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[54] **FLOATING DREDGE MOTION COMPENSATOR**

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[52] **U.S. Cl.** **37/67,** 37/72

[51] **Int. Cl.** **E02f 3/90**

[58] **Field of Search** 37/72, 67; 254/172

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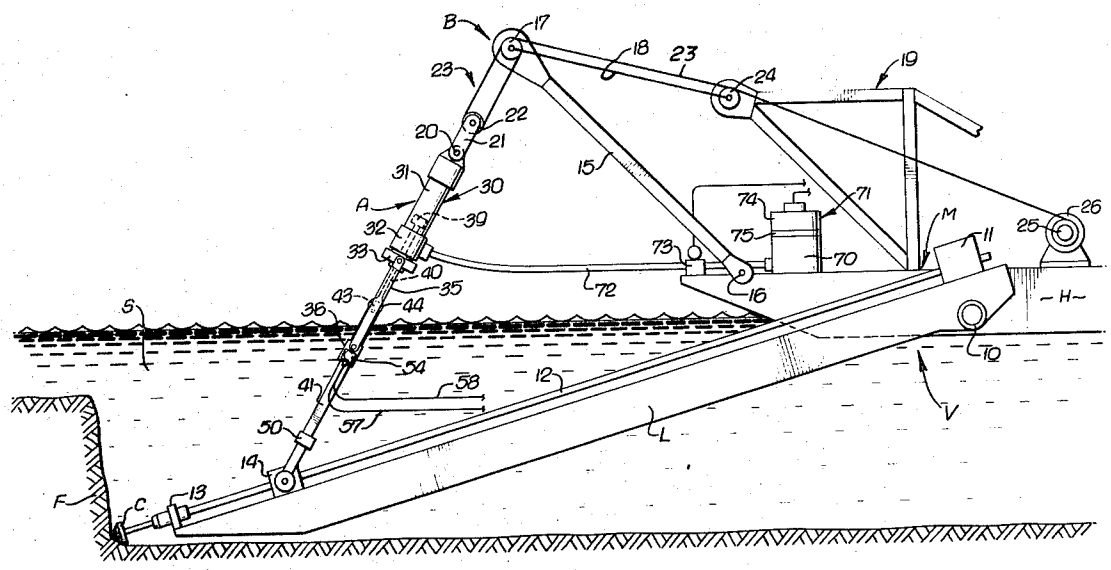
[57] **ABSTRACT**

Apparatus automatically compensating for relative vertical movement between a dredging vessel and its cutter, or other formation removing mechanism, to maintain a predetermined vertical position of the cutter mechanism despite vertical motion of the floating dredge vessel caused by sea conditions. The compensating apparatus includes a cylinder and piston device containing a hydraulic fluid under pressure exerting a preselected lifting force on the cutter mechanism and automatically extensible and contractable to permit the vessel to move without effecting movement of the cutter mechanism and the force that such mechanism exerts on the formation.

