealing with a medium which we cannot actually see in its insitu condition and in a field in which there are so many variables that accurate, simple, and firm determination of a given engineering problem is not susceptible of positive solution. The functior of an engineer is not just to perform engineering work but to perform it in the most economical manner. Although this branch of engineering certainly is not as highly technical as some other branches, I know of no field that offers any more rewards in the field of method improvement and cost reduction as does the field of dredging.

Certainly dredging has been and continues to be a necessary science to progress. From the beginning of history men must have performed some type of dredging and we know that the Egyptians constructed the original Suez Canal some 4,000 years ago and must have excavated by one means or another vast quantities of submerged material. In 1289 Kublai Khan completed the 1,000-mile Grand Canal from Hangchow to Peiping which is still one of the longest canals in the world. I hope to demonstrate that in dredging as in all other sciences, the primitive methods of our forefathers were a far cry from the modern sophisticated equipment in use today.

Because of the low nature of their land and the indomitable will of the Dutch people for self-preservation, mechanical methods of subaqueous excavation became a necessity of life in the Netherlands many, many years ago and it is for that reason that the Dutch influence will be predominant in the slides which I am going to show.

Leonardo da Vinci is reputed to have developed the first"dredge wheel" in about 1500. You see from the slide that the source of power was manpower cranking over the multi-bucketed wheel which can be seen. (Slide 1)

Some years later the "spoon and bag" dredge was developed. This dredge is the direct ancestor of the dipper dredge and on the next two slides you will see two types of spoon and bag dredges. Crude though these machines be they represent the earliest attempts to gain mechanical advantage by simple engineering methods. (Slides 2, 3)

A manpowered scraper-type dredge is seen next. This dredge was used in Holland in 1565. Note that we begin to see some advances in mechanical details. (Slide 4)

In 1600 we find that the Dutch had what they called a "mud mill" which you see now. Truly manpowered, this dredge utilized for the first time an endless chain bucket and discharged dredged material into scows. (Slide 5)

A manpowered predecessor to our clamshell dredges today was in use in 1617. This once again illustrates the ingenuity of the Dutch in providing the excavating equipment with mechanical advantage. Apparently the dumpscows were pushed under the bucket located between the two halves of what we would today call a catamaran type hull. (Slide 6)

Manpower apparently became in short supply even in those days and horsepower came into use. We see now a horsepowered dredge, vintage 1650. The house-type structures on the deck are actually shelters for the horses which are providing the motive power for the endless chain buckets. In order to get a better idea of how this equipment works the next slide shows the cut-away of a very similar dredge and if you will look closely you can see the horses in the turnstile. The spoked wheel was apparently used to adjust the digging height of the endless chain bucket ladder. (Slides 7, 8)

I do not have the date of this next dredge but it is an interesting cut-away of another type of manpowered machine. The method of excavation apparently involved a circular wheel with buckets rather than an endless chain. (Slide 9)

So much for the development of early dredging equipment. Various and sundry improvements continued to take place in subsequent years but the revolution in mechanical dredging equipment came with the invention of the centrifugal pump by Papin in 1705 and the steam engine by Watt in 1795. Records have been found indicating that two Germans, Hofmann and Schwarztcoff, developed a hydraulic dredge for land filling around Berlin in 1855, but details are not available.

Dredges today come in two classifications - hydraulic and mechanical. Both of these basic types are broken down into different applications and the next 6 slides will merely present the types which are in use today. First, we see a plain suction hydraulic type dredge. This dredge is without cutter power and merely sucks material off the bottom and discharges through a stern connected pipe leading to a spoil disposal area. This type of dredge is the predecessor of the dustpan dredges which are used today in some parts of the United States, particularly along the Mississippi & Missouri River Valley. (Slide 10)

Next we see the cutterhead pipeline dredge with which I am sure most of you are familiar. A rotating cutter on the end of the ladder physically excavates the material from its in situ condition and from there it is pumped hydraulically and discharges through a stern connection to pontoon and shore pipe. The dredge is controlled on stern mounted spuds and is swung from one side of the channel to the other by means of a swing gear. (Slide 11)

Next comes a mechanical type dredge of the clamshell or grapple type. Larger dredges of this type are going out of favor but they have played an important part in many large projects in the past. On some projects today this same principle is used but by mounting mobile type cranes on barges. (Slide 12)

The next type is the mechanically operated endless chain bucket dredge which was for many years probably the most used type of equipment in Europe. It was also utilized in the United States but never to the degree that it was in Europe. Dredges of this type assisted in the construction of the Panama Canal but they are "as scarce as hens teeth" in the United States today but are still used in Europe as we will see later. (Slide 13)

The mechanical dipper dredge is next. Machines of this type are still in use in the United States and serve an excellent purpose in excavation of rock and other quite hard materials. (Slide 14)

Finally, we see the self-propelled hydraulic hopper dredge. In normal operation a hopper dredge sucks up the bottom material through drags mounted on the sides of a vessel and into the hoppers while making one or more passes through the dredging area. Then, the dredge proceeds to sea or some other assigned dump area and discharges the material through doors in the bottom of the hoppers. This type of dredge is normally employed where the water is too rough for a pipeline dredge or where spoil disposal areas for use by a pipeline dredge are not available within economic distance. (Slide 15)

