United States Patent [19]

Fahrner

[11] **3,820,258**

[45] **June 28, 1974**

[54] **APPARATUS AND METHOD FOR DREDGING, RETENTION, TRANSPORT AND DISPOSAL OF DREDGED MATERIAL**

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[52] **U.S. Cl.**..... **37/58,** 37/72, 37/195, 114/26, 114/235 R, 141/237, 141/287, 141/387, 285/97

[51] **Int. Cl.**..... **E02f 3/88,** B63b 21/62, B63b 35/28

[58] **Field of Search** ..... 37/54, 58, 72, 195; 114/235 R, 235 A, 26, 27; 285/97; 214/13; 141/279, 387, 284, 237, 287

[56] **References Cited**

UNITED STATES PATENTS

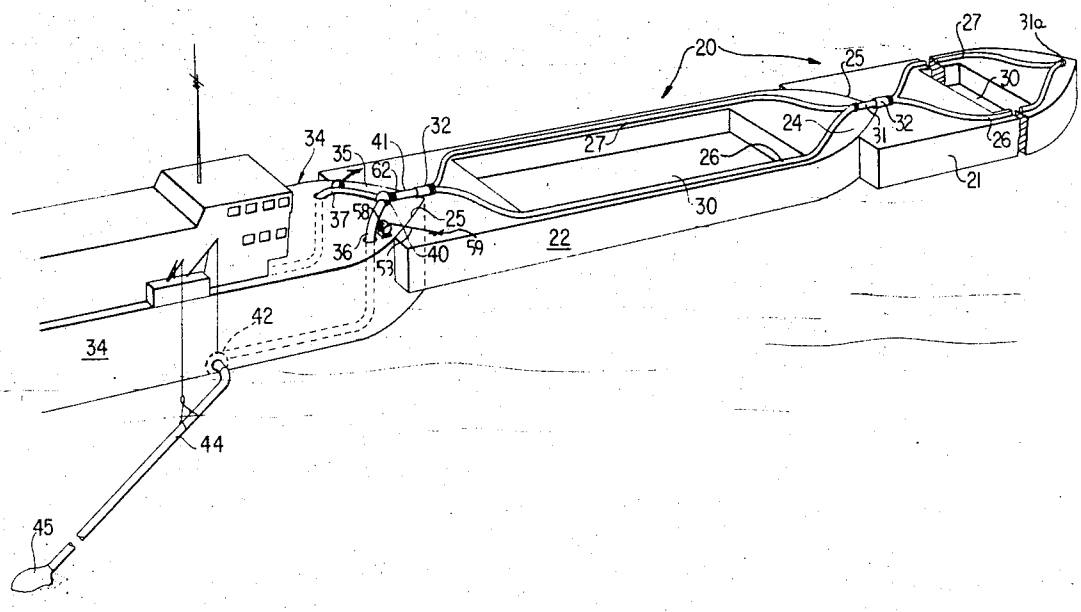
3,222,076	12/1965	Hollingsworth	285/97 X
3,485,200	12/1969	Iozza	114/235 R
3,557,741	1/1971	Teasdale	114/235 R
3,650,238	3/1972	Stockdale	115/235 R

Primary Examiner—Robert E. Pulfrey
Assistant Examiner—Clifford D. Crowder
Attorney, Agent, or Firm—Mason, Mason & Albright

[57] **ABSTRACT**

A system of subaqueous excavation and material removal having the combination of a hopper dredging vessel, hopper barges with independent dumping capacity and a prime mover vessel such as a tug, each barge having a stern notch and a bow portion which is contoured to be received in a like stern notch of an adjacent barge so that two or more barges can be arranged in an assemblage, end-to-end with bow portions fitting into the stern notches. The dredging vessel and prime mover vessel also have like bow portions whereby they can connect into the assemblage. By transporting filled assemblages from the dredging vessel for dumping and replacing same by empty assemblages the dredging vessel may continue its operation on practically a 24 hour basis. Rapid and effective securing of the assemblage, the dredging vessel and prime mover vessel are obtained through pneumatic fenders attached to the sides of the stern notches and a pneumatically controlled cushioning fender couple attached to the stem which is received between vertical expansible fenders at the apex of the stern notch. By expansion of the fender couple and the apex fenders the vessel is effectively secured to the assemblage. In order to separate the assemblage and the vessel, the fender couple and the tubular members are deflated. Conduits to carry dredged material are located on each barge and the dredging vessel. Each has a tubular outlet extending proximate the bow portion which is received in a larger tubular inlet extending proximate the stern notch, there being an arrangement of annular members about the engaging conduit means which are expansible and securely connect the conduits together whereby dredged material may be delivered from the dredging vessel simultaneously to each of the barges in the assemblage. The connection of the units is accomplished without any rigid structural linkage over a relatively broad and large surface to surface area whereby unwanted redundancy of strength at the connection is largely eliminated.