16 Claims, 3 Drawing Figures



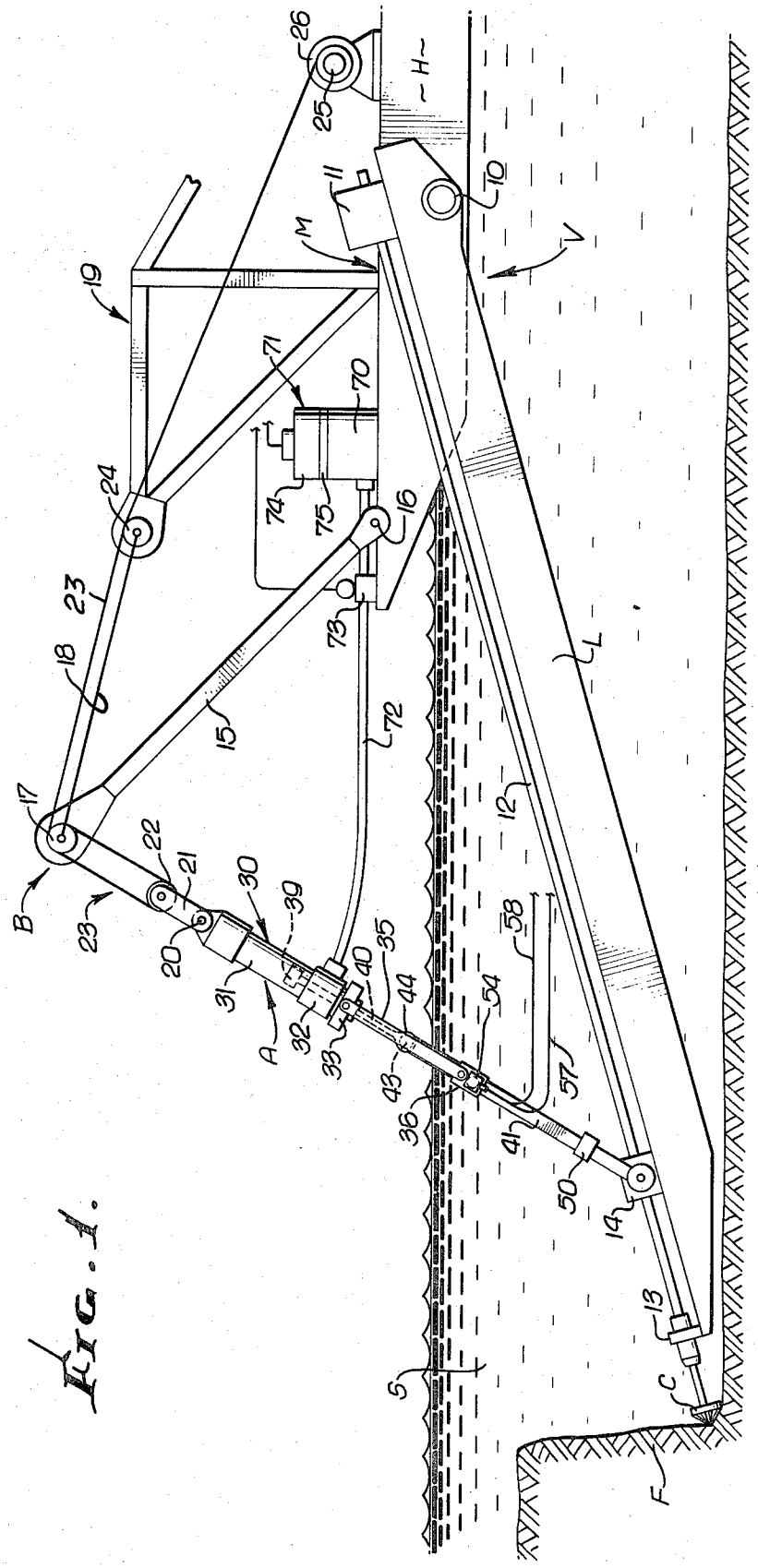

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Fig. 1.

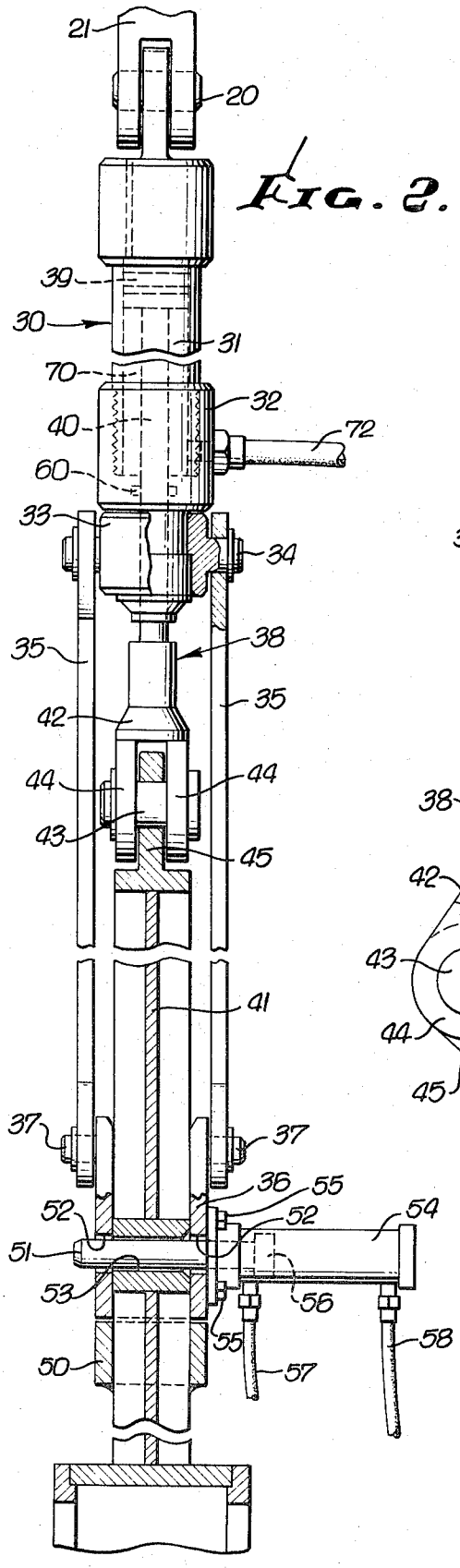
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FIG. 2.