Before proceeding with a discussion of recent inovations which are taking place in the hopper dredge field, I will spend a few moments on the current trend in the development of cutterhead pipeline dredges. This type of dredge is certainly the most numerous here in this country and is the basic tool of the private dredging industry. Although the Corps of Engineers owns and operates a limited number of these dredges throughout the United States we largely look to the contractors for the performance of the type of work which is suited to the hydraulic pipeline or cutterhead dredge. Pipeline dredges are well suited to operation in sheltered waters and where a disposal area is available within reasonable distance. These dredges vary through a wide range of sizes from quite small and sometimes "Rube Goldberg" items of plant used for small real estate fills on up to those having discharge pipes 36 inches in diameter. The size of the discharge pipe is the normally utilized method of referring to the size of a pipeline dredge. Contractor owned equipment in the United States today varies from 10-inch dredges with 300 h.p. on the dredging pump to 36-inch dredges with as much as 10,000 h.p. Pipelines frequently exceed 10,000 feet in length and boosters are required if necessary if discharge lines are too long. Cutter horsepower varies from 75 h.p. or less on quite small dredges to as much as 2500 h.p. on the larger ones.

Pipeline dredges can excavate a remarkable range of materials and have successfully dredged large quantities of hard rock. It is indicated that rock with a Mohs scale hardness of 2 and 3 can be excavated by a well designed pipeline dredge without blasting. Rock of harder classification requires breaking up by chisel or blasting, the latter method being widely used on numerous projects.

The next slide shows a typical 27-inch contractor owned dredge as operated here in the United States. This particular dredge has 4500 h.p. on the pump and is following the modern tendency to eliminate crews quarters. Anchor booms which are a relatively recent development can be seen extended from the bow. With these booms the swinging anchors can be handled with much more convenience and with much less time than with the old method by which attendant derrick boats had to pick up and relocate swinging anchors as necessary. (Slide 16)

This next dredge is a very large and modern dredge. This dredge has a total connected horsepower of 8,000 and is of 27-inch size discharge pipe. In this view the after spud frame has been lowered for transit under restrictive bridges but in the next slide we see the same dredge in operating condition. You will note that crew's quarters for a crew of about 85 men are included. (Slides 17, 18)

Now we come to a few Dutch designed pipeline dredges. This first one has a 26-inch discharge line, 4,000 h.p. on the pump, and 900 h.p. on the cutter. A different type of ladder A-Frame will be seen and the swinging booms are tubular instead of latticed as on the American dredges which you just saw. No quarters are provided and the swinging and hoisting gear is located on deck. One of the differences of Dutch dredges is in the spud system and you will note here that they do not have the massive spud frames which you saw on the American type dredges. Further, the digging spud is located on the centerline of the dredge in a carriage which is moved fore and aft by screw jacks in such way that it (Slide 19) pushes the dredge ahead in the cut. The auxiliary or side spud is used only for holding the dredge in position while the carriage is reset. On the American type dredges the spuds are offcenter and mounted in fixed wells and the dredge moves forward by walking with one spud up and one spud down as it swings back and forth across the cut.

Next we see another modern Dutch dredge with 3,000 h.p. on the pump and 750 h.p. on the cutter with a 26-inch discharge line. The gallows frame for the ladder appears more like the conventional American dredges and the anchor booms are latticed. Some quarters are provided but the swinging and hoisting machinery is again exposed. The carriage-mounted spuds are used and an interesting feature is the very high level of the discharge pipe which can be seen running along the side of the house. (Slide 20)

Endless chain bucket dredges are still in everyday use in Europe and I felt it proper to show one such dredge. This particular dredge is quite modern and discharges through a trough on each side. You can see the one on the near side of the dredge in elevated position. On the far side you can see the stern of a dump scow which is receiving material on that side of the dredge. When that scow is filled another one will be alongside on the near side of the dredge and material deposited continuously. The chain on this dredge is powered with a 400 h.p. engine and moves at a rate of 26 buckets per minute. Each bucket carries 860 liters of material and bucket dredges are rated in this manner. (Slide 21)

Proceeding on - or perhaps back - to the hopper dredge, for a little background I will state that this type of dredge is largely the brainchild of the Corps of Engineers here in the United States. The GENERAL MOULTRIE was utilized by the Corps in 1855 and is considered by many to be the first documented hydraulic type dredge developed. It was a converted wooden hull vessel with a length of 150 feet and powered by a single non-condensing steam engine operated under 60 psi steam pressure. The GENERAL MOULTRIE was a casualty of the War Between the States and it was not until 1872 that the Steamer HENRY BURDEN was converted for use as a hopper dredge and operated for a number of years at the entrances to the St. Johns River, Florida, Charleston Harbor, South Carolina, and Savannah Harbor, Georgia. From that time on hopper dredges have been continuously developed by the Corps of Engineers up to the stage of our modern plant which I am coming to. The next slide is of the Dredge MARKHAM which was constructed by the Corps of Engineers in 1960 and is the newest and most sophisticated hopper dredge currently in service by the Corps. The dredge was specifically designed to handle projects on the Great Lakes. It is diesel-electric and has 5300 h.p. for propulsion and hoppers with a capacity of 2,681 cu. yds. The MARKHAM operates basically as a conventional hopper dredge but is also equipped with capability of pumping out its own hoppers through an overboard discharge line or the capability of "direct pump-ashore" which is a process which I will describe in greater detail later. The two dredge pumps are arranged so that they can be connected in series with 2,000 h.p. made available for pumping out into a shore discharge pipe. The layout of the MARKHAM is typical of our modern dredges with the bridge forward, the hoppers amidship, and machinery spaces aft. It, together with the ESSAYONS which you see on the next slide, is part of the current fleet of 15 hopper dredges in operation by the Corps of Engineers. They range in size from the ESSAYONS which you see here, which has a hopper capacity of 8,270 cu. yds. to the 500 cu. yd. PACIFIC which operates on the West Coast. During FY 1964 this fleet of dredges dredged over 85,000,000 cu. yds. of material at a net unit cost per cubic yard of almost exactly 30¢. (Slides 22, 23)

