United States Patent

Nelson

[15] **3,638,338**

[45] **Feb. 1, 1972**

[54] APPARATUS AND METHOD FOR DEEP SEA DREDGING

[72] Inventor: **Arthur J. Nelson,** 3304 Shasta Drive, San Mateo, Calif. 94403

[22] Filed: **Nov. 4, 1969**

[21] Appl. No.: **873,985**

[52] **U.S. Cl.** **37/65,** 37/72, 37/195, 37/DIG. 8, 61/46, 114/144, 175/7

[51] **Int. Cl.** **E02f 3/88**

[58] **Field of Search** 175/7; 114/144; 37/58, 72, 37/DIG. 8, 64–67; 61/46, 46.5

[56] **References Cited**

UNITED STATES PATENTS

3,429,062	2/1969	Nelson	37/72 X
2,933,837	4/1960	Nelson	37/65
3,528,497	9/1970	Lehman	175/7 X
3,359,741	12/1967	Nelson	37/72 UX
3,522,670	8/1970	Flipse et al.	37/58
3,142,343	7/1964	Otteman et al.	175/7

Primary Examiner—Robert E. Pulfrey
Assistant Examiner—Clifford D. Crowder

[57] **ABSTRACT**

A pair of cutters and a dredge pump mounted to a lowermost pontoon is immersed to penetrate the floor of a body of water employing an indicator to limit the depth of cut for the pendulous traverse over a selected floor area. Anchors are selectively embedded into the floor remote to the dredged area to which wires are connected extending from powered winches mounted on the lowermost pontoon. The extended anchored wires are intermediately supported by a buoyed pendant so as to elevate those wires off the floor to avoid prolonged dragging and contaminating effect to them. Consequential with the catenary curve resulting from that elevation, a tension is developed creating an artificial demand of a slacked wire paid off one of a pair of identical winches at a greater rate than the opposite wire hauled-in to effect the pendulous swing established by a wire fixed to an anchor axially central with but remote to the selected area. Each pendulous swing is at a radius shortened by a winch oriented in mounting with the two identical winches so that all wires lead from the winch as tangent lines direct to the anchor. The anchors are relocated by towing on a surfaced conduit pendant extending to a lower buoy of adjustable support capacity secured by a cable pendant to the anchor whereby the buoy lift capacity is increased to free the embedded anchor off the floor.

An articulative conduit in fluid communication between the pump and a delivery terminal on a surfaced service station is supported as a suspended tensioned array stabilized by immersed pontoons of selected and automatically adjusted support capacity responsive to changes encountered. An arrangement of hoists, structural provisions and utilization of pontoons common with the array facilitate the transfer of objects to and from the service station and the array to modify the dredging apparatus.

11 Claims, 14 Drawing Figures

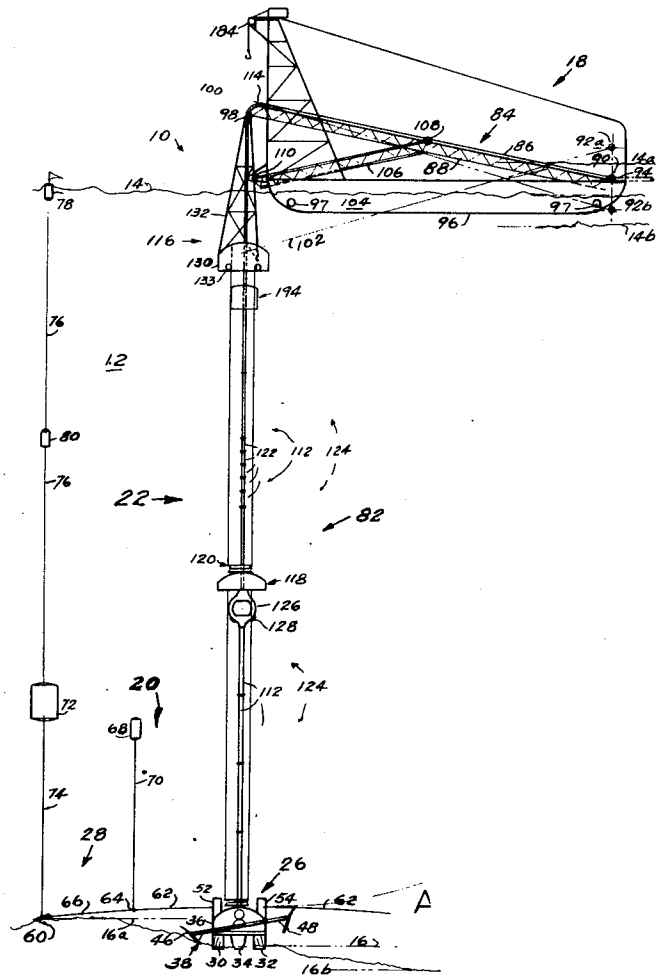


Fig 1

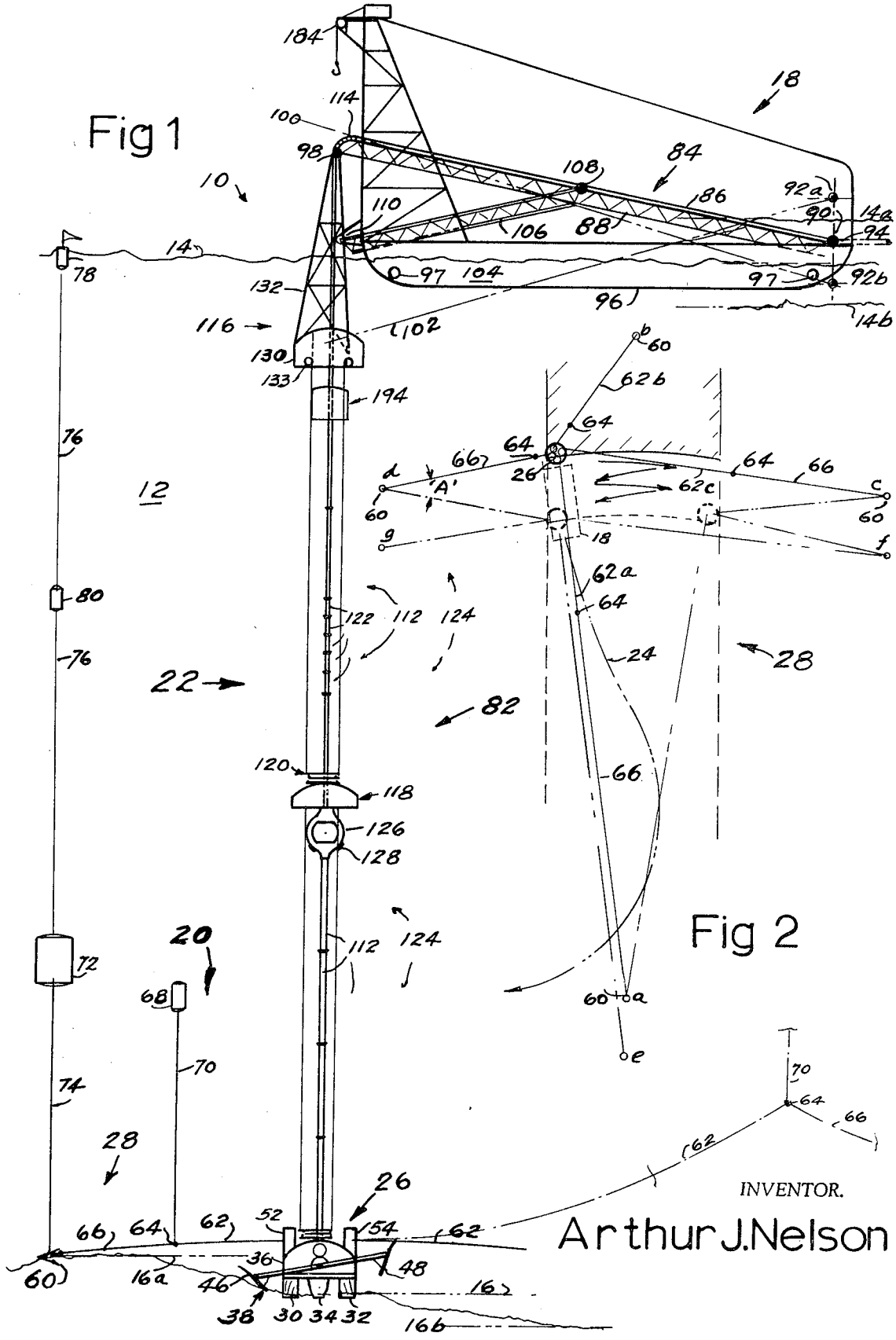


Fig 2

INVENTOR.