7 Claims, 16 Drawing Figures



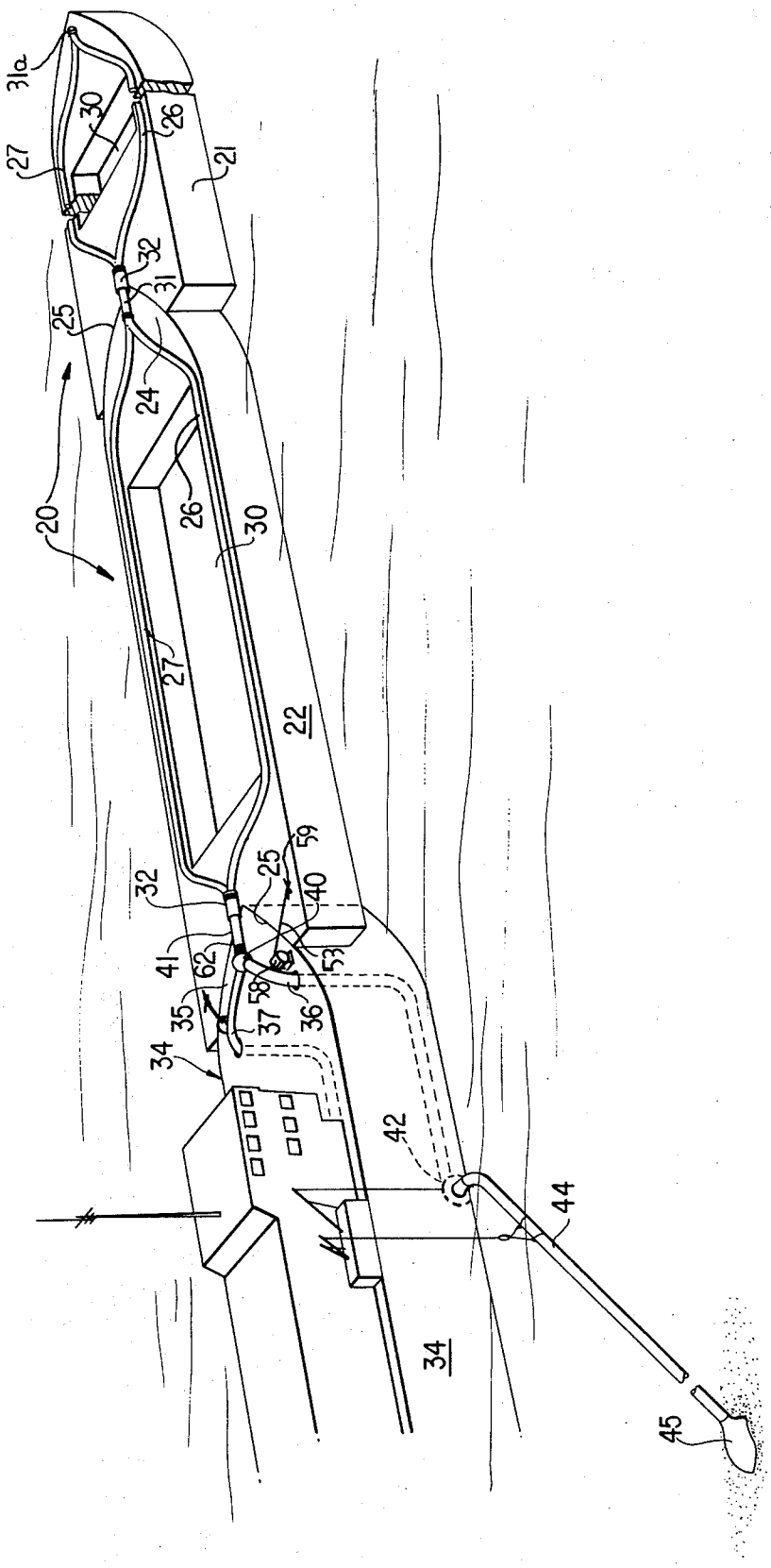

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FIG. 1

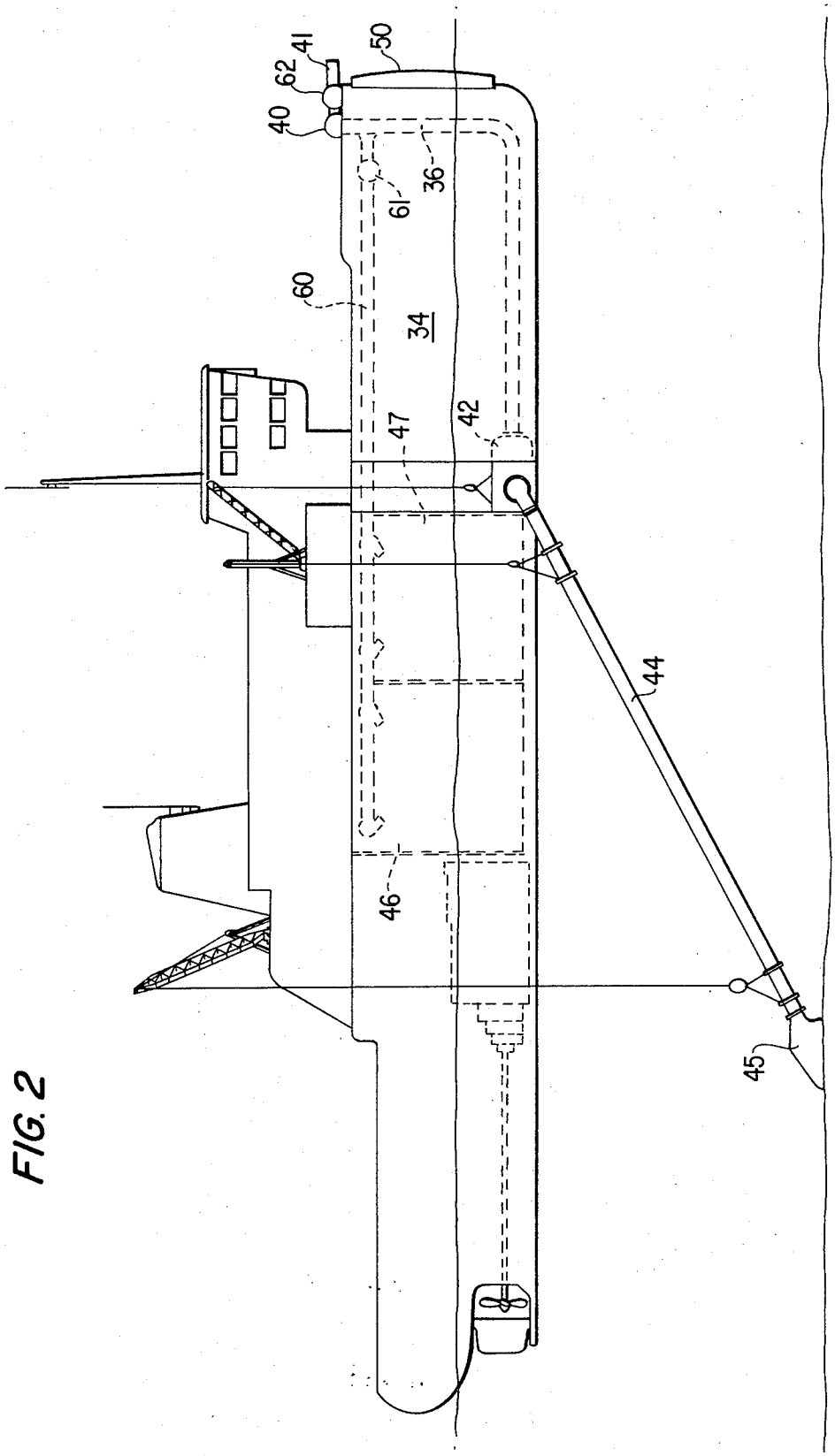


FIG. 2

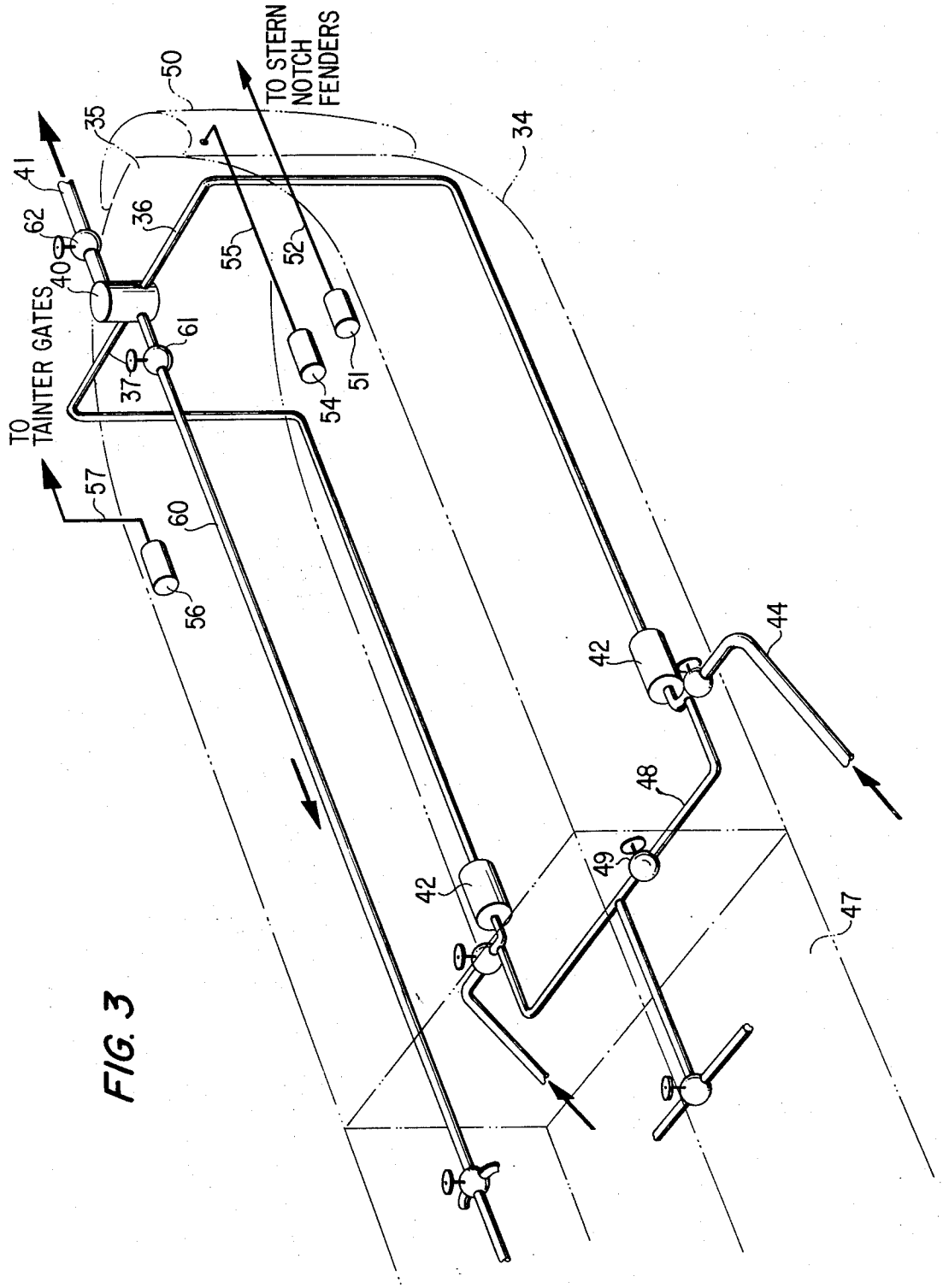

TO STERN NOTCH FENDERS
TO TAINTER GATES