We in the Corps are proud of the fact that although the operating cost of our dredges has increased in recent years in approximate conformance with the Engineering News Record Index, the cost per cu. yd. has remained virtually constant. This is attributed to the retirement of older dredges, the greater efficiency of newer dredges, and increased concern with technical aspects of dredge operation.

The cutaway view of the ESSAYONS shows the basic features of the typical seagoing hopper dredge with which I am sure most of you are familiar. The quantity of material loaded depends primarily on its character, the pumping time, the hopper capacity, and the distance to which the material has to be carried for dumping. In heavy coarse types of material which readily settles out most if not all of the solids are retained. Conversely, in light and silty materials a good proportion of the solids flow overboard through the hopper overflow. On each assignment the most economic load has to be determined.

The problems presented in maintaining the Delaware River at Philadelphia some years ago led to the development of what we call a sump rehandling unit which later has evolved into direct pump-ashore and I would like to describe those processes. Spoil areas for use by pipeline dredge were not available within reach of the area susceptible of shoaling and a haul to sea of 50 miles or more would have been required to effect disposal in deep water by hopper dredge. Therefore, for many years the shoaling was removed by hopper dredges and dumped in prepared basins some distance from the shoal area. From those basins the material was rehandled by pipeline dredge and discharged ashore behind retaining dikes. Although this method was used for over half a century it became clear that only a small proportion of the shoal material actually reached the upland spoil areas where it was retained. The material is a light silt weighing about 1300 grams per liter and studies showed that from 20 to 25 million cubic yards of material was being dredged each year from the Delaware River whereas only approximately one-third of this amount was entering the estuary as new material. It was determined that a method of providing for the positive capture, retention, and permanent disposal of dredged material was essential and after various solutions were studied there evolved the idea of unloading a hopper dredge through a self-contained and elevated discharge line into a rehandling vessel moored at a suitable location from which point the material could then be pumped ashore. One of our regular fleet of hopper dredges, the GOETHALS, was converted to enable it to pump out its hoppers and discharge the material through an elevated "snorkel" into a companion vessel. For the companion vessel the old and obsolete hopper dredge NEW ORLEANS was converted into what was called a sump rehandler. The propulsion and original dredging machinery was removed and 6,000 h.p. pump power installed for pumping the material deposited into the vessel by the GOETHALS to shore disposal areas through a pipeline in the same manner as employed by a pipeline dredge. The sump rehandler vessel was moored to established dolphins in the Delaware River and connected by a pipeline to the shore disposal area. The next slide will show a close-up view of the Dredge GOETHALS with its snorkel extended over to the sump rehandler. (Slide 24)

This system was placed in operation in late 1954 and had remarkable success in maintaining the Delaware River between Philadelphia and the sea. It has also been used at other locations. In brief, the sump rehandling system and the positive disposal of dredged material have reduced the required dredging effort to approximately one-half of its former level.

The Hopper Dredge COMBER was also converted for use in conjunction with the GOETHALS and the NEW ORLEANS and this team of two hopper dredges and the sump rehandler worked very efficiently. However, as always happens when we progress with developments, it soon became apparent that the sump rehandler would be unnecessary if the dredges themselves had the capability of connecting to a shore discharge line and pumping ashore directly. Therefore, the most recent development along these lines has been to convert both the GOETHALS and the COMBER to permit direct pump-ashore and this system has now replaced the sump rehandling system in the Delaware River and the NEW ORLEANS has been retired. The next slide shows the COMBER moored alongside a mooring barge and pumping directly ashore through a connected pontoon line. A Wellons pier barge was acquired and modified for a mooring barge. The barge is more or less permanently moored to substantial dolphins located at selected points along the Delaware River. When the dredge finishes accumulating a load of material in the dredging area its drags are raised and the vessel proceeds to the mooring barge. Through practice it has been possible to reduce the connection time to 5 or 6 minutes and the disconnection time to about 3 minutes upon completion of the discharging of the material. The direct pump-ashore procedure is currently being used with a great degree of success and with advantageous economy. (Slide 25)