Arthur J. Nelson

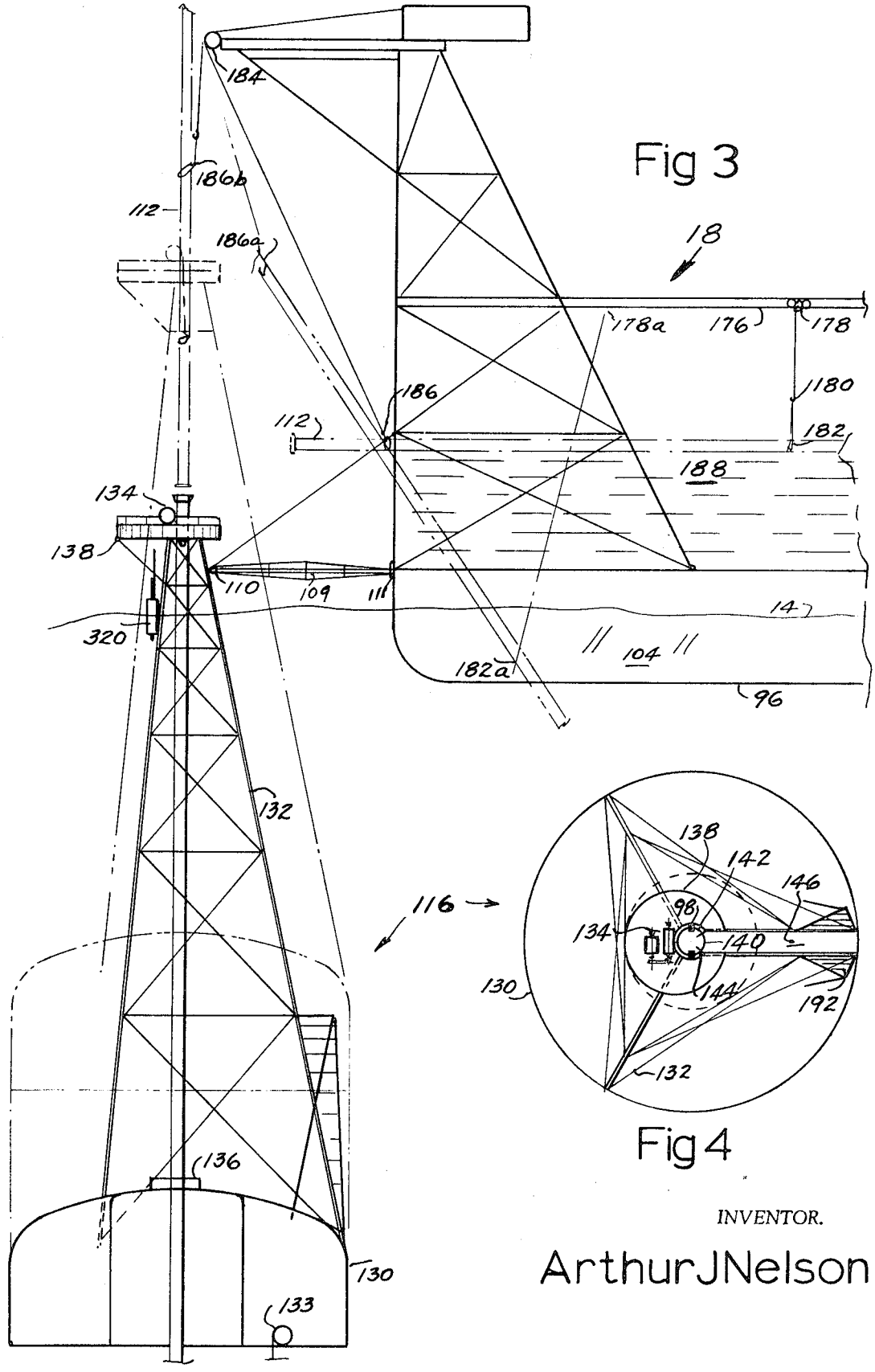


Fig 3

Fig 4

INVENTOR.

ArthurJNelson

Fig 6

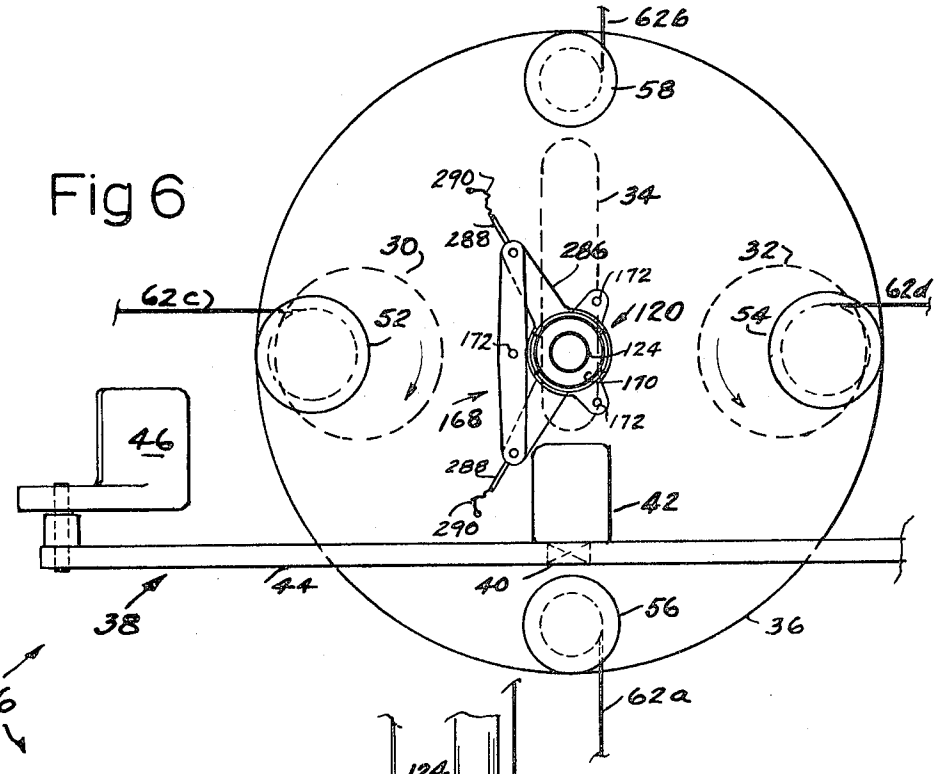
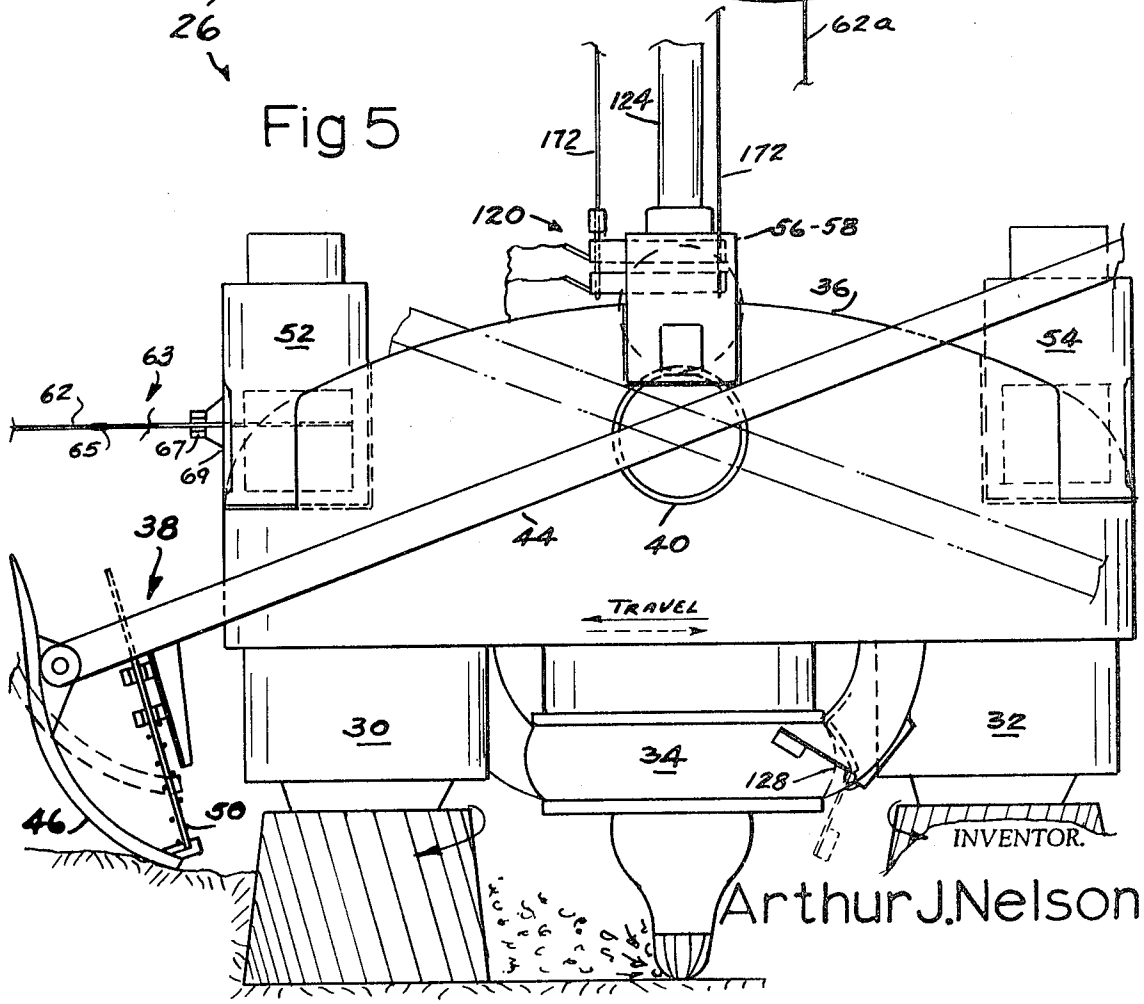


Fig 5



INVENTOR.

Arthur J. Nelson

Fig 9

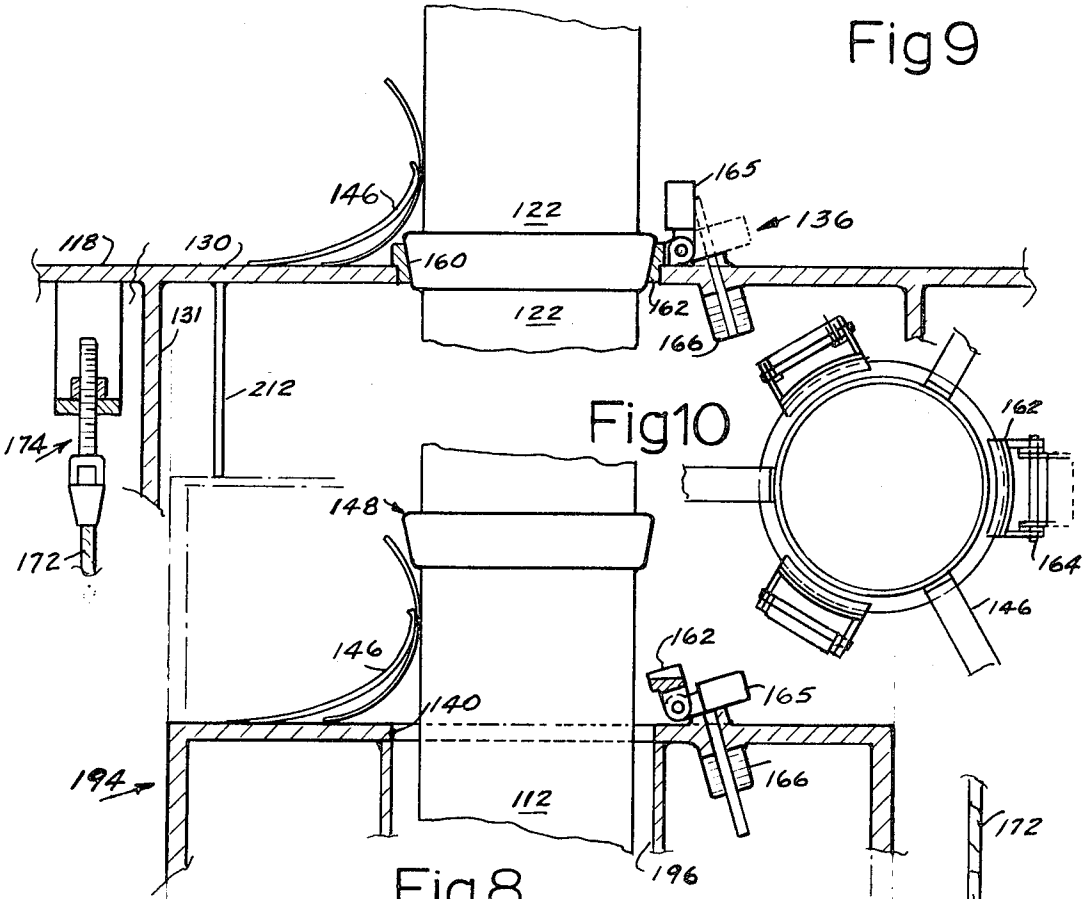
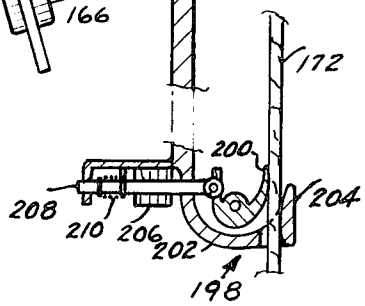