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FIG. 3

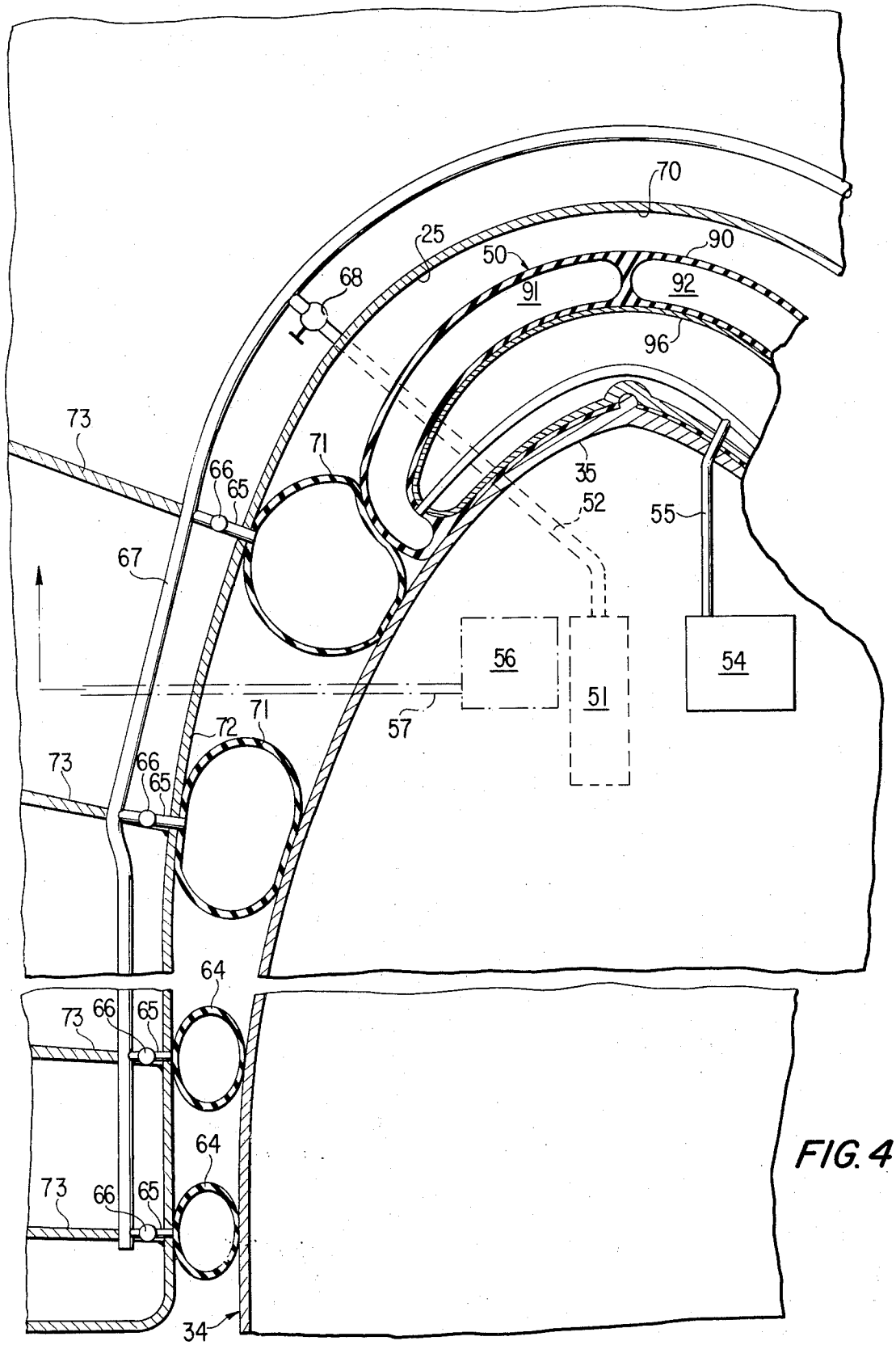

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FIG. 4

FIG. 5

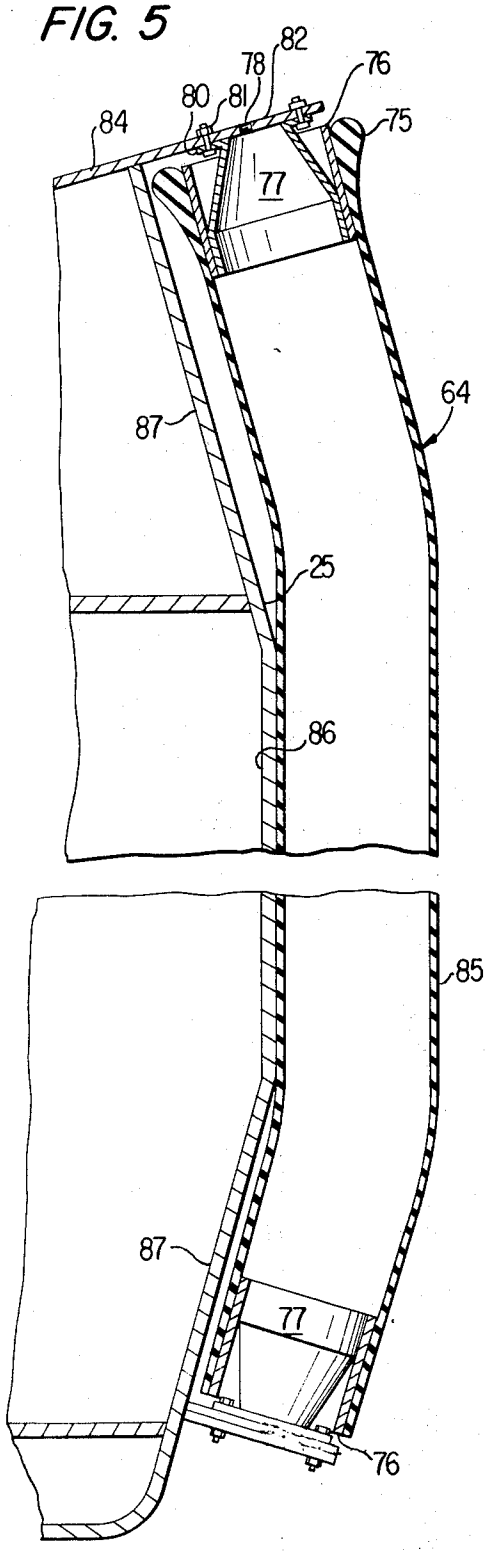
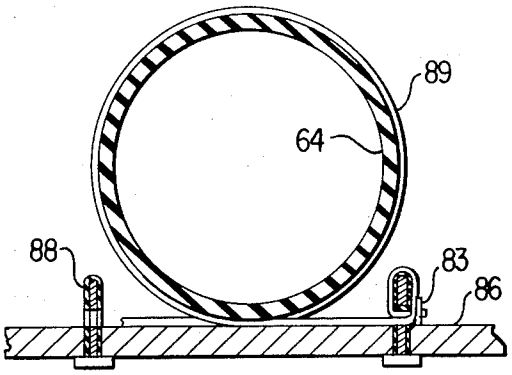