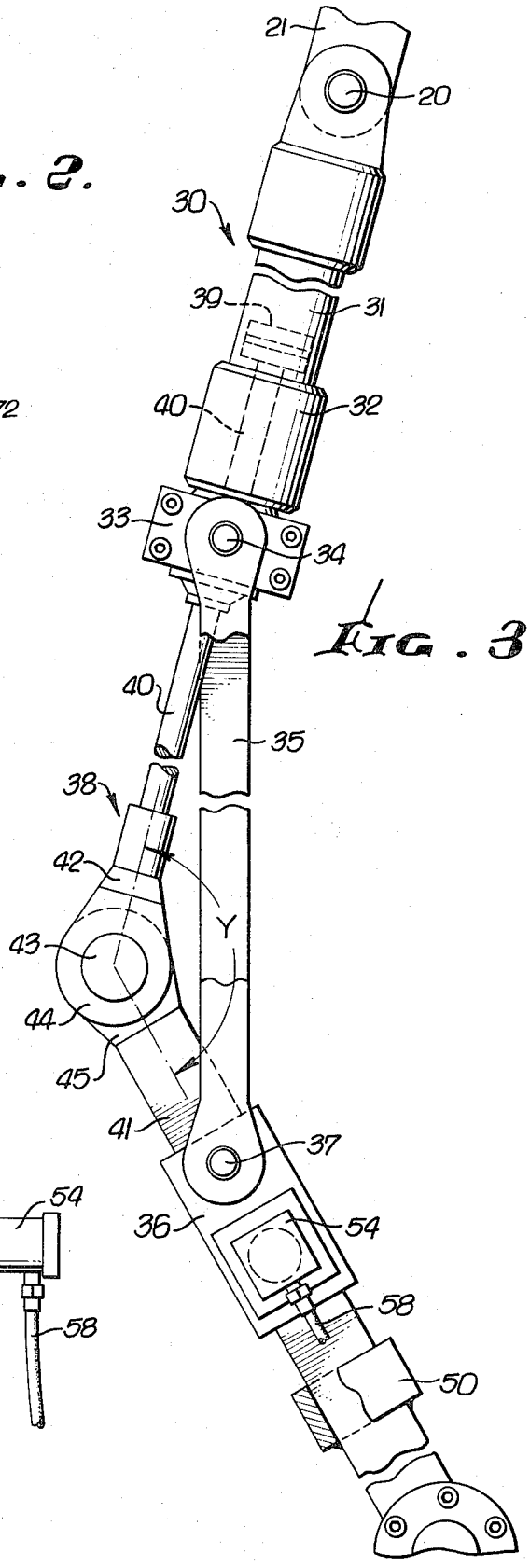
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FIG. 3.

FLOATING DREDGE MOTION COMPENSATOR

The present invention relates to dredges, and more particularly to motion compensating apparatus for dredging vessels floating in a sea or other body of water, to isolate the cutter mechanisms of the dredges from the vertical or pitching motion of the floating vessels under sea conditions.

Floating dredging vessels are subject to vertical motion caused by sea conditions, such vertical motion seriously impairing the operation of the dredge in cutting the formation underlying the sea, ocean or other body of water, and also reducing the rate at which the spoil may be removed. In addition, such vertical motion of the dredge vessel imposes severe loads on the dredge ladder and the hull structure of the vessel. Long swells from the open sea are common in harbor mouth dredging, while short swells resulting from ships passing generally result in a complex hull motion. Swells having length similar to or longer than the dredge hull cause pitching of the hull, and, therefore, great variations in the force with which the cutter head bears against the formation.