The development of direct pump-ashore immediately interested many of us in the possibility of adapting this type of operation to beach nourishment and since I know that many of you gentlemen are very interested in this subject I will tell you all that I can about this possibility. As you know, current thinking is that artificial nourishment of eroded beaches is certainly one of the best approaches in endeavoring to overcome our present erosion difficulties, and it appeared logical that a hopper dredge capable of picking up a load of good beach sand at some available location and with the ability to pump the material onto the beaches might provide an economical and speedy method of beach nourishment. Serious thought has been given to this problem by the Corps since early 1963 and progress is being made. The difficulty has been in the mechanical problem of providing adequate mooring facilities in an exposed sea area near a beach which will provide safe and economical operation of a hopper dredge. The type of operation which I described in the Delaware River permitted rather costly mooring dolphin construction at selected points. But in nourishing beaches so many discharge points would be required that the cost of providing elaborate mooring facilities could not be justified. Further, under wind, wave, and tide conditions normally occurring in shallow water areas off an ocean beach the problems of coming in and making a quick tieup connection to a mooring facility are obviously far different from those experienced in the protected Delaware River or other similar areas. Also, maintenance of a conventional pontoon line through an ocean surf would be extremely difficult if not entirely impracticable and it has therefore been necessary to study various types of submerged pipelines and some sort of connection facility which would permit prompt connections with the dredge. Offshore unloading facilities for tankers have been in use for a number of years but these generally are of relatively small pipe sizes and the tankers take a number of hours to pump their load ashore. If we are to achieve economic pump-ashore of beach sand it is obviously necessary that numerous dredge loads be discharged per day and therefore facilities for prompt hooking up and disconnecting are essential.

Engineers of the Corps of Engineers are currently actively engaged in studying this problem. We had hoped to make an experiment off the New Jersey coast this fall but difficulties encountered with an experimental barge have now delayed the experiments until sometime next spring. However, the necessary parts for the offshore connection are being purchased and the barge for mooring purposes is under preparation. This experiment will determine the practicability of a hopper dredge coming alongside a mooring barge under exposed surf conditions, making prompt connection, and discharging a load of sand onto the beach. We know that both the COMBER and the GOETHALS have the capability of pumping out a load of sand in a relatively short time; our only problem has been in the physical connections to permit such pump-ashore onto a beach.

In the meantime, under the auspices of the Coastal Engineering Research Center, a sand inventory of offshore areas is in progress off the east coast of the United States. The purpose of this inventory is to locate deposits of acceptable sand for use in beach nourishment. Sand deposits must be found within economic hauling distance and at depths which can be reached by hopper dredges (these will be in the order of not to exceed 50 feet).

We have every reason to believe that a feasible method of depositing sand ashore directly from a hopper dredge will be developed at a relatively early date and we believe that this procedure will provide a much more economical and effective method of beach nourishment than has so far been devised.

My mentioning of the experiments with respect to beach nourishment by hopper dredge is not intended to depreciate the possibility of beach nourishment by pipeline dredge. It is my observation that sand bypassing at ocean inlets has not yet been developed into an easy, simple, and effective procedure and it therefore appears that artificial nourishment from borrow pit sources is almost a must. There are not usually too many areas where pipeline dredges can operate in protected waters and pump the proper type of sand to a beach at economical cost. However, necessity is the mother of invention and it is felt certain that the ingenuity of the American dredging contractors will develop economical means of beach nourishment by pipeline dredge. A project which is now underway and delivering material to the Newark Airport at Newark, New Jersey, is interesting because of its possibilities along the lines of beach nourishment. In this case material is being dredged by a pipeline dredge and discharged into specially designed distribution barges. These barges in turn are towed several miles to a point where another dredge has been especially developed to remove the material from the barge and deposit it on the fill area. Such a system might well have beach nourishment application in some locations.

Another recent development in dredging is sidecasting from a hopper dredge. This system was first developed a number of years ago by the National Bulk Carriers in an effort to maintain the mouth of the Orinoco River in Venezuela. A T2 tanker was converted with an extended boom off the starboard side through which the dredge pumped material direct rather than going through hoppers. The boom extended 250 feet outward from one side of the vessel and the dredge had fantastically successful results in providing a usable channel into the mouth of the Orinoco which no previous equipment had been able to do. In a little less than 3 years this dredge removed over 104 million cubic yards of material from the Boca Grande entrance channel and the success of the dredge was so great that the same company built in Japan at a cost of some $15 million the giant dredge ZULIA for operation in the channels of Lake Maracaibo, Venezuela. The ZULIA was provided with conventional hopper dredge capability but was also fitted with a boom 415 feet in overall length and capable of being rotated 180° so that discharge could be achieved on either the port or starboard side. The boom extends 328 feet beyond the side of the vessel. The next slide is a head on view of the ZULIA dredging in Lake Maracaibo. The discharge pipe in the boom is 57 inches in inside diameter. The vessel itself is 548 feet long, has a beam of 95 feet, and a draft of about 26½ feet. It has 11,000 h.p. on the propulsion machinery and 12,000 total h.p. on its 4 dredge pumps. (Slide 26)

The ZULIA has made an outstanding record at Lake Maracaibo and has permitted the maintenance of a usable deep draft channel for the heavy volume of tanker trade into that port. Records of the Instituto Nationale de Canalizziones of the Venezuelan Government show that during the period between 17 February 1960 and 17 July 1962 the ZULIA pumped through the boom a total of 104,663,000 cubic meters of material and by conventional hopper dredging 2,801,000 cubic meters for a total of 107,464,000 cubic meters. In place surveys indicated the removal of 70,462,000 cubic meters indicating an average efficiency of 67.32 percent. With the truly fantastic pumping rates achieved, over 7,000 cubic meters per hour, it can be seen that very effective and economical dredging with the ZULIA has been possible. The cost of the dredging during the period cited was some 23¢ American money per cubic meter.