Fig 10

Fig 8



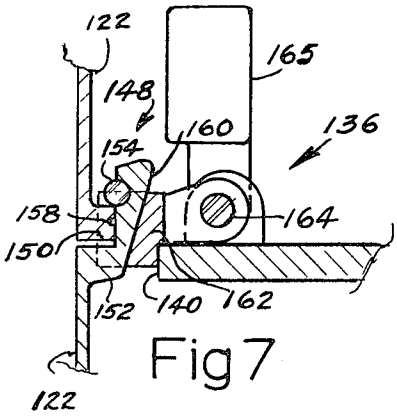


Fig 7

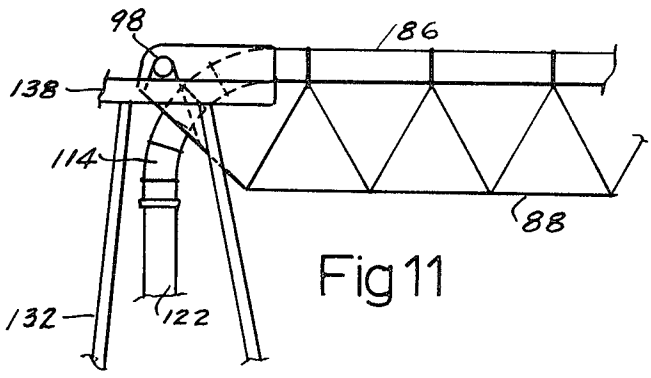


Fig 11

INVENTOR.

Arthur J. Nelson

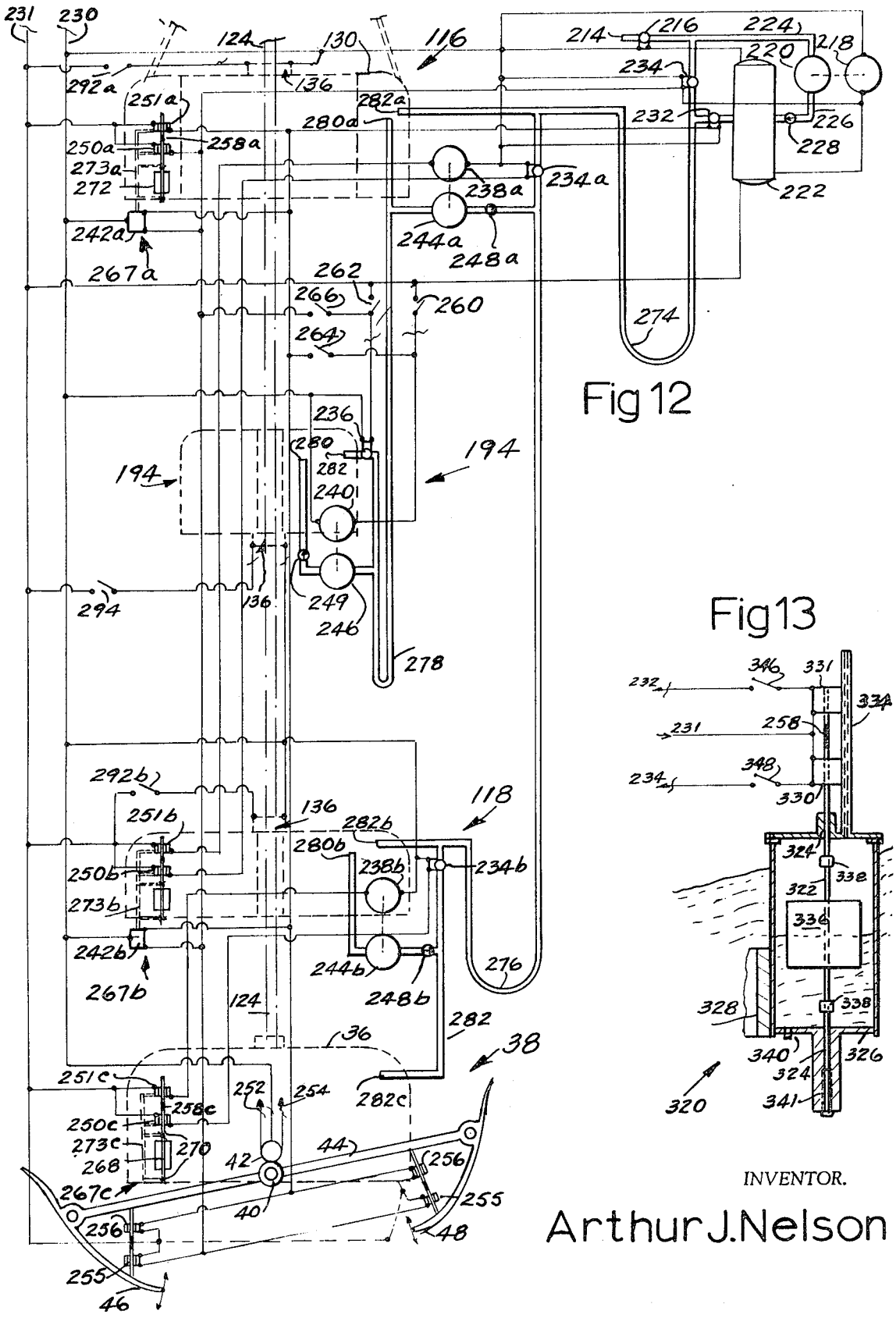


Fig 12

Fig 13

INVENTOR.

Arthur J. Nelson

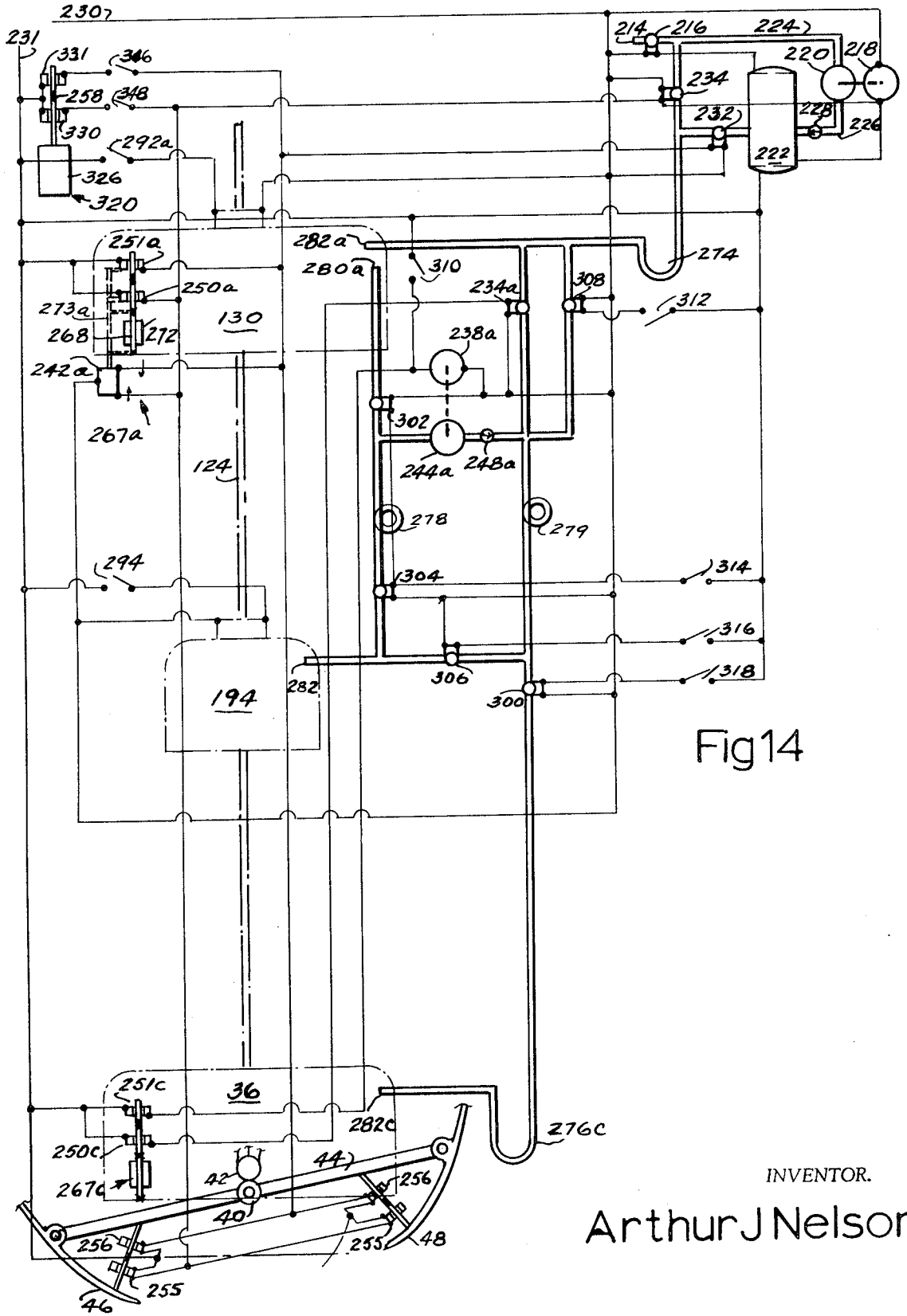


Fig14

INVENTOR.

Arthur J Nelson

APPARATUS AND METHOD FOR DEEP SEA DREDGING

BACKGROUND OF THE INVENTION

The present invention relates to the means of excavating a sea floor to produce a yield of material as distinguished from mere harvesting of material disposed as a surface deposit. Such excavation may extend over a selected area or restricted to trenching and for the latter condition where no yield of material is sought the assembly is modified accordingly.