By virtue of the present invention, a compensator apparatus is provided which is capable of isolating the vessel movement from its cutter mechanism, whereby the desired weight or drilling force is maintained on the cutter head irrespective of heaving of the vessel in a sea, ocean or other body of water.

In general, a compensator apparatus includes a cylinder and piston device connected between a dredge ladder and the supporting structure of the dredge, which is carried by the vessel hull. The ladder is pivotally mounted on the hull, carrying the drive mechanism and the cutter, which is to operate upon the formation underlying the body of water. The position of the ladder and the cutter mechanism carried thereby is determined by a cable support, which can be used to raise or lower the cutter relative to the hull. In apparatus embodying the present invention, the ladder and the cutter mechanism are supported hydraulically or fluidly by interposing a compensating apparatus between the travelling sheaves of the cable support and the free end of the ladder. The apparatus relies upon the maintenance of a required pressure in a fluid, such as a hydraulic fluid disposed within a cylinder and piston device of the apparatus, such pressure being maintained in the absence or presence of longitudinal movement of the cylinder and piston portion of the device with respect to each other, the hydraulic fluid exerting a continuous, substantially constant stress on the ladder. In other words, the hydraulic fluid supports a portion of the weight of the ladder and the cutter mechanism, the remainder of its weight being exerted on the cutter and against the formation being removed, such remainder of the drilling or cutter weight being maintained substantially constant since the relative longitudinal movement between the cylinder and piston, within the limits of their longitudinal travel with respect to each other, has no effect on the supporting force of the hydraulic fluid under pressure within the cylinder. Despite heaving or other vertical movement of the hull portion of the dredge, the free end of the ladder and the cutter carried thereby will not move correspondingly to any appreciable degree, the movement of the dredging vessel or hull being incapable of transmission to the ladder and its cutter, which will remain in a predetermined position with respect to the formation being drilled.

It is, accordingly, apparent that the extensible hydraulic or fluid compensator maintains a generally constant suspension force on the ladder, causing the cutter to bear against the formation with the desired force, despite pitching or heaving of the dredge or its other vertical movement.

Another object of the invention is to provide an apparatus in which the cable system used for elevating the ladder and cutter mechanism carried thereby can function to raise or lower the cutter portion of the apparatus, including its ladder structure, to and from an operative position with respect to the formation without the necessity for such elevating force being transmitted through the fluid, such as hydraulic fluid, in the cylinder and piston compensator. In a more limited sense, this aspect of the invention is achieved by providing a lock mechansim that secures the cylinder and piston together when the cylinder and piston are fully telescoped one with the other, such lock mechanism preferably being selectively operated from a remote location. Thus, the hydraulic fluid need not even be under pressure once the lock has been made effective, since the entire lifting force will be transmitted between the cylinder and piston portions of the compensator to the lock mechanism, and without the necessity for any of such force being transmitted through the hydraulic fluid within the cylinder. By virtue of providing a lock, such as a mechanical lock, between the cylinder and piston portions of the apparatus, the hydraulic fluid within the cylinder need not have an unduly high unit pressure imposed upon it. This is due to the fact that the load imposed upon the cable support mechanism in raising the ladder and the cutter mechanism out of the water is considerably greater than the hydraulic force required to support only a portion of the load or weight of the ladder and the cutter mechanism during the performance of a drilling operation, in which the hydraulic fluid maintains the ladder and the cutter mechanism in a predetermined position without any substantial adverse affect by the pitching or heaving of the vessel in the water.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense.

Referring to the drawings:

FIG. 1 is a side elevational view, shown somewhat diagrammatically, of a dredge floating in a body of water for drilling a formation underlying a body of water;

FIG. 2 is an enlarged plan view, parts being shown in section, of the cylinder and piston portions of the apparatus in a fully collapsed position and locked to one another;

FIG. 3 is an elevational view, taken at right angles to the view illustrated in FIG. 2, disclosing the cylinder and piston portions of the apparatus in their unlocked or operative condition.