The success achieved by the ZULIA prompted construction of a somewhat similar sidecasting dredge, the ICOA, which is also operating in South America.

The Corps of Engineers has become convinced that sidecast dredging offers very distinct advantages under proper circumstances. It is essentially an improved method of agitation dredging which is performed to some extent by all hopper dredges. The term agitation dredging is used to denote the effect of solid particles which have been disturbed from their in situ condition being carried by prevailing currents outside the dredging area where they are later deposited. Under certain conditions agitation dredging has always been effective and economical and with the high volume of material which can be pumped by a modern sidecasting dredge and the ability to initially discharge the material entirely outside of the channel prism the advantages are greatly multiplied. Although boom dredging must be limited in application, it has unquestioned applicability in areas where the material is relatively fine and where there is a prevailing current away from the area.

It may occur to you that in describing the sump rehandling and direct pump-ashore techniques and then following that description with a description of the sidecasting technique that I have contradicted myself. In the direct pump-ashore technique we are going to great ends to get the material entirely out of the estuary whereas in the sidecasting technique we are deliberately discharging material very close to the channel area. This apparently contradictory situation only serves to point up the vast difference in the situations which always face an engineer engaged in dredging. A procedure which will be extremely effective in one location will be completely ineffective in another.

Some thought has been given to utilizing boom dredges for beach restoration work but so far the method has not appeared to offer much prospect for success. Beach experts tell us that unless material is deposited in water of 6 feet or less in depth it is not effective in beach nourishment and so far none of the boom dredges which have been built are capable of operating that close to a beach.

The Corps of Engineers had promising results with experimental sidecasting performed by the Dredge HAINS in the Great Lakes and last year converted a surplus YSD secured from the Navy into a small sidecasting dredge without hoppers. This dredge, known as the MERRITT, is currently in operation in our Wilmington, N.C., District and can be seen on the next slide. As you will see the MERRITT is a quite small vessel with length of only 107' 10". A conventional rotating crane which was already on the YSD has been utilized to support the boom. The vessel has two 10" side drags and discharges through a 12" inside diameter boom 80 feet in length. With the trajectory of the material this permits deposit about 90 feet from either side of the dredge. The boom can be swung to either side and the next slide will show an additional view with discharge being effected through the boom. (Slides 27, 28)

Although the MERRITT has been in operation only a limited period it is indicated that it will serve an extremely useful purpose. There are several ocean inlets along the coast of North Carolina which are of such shallow depth as to preclude operation by even the smallest Corps of Engineers hopper dredges under usually prevailing circumstances. The areas are too rough for the economical use of pipeline dredges. In recent operations at Oregon Inlet, North Carolina, under quite adverse circumstances the MERRITT dredged 76,847 cu. yds. of in place material at a cost of 57.6¢ per cubic yard. The dredging created a pilot cut through the ocean bar at Oregon Inlet of sufficient dimensions to permit the safe operation of the larger and conventional Hopper Dredge HYDE. Although the MERRITT is experimental in nature we look for splendid benefits from it on small ocean bars.

As a matter of fact, the Corps is currently converting another surplus Naval vessel, a YF, for use in the New Orleans District. The conversion work is now underway and this vessel will be fitted with a rotating boom similar to that which you saw on the ZULIA.

Going still further and saving the best for the last, the Corps of Engineers currently has under construction at Sparrow's Point, Maryland, what we think will be the most advanced and sophisticated piece of dredging equipment ever built. The last slide will give you an artist's conception of this dredge to be known as the McFARLAND. It will have full hopper dredge capability, capability to pump ashore through a discharge line as was previously described in connection with the COMBER and the GOETHALS, and in addition will have a boom for sidecasting purposes. This dredge will be assigned to the Galveston, Texas, District and it is expected that the sidecasting capability can be used to distinct advantage on some of the entrance channels along the Texas coast which apparently have conditions ideal for this type of operation. The McFARLAND will have an overall length of 300 feet, a beam of 72 feet, and a loaded draft not to exceed 22 feet in order to permit efficient operations in some relatively shallow areas in the Galveston District. The boom will have a total length of 221 feet, 10 inches and will extend over the side approximately 140 feet. The boom will be constructed of aluminum and when not in use will be stowed in the aft position. The propulsion system will consist of 4 diesel engines driving twin controllable-pitch propellers. Each of the 4 engines will be rated at 1600 h.p. giving a total propulsive h.p. of 6,400. The dredge pumps will be electric drive from separate diesel generator units, each pump being 2800 h.p. Piping arrangements will permit connecting the pumps in series for use in pumping ashore or boom discharging. The maximum hopper capacity will be 3100 cu. yds. (Slide 29)

The McFARLAND will be fitted with all of the latest types of instrumentation, central engine room control, and all modern developments known to the shipbuilding art. With its ability to operate as a conventional hopper dredge, to sidecast material at rates never before available in the United States, and to discharge through as much as 10,000 feet of shore disposal lines, we expect great things of the McFARLAND.

REFERENCES

"Dragado de Agitacion con Brazo en el Canal de Maracaibo, Venezuela," 1962, Instituto Nacional de Canalizaciones, Republic of Venezuela, Caracas, Venezuela.