In the prior art sea dredgers have been restricted to working at moderate depths even with immersed dredging equipment because of mechanical limitations.

It is accordingly an object of the present invention to provide a dredging apparatus capable of working to extreme depths employing anchored wires powered by immersed winches to effect a selected traverse.

Another object is to simplify transfer of anchors and extend the life of wires connected to them.

Still another object is to selectively control the dredge penetration of the sea floor.

Yet another object is to provide a substantial latitude in the depth of excavation while contending with oscillations of the surface affected apparatus.

Another object of the present invention is the method and apparatus employed in effecting changes to the assembly.

An important object is also to provide immediate support to masses in monitored or selected control to diminish the stress in members as arranged in the assembly.

SUMMARY OF THE INVENTION

A method and apparatus arranged to excavate sea floors either as an extended area or trench whether for recovery of material or preparation of a site. Apparatus is included to cope with undulations of the sea floor and vagrancies of the sea surface. A method of establishing selected portions of the area to be worked and the mode of operation is developed to expedite work and prolong life of equipment. The reliance upon buoyant chambers to selectively support apparatus immediate to it minimizes stresses in the members comprising the assembly. Provisions are included to facilitate modification to the assembly even under adverse conditions.

The foregoing and other objects of the invention will become more apparent when viewed in light of the following description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an elevational view diagrammatically illustrating the entire system of the invention in the condition it would assume during an excavation operation.

FIG. **2** is a plan view schematically illustrating the mode of operation and orientation of apparatus in relation to the area being dredged.

FIG. **3** is an enlarged view of that portion of the apparatus rearranged during a nonoperative period for modifying the length of the vertical array.

FIG. **4** is a plan view of the dominant station indicating provisions in the structure pertinent with assembly.

FIG. **5** is a enlarged elevational partial view of the dredging element indicating an operative condition.

FIG. **6** is an enlarged plan view of the dredging element indicating orientation of apparatus connected to it.

FIG. **7** is a partial sectional view of the coupling and clamp device securing conduit to pontoons.

FIG. **8** is a partial sectional view illustrating in general the disengaged position of the clamp and more particularly depicts the utility station of the array.

FIG. **9** is a partial sectional view illustrating in general the engaged position of the clamp and more particularly depicts the provision to nest the utility station within the dominant substation.

FIG. **10** is a plan view schematically illustrating disposition of clamp and guide means on a pontoon.

FIG. **11** is a partial elevational view of the support of the cooperative member by the vertical array in contention with oscillations of the surface vessel.

FIG. **12** is an elevational schematic view illustrating the buoyancy control circuiting employed with the arrangement of FIG. **1**.

FIG. **13** is an elevational view partially in section, illustrating the displacement control float adapted to stabilize the position of the vertical array when buoyed off the floor.

FIG. **14** is an alternate arrangement of FIG. **12** to include the dual function of the elevator (utility station).

Reference is made by symbol in the description to my patents and applications as tabulated below in effort to simplify identification of related presentations.

Reference Symbol	My U.S. Pat. Ser. No.	Date of Issue
B	2,933,837	Apr. 26, 1960
C	3,286,286	Nov. 22, 1966
K	3,429,588	Feb. 25, 1969
D	3,359,741	Dec. 26, 1967
A	3,429,062	Feb. 25, 1969
L	3,432,704	Mar. 11, 1969
G	3,438,462	Apr. 15, 1969
H	3,570,815	Mar. 16, 1971
J	3,563,043	Feb. 16, 1971

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

General arrangement of FIG. **1** illustrates system **10** of the invention employed in a body of water **12** having a surface **14** and a floor **16**. Lines **14***a*, **14***b* represent variations of the surface as the result of tidal and wave action. Lines **16***a*, **16***b* represent undulations or variations in elevation of the floor.

System **10** basically comprises three compositions:

Service Station **18** disposed in contention with the vagrant surface **14**, production arrangement **20** disposed to work floor **16**, and transport system **22** in fluid communication with arrangement **20** and a surface pontoon line **24** (merely indicated in FIG. **2**) used when source of yield is near to shore. It is anticipated to replace pontoon line **24** with barges for delivery of yield from more remote areas. Insofar as this invention is concerned, the delivery terminal is considered that connection actually situated on service station **18** (to be coupled with other extended means). Station **18** provides power generating equipment, handling equipment, various appurtenances and storage space to accommodate the servicing and operation of the system. Tow tugs ordinarily (though not necessarily) provide for transport of the retracted system between sites.

Production arrangement **20** includes the dredging element **26** (see FIG. **5**, **6**) and the maneuvering system **28** (see FIG. **1**, **2**). Dredging element **26** comprises: a pair of contra revolving cutter assemblies **30–32** straddling a dredge pump assembly **34** (corresponding to that developed in Ref. B., L, G.) and are supported from a pontoon **36**, and a penetration indicator **38** articulatively mounted to pontoon **36** at journal **40** and controllably actuated by a torque means **42**. The actuated member beam **44** pivotally supports shoes **46–48** at each end with the pivot of the shoes restrained by a spring means **50**. The function of indicator **38** will be subsequently discussed covering operational procedure.

Maneuvering system **28** includes: winches (corresponding with Ref. H) receiving support also from pontoon **36**, and the readily rearranged distribution of their anchored wires. Anchors **60** (one for each winch) are embedded in floor **16** in general plan per FIG. **2**. It is to be understood that the single representation of the anchor in FIG **1** applies for winches **52–54–56–58**. Swing winches **52–54** relates to the wires secured to anchors **60** positioned initially at places "*d–c*" respectively. Bow winch **56** relates to the wire secured to anchor **60** positioned initially at place "*a*," and stern winch **58** relates to the wire secured to anchor **60** positioned initially at place "*b*."

Flexible wires 62 wound on these four winches terminate at their shackle 64 and are of length and selection to provide manipulation of the dredge element 26 over the intended area. Wire strands 66 do not wind on drums as an operational requirement but connect shackles 64 to anchors 60 to greatly increase the positioning of anchors 60 from the traversed area. This minimizes the angle of departure of wires from he normal to the worked area, thus increases the effective pull as a percent of the tension in the wires. The total angle of departure "A" represents the amount of drag of the wire on the floor 16 that would occur over a considerable portion of the extended wire. Buoys 68 with pendants 70 are connected to shackles 64 and are regulated in support capacity corresponding with the load to which they are subjected. When the 'slacked' wire is raised by this support means much of the length is free from abrasive wear and contamination by foreign material that would have been picked up if dragged on the floor.

Buoys 72 with pendants 74 are connected to anchor 60. Buoys 72 have adjustable support capacity controlled by surface buoy 78 via flexible conduit 76. For dredging conditions the tension impressed on pendant 74 is just sufficient to avoid sag. When it it desired to move anchor 60 (as for example from "*a*" to "*e*" of FIG. 2) tension in pendant 74 is increased sufficiently to free the embedded anchor by increasing the buoyant capacity of Buoy 72. Relocation of the anchor is effected by tow of Buoy 78. Buoys 80 are interposed when necessary in conduit 76 for deep dredging to provide intermittent support of the aggregate dead weight thereby providing a proportionate increased tow capacity. The procedure to effect traverse of an area conforms with the method fully covered in Ref. B and will be treated subsequently in association with further developments. The means of predetermining the exact positions as for example "*a–e*" is not considered within the scope of the invention.

Transport system 22 comprises two constituents: a vertical array 82 stably positioned to selected and controlled elevations, and an articulating assembly 84 supported as a simple beam. Assembly 84 includes conduit 86 securely clamped to truss 88. Delivery terminal 90 of conduit 86 is a flexible coupling arranged to be adaptable to the receiver provided for further transport of the yield. The truss support 92 coincident with terminal 90 is slideably journaled in a horizontal track 94 remountably fixed on hull 96 of station 18. The opposite end of assembly 84 is supported by a trunnion 98 integral with the upper extremity of stable array 82. FIG. 1 shows assembly 84 in a declining position toward terminal 90. An increased declined position is represented by phantom line 100 for surface condition 14*b* and phantom line 102 represents extreme incline position with surface 14*a* condition combined with structure 132 depressed to lowermost position. In order for assembly 84 to take the position indicated by line 102, an alleyway 104 is provided in hull 96. To retain a constant horizontal spacing of trunnion 98 from hull 96, a beam 106 of half the length of and straddling assembly 84 is secured at one end by pivot means 108 midway of and to assembly 84 and at the other end to pivot means 110 extending from hull 96 and to be vertically aligned with trunnion 98. The extended wings 109 supporting pivot means 110 are a pair of swingable frames mounted to journals 111 part of hull 96. The wings 109 are secured as by braces (not shown) to remain fixed in position until such time as the wings should be swung clear oppositely of each other as required.

Vertical array 82 comprises: the string of conduit sections 112 assembled between pump 34 and flexible elbow 114 connecting array 82 to assembly 84, the support system of substation 116 and intermediate stations 118, and the equalizer wire system 120. Sections 112 are stored and used as preassemblies of a number of conduits of maximum manufactured length 122. The string of sections 112 are dependent for support upon substation 116 and when the dredging depth is such that the aggregate mass produces tension stress in excess of the allowable value, then intermediate pontoons 118 are interposed to divide the string into essentially equal segments 124; so that only permissible tensile stresses exist in the conduit at the support provided by the pontoons. Thus for moderate depths of dredging the array 82 may not have intermediate pontoons 118. With deep dredging and when one or more pontoons 118 are used it may be necessary to employ one or more booster pumps 126 interposed between segments 124 and supported by pontoons 118. Dredge pumps are duplicate in parts except for the suction piece of pump 34 and are fitted with relief valves 128 as shown in more detail in FIG. 5. These valves 128 are activated to open upon loss of pumping effect; so that entrained solids are discharged from the conduit string and cannot clog the pumps. A subsequent discussion will elaborate on the coupling means only referred to here by indicating FIG. 7.

Substation 116 comprises: a pontoon 130, a tower structure 132, winch means 133 associated with equalizer system 120, a hoist 134, structure 320, claim device 136 to suspend segments 124, and trunnion 98. FIG. 3 is an enlarged view of that portion of FIG. 1 but with the articulative assembly 84 displaced while undergoing changes to the transport system 22. Pontoon 130 is always retained in an immersed position to minimize any surface effect to substation 116; however, tower 132 tops off with a work platform 138 containing machinery, guide and control devices which at times is above water surface 14*a* especially during changes to system 22. As seen in FIG. 4, a clearance hole 140 through the pontoon 130 permits passage of section 112 with port 142 provided in platform 138 having a pair of self closing gates 144 communicating with passage 146 contrived in tower 132 to facilitate assembly of string 112. At least 3 spring guides 146 provide the alignment of string 112 coaxially with hole 140 (best seen in FIG. 8, 9, 10).