FIG. 6



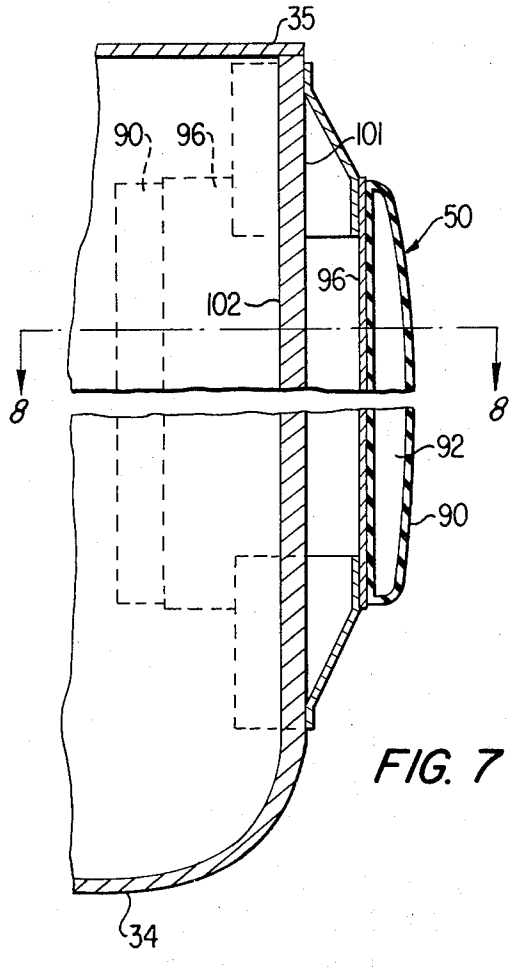


FIG. 7

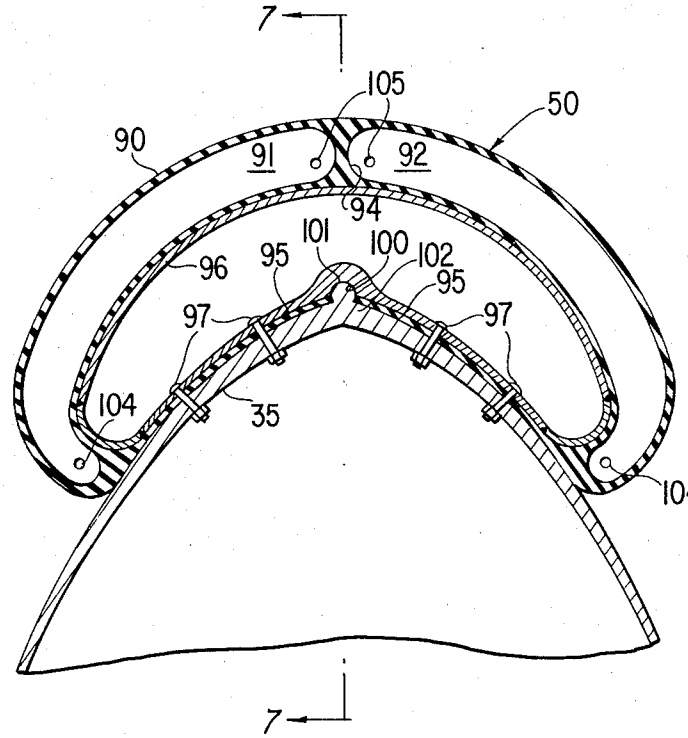


FIG. 8

FIG. 14

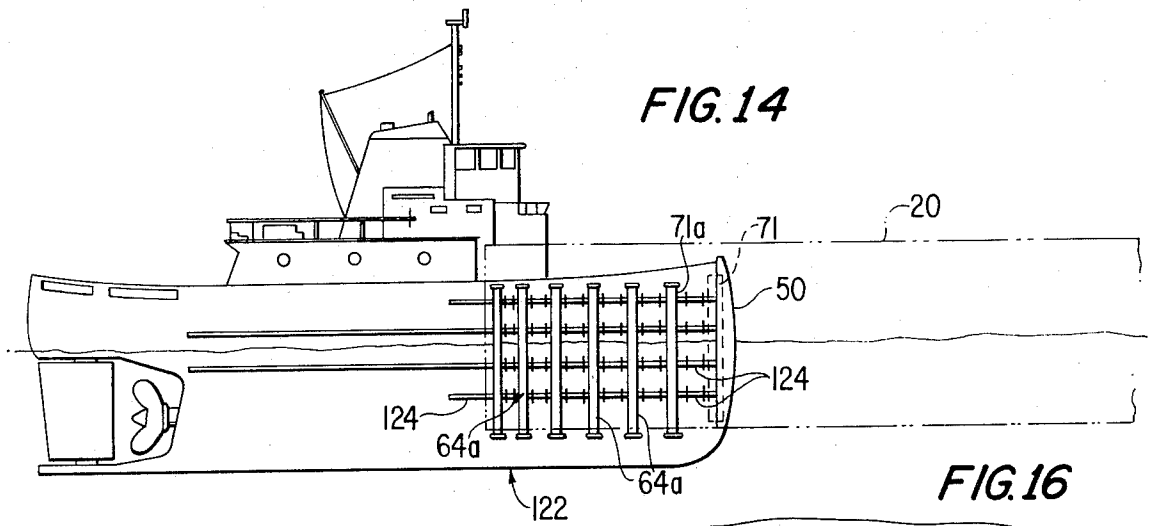


FIG. 16

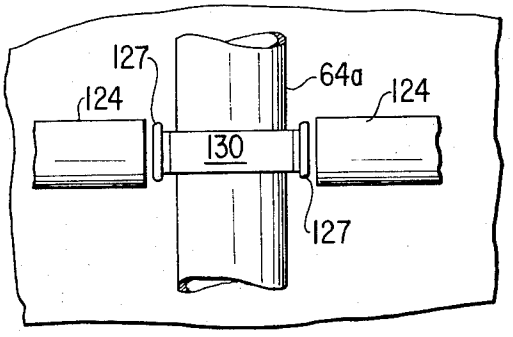
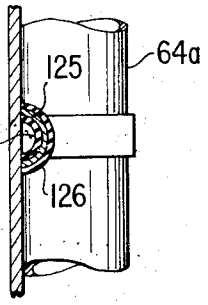