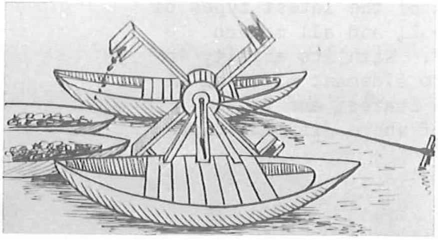
"Sidecast (Boom) Dredging - Foreign Experience and Local Application," Henry G. A. Hayward, American Society of Civil Engineers, Fall Meeting, New York, N. Y., 1961.

"Latest Dredging Practice," Ole P. Erickson, Transactions, American Society of Civil Engineers, Vol. 127, 1962, Part IV.

"Hopper Dredge Disposal Techniques and Related Developments in Design and Operation," Louis J. Mauriello & Lewis Caccese, Corps of Engineers, U. S. Army, Federal Interagency Sedimentation Conference, 1963.

"The Hopper Dredge," Corps of Engineers, Frederick C. Scheffauer, Government Printing Office, Washington, D. C., 1954.

Photographs of Dutch dredges, courtesy of I.H.C. Holland, Amsterdam



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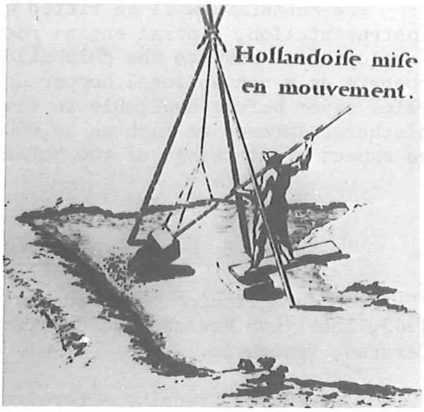

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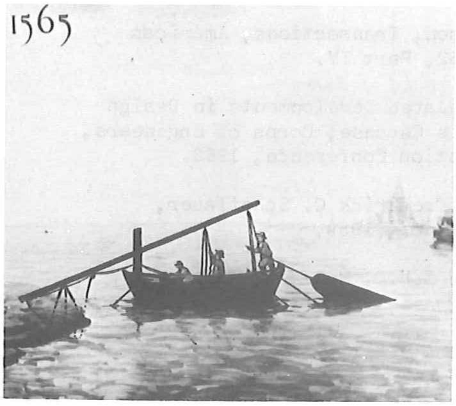

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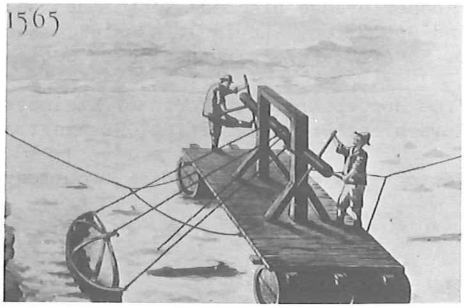

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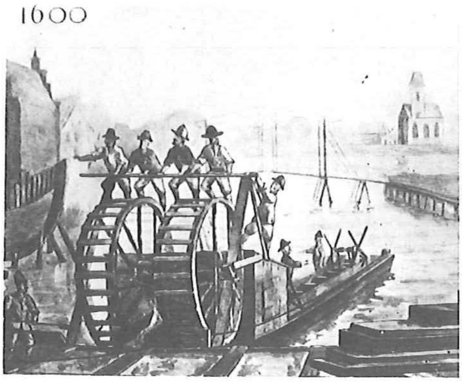

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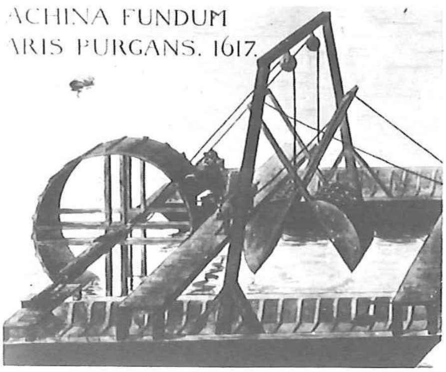

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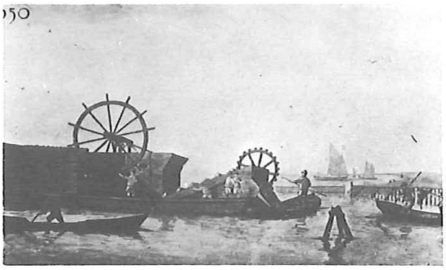

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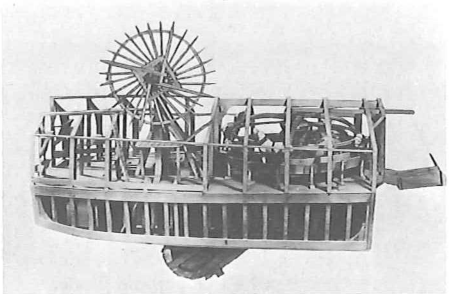

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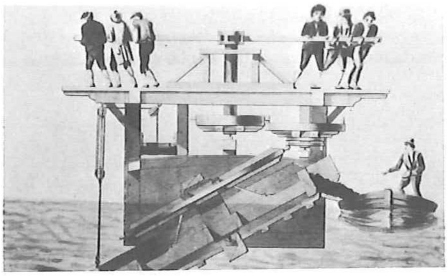