Coupling 148 employed to connect adjacent conduit lengths 122 (FIG. 7) is adaptable for engagement with clamp 136. The lower end of length 122 is flanged 150 to engage within an integral collar 152 defining the upper end of the adjacent length 122. A ring 154 fitted to groove 156 prepared in collar 152 retains flange 150 in position and a conventional O-ring gasket 158 effects the seal. The collar 152 is shaped to the frustum of a cone 160 which also clears hole 140. Segmental wedges 162 having mating surfaces corresponding with cone 160 and are pivotally mounted by rods 164 as part of the clamp 136. Wedges 162 assume a free position clear of collar 152 (as seen in FIG. 8) by a counter weight and/or spring device 165 associated with rod 164. A solenoid 166 is activated to position wedge 162 for engagement with a selected collar 152 (see FIG. 9).

Equalizer wire system 120 is much the same as that employed by Ref. J and established tin principle by Ref. D. Equalizer device 168 is secured to pontoons 36 and 118 by an extending cylindrical shell 170 integral with the pontoons and of sufficient diameter to clear clamp means 136. Wire segments 172 extend to winch 133. In the event intermediate pontoons 118 are used the wire segments are interrupted in continuous length by fastening 174 permitting adjustment of length and tension by utilizing calibrated torque wrenches to establish a relative tensile load between wires 172 and conduits 124. The three wires 172 symmetrically spaced about conduit 124 are utilized to transmit a portion of the suspended weight to substation 116; so that those pontoons situated beneath cannot provide a support capacity in excess of the weight dependent below, thus avoiding columnar stresses. Hoists 133 serve the purpose of providing adjustability in length with changes to array 82 and establishes tension in wires 172. Pontoons have adjustable buoyant capacity to contend with environmental and load changes imposed. The system of monitoring and control based upon the principle covered by Ref. D is modified per FIGS. 12, 13, 14 and as to be discussed subsequently.

Procedure to utilize maneuvering system 28 is illustrated in FIG 2 and presumes previous data has established the necessary particulars as to anchor location, depths, nature of the bottom, etc. The cross-hatched area represents completed work with further progress directed toward position '*a*' as

represented by pair of dotted lines. Thus anchor '*d*' is to the starboard side of the channel and dredge element **26** is shown at or near to the limit of swing. Swing to either side is restrained to a circular arc by the wire pendant between anchor "*a*" and winch **56** with tension in the pendant corresponding to that component of reaction of cutter **32** against the bank representing the penetration established by indicator **38**. Torque means **42** of indicator **38** is wired with both winches **52, 54**; so that with one winch for hauling-in the beam **44** is tilted to bring the corresponding shoe **46, 48** to bear with floor **16** preceding the digging cutter (it being anticipated that cutters rotate continuously). Prior to the port swing the winch **56** hauls-in the wire an increment to advance the cutter further into the bank. Then beam **44** is repositioned to have shoe **48** establish the selected penetration and winch **54** then hauls dredge element **26** toward anchor position '*c*'. This operation repeats till advance produces angularity 'A' in wires whereupon the dredge element is returned to the initial position by winch **58** and then dredge element **26** is lowered an increment prior to repeat of action. When at final depth with wires at angle 'A' the limiting position, the anchors are moved as explained to position '*e, f, g*'. The dredge element is raised to initial level and repositioned for the first traverse of the first layer cut of the new area.

Termination of the port and starboard swing is automatically regulated by a limit means **63** established from the known extent of traverse of the area. Means **63** comprises a vane **65** secured to wire **62** where it will intercept magnetic switch **67** mounted on movable door **67** provided on winches **52–54** per FIG. **5** and Ref. H. These switches **67** reverse rotation of winches and are of the type subsequently described in association with those used in buoyancy control. Winches **52–54** are duplicate in size and arrangement so that when element **26** is disposed to a traversed limiting position, one drum will be at maximum stored diameter and the other at minimum stored diameter. As for example in FIG. **2** with start of travel toward position '*c*', winch **54** is effective in pull and will haul-in of wire **62** less than will be paid out by winch **52**. Thus a slack is set up in the starboard wire and it is this 'shack' which buoy **68** contends with as previously mentioned. The buoy **68** establishes a composite length conforming to the projected length representative of the distance effected by winch **54** in the port swing. Both motors of winches **52–54** operate from common leads and are powered to similarly rotate one to the other. Thus buoy **68** keeps the wire taut that is powered off the drum at a faster rate (than would be produced if simply dependent on drag and fastening to the anchor.) It will be observed that one of the purposes of this invention is demonstrated in FIG. **1, 2**, that is the wires **62** connected between shackles and the winches are subjected to a single bend at the drum. Other directional sheaves are eliminated that cause diminution of wire life. Furthermore, the length of wire wound on the drum representing the 'travel' is virtually the full wire length; so that they are shorter than other arrangements requiring further deployment.

Mobility of service station **18** responsive to maneuvering of production arrangement **20** is accomplished by a series of ports **97** strategically located in hull **96** for discharge of propulsion jets. These jets are selectively activated in response to a misalignment monitor associated with array **82**. Such monitor may be as developed in principle in Ref. B or other marketed means already developed. It is anticipated that with deep dredging, an appreciable amount of misalignment is permissible relative the working area. FIG. **1** shows service station oriented from that in FIG. **2**. This alternate position is assumed when advance in dredging proceeds in line with anchor positions '*c–d*' as for trenching whereupon both winches **56–58** function simultaneously to provide linear travel.

The pivotable shoes **46–48** of indicator **38** are constructed and mounted as a combination fender and sled, yielding and flexing consequential to situations encountered within a prescribed limit. Thus they serve as compensators for the tilt beam **44** consistent with allowable changes in the floor contour that the cutters can cope with and so avoids needless signal to alter changes to the stable setting of array **82**. As example, the resistance of the floor to penetration of the cutters is a reactive force supplementing the buoyant force provided in support of the aggregate dead weight of array **82**. When this reactive force diminishes as in softer digging, then the array will settle lower possibly to an extreme condition when means associated with assembly **84** will signal to increase the buoyant support probably in conjunction with overload protection with the cutters. The shoes, however, have large exposed areas resisting embedment thus would activate control means initiating increased buoyant support. Conversely with excess buoyancy so that array **82** is off the floor, the lowermost shoe will hang suspended with spring action forcing the control of the system to vent buoyant chambers. The position of the opposite elevated shoe hangs in neutral position ineffective in the control system.

SUPPORT SYSTEM AND CONTROL

The support system embodied in array **82** is to have capability of:

1. providing a constant support capacity within specific limits corresponding to the imposed load in contention with ambient or environmental changes;
2. contending with changes to the imposed load and to sustain the adjusted support capacity within specific limits;
3. being cooperative with changes to the support contributed by the reaction to penetration of the floor;
4. being responsive to an obstruction detector;
5. being responsive to a penetration detector;
6. restricting concentration of imposed loads by sectionalizing the array with distributed supports;
7. transmitting deliberate deficiencies in support of the sectionalized array to a station whereby damaging columnar stresses are avoided;
8. participating in adjustment to the length of the array by incorporating an elevator capable of transferring the position of columnar members;
9. utilizing the elevator as a supplement to the load carrying capacity of the system;
10. providing a stepwise process of gas exchange between adjacent support stations in contention with their pressure differentials by utilizing members with duplicate characteristics to effect economies in standardization and diminution of physical requirements.

These capabilities are performed by monitoring and adjusting the volume of gas chambers provided by pontoons **36, 118, 130, 194** diagrammatically illustrated in FIG. **12, 13, 14** in support of the column segments **124** comprising array **82**. To simplify the discussion like members are designated with the same numeral followed by a particular suffix letter ("*a*" applicable to substation **130**, "*b*" to intermediate station **118** and "*c*" to dredging element **36**).

Also to avoid repetition of protracted definition of members, like members are grouped and classified.

APPURTENANCES

1. Valves: **216, 232, 234, 234*a*, 234*b*, 236, 304, 306, 308.** Spring loaded closed, electrically actuated solenoids to open.
2. Valves: **300, 302.** Spring loaded open, electrically actuated solenoids to close.
3. Valves: **228, 248*a*, 248*b*, 249.** Conventional check valve types installed for directional fluid flow from compressors.
4. Motor **218** with compressor **220** are conventional equipment applicable for mounting aboard hull **96.**
5. Motors: **238*a*, 238*b*, 240, 242*a*, 242*b*,** and compressors: **244*a*, 244*b*, 246.** Submersible types and may comply with that covered by Ref. L.

6. Switches: **250***a, b, c;* **251***a, b, c;* **255, 256, 330, 331** (and **67** w/vane **65**). Immersible type magnetic switches relying on the interception of vane **258** across the magnetic field to close the switch.
7. Switches: **260, 262, 264, 266, 292***a, b*; **294, 310, 312, 314, 316, 318, 346, 348**. Conventional switches suitable for service and mount for remote operation of the circuitry.
8. Structure **267** (*a, b, c*) (FIG. **12**) comprises: a rod **268**, 2 journals **270** in support of rod **268**, a float **272** adjustably mounted on rod **268**, 2 magnetic switches (**250***a, b, c*, when closing the electrical circuitry effects venting of gas chambers by opening valves **234**, **234***a*, **234***b*, respectively; **251***a, b, c*, when closing the electrical circuitry effects 'charging' gas to the chambers by opening valve **232**, starting up motor **238***a* and **238***b* respectively), vane **258** mounted on rod **268**, so that the float position will establish the vane neutral with or in the field of one or the other of the magnetic switches, brackets **273***a, b, c* upon which the journals and switches are mounted are slidably positioned to the pontoons to provide adjustment in the volumetric content of the contained gas chambers. Structures **267***a, b* are power actuated by torque means **242***a, b* respectively to remotely establish the volume determining position. Structure **267***c* may as well be so powered, though shown to have been manually positioned corresponding with the known fixed requirement.
9. Structure **320** (FIG. **14**) comprises: a rod **322**, 2 journals **324** in support of rod **322**, a tank **326** mounted by bracket **328** to tower structure **132**, 2 magnetic switches (**330** when closing the electrical circuitry effects venting of gas chamber by opening valve **234**; **331** when closing the electrical circuitry effects charging of gas chamber by opening valve **232**). Standing vent pipe **334** part of tank **326** supports switches **330, 331** that are actuated by vane **258** mounted on rod **322** responsive to movement of float **336** slidably mounted on rod **322** between limiting stops **338**, An adjustable port **340** determines the rate of flow of liquid to and from the chamber provided by tank **326**. Vent pipe **334** terminates above surface **14***a* so that the gas volume established by liquid level within tank **326** is open to atmosphere. Spring **341** supports the assembled weight of rod **322** to position vane **258** neutral to the switches **330, 331** when not acted on by float **336**.
10. **274, 276, 276***c* **278, 279** represent the adaptability of flexible conduit to compensate for variation in the spacing of pontoons to which they are linked.