As disclosed in FIG. 1, a dredging vessel V is provided having a buoyant hull H floating in a sea, ocean or other body of water S, and adapted to cut into the

formation F underlying the body of water through appropriate rotation and manipulation of a cutter head C brought to bear against the formation. A ladder structure L carries the cutter mechanism M, this ladder structure having its rear portion suitably pivotally supported by the buoyant hull H, such as by one or a plurality of pivot pins **10,** the ladder structure being of a suitable length and extending forwardly of the hull a suitable distance from the pivot support **10,** which, for example, may be about 200 feet, the ladder structure L and the cutter mechanism M carried thereby representing a total weight of perhaps 200,000 to 300,000 pounds.

The rear portion of the ladder structure carries a suitable drive motor **11** adapted to rotate a drive shaft **12** extending through a bearing support **13** secured to the forward end of the ladder structure, and further passing through a bearing support **14** behind the forward bearing support. The cutter head C is attached to the drive shaft **12** for bearing against and cutting the formation F. Such cutter head may be rather large, for example, weighing about 40,000 pounds. The weight of the ladder structure L not supported by the buoyant hull H is supported in part by the cutter head C bearing against the formation F, which effects the cutting action as a result of such weight, as well as by forward and lateral movements of the cutter head through use of suitable known mechanisms (not shown), and which per se form no part of the present invention. The weight of the ladder structure and the cutter mechanism M carried thereby, which is not to be imposed upon the cutter head C, is supported through a compensator apparatus A and a cable mechanism B attached thereto.

The compensator apparatus also permits relative vertical movement of the floating vessel V and the structures carried thereby with respect to the cutter head C, and without substantially modifying the weight imposed on the cutter head, or its position against the formation F. As disclosed, a suitable frame **15,** such as an A frame, has its lower end pivotally mounted on the hull H by means of a pivot pin **16,** its upper end rotatably supporting one or a plurality of upper sheaves **17,** the A frame being suitably supported in an upwardly and forwardly inclined position through an intervening tension line or cable **18** extending between the upper end of the frame **15** and the forward portion of a fixed frame structure **19** secured to the buoyant hull H. The upper portion of the compensating apparatus A is connected by a pivot pin **20** to one or more links **21,** the upper part of which carries one or a plurality of rotatable sheaves **22** movable toward and away from the upper portion of the A frame **15.** A suitable cable system **23** extends around the upper and lower sheaves **17, 22,** and around a pulley **24** rotatably mounted on the forward portion of the frame **19,** the cable being wound upon the drums **25** of a suitable winch **26** which is manipulatable in a known manner to pull the travelling sheaves **22** towards the upper sheaves **17,** or allow the travelling sheaves to move downwardly from the upper sheaves. Through appropriate manipulation of the winch, the ladder structure L and cutter mechanism M carried thereby can be swung about the pivot support **10,** the tension in the cables **23** being transmitted through the compensator apparatus A to the forward portion of the ladder bearing support **14.** As described hereinbelow, the ladder structure L and the cutter mechanism M can be elevated completely from the water, or they can be lowered to a desired position below the surface of the water.

The compensator apparatus includes an elongate cylinder structure **30,** the upper end of which is pivotally connected through the pivot **20** to the lower portion of the links **21.** The cylinder structure includes an upper cylinder portion **31** whose lower cylinder head **32** is suitably secured to a connector **33** having upper pivot pins or trunnions **34** extending laterally therefrom, on which are pivotally mounted links **35** extending downwardly to a lower guide **36,** the lower ends of the links being pivotally mounted on pins **37** suitably affixed to the upper portion of the guide. Movable longitudinally within the cylinder structure **30** is a piston structure **38** including a piston **39** slidable along the inner wall of the cylinder **31** and having a piston rod **40** attached thereto and extending slidably through the lower cylinder head **32** to a position below the connector **33.** The piston rod structure **38** further includes a lower portion **41** pivotally secured to the upper rod portion **40** by a clevis **42** attached to the lower end of the upper rod portion and a pin **43** passing through the arms **44** of the clevis and through the upper end **45** of the lower portion **41** straddled by the clevis arms. The lower rod portion **41** is slidable longitudinally through the lower guide **36,** extending downwardly a sufficient distance for pivotal attachment to the bearing support **14.**