FIG. 15



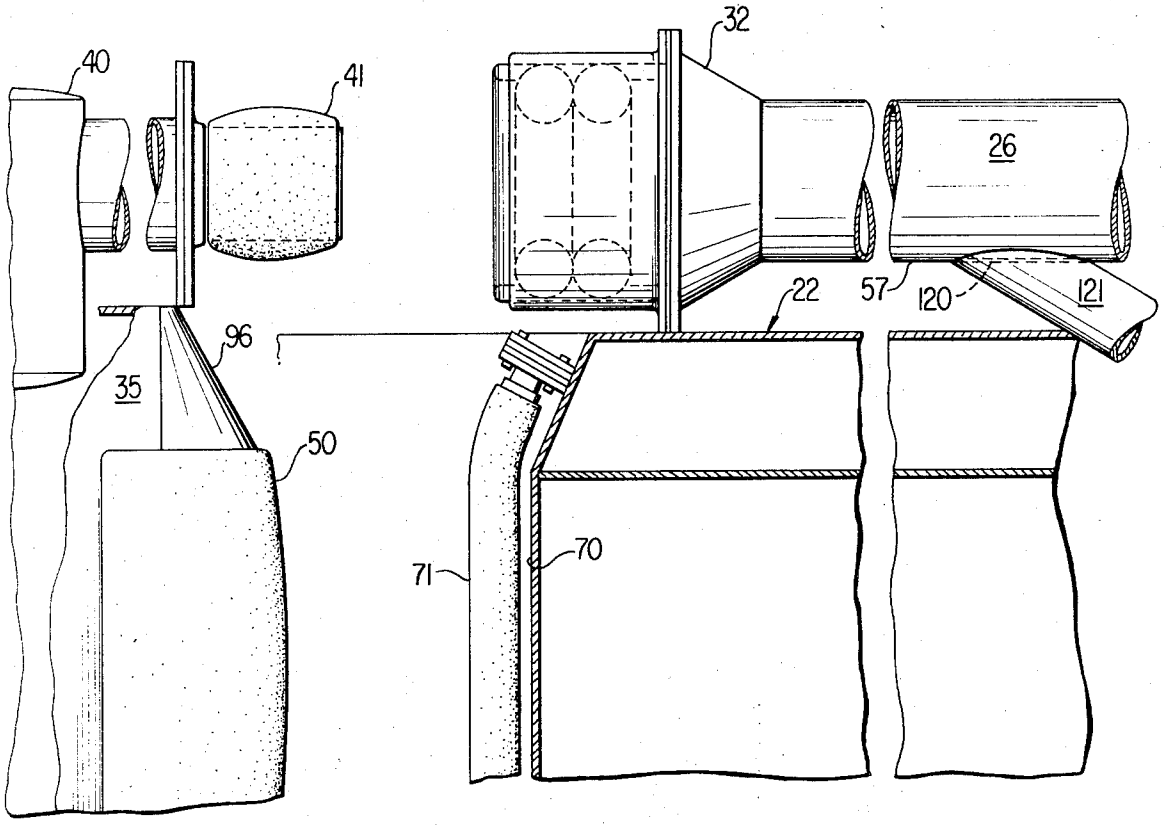


FIG. 9

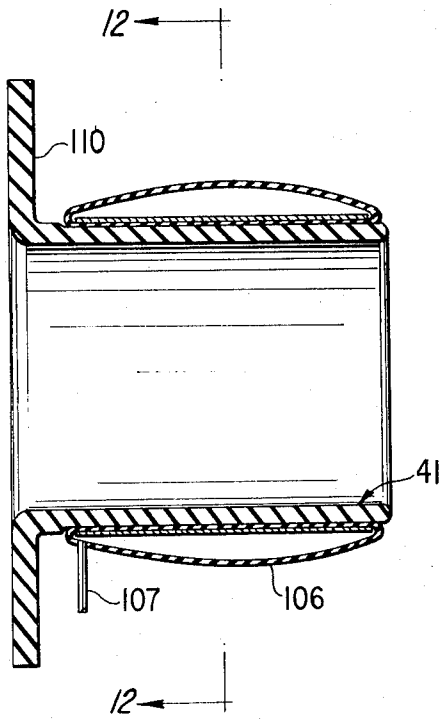


FIG. 10

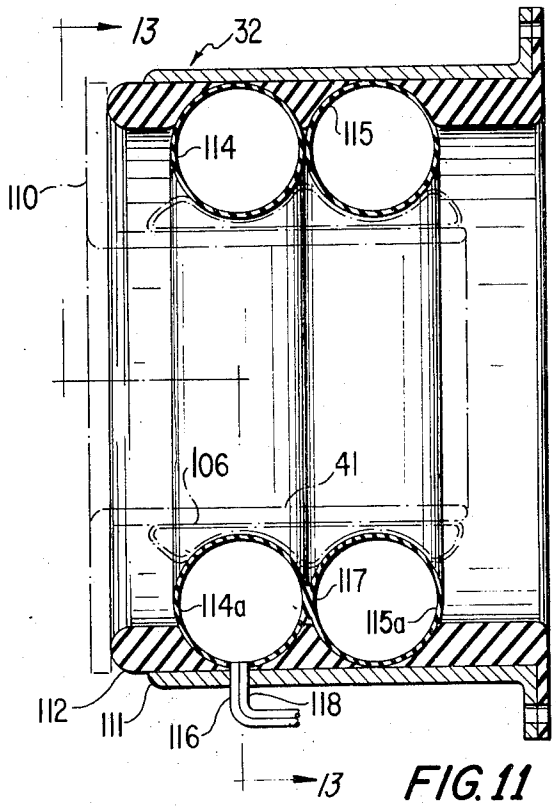


FIG. 11

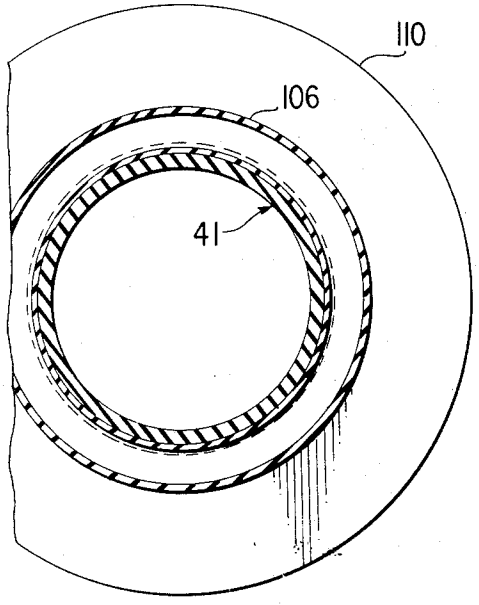


FIG. 12

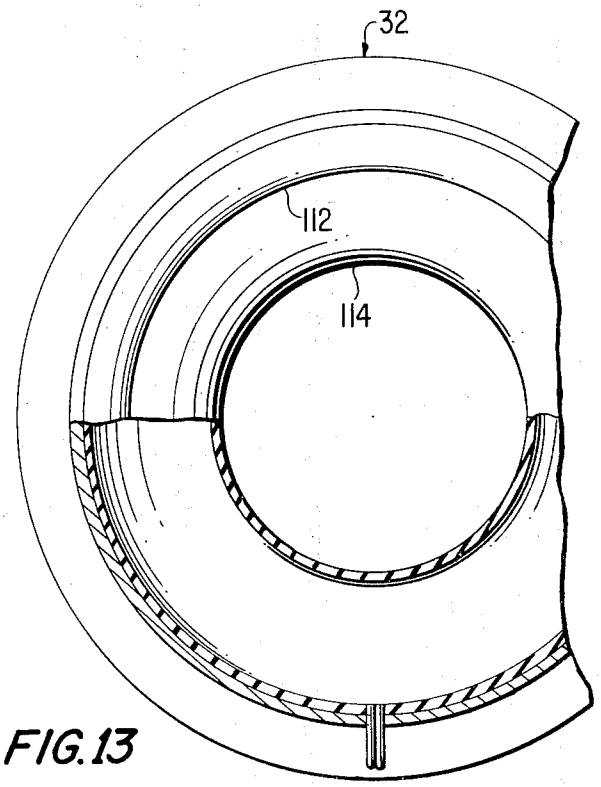


FIG. 13

APPARATUS AND METHOD FOR DREDGING, RETENTION, TRANSPORT AND DISPOSAL OF DREDGED MATERIAL

BACKGROUND OF THE INVENTION

The invention relates to an efficient dredging system wherein continuous subaqueous excavation is maintained by delivering dredged material continuously to an assemblage of hopper barges connected together and to the dredging vessel in an assemblage through a system of pneumatic fenders acting on bow portions received in stern notches, the securing being effected by the pneumatic pressure applied by the fenders against the side hulls of the bow portions of the barges and dredging vessel. By removing the barges as an assemblage and quickly replacing same with a further assemblage of barges the dredging operation may continue without interruption. A prime mover having a bow portion similar to that of the dredging vessel may be utilized to push the detached barge assembly out to sea or otherwise where it may be dumped and thereafter to return the assemblage to the dredging vessel for replacing a like barge assemblage which has been filled with dredging material in the meanwhile.

The function of the contemporary hopper dredge is dredging, which is an underwater, subaqueous type excavation. The primary modes of operation of contemporary hopper dredging vessels are as follows:

1. Agitation Dredging -- The dredge spoils are allowed to overflow from the vessel's hoppers during the dredging operation. As a result, the vessel's hoppers need only be dumped at infrequent intervals. Unless the dredged material which overflows is carried away by the current, much and perhaps most of the overflow dredged material eventually is redeposited in the dredging project prism.

2. Side Casting -- In this mode of operation the dredging vessel continually discharges dredged material directly via an extended conduit to an immediately adjacent disposal area. As a practical matter, this mode requires that the disposal area be within about 200 feet of the channel being dredged and parallel to such channel with a dike or the like isolating the disposal area from the dredging project prism.

3. Boom Dredging -- In this mode, the hopper dredge is located relatively near the disposal area but not sufficiently near to utilize the side casting mode. The hopper dredge proceeds to such disposal area whenever an economical load has been obtained in the dredge's hoppers and the dredged material is dumped in that portion of the disposal area nearest the point at which the hopper dredge left in the dredging project. After such dumping, the hopper dredge resumes dredging at the point it previously left.

4. Dredging and Hauling -- In this mode, the disposal area is located at a substantial distance from the site being dredged. Each dredged load must therefore be hauled to the disposal area and dumped or otherwise discharged before the hopper dredge can return for another load. The disposal area may be relatively remote; that is 3 to 60 miles from the dredging site.

To accomplish the latter mode, Dredging and Hauling, and also the mode, Boom Dredging, the hopper dredge actually forms three separate functions which are: (1) The subaqueous excavation within the project prism: (2) the retention of solids and slurry or both which have been removed from the project prism, and (3) The transport and final disposition of the dredged and retained solids or slurry, together with return to the dredging site.

The contemporary hopper dredge is a unique self-propelled, seagoing ship which is physically designed, constructed and operated to perform all three of the above-mentioned functions. It will be appreciated that the hopper capacity limitations of the dredge requires that these functions be performed in the sequence given. It has been found that for a typical 3,000 cubic yard hopper capacity trailing section hopper dredge wherein the dredging project is located approximately 6 miles from the sea-dump disposal site, the ratio between dredging and retention activity and transport and disposal activity is approximately one to two. Accordingly, if a hopper dredge of such type dredges say 8,500,000 cubic yards in 300 operating days and the vessel's operating cost, excluding repairs, during such period is about 3,000,000 dollars, about 1,000,000 dollars is applied to dredging and retention activities and about 2,000,000 dollars to disposal activity.

Under the same conditions, except that the sea dump disposal site is located 30 miles from the dredging site, the ratio between the dredging and retention activity on one hand and the transport and disposal activity on the other, is about one to nine.

At present, due to increased interest in geological and ecological considerations, there is a trend leading to a substantial increase in distance between the dredging activity and the disposal dump and an increased use of the dredging and hauling mode of operations. The alternative is to provide specialized disposal facilities for the direct or indirect discharge of dredging materials at shoreside establishments on each project. In either event, the expenditures for the dredging and disposal operations are greatly increased.

In face of the increasing costs, an expansion of dredging operations is and will be for some time required for commerce and traffic in the various harbors and inland waterways of this country. This is particularly so due to the substantial increases in draft and capacity of merchant vessels which has taken place in the last several years.

Although a growing awareness concerning marine and shoreside ecological considerations has served to emphasize the economical problems of present hopper dredger operations, the fact is that a need has long existed for a system which is substantially more efficient than that used at present from the standpoint of productivity in the excavation and disposal of the dredged material.

SUMMARY OF THE INVENTION

It has occurred to the inventor that the construction and utiization of modulized or unitized separate specialized units might prove advantageous for all modes of hopper dredge type operations. In this connection, it is known that for some time, a system of marine transportation has existed on rivers and inlet waterways wherein a tug boat moves a barge to and from an unloading area and barges may be connected by the tug boat in various configurations for either pushing or towing operations. More recently, a more or less similar system has been used for ocean going barges, usually with a single barge, designed for that purpose. However, as is well known by experienced mariners,

there is a vast difference between operations in the inland waterways and harbors, and operations at sea. Inasmuch as the hopper dredge is at times required to dredge or travel in areas which are essentially open sea or, in any event, areas subject to effects of winds and tides together with relatively high waves, and must load and unload under such conditions, the problems involved are distinctive from both inland and sea-going cargo carrying and handling operations. Nevertheless, it has occurred to the inventor that with appropriate means of rapidly and effectively linking several units in a system comprising a dredging unit, a plurality of barge units, and a prime mover or tug unit, a practicable solution for cutting costs of dredging operation may be realized. In fact, the savings in certain typical operations exceed 50 percent.