Operational sequences are preceded and established by provision of gas introduction at entry **214** upon activation of valve **216** and motor **218** driving compressor **220** in response to conventional indicators contained in tank **222** with fluid flow directed through conduits **224–226** solely to the tank by check valve **228**. An electric power source represented by lines **230, 231** have a number of branch circuits arranged so that line **230** is the feeder to the power consuming appliance and line **231** is the feeder to switches in the circuitry interconnected to the appliance.

The following cases bear the same numerals as applied in the previous list of capabilities related to support and control. Discussion of elevator **194** will be covered subsequently because of its dual function, and it should be mentioned first with reference to FIG. **12, 14** that illustrated positions are for diagram purposes to avoid congestion of figures, etc., especially with regards the position of motor **240**, compressor **246** and valve **236** which serve elevator **194**.

1. As the vertical array **82** descends in the body of water the volume of trapped gas in the pontoons will decrease with the corresponding increased water pressure encountered; so that the resulting rise of float **272** will activate switch **251** by means of positioned vane **258**. The air makeup to each chamber is received from the upstream volume; thus table 1 relates the members. The reverse situation occurs with ascent of array **82** with decreasing environmental pressure to increase the gas volume in pontoon chambers thus lowering float **272** to activate switches **250** by means of positioned vane **258**; thus table 2 relates the members.

TABLE I

Active Switch	Powered Device	Supply Inlet	Supply Outlet
251*c*	**244***b*	**280***b*	**282***c*
251*b*	**244***a*	**280***a*	**282***b*
251*a*	**232**	**222**	**282***a*

TABLE II

Active Switch	Powered Device	Supply Inlet	Supply Outlet
250*c*	**234***b*	**282***c*	**282***b*
250*b*	**234***a*	**282***b*	**282***a*
250*a*	**218**	**282***a*	**222**
	234		

2/5. These capabilities are associated with implementation of indicator **38**. As example; with increased imposed weight due to change in specific gravity of fluid within conduits **124**, the array **82** will settle somewhat and if to the extent that bearing shoe **46** is forced sufficiently upward to effect activation of switch **256**, then motor **242***a, b* will power structures **267***a, b* to be lowered establishing switches **251***a, b* to monitor an increased buoyant chamber. Thus floats **272** will introduce vanes **258** to switches **251***a, b* associated with valve **232** and compressor **244***a* thus charging the chambers to the required support capacity. Conversely with decreased imposed weight, array **82** will rise until shoe **46** is free of floor **16** whereupon the mass effect and spring **50** will lower vane **258** to activate switch **255** monitoring motors **242***a, b* to raise structure **267***a, b*, thus establishing switches **250**, *b* to monitor a decrease buoyant chamber. Thus floats **272** will introduce vanes **258** to switches **250***a, b* associated with valves **234**, **234***a* thus venting the chambers to the required support capacity. Observe that pontoon **36** is independent of this performance since its buoyant capacity is unrelated to instantaneous changes in load.

6 and 10. The introduction of intermediate station **118** with regards capabilities in these cases has been covered in the previous discussion.

7. The capability of this case has been discussed with respect the use of equalizer system **120**. It is touched on here again with regards an electric circuiting associated with it to assure the beam members **286** are level. This circuitry includes a mercoid type switch **288** as introduced in Ref. J and illustrated in FIG. **5, 6**. Switch **288** is internally pressurized to equal external pressure by connecting it to the adjacent gas chamber by means of conduit **290**. Electric wire leads within the switch are shorted where beams **286** are appreciable out of level to which switches **288** are attached. This short/or closed circuitry extends to the vicinity of the upper fastening of wires **172**, such as an alarm at fastening **174** to assist in its proper adjustment, and to monitor equalizer hoists **133**.

8/9. These cases will be covered subsequently in disclosure of servicing of array **82**.

Service Station **18** furthermore includes a means to disengage assembly **84** and displace it temporarily during assembly periods (if desired) so as not to interfere with access to alley way **104** or certain head room directly above. Such a condi-

tion is illustrated in FIG. 3 with the introduction of a monorail 176 in this cleared position to accommodate an electric powered cable hoist 178. An accessory for hoist 178 in addition to the terminal hook 180 is a conventional pipe tong 182 which is self locking when loaded and self opening when unloaded. Extending above hull 96 is a tower to support a hoist 184 having accessories principally including wire or chain slings 186 which can quickly be adapted to engage with or disengage from a pipe.

Servicing or assembling array 82 is disclosed in the following with reference first to previous comments regarding lengths of conduit sections 112 and their storage. Pipe storage area 188 extends substantially the length of alley way 104 that in effect contrives hull 96 to be a catamaran. Sections 112 conveniently occupy the length of area 188; so that sections 112 are anticipated to exceed 160' lengths, representing the assembly increment of change to array 82. Phantom illustration in FIG. 3 depicts the method to add a section 112 to array 82 with tong 182 engaging and partially supporting a section 112 and sling 186 contributing the balance of support with the section 112 drawn somewhat outboard of the storage area. Phantom line 178*a*/182*a* shows a extended cable and new position of the hoist as at 178*a*. Thus the alley way has been utilized as a clearance space for the movement of section 112 while hoist 184 has raised its sling to 186*a*. Eventual position 186*b* with section 112 approximately vertical will permit slack off of hoist 178 so that tongs 182 disengage. The lower end of section 112 will have been guided through passage 146 assisted at entry by by flare 192, and at the upper end encased by clearance 142 and gates 144 so as to confine section 112 within structure 132.

In this position section 112 will be oscillating vertically responding with movement of hull 96, whereas substation 116 is essentially immobile (motion of 116 to be covered subsequently). A sling (duplicating sling 186) is supported from hoist 134 and engages section 112 approximately where previously supported by tong 182. With an upward surge of section 112, as mentioned, hoist 134 is activated to take over the support of section 112 so that with descent of hull 96 crane 184 is made ineffective. Having accomplished transfer of section 112 to a 'stable' hoist the newly assumed length is lowered by crane 134 to make up to a coupling connection 148 secured by clamp 136 at pontoon 130, with the upper end of 112 guided within port 142.

FIG. 1 shows an elevator 194 positioned immediately below substation 116 with an enlarged view FIG. 8 showing a well 196 providing passage for conduit 112 and retain the buoyant chamber of the pontoon structure defining elevator 194. Spring centering device 146, clamp device 136, and brake means 198 comprise the essential apparatus for it aside from the buoyancy control means associated with it and yet to be discussed.

Brake 198 is activated to grip a wire strand 172 of system 120 to establish a fixed elevation when its buoyant capacity corresponds with the mass it supports. When brake 198 is deactivated, cam lever 200 is released from bearing contact with wire strand 172. Then with an increased buoyant capacity elevator 194 will raise the supported load or with decreased buoyant capacity will lower the load. A bracket 202 includes: the backstop 204, activating solenoid 206, release spring 208 and connecting link 210 associated with cam 200 to comprise brake 198. Elevator 194 is positioned beneath the next lower coupling 148 below that coupling utilized by substation 116 in support of array 82 assigned to it. FIG. 12, 14 show switches 292*a*, *b* and 294 are used to close the circuit and activate clamps 136 fitted to pontoon 130, 36 and 194 respectively. The buoyant capacity of elevator 194 is increased to raise its position with clamp 136 activated to receive coupling 148 and after release of brake 198. Upon engagement with coupling 148 the buoyant capacity is further increased to assume the load from substation 116 and slight further raise of array 82 to permit the clamp 136 of pontoon 130 to disengage free of its coupling 148. Thereafter the elevator buoyant capacity is decreased to lower the load until uppermost collar 152 approaches clamp 136 on pontoon 130 with a repeat of the procedure to have substation 116 resume support of array 82. Continuation of descent of the unloaded elevator by decreasing its buoyancy will disengage its clamp to free the elevator for return to position with the substation upon again increasing its buoyancy. Repeated introduction of sections 112 will eventually establish the approximate dredging depth whereupon one or more lengths 122 may be removed from the last section 112 to establish the assembled transport system so that assembly 84 will approach but never exceed the position indicated by phantom line 100. Whenever dredging conditions exist to approach condition of phantom line 102, another length 122 must be added to achieve an increased depth of dredging. To introduce the uppermost section 112 or portion thereof, assembly 84 is replaced to its normal occupancy of space with respect alley way 104 and flexible elbow 114 is connected as by coupling 148 to that last dependent section supported by hoist 184 whereupon the transfer to hoist 134 is made to complete the assembly. Likewise in disassembly the uppermost section 112 is removed from array 82 with the assembly 84 previously displaced so that restack of conduit 112 can be undertaken progressively to storage area 188.

When intermediate pontoons 118 are to be used they are prearranged to become integral with and immediately below elevator 194 so that at the known proper incident one can become separated to engage the assumed load. For storage of elevator 194 while not used in assembly operation, a stop 212 is provided to pontoon 130 to space the elevator 194 from it against slight excess buoyant capacity of the elevator to hold that position. The size of elevator 194 is arranged to nest it within chamber 131 of pontoon 130. See FIG. 8 as projected by the phantom lines.

When in the process of servicing and array 82 receives no component of support from the floor 16, then stability of tower structure 132 above water is approximated by the selective positioning of structure 320 to a means surface 14 the desired distance below platform 138 and switches 346, 348 normally open are closed. In response to wave position 14*a*–14 the tank 326 is alternately immersed or exposed above water, but the water level within tank 326 does not vary erratically with wave change. Float 336 buoyantly supported is only effective at extreme positions during prolonged immersions or exposure above water and then transmit the demand to vary buoyant capacity of pontoon 130. Such movement as occurs in array 82 during assembly is over extended periods permitting the transfer as contemplated.