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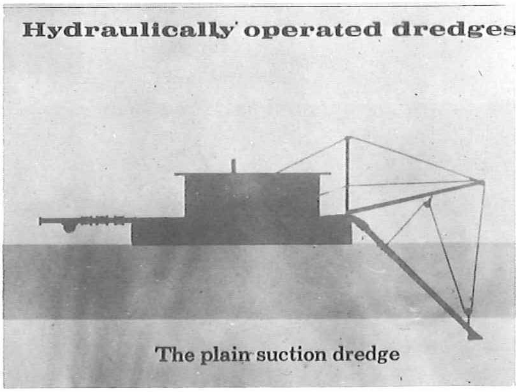

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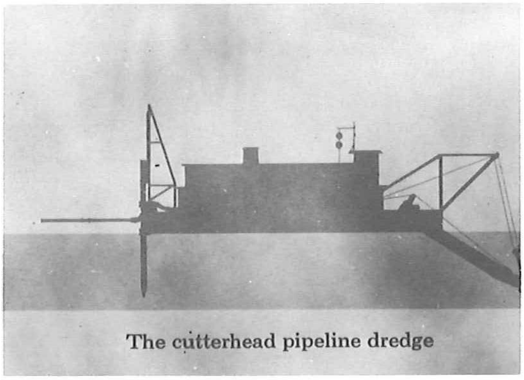

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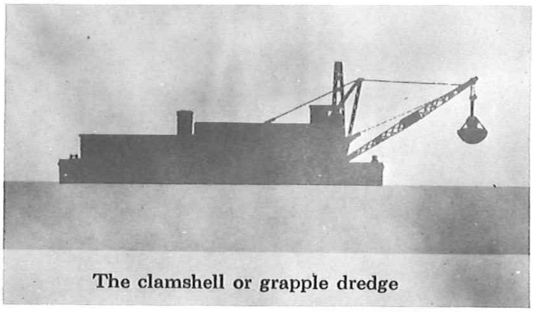

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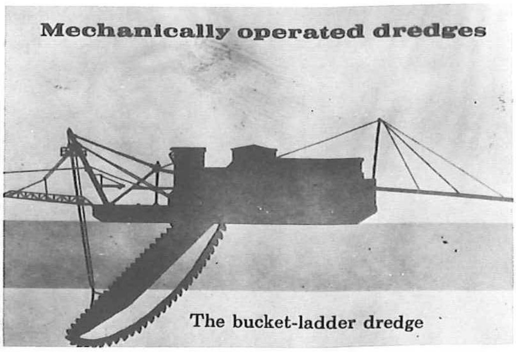

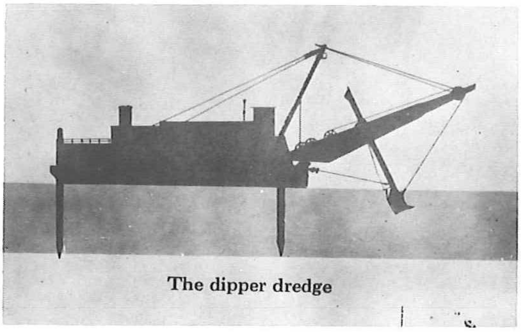

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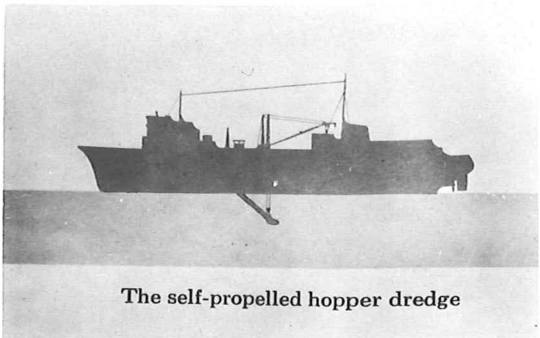

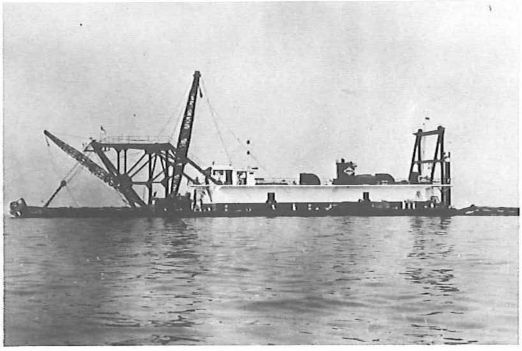

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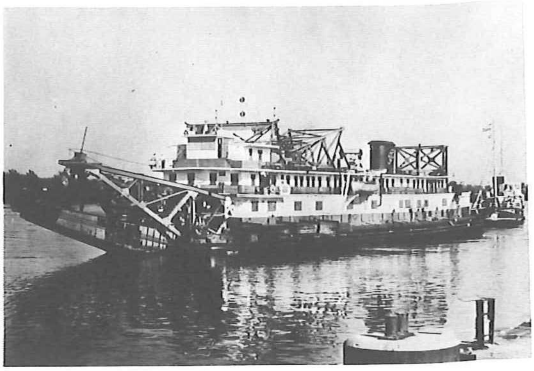

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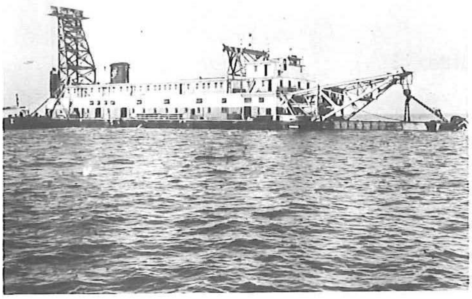