The function of the dredging unit or vessel in accordance with the invention is to remove hydraulically the dredged material, known as spoils in the art, from the bottom being dredged, and at the same time, retain a barge assemblage made up of one or more barge units (which serves functions for the retention, transport and disposal of the spoils) in a desired position in the waterway, and to convey the spoils into the detachable repository constituted by the barge assemblage. The function of the barge assemblage is a detachable repository to receive the dredged material, and, when detached from the dredging unit, to serve in effect as a mud scow either in the assemblage form or as individual units which can be towed or pushed to distant disposal areas, dumped and brought back to the project anchorage wherein they may be linked up in assemblages of two, three or more barges again to constitute the appropriate hopper section or repository for spoils from the dredging vessel. The third unit required is the prime mover which can be an ordinary tug boat or a vessel specially designed for this operation.

An important aspect of this invention comprises the "link-up" of the dredging unit with the barge unit assemblages. The term "link-up" is utilized herein to mean the integration of separate units so that the separate hulls may be maneuvered and secured together so that their compatible piping and conduit systems are functionally connected. Thus, the link-up of the dredging unit with the barge unit assemblage forms a further assemblage whic is essentially a complete hopper dredge. However, when such hopper assemblage has been filled as a result of dredging cuts over the project, the barge assemblage is detached or otherwise unlinked and anchored or otherwise removed and the dredging vessel links up as before with another assemblage of barge units to resume the dredging cutting as before until this second barge assemblage has also been filled whereupon another exchange takes place. In the meantime, the filled barge unit assemblage is towed or preferably pushed by a prime mover designed for this purpose to disposal area, dumped and then returned to the project to again be linked up with the dredge vessel. It will be appreciated that when operating under reasonable sea conditions, the prime mover or tug may move two or more of the barge units as an assemblage or two assemblages connected together, but under adverse conditions this may not be advisable. Linked-up barges should be dumped simultaneously.

From environmental and ecological standpoints, the barge units and assemblages in accordance with the invention present many advantages. In this connection, it should be appreciated that spoils which have been dredged from underwater may vary considerably in content from clean sand to mud to a sludge or tarlike substance which may be contaminated by sewerage, industrial waste and the like. Such spoils, however, have potential value due to their content to industry and construction as well as to agriculture. Sea dumps and waterways now being used for dumping must, of necessity, soon be greatly curtailed and I anticipate that disposal facilities will take their place which are suitable for floating crafts such as assemblages and barge units in accordance with the invention. Shoreside plants and facilities which are profitable, at least to the extent that they can provide savings over other alternatives, can then be established on a temporary or permanent basis for recovery and processing of spoils in such enclosures or areas. The barge units of this invention may be advantageously conveyed through a waterway in such an enclosure, formed by, say, a series of three locks, with the middle lock comprising the spoils disposal enclosure from which permanent and fixed means for transportation of the spoils to a shoreside facility may be easily installed or incorporated. Thus, it is considered that barge units in accordance with the invention can be utilized in such a spoils disposal activity more easily and economically than would exit for a powered vessel inasmuch as automatic means may be utilized to carry the loaded and empty barges through the facility on essentially an assembly line basis.

In a situation where it is desired to dispose of clean sand spoils for replenishment of a beach, it will also be understood by those skilled in the art that barge units which conform to the disclosure herein may be utilized advantageously for this purpose.

Although it will be recognized that for the first time a sectional or unitized concept is applied in my invention to major units in the dredging industry, existing and known types of dredges, barges and the like are not adaptable in an efficient manner to the system of the invention unless substantially modified. Thus, it is important to understand that a completely new and novel system and means for linking up the various units and for effecting their disconnection is presented hereby for connecting the specially designed barge units together and the assemblage thereof to the unique dredging vessel. A bow end received in a stern notch is provided wherein the stern notch includes a plurality of vertically disposed pneumatically and inflatable members which, when the bow end is received in the stern notch may be quickly inflated to effect a strong frictional grip over a broad area of the hull portion effectively linking the units together. The link-up is facilitated by means of an inflatable fender couple on the stem of the bow portion received between a pair of inflated tubular fender members on either side of the interior apex of the stern notch. With receipt of such inflatable fender couple between the two vertically disposed tubular members, an outlet portion for the conduit for conveying dredging material is received within an inlet tube on the barge unit and a special arrangement of annular inflatable members between the inlet and outlet conduits are inflated to effect a connection and substantially water-tight seal between such conduit portions. Subsequently, if and when necessary, the inflatable fender couple may be momentarily eased by partial deflation to facilitate limited adjustments which may be required by dissimilarities in the draft or trim

of the vessel and barge unit. By doing so, the vessel and barge units are appropriately adjusted to float at the draft and trim imposed by their loaded condition, and the adjustment is desirable to ease stress at the individual couples and adjacent structures. In this connection, one foot of tolerance is provided in the conduit connections to permit such limited adjustments.

With the dredging vessel connected to the barge assemblage, and the dredging material conduit from the dredging vessel connected to barge conduits, also connected, on the barge assemblage, the dredged material is conveyed from dredge pumps through the dredge material conduit to the barge units of an assemblage and through tainter gates. As the barge units fill and sink lower in the water, the dredging vessel is trimmed in an appropriate manner so as to prevent the application of undersired stress on the pneumatic apparatuS which has effected the link-up. Subsequently, when the barge assemblage units are filled with spoils, the assemblage is quickly disconnected by deflating the various members which previously effected the pneumatic link-up and such linkage is thus effectively and rapidly disestablished.

A fuller understanding of the adaptabilities and capabilities of the invention will be had by those skilled in the art as the description progresses and with reference to the accompanying drawings which illustrate schematically and by way of example a system embodying the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view showing an assemblage of two barge units and a dredging vessel in accordance with the invention;

FIG. 2 is a side elevation of a dredging vessel in accordance with the invention;

FIG. 3 is a schematic representation of the bow portion of the dredging vessel shown in FIG. 2;

FIG. 4 is a plan view of the bow portion of the dredging vessel received in the stern notch of a barge unit in accordance with the invention;

FIG. 5 is a sectional side view of a vertically disposed fender tube connected to the sides of the stern notch;

FIG. 6 is a top sectional view of the vertically tubular member shown in FIG. 5 illustrating means for securing same to the vertically disposed face of the stern notch;

FIG. 7 is a side sectional view of the stem fender assembly attached to the stem of the dredging vessel;

FIG. 8 is a cross-sectional view of a stem fender shown in FIG. 7;

FIG. 9 is a side view illustrating the relationship of the stem fender and dredging material conduit outlet of the dredging vessel with the corresponding dredging material conduit inlet of the barge unit and stern notch fender piece before same are joined;

FIG. 10 is a detailed cross-sectional view of the dredging material conduit outlet shown in FIG. 9;

FIG. 11 is a cross-sectional view of the dredging material inlet shown in FIG. 9;

FIG. 12 is a front sectional view of the dredging material conduit outlet as shown in FIGS. 9 and 10;

FIG. 13 is a similar view of the dredging material conduit inlet shown in FIGS. 9 and 11;

FIG. 14 is an elevational view of a prime mover vessel in accordance with the invention;

FIG. 15 is a fragmentary side view in partial section of a fender piece attached to the vessel shown in FIG. 14; and

FIG. 16 is a fragmentary elevational view of the fender of FIG. 15.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a barge assemblage designated generally by reference numeral 20 comprises a retention, transport and disposal modular, barge unit 21 and a similar barge unit 22. Each barge unit has starboard and port dredging material conduits 26 and 27 respectively. The conduits 26 and 27 circumvent the opening for hopper space 30 and combine forward where conduits 26 and 27 join in a dredging material conduit outlet portion 31 which is received by a dredging material conduit inlet portion 32. Dredging material conduit outlet portion 31*a* in the bow portion of barge unit 21 is secured by a valve or other appropriate means unless received by the inlet portion 32 of a further barge unit, it being necessary that the foremost outlet portion of the dredging material conduit be closed during leading operations.

The dredging vessel 34 includes a bow portion 35 which is similar in contour and structure to bow portions 24 of barge units 21 and 22. Dredging vessel conduits 36 and 37 on the star-board and port respectively join at a dredge pump discharge distribution chamber 40, forward from which extends a dredging material conduit outlet portion 41 which is similar to outlet portions 31 of barge units 21 and 22. Conduits 36 and 37 extend into the interior of the vessel 34 to the discharge of port and starboard dredging pumps 42 which take their suCtion through drag arms 44 that terminate in suction ends or drag heads 45. The hopper dredge assembly of drag heads, drag arms and suction pipes, dredge pumps, and the discharge piping from the dredging pumps are well known in the art and will now be described in detail herein.