8/9. As defined previously in covering capabilities of the support system these cases relate to the elevator 194. In FIG. 12 switch 260 is manually closed to activate compressor 246 to increase the buoyant capacity of elevator 194 for the purpose either to assume a load in the process of transferring a section 112 or when elevator 194 is in the stored position within chamber 131 to serve as auxiliary support. Conversely valve 262 is manually closed to active vent valve 234 and activate compressor 220 to diminish buoyant support capacity of elevator 194 with corresponding effect. As projected in FIG. 12 this process is performed in the stepwise means that is between pontoon 130 and 194 via single conduit 274.

When assembly 84 approaches the position represented by phantom line 102, switch 264 mounted with assembly 84 and hull 96 is activated monitoring valve 232 so gas is charged into pontoon 130 thus raising array 82. Conversely switch 266 is mounted to monitor valve 234 and compressor 220 when assembly 84 approached position of phantom line 100 to lower array 82.

An alternate arrangement to employ the dual role of elevator 194 is shown in FIG. 14. In this arrangement the stepwise process of exchanging gas between pontoons 130 and 194 for the transfer of load during assembly is: charge pontoon 194 by closing switches 310, 316, 318 to open valve 306 and close valve 300 respectively. Conversely to vent pontoon 194, close

switches **310, 312, 314, 318** to close valve **300** and **302** and open valve **304, 318**. The system as shown is developed with the capabilities of FIG. **12** except intermediate stations **118** are omitted as optional as are switches **264** and **266** readily added for the previous purpose. Closing switch **310** will feed gas to pontoon **36** from pontoon **130** and conversely closing switch **312** will vent gas from pontoon **36** to pontoon **130**. Closing switches **312, 316, 318** will provide simultaneous control of elevator **194** with that of pontoon **130** as the latter is monitored.

CONCLUSION

While the foregoing description has concentrated on specific controls and the like, it should be understood that the system method and apparatus of the invention may be varied from that illustrated without departing from the invention. No attempt is made to enumerate all the possible variations nor other incidental apparatus.

What is claimed is:

1. In an elongated array of objects stably disposed to selected elevations respective the floor of a body of water and contiguous with a buoyant service station subject to vagrancies of the surface of said water, an improved dredging apparatus comprising:

a. dredging means powered to yield material procured stratawise from penetration of said floor;

b. conduit means in fluid communication between said dredging means and a delivery terminal means adjustably mounted to said service station;

c. a plurality of immersed buoyant chambers sectionally disposed to said array and adapted for each chamber to contribute partial support to only the dependent portion of said array in cooperation with supplementary support consequential from said floor establishing vertical stability of said array;

d. an equalized tensioned wire system transmits to the uppermost of said chambers a deliberate deficiency of support by each lower chamber to avoid columnar compressive stress in said conduit;

e. monitoring and control means to retain said stability responsive to changes in environment, assumed loads, surface elevation and floor elevation encountered by said array;

f. maneuvering means adapted to effect the traverse of said dredging means over a selected area of said floor by an arrangement of winches and anchored wires, said arrangement entirely immersed in said water; and,

g. the elongated array pivotally suspends at the upper end to and in fixed elevation with a substation formed to and above the uppermost of chambers having adjustable buoyant support controlled by an indicator selectively established to monitor said penetration.

2. A method of coordinating correlative apparatus to provide communication between the floor and surface of a body of water in contention with changes in elevation thereof during traverse of a selected area of said floor, said method comprising:

a. submerging a vertical array of objects within the body of water and into a position supported in part by the floor thereof;

b. controlling the array position by a floor penetration detector monitoring an uppermost of all buoyant chambers totally immersed and regulated to have a deficient support capacity for the weight imposed of sectionalized portion of the array depending from that chamber;

c. transferring deficiencies in support to said uppermost chamber of a dominant station topping the array suspended therefrom;

d. adapting a vessel buoyed at the surface to accommodate a correlative adjustable member extending said communication between the array and vessel;

e. activating a utility station part of the array to supplement the support by the dominant station at instances in said contention with floor elevation changes;

f. embedding anchors in the floor remote to said area, each anchor positioned respective the submerged winch fixed to the array for direct connection of extended wires therebetween, said wires deformed solely when wound to submerged said winches affixed to the array;

g. effecting said traverse as a pendulous swing by alternately paying out and taking up on a pair of oppositely anchored said wires, each successive swing from a shortened length of another said wire anchored with an axis centrally positioned to said oppositely anchored wires;

h. powering said oppositely anchored wires by identical winches effects one winch in accumulating wire hauled in to an increasing reeled diameter to the end of a traverse with the other identical winch at a minimum reeled diameter, said winches upon hauling in wire initiates an opposite swing at maximum torque capacity, said winches pays off wire at a rate differing from the rate of traverse;

i. suspending each said extended wire by a buoyed wire pendant intermediately connected between anchor and winch to support off said floor the slacked wire paidoff a powered winch at a greater initial rate than the rate of haul-in wire establishing traverse; and,

j. tensioning of the slacked wires consequential with that support of wire off said floor preserves undisturbed the remaining stored wire to be unreeled from the powered revolving winch.

3. A vertical dredging apparatus to be assembled as a tensioned elongated array of objects stably disposed to selected elevations respective the floor of a body of water and contiguous with a buoyant service station restrictively subject to the vagrant water surface, having:

a. a dredging means integral with a lowermost pontoon confining an adjustable volume buoyant chamber monitored and controlled to effect a deliberate insufficient support to the resultant aggregate weight of the dredge means adapted to a selected orientation relative the floor by an immersed arrangement of anchored wires;

b. an articulative conduit means in fluid communication between said dredging means and a delivery terminal means adjustably mounted to said service station comprises a vertical constituent with the dredging means to define said elongated array and a trussed pivotal constituent with guide means accommodating the articulative connection of contiguous ends of the two constituents in contention with limited displacement of said buoyant service station relative the stable array;

c. a substation having a platform rigidly mounted to and towering above an immersed uppermost pontoon confining an adjustable volume buoyant chamber monitored and controlled to effect a support capacity to maintain tension in said array pivotally suspended from said platform at selectively fixed space relationship above said dredging means;

d. an equalized selectively adjusted wire system connected between pontoons and tensioned by said unsupported weight of the dredging means to minimize tension in said vertical constituent of the suspended array;

e. monitoring and control means responsive to changes in environmental conditions, assumed loads and water surface encountered, maintains said stable array relation with the service station;

f. maneuvering means adapted to position said dredging means over a selected area of said floor by an arrangement of winches and anchored wires restricted to an immersed condition; and,

wherein the improvement comprises:

1. a latticed tower structure integral with said uppermost pontoon extends to support said platform;

2. a concentric passage extends through said substation in accommodation with the assembly, bracing and support of said conduit;

3. a substation mounted auxiliary clamp means selectively supports the assembled portion of said array when altering elevational position of the dredging means respective the service station, the dredging means then raised off said floor with the substation monitored and controlled for a selected freeboard with the water surface by stabilizing means fixed thereto at mean water level;
4. a cooperating utility station of adjustable buoyant support with clamp means, alternately with the substation supports and positions said assembled portion to adjusted elevation relative the substation when modifying the length of the inoperated array; and,
5. a plurality of hoist means disposed on said service station and said substation coordinate to effect or alter said assembled objects by the transfer of array components between the stable substation and in contention with the disturbed service station affected by said vagrant surface.

4. A vertical dredging apparatus assembled as a tensioned nonadjustable elongated array of objects stably disposed to selected elevations respective the floor of a body of water and contiguous with a buoyant service station restrictively subject to the vagrant water surface, the improvement comprises:

a. a dredging means integral with a lowermost pontoon confining an adjustable volume buoyant chamber monitored and controlled to effect a deliberate insufficient support to the resultant aggregate weight of the dredging means supported in part by allowable floor reaction to penetration by the dredging means;
b. an articulative conduit means in fluid communication between said dredging means and a delivery terminal means adjustably mounted to said service station comprises a vertical constituent with the dredging means to define said elongated array and a trussed pivotal constituent with guide means accommodating the articulative connection of contiguous ends of the two constituents in contention with limited displacement of the service station relative the stable array;
c. a substation having a platform rigidly mounted to and towering above an immersed uppermost pontoon confining an adjustable volume buoyant chamber monitored and controlled to effect a support capacity to maintain tension in said array pivotally fixed to suspend from said platform, said support capacity supplementary with floor reactive upward force to the dredging means;
d. an equalized selectively adjusted wire system connected between pontoons and tensioned by part of the consequential net unsupported said weight of the dredging means to minimize tension in said vertical constituent of the suspended array;
e. monitoring and control means responsive to changes in environmental conditions, assumed loads, water surface and floor elevations encountered, maintains said stable array relation with the service station; and,
f. maneuvering means adapted to effect traverse of said dredging means over a selected area of said floor by an arrangement of winches and anchored wires restricted to an immersed condition with attending support means connected to raise said anchored wire to generate an artificial demand of wire off said drum.

5. In an elongated array of objects according to claim **4**, the improvement comprises:

a. at least one intermediate pontoon interposed to contribute support of said vertical conduit to progressively retain the effect established by a lower pontoon of said deliberate insufficient support of the array aggregate weight suspending therefrom; and,
b. monitor and control means alter the buoyant chamber volume of the intermediate pontoons responsive to environmental and load changes.