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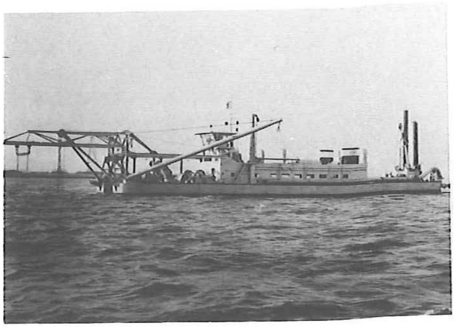

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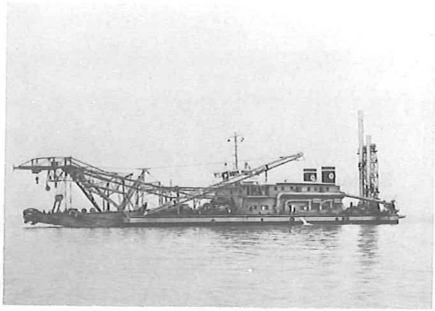

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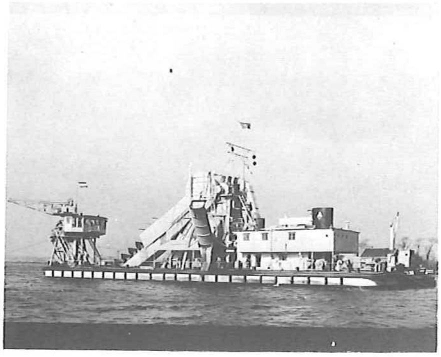

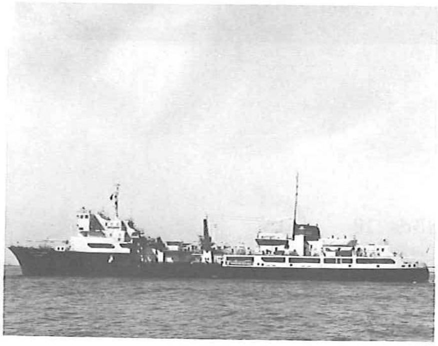

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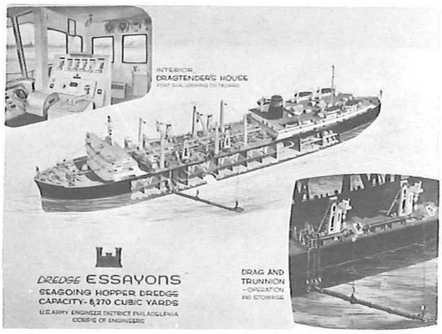

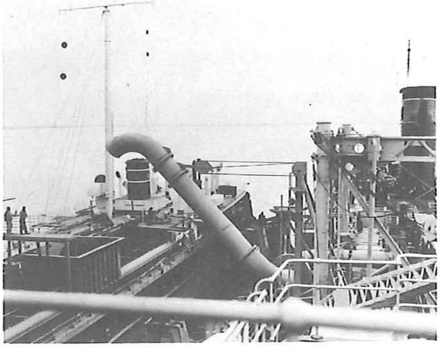

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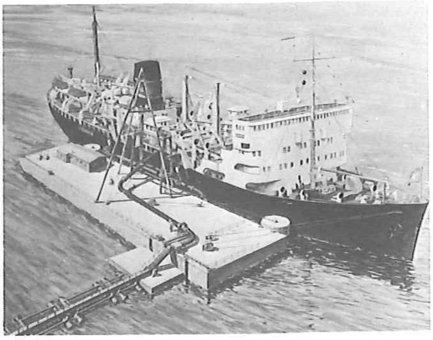

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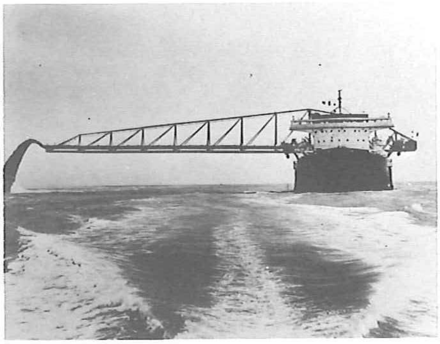

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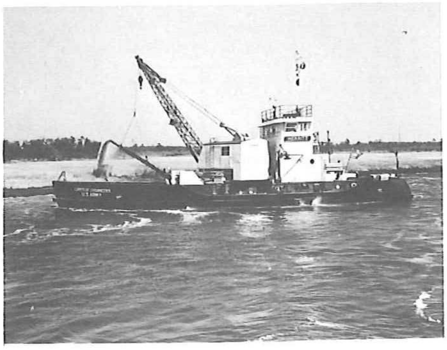

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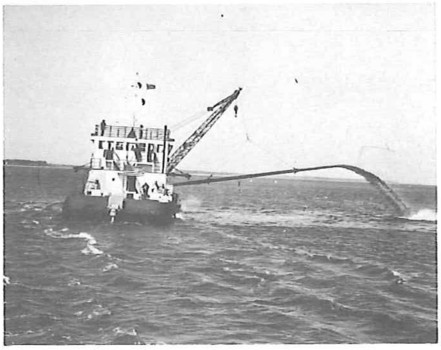

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