With reference to FIG. 2, it will be noted that the dredging vessel 34 includes trimming tanks or hoppers 46 and 47. An elment of the cushioning fender couple between vessel 34 and barge units 21 and 22 comprises a stem fender assembly 50 which is connected to the stem of vessel 34 in a fashion which will be described in more detail hereinafter.

As may be seen in FIGS. 3 and 4, an air compressor 51 connects to a discharge air line 52 which selectively connects through a plurality of valves to fender pieces 71 and 64 connected to the stern notch sides as will be described hereinafter. A further air compressor 54 delivers compressed air through a conduit 55 to stem fender assembly 50. A hydraulic pump 56 connects through hydraulic line 57 to various tainter gates which are contained in conduits 26 and 27 for controlling the flow of dredging material into the hopper spaces 30 of barge units 21 and 22.

As shown in FIGS. 2 and 3, a return line 60 serves to return dredging material with the accompanying water to trimming tanks 46 and 47. For the purpose of controlling flow from distribution chamber 40, a gate valve 61 is provided in return line 60 and a further gate valve 62 is provided between the distribution chamber 40 and outlet portion 41. A suction line 48, including a valve 49, connects the bottom of tanks 47 with the suction of the starboard dredging pump 42. A similar line,

not shown, connects the lower part of tanks **46** with the suction of port dredging pump **42**.

Referring to FIG. **4**, it will be noted that the stern notch **25** includes a plurality of stern notch fender pieces **64** each of which is connected through an air branch line **65** having a control valve **66** to an air manifold line **67** which is connectable to air conduit **52** via valve **68**. Near the apex, designated by reference numeral **70**, of stern notch **25** a pair of apex stern notch fender pieces **71** are secured to the sides of the stern notch **25**. Such fender pieces **71** are similar to fender pieces **64** except that the diameter of the apex fender pieces **71** is about double that of fender pieces **64**. However, apex fender pieces **71** are also connected through air branch lines **65** to air branch manifold line **67**, control valves **66** being located in lines **65**.

It will be noted that the interior hull portion of stern notch **25** designated **72** has frames **73** welded thereto and extending normally therefrom behind each of the fender pieces **64** and **71**.

Referring to the detailed drawing shown in FIG. **5**, each fender piece **64** is composed of a rubber-like material and comprises a carcass portion **75** which is rigidly connected to a steel tubular member **76**. A steel reducer insert **77** is welded to tubular member **76** and also to the reducer flange **80** which is connected through flange bolts **81** to an apron flange **82** which extends from the staging surface or deck **84** of the barge unit. Deck **84** has a threaded opening **78** leading into the interior of the fender piece **64** for re-ceiving an air branch line **65**. A flexible tubular portion **85** extends downwardly from carcass **75** to a similar connection in the lower portion of the barge unit. In dimensions, the fender piece **64** is about 12 to 14 inches in diameter and extends about 4 feet above and below the molded vertical sides **86** of the stern notch **25**. The apron flange **82** is inclined about 15° inboard and surmounts the molded stern notch. The inclined sides of the stern notch are designated by reference numeral **87**. It will be appreciated as important that non-resilient structure within the stern notch **25** be absent from the vertical side **86** thereof except close to side **86** as, for example, used to secure fender piece **64** as shown in FIG. **6**. Here, a pair of guides **88** are connected to and extend normally from side **86**. A nylon strap **89** snuggly surrounds fender piece **64** and is secured through openings in guides **88** by retention staples **83** to guides **88**. Guides **88** are preferably coated with a resilient rubber or rubber-like material.

As shown in FIGS. **7** and **8**, the stem fender assembly **50** comprises a resilient portion **90** which is preferably constructed of a six ply automotive type carcass and encloses separate expansible chambers **91** and **92**, the port chamber **91** being divided from the starboard chamber **92** by a vertically oriented center wall **94**. Lateral projections **95** are connected to a roughly cardioid configured steel portion **96** of fender assembly **50** by means of bolts **97** which extend from bow portion **35**. A notch **100** formed at a central location in steel portion **96** is shaped to receive an interlock **101** which extends forwardly from the stem **102** of the dredging vessel's bow portion **35**. Steel portion **96** is joined to bow portion **35** by the vertically lowering the stem fender assembly **50** so that notch **100** receives and firmly engages interlock **101**. Each chamber **91** and **92** connects with an air pressure inflation valve **104** and a deflation valve constituting an air pressure bleeder **105**.

As shown in FIG. **4**, the stem fender assembly **50** is, when inflated, adapted to be received between the innermost apex fender pieces **71** in an interlocking engagement. It will be appreciated that each bow portion **24** of the barge units **21** and **22** has a stem fender assembly **50** as well as the fender pieces **64**, **71** and other related apparatus to effect the same necessary interlocking engagement.

As shown in FIG. **9**, proximate stem fender **50** and disposed above same is the dredging material conduit outlet portion **41** whereas proximate to the apex **70** of stern notch **25** and disposed above same is the dredging material conduit inlet portion **32** which leads and connects to conduits **26** and **27**. It will be noted that the diameter of the inlet portion **32** is substantially greater than the diameter of outlet portion **41**. The measurement of the former relative to the latter being about 64 to 34 inches, or a ratio of about two to one. Disposed about outlet portion **41** and connected thereto is an elongated expansible tubular member **106**, a pressurized air supply **107** being connected to the tubular member **106** for selectively introducing or withdrawing compressed air from tubular member **106**. Preferably tubular member **106** is composed of a rubber material and has a wall which is, in the center portion, about 1/4 inch thick and diverges in width to about 1/2 inch at the edges. The outlet portion **41**, to which tubular member **106** is connected, preferably is composed of a rigidly reinforced hose carcass with the interior coated with an abrasion resistant type rubber. A flange **110** is provided to limit entry of outlet portion **41** into the inlet portion **32**. Outlet portions **31** of barge units **21** and **22** are constructed in the same manner as outlet portion **41** described above.

As will be noted with reference to FIG. **11**, the inlet portion **32** comprises a steel tubular member **111** having a rubber lining **112** connected to its interior bore which is indented to receive a pair of tubular members **114** and **115** having a circular cross-section. Members **114** and **115** are expansible through means of an air conduit **116** which serves to introduce pressurized air within member **114**. Air may be exhausted through conduit **118**. A similar air conduit is provided for the tubular member **115**. Tubular members **114** and **115** may be separate annular configured members as shown in cross-section of upper portion of FIG. **11**; or they may have a common interior wall **117** as shown, to illustrate an alternatiVe structure, for tubular members **114*a*** and **115*a*** in the lower portion of FIG. **11**.

FIGS. **12** and **13** show the comparative size of the outlet portion **41** with tubular member **106** completely expanded and the inlet portion **32** with tubular members **114** and **115** expanded inwardly. It will thus be appreciated that engagement of an expanded tubular member **106** against tubular members **114** and **115** provides a substantially water-tight connection between the outlet portion **41** and inlet portion **32**.

As shown in FIG. **9**, the dredging material conduit **27** includes a tainter gate **120** whereby distribution to the hopper spaces **30** of barge units **21** and **22** via a hopper distribution conduit **121** is facilitated. It will be understood that a tainter gate **120** together with an associated conduit **121** is provided for each hopper space. Tainter gates **120** are governed through the hydraulic line **57** and hydraulic controls, not shown -- such apparatus being well known in the dredging apparatus and machinery art.

Conduit 52 to supply compressed air to fender pieces 64 and 71 and hydraulic line 57 are connected manually from barge unit to barge unit. Conduit 52 is preferably mounted on either conduit 26 or 27 or both when carried across the barge units. The same is true of the hydraulic line 57 which controls the tainter gates 120.

FIG. 14 illustrates a prime mover vessel 122 which has secured thereto in its bow area, in addition to the stem fender assembly 50, bow portion fender pieces 64*a* and a forward fender piece 71*a* which are similar in structure to stern notch fender piece 64 and apex fender pieces 71 except that they are secured to the bow portion of vessel 122 rather than the stern notch. Assemblage 20 is indicated in dot-dash lines together with the apex fender pieces 71 which engage the stem fender assembly 50 as previously described. The fender pieces 64*a* and 71*a* engage the sides of a stern notch such as stern notch 25 which, however, does not include fender pieces 64 and outboard apex fender pieces 71.

A plurality of spaced substantially horizontal strakes or bumper members 124 extend between the individual fenders 64*a* and 71*a* and between the fender 71 and the stem fender assembly 50 as shown in FIG. 14. Each bumper member 124 comprises a steel core member 125 which has a coating on each side of a rubber-type material 126. On either side of each fender piece 64*a* and 71*a*, a plurality of lugs 127 extend which receive and secure nylon straps 130 which snugly encircle fender pieces 64*a* to hold same in their desired lateral position in a manner similar to the construction disclosed relative to FIG. 6 for fender pieces 64 and 71. The horizontal bumper member 124 serves a double purpose of acting as guards for lugs 127 and, should the need arise, as part of the energy absorbing structure in the event that the fenders 64*a* and 71*a* are subjected to a substantial localized force through engagement with another vessel or object.