When the piston rod structure **38** is in its uppermost position within and relative to the cylinder **31,** as determined by the abutting of a stop or limit sleeve **50** suitably welded or otherwise affixed to the lower rod structure **41** with the lower end of the guide **36** (FIG. 2), the piston rod structure and cylinder structure **30** can be mechanically secured to one another to prevent their relative movement. With the piston rod structure in its uppermost position with respect to the cylinder structure, a suitable lock pin **51** can be inserted through opposed holes or bores **52** in the guide **36** and through a central hole **53** in the lower rod structure aligned therewith. This pin **51** is inserted hydraulically into the locked position illustrated in FIG. **2,** or removed therefrom, from a remote point on board the dredging vessel. As specifically illustrated, a lock cylinder **54** is suitably secured, as by screws **55,** to the exterior of the guide **36,** this cylinder containing a piston **56** secured to the lock pin **51.** The introduction of suitable fluid under pressure through a suitable line **57** into the rod end of the cylinder **54** will cause the piston **56** to move longitudinally toward the head end of the cylinder to fully withdraw the lock pin from the rod structure, thereby permitting relative longitudinal movement to occur between the piston rod structure **38** and cylinder structure **30.** On the other hand, the bleeding of the fluid under pressure from the rod end of the cylinder and its introduction through a suitable line **58** into the head end of the structure will shift the piston **56** in a direction away from the head end of the cylinder and insert the lock pin **51** through the aligned holes **52, 53** in the guide **36** and lower rod **41,** thereby locking the parts **38, 40** together.

The upper and lower piston rod portions **40, 41** of the apparatus are articulated with respect to one another through their pin interconnection **43** to avoid bending and binding in the parts because of the very substantial weight imposed upon them by the ladder structure L and the cutter mechanism M carried thereby. The inclination of the compensating apparatus A relative to the

ladder structure L introduces a bending moment into the compensator structure, which would tend to bind the upper piston rod structure **40** within the cylinder **31** and introduce undue friction resisting relative movement between the cylinder **31** and the piston **39** and rod **40**, as well as effect leakage of the seals **60** in the system between the head **32** and rod **40**. The articulated relation between the upper and lower piston rod structures **40, 41** prevents or minimizes such binding. The angle Y between the upper and lower piston rod structures has been exaggerated in FIG. **3** of the drawings. Actually, the included angle is about 83° to 85°, the misalignment between the upper and lower rod structures being only a matter of about 5 to 7°.

The compensator cylinder **31** contains a liquid **70** under pressure derived from a suitable accumulator **71** mounted on the drilling vessel, the liquid passing through a suitable hose **72**, controlled by a valve **73**, and into the head end **32** of the cylinder below the piston **39**. The pressure of the liquid is maintained by a suitable compressed gas **74**, such as compressed air, in the upper portion of the accumulator **71**, the pressure of the gas being transferred through a suitable floating accumulator piston **75** to the liquid **70**. The compressor piston **39** is movable longitudinally relatively within the cylinder **31**, the liquid pressure therein being maintained at all times since the liquid **70** can pass through the hose **72** into and from the accumulator **71**. The hydraulic and compressed air system for maintaining the liquid in the cylinder under pressure per se forms no part of the present invention. A description of such system is set forth in the application of Edward Larralde, Ser. No. 222,919, filed Feb. 2, 1972, for "Variable Rate Hydraulic-Pneumatic Weight Control and Compensating Apparatus," to which attention is directed.

In the operation of the apparatus illustrated in the drawings, the pressure of the compressed gas or air **74** is selected which will conform to the desired unit pressure of the liquid **70** acting within the compensator cylinder **30**, such liquid pressure depending upon the formation being cut by the cutter head C, the pressure relieving the cutter head of a required portion of the weight of the ladder structure L and the cutter mechanism M mounted thereon. The vertical position of the cutter head is controlled by the winch **26**, which will either feed off cable **23** or pull in cable to raise or lower the ladder L and the cutter head C supported thereby. Actually, it is not necessary to continually manipulate the winch to determine the vertical position of the cutter head C since the position **39** can lower in the cylinder **30** as the cutter head drills in a downward direction, the cuttings being suitably removed from the location of the head C in any suitable manner, as through use of suction equipment, which forms no part of the present invention and which is therefore neither illustrated nor described herein. The pressure of the liquid **70** in the cylinder remains substantially constant and will determine the net weight of the ladder structure L and cutter mechanism M imposed on the cutter head C. Pitching or heaving of the vessel in the water, as, for example, as a result of swells, will not modify the position of the cutter head or the net drilling weight imposed thereon, since elevation of the hull H and of the compensator cylinder structure **30** can readily occur with respect to the piston structure **38**, such extensible movement of the cylinder structure relative to the piston structure merely resulting in the liquid **70** flowing through the hose **72** toward the accumulator **71**, but without modifying the pressure of the liquid **70** acting in an upward direction in the piston **39**, the tensile force imposed by the liquid on the piston structure remaining unchanged. On the other hand, lowering of the hull H will result in a corresponding relative descent of the cylinder structure **30** along the piston structure **38**, the liquid moving from the accumulator **71** through the hose **72** back into the cylinder **31** without the unit pressure of the liquid being modified, such liquid under pressure still maintaining the same degree of tension in the piston rod structure **38**, resulting in the forward portion of the ladder and the cutter head C remaining in position and without partaking of any degree of vertical movement that would substantially modify the drilling weight of the cutter head C against the formation F and of the continuous drilling effectiveness of the head in the formation being removed.

It is, accordingly, apparent that the liquid pressure in the compensator remains substantially constant, the compensator being capable of extending or contracting in accordance with vertical movement of the vessel in the water without essentially modifying the position of the cutter head C or of its drilling weight or force against the formation F being cut.

In the event it is desired to elevate the ladder structure L and the cutter mechanism M from the water, the winch **26** is appropriately manipulated to cause the travelling sheaves **22** to lower with respect to the upper sheaves **17**, until the cylinder structure **30** moves downwardly to its fullest extent along the piston structure **38** and the guide **36** abuts the limit sleeve **50** affixed to the lower piston rod member **41**, thereby aligning the holes or bores **53, 52** in the rod member **41** and the guide **36**. Fluid pressure can then be directed into the cylinder **54** through the head end fluid line **58** to move the piston toward the rod **41** and shift the lock pin **51** through the aligned holes **52, 53**, thereby locking the cylinder structure **30** and piston structure **38** to one another. The winch **26** can then be manipulated to move the travelling sheaves **22** toward the upper sheaves **17** and elevate the ladder L completely from the water S, the hydraulic fluid in the cylinder **31** not being required to transmit any of the load being lifted. Accordingly, when the comparator system A is to be made functional, only that liquid pressure is required in the cylinder **31** for relieving part of the weight of the ladder L and cutter mechanism M from the cutter head C. A unit liquid pressure for supporting the entire load of the ladder L and cutter mechanism M is not required.

In the event it is desired to vary the lifting force on the piston structure **38** and, therefore, the resultant load imposed on the cutter head C, it is only necessary to change the unit pressure of the compressed air **74**, or other gas, in the accumulator **71**, which will correspondingly change the unit pressure of the liquid **70** in the system, as set forth in the above-identified patent application, Ser. No. 222,919. Usually, if soft formations are being cut, the unit pressure will be greater in order that the cutter head be relieved of a greater portion of the weight of the ladder L and of the cutter mechanism M. In drilling hard formations, the unit pressure will be decreased to cause a corresponding greater load to be imposed on the cutter head C. The resultant load on the cutter head will remain substantially constant despite extensive pitch or heave of the dredge in the water, as described above.

I claim:

1. In dredging apparatus: a vessel floating in a body of water; a cutter mechanism carried by and extending forwardly from said vessel and movable with respect thereto, said mechanism including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; both of said means being located above and overlying said mechanism; means extending forwardly of said vessel and supporting one of said means from said vessel; means operatively connecting said other of said means to said cutter mechanism; means for maintaining a fluid medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move longitudinally with respect to each other to provide an upwardly directed force on said cutter mechanism supporting at least a portion of the weight of said cutter mechanism and thereby retaining the drilling weight of said cutter device against the formation at a selected value; and means for maintaining said fluid medium in said cylinder means at a substantially constant selected pressure.

2. In dredging apparatus as defined in claim 1; said one of said means being said cylinder means; said other of said means being said piston means.

3. In dredging apparatus: a vessel floating in a body of water; a cutter mechanism carried by and extending forwardly from said vessel and movable with respect thereto, said mechanism including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; both of said means being located above and overlying said mechanism; means supporting one