6. A vertical dredging apparatus assembled as a tensioned nonadjustable elongated array of objects stably disposed to selected elevations respective the floor of a body of water and contiguous with a buoyant service station restrictively subject to the vagrant water surface, the improvement comprises:

a. a dredging means integral with a lowermost pontoon confining an adjustable volume buoyant chamber monitored and controlled to effect a deliberate insufficient support to the resultant aggregate weight of the dredging means supported in part by allowable floor reaction to penetration by the dredging means, comprises:
   1. a pair of contra rotatable cutters straddle a dredge pump fitted with disposal means ejecting solids in suspension returning to the pump upon termination of pumping effect;
   2. a plurality of winches oriented in position on pontoon for a direct line wire connection to anchors selectively embedded in said floor; and,
   3. an indicator remotely controlled to establish cutter penetration of the floor;
b. an articulative conduit means in fluid communication between said dredging means and a delivery terminal means adjustably mounted to said service station comprises a vertical constituent with the dredging means to define said elongated array and a trussed pivotal constituent with guide means accommodating the articulative connection of contiguous ends of the two constituents in contention with limited displacement of the service station relative the stable array;
c. a substation having a platform mounted to and towering above an immersed uppermost pontoon confining an adjustable volume buoyant chamber monitored and controlled to effect a support capacity to maintain tension in said array suspended from said platform in accommodation with penetration of the floor;
d. an equalized selectively adjusted wire system connected between pontoons and tensioned by part of the consequential net unsupported said weight of the dredging means to minimize tension in the vertical constituent of the suspended array;
e. monitoring and control means responsive to changes in environmental conditions, assumed loads, water surface and floor elevations encountered, maintains said stable array relation with the service station; and,
f. maneuvering means adapted to effect traverse of said dredging means over a selected area of said floor by an arrangement of winches and anchored wires restricted to an immersed condition with intermediate suspension means for wires between winches and anchors, comprising:
   1. said maneuvering means depends on the disposition of anchors corresponding with orientation of said winches employed to tension interconnected wires to effect work in both port and starboard traverse of said area at succeeding lessened pendulous swing;
   2. said wires have a constituent length corresponding approximately with the amount wound to a drum to effect a traverse terminating with a shackle and a nonwound constituent length extending to connect said shackle to the remotely disposed anchor;
   3. oppositely disposed drums effecting port and starboard swings conclude each traverse with opposite amounts of stored wire consequently differing the rate of payoff of wire with the rate of advance of said dredging means;
   4. said shackle being suspended off said floor by a shackle buoy to be said intermediate suspension to effect a catenary curve of the slacked wire paidoff said drums with consequential tension establishing demand for wire responsive with supply by the drum;
   5. said oppositely disposed winches are fitted with magnetic switches to monitor controls to reverse rotate the winches upon interception of a vane closing switch means mounted to said wire for termination of traverse and to activate return swing;
   6. an adjustable capacity anchor buoy secured above and to said anchors by a pendant fastened in opposition to the effect established by said winch wires;

7. said anchor buoys normally are controlled to provide a minimum of pendant tension by a buoyant conduit in fluid communication with a surfaced detector buoy; and,

8. said detector buoy is attended by auxiliary gas charging and venting means effecting said adjustable capacity to free said anchor from embedment in the floor and suspend same while in transit between positions for embedment.

7. A vertical dredging apparatus assembled as a tensioned elongated array of objects stably disposed to selected elevations respective the floor of a body of water and contiguous with a buoyant service station restrictively subject to the vagrant water surface, the improvement comprises:

a. a dredging means integral with a lowermost pontoon confining an adjustable volume buoyant chamber monitored and controlled to effect a deliberate insufficient support to the resultant aggregate weight of the dredging means supported in part by allowable floor reaction to penetration by the dredging means with penetration regulated by an indicator means having:

1. a pivotally mounted tilt beam in controlled angularity by a torque means that is selectively monitored to winches effecting a traverse of the floor, said torque means establishes a depressed beam end automatically positioned in advance of the progress of said dredging means to lead said traverse;

2. shoes pivotally mounted to the ends of said tilt beam are counterbalanced and expose broad bearing surfaces to diminish their self embedment upon contact with said floor;

3. monitoring means to provide limiting movement of said shoes for activating said controls associated with said array relating cutter penetration with said floor;

b. an articulative conduit means in fluid communication between said dredging means and a delivery terminal means adjustably mounted to said service station comprises a vertical constituent with the dredging means to define said elongated array and a trussed pivotal constituent with guide means accommodating the flexible connection of contiguous ends of the two constituents in contention with limited displacement of the service station relative the stable array;

c. a substation having a platform mounted to and towering above an immersed uppermost pontoon confining as adjustable volume buoyant chamber monitored and controlled to effect a support capacity to maintain tension in said array suspended from said platform in accommodation with penetration of the floor;

d. monitoring and control means responsive to changes in environmental conditions, assumed loads, water surface and floor elevations encountered, maintains said stable array relation with the service station; and,

e. maneuvering means adapted to effect traverse of said dredging means over a selected area of said floor by an arrangement of winches and anchored wires restricted to an immersed condition with intermediate support means for wires between winches and anchors.

8. A vertical dredging apparatus to be assembled as a tensioned elongated array of objects stably disposed to selected elevations respective the floor of a body of water and contiguous with a buoyant service station restrictively subject to the vagrant water surface, having:

a. a dredging means integral with a lowermost pontoon confining an adjustable volume buoyant chamber monitored and controlled to effect a deliberate insufficient support to the resultant aggregate weight of the dredging means adapted to a selected orientation relative the floor by an immersed arrangement of anchored wires;

b. an articulative conduit means in fluid communication between said dredging means and a delivery terminal means adjustably mounted to said service station comprises a vertical constituent with the dredging means to define said elongated array and a trussed pivotal constituent with guide means accommodating the articulative connection of contiguous ends of the two constituents in contention with limited displacement of the service station relative the stable array;

c. a substation having a platform rigidly mounted to and towering above an immersed uppermost pontoon confining an adjustable volume buoyant chamber monitored and controlled to effect a support capacity to maintain tension in said array pivotally suspended from said platform at selectively fixed space relationship above said dredging means;

d. monitoring and control means responsive to changes in environmental conditions, assumed loads and water surface encountered, maintains said stable array relation with the service station; and, wherein the improvement comprises:

1. a latticed tower structure integral with said uppermost pontoon extends to support said platform above;

2. a concentric passage extends through said substation in accommodation with the assembly, bracing and support of said conduit;

3. a substation mounted auxiliary clamp means to selectively support the assembled portion of said array with said dredging means disposed off said floor by a stabilizing means monitoring increased freeboard of the platform above water surface through increased volume of said adjustable buoyant chamber to supplant any floor support, said stabilizing means having:

a. a float chamber with an adjustable aperture positioned on said substation to an elected mean water surface below said platform for an adjusted freeboard of the elongated array needed to clear the dredging means to a stable position off said floor;

b. said float chamber contains a supply of water alternating in volume with its submergence in and exposure above said body of water response with restricted passage of water through said aperture;

c. a loosely received float means contained in said float chamber responds with the retarded said supply of water to correspondingly actuate monitor means; associated with said array to increase said buoyant support with prolonged decrease of freeboard and diminish buoyant support with prolonged increase of freeboard;

4. a cooperative utility station of adjustable buoyant support with clamp means alternately with the substation supports and positions said assembled portion to adjusted elevation relative the substation when modifying the length of the inoperated array; and,

5. a plurality of hoist means disposed on said service station and said substation coordinate to effect or alter said assembled objects by the transfer of array components between the stable substation and the disturbed service station affected by said vagrant surface.

9. A vertical dredging apparatus to be assembled as a tensioned elongated array of objects stably disposed to selected elevations respective the floor of a body of water and contiguous with a buoyant service station restrictively subject to the vagrant water surface, having:

a. a dredging means integral with a lowermost pontoon confining an adjustable volume buoyant chamber monitored and controlled to effect a deliberate insufficient support to the resultant aggregate weight of the dredging means supported in part by allowable floor reaction to penetration by the dredging means;

b. an articulative conduit means in fluid communication between said dredging means and a delivery terminal means adjustably mounted to said service station comprises a vertical constituent with the dredging means to define said elongated array and a trussed pivotal constituent with guide means accommodating the flexible connection of contiguous ends of the two constituents in

contention with displacement of said movable service station relative the stable array;

c. a substation having a platform mounted to and towering above an immersed uppermost pontoon confining an adjustable volume buoyant chamber monitored and controlled to effect a support capacity to maintain said tensioned array suspended from said platform in accommodation with penetration of the floor;

d. an equalized selectively adjusted wire system connected between pontoons tensioned by part of the consequential net unsupported said weight of the dredging means to minimize tension in the vertical constituent of the suspended array;

e. monitoring and control means responsive to changes in environmental conditions, assumed loads, water surface and floor elevations encountered, maintains said stable array relation with the service station; and, wherein the improvement comprises:

1. a latticed tower structure integral with said uppermost pontoon extends to support said platform above;

2. a concentric passage extending through said substation in accommodation with the assembly, bracing and support of said conduit;

3. a clamp means to selectively support the assembly portion of said array with said dredging means disposed off said floor by a stabilizing means monitoring increased freeboard of the platform above water surface through volume control of said adjustable buoyant chamber to supplant said floor support;

4. a cooperative utility station of adjustable buoyant support with clamp means alternately supports and positions said assembled portion to adjusted elevation relative the substation when modifying the length of the inoperated array, with said utility station having:

a. a pontoon with well extending through to accommodate passage of said conduit;

b. gas charging and venting apparatus with piping for exchange of portions of gas volumes between said substation and said utility station consistent with said load transfer to retain the balanced buoyant support of said vertical array;

c. a brake means associated with wires of said equalizer system to establish selective elevations of an essentially load balanced utility station; and,

5. a plurality of hoist means disposed on said service station and said substation coordinate to effect or alter said assembled objects by the transfer of array components between the stable substation and the disturbed service station affected by said vagrant surface.

10. An elongated dredging apparatus vertically disposed as a tensioned array of objects in a body of water, mainly supported by buoyant means, extends from a selected penetration of the water floor to an articulative portion of the apparatus contiguous with a water surfaced buoyant service station monitored and implemented to retain spaced relationship with said array stabilized consequential with said penetration and by monitoring and control means responding to changes in environment, loading and obstructions encountered during traverse of the dredging apparatus over a selected area of said floor, said traverse implemented by a method comprising:

a. embedding anchors in the floor oriented with and remote to said area for direct connection of wires deformed solely when wound to drums of powered submerged winches affixed to dredging means disposed lowermost in said array;

b. controlling the array elevation by a floor penetration detector integral with the dredging means supporting floor cutter means and pump from a lowermost pontoon having an adjustable buoyant chamber and said penetration detector monitors in immersed uppermost adjustable chamber in buoyant support of a substation from which the elongated apparatus suspends;

c. effecting a port and starboard said traverse by alternately reversing rotation of identical winches oppositely disposed to dredge with a pendulous swing from a wire repetitiously shortened from each advance in the area by a bow winch;

d. suspending the extended wires by a buoyed wire pendant intermediately connected between anchor and winch to generate catenary curves of the slacked wire paidoff a powered winch at a greater rate than the rate of haul-in wire establishing traverse; and,

e. tensioning of the slacked wires consequential with catenary curves provides an artificial demand consistent with supply of wire paidoff to preserve undisturbed the remaining stored wire to be unreeled from the winch powered to revolve.

11. In a dredging apparatus according to claim **10** additional equipment included to implement modifications to the array and shift anchors, employs a method comprising:

a. arranging the array off said floor by a surfaced stabilizing means influenced by periodic immersion to control the support capacity of said buoyant means;

b. transferring said objects between the stable array and movable service station by altering both location of support of the array and the support means, and exchanging objects by coordinating a plurality of hoist means disposed with accommodating passageways;

c. imparting a lifting force to free the embedded anchor by means of a buoyant pendant extended to the water surface for towing to new location.

* * * * *