In operation, a dredging vessl 34 maneuvers its bow portion 35 into the stern notch 25 of an assemblage of barge units 20. This may be assisted by means of lines or straps 53 from winch 58 on vessel 34 connected to bits 59 on the barge unit 22. With compressors 51 and 54 in operation, stem fender 50 is brought into the apex 70 of stern notch 25. With stem fender 50 located at apex 70 between the inboard fender pieces 71, the resilient portion 90 of stem fender 50 is expanded by opening an appropriate valve in line 55 and at about the same time, the conduit 52 having been connected to manifold 67, fender pieces 64 and 71 are inflated preferably in sequence on both the starboard and port sides from forward working aft. Upon full inflation of fender pieces 64 and 71 and stem fender 50 the fender pieces 64 and 71 frictionally secure the hull of bow portion 35 within stern notch 25.

As stem fender 50 is brought into apex 70 of stern notch 25, outlet 41 is simultaneously brought into inlet 32, the vessel 34 previously having its draft adjusted to the proper draft for such insertion by means of trimming tanks 46 and 47. Due to the fact that the dredging vessel 34 and the barge assemblage 20 (including the barge units 21 and 22) when being made up and while being loaded float at approximately the same draft, the alignment and mating of outlet portion 41 with inlet portion 32 is a practicable expedient in normal seaways. In order to minimize possible misalignment, the inlet portion of 32 has a tolerance of about 12 inches in any direction from center relative to outlet portion 41.

As soon as the outlet portion 41 is received in inlet portion 32, tubular member 106 is expanded via air supply conduit 107 which is interconnected to conduit 55. At about the same time, tubular members 114 and 115 are also expanded to surround and engage tubular member 106 and provide a substantially water-tight connection between the outlet 41 and inlet 32. When this connection is made, assuming that the assemblage 20 has already been made up, dredging operations are ready to commence. If assemblage 20 is not yet made up, the bow section 24 of barge unit 22 is then secured into stern notch 25 of the adjacent barge unit 21 in the same manner as described and this is also true of the outlet portions 31 and inlet portions 32 of the connecting barge units. Additional barge units may be also attached. However, as previously indicated, the last outlet 31*a* must necessarily be secured.

During the dredging vessel and barge units' connecting procedures, gate valve 62 remains closed and, if dredging operations are continued during such procedure, gate valve 61 is opened and dredging material is conveyed to tanks 46 and 47. After the connections between the dredging vessel 34 and the barge assembly 20, including the barge units 21 and 22, have been made, gate valve 62 is opened and gate valve 61 is closed whereupon dredging material is received through conduits 26 and 27 into both units 21 and 22 and is delivered to the hopper spaces 30 via the hopper distribution conduits 121 and tainter gates 120 controlled through hydraulic fluids from hydraulic line 57 to insure uniform loading of the assemblage 20. As the assemblage is loaded with dredged material, the draft of vessel 34 is trimmed by the filling of trimming tanks 46 and 47. In the event that dredging was continued during the connecting operation, dredging material in tank 46 and 47 may be removed in part or whole via the suction lines which leads from the bottoms of such tanks to the intake of at least one of the dredging pumps 42. However, this will normally not be necessary.

When the assemblage 20 has been filled, it is disconnected by closing valve 62 after having opened valve 61 if it is desired to continue dredging operations during this procedure. The hydraulic line 57 is then secured and disconnected, air is bled from chambers 91 and 92 of the stem fender 50 via valves 105 and the fender pieces 64 and 71 are deflated by bleeding, air conduit 52 having been disconnected. After assemblage 20 has been disconnected from the dredging vessel 34, a further assemblage can be connected to the dredging vessel as previously described and a prime mover vessel such as vessel 122 may then remove the assemblage to the location where removal of the dredged material is effected after which assemblage 20 may be returned to the dredging vessel for reconnection when the assemblage which it is to replace or another assemblage has been disconnected from the dredging vessel 34. Preferably, the prime mover vessel will include a bow portion similar to that of bow portion 35 of vessel 34. With same, the prime mover vessel becomes, in effect, integral with the assemblage which increases its efficiency and flexibility in transporting the assemblage.

It will be appreciated by those skilled in the art that instead of having the fender pieces 64 and the outboard

fender pieces 71 connected to stern notch 25, they may be connected to either bow portion 24 or 35 and controlled directly from such unit. When a prime mover vessel has fender pieces 64 and 71 as indicated secured to its bow portion, it not only can be utilized to propel barge assemblies but also cargo barge assemblages having similar stern notch configuration. Moreover, it may be utilized for known tug boat operations wherein fender pieces such as 64 and 71 and a stern fender such as fender 50 may be required. Accordingly, the pneumatic type of securing means via a plurality of inflatable fenders permits a considerable amount of flexibility insofar as the utilization of the prime mover vessel is concerned. This potential for flexibility in the use of the prime mover vessel is of importance due to the fact that the number of prime mover vessels required in any given dredging operation will depend largely upon the distance to the disposal area — a parameter which will vary from operation to operation. Thus, a prime mover vessel in accordance with the invention can be utilized as tug or for pusher type cargo barge operations when it is not needed to function as part of the dredging, transport and disposal team.

Having described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A system for dredging, retention, transport and disposal of dredged material which comprises: a dredging vessel having a bow of predetermined contour: a prime mover vessel having a bow of predetermined contour: said prime mover vessel having a bow contour substantially the same as that of said dredging vessel; a plurality of barges; each said barge having a bow contour substantially the same as that of said dredging vessel and a stern with a recess sufficiently large to provide clearance for receiving the bow of said dredging vessel or said prime mover vessel or other barges of the system; coupling means for selectively connecting said bows of either said barges, dredging vessel, or prime mover substantially rigidly in a said recess of any of said barges, whereby an assemblage of said barges may be selectively coupled in a substantially rigid relationship to said dredging vessel or said prime mover; each said barge and said dredging vessel having conduit connection means and conduit means which are connected together by said conduit connection means when said barges and said dredging vessels are coupled together in a substantially rigid assemblage by said coupling means; dredging and pumping means in said dredging vessel for delivering said dredged material through said conduit means to each of said plurality of barges coupled together in said assemblage to said dredging vessel, whereby each said barge of said assemblage may be filled with dredged material by said dredging vessel while connected thereto and thereafter connected to said prime mover and moved in an assemblage by said prime mover for dumping while said dredging vessel fills a further assemblage of said barges with dredged material.

2. A system in accordance with claim 1 wherein said coupling means includes pneumatic means attached to the sides of a said recess for selectively rigidly securing each of said bows received therein by exerting sufficient force for such purpose against said bow.

3. A system in accordance with claim 2 wherein said pneumatic means includes expansible tubular members and means for selectively inflating and deflating each of same.

4. A system in accordance with claim 3 wherein said coupling means further includes a selectively expansible and contractable member secured at the bow stem of said dredging vessel which is adapted to cooperate with means in a said recess for selectively coupling and uncoupling said bow of said dredging vessel within a said recess.

5. A method of dredging, retaining, transporting and disposing of dredged material which comprises the steps of:

arranging an assemblage of dredging barges and a dredging vessel by coupling them together in a substantially rigid fashion;

connecting a conduit means from said dredging vessel to each of said barges in said assemblage;

continuously dredging underwater material into said dredging vessel and pumping said dredged material therefrom substantially simultaneously to each of said barges of said assemblage;

causing said dredging vessel to become lower in the water substantially in unison with the barges of said assemblage as they become loaded;

disconnecting said assemblage of barges from said dredging vessel when said barges are substantially filled with dredged material connecting said assemblage to a prime mover and transporting same to where they are dumped while connecting a further assemblage of barges to said dredging vessel and continuously dredging underwater material into said further assemblage, whereby said dredging vessel is maintained in substantially continuous dredging operations.

6. A method in accordance with claim 5, wherein said assemblage of barges and a dredging vessel are rigidly coupled by providing slots in each said barge adapted to receive a bow end on each of said barges and said dredging vessel and pneumatically expansible means in said slots, and by expanding by pneumatic pressure said expansible means against a said bow end so that the force of said expansible means between said slots and a said bow end effects a substantially rigid connection.

7. A method in accordance with claim 5 wherein said conduit means is provided with pneumatically inflatable and deflatable means for selectively connecting and disconnecting the conduits of adjacent barges and said dredging vessel, wherein said inflatable and deflatable means is inflated upon the outlet of the conduit of a first barge of said assemblage being received by the inlet of a second barge of said assemblage when said first and second barges are coupled for arrangement into said assemblage, said inflatable means thereby coupling said conduits of adjacent barges, and is deflated when said conduits are disconnected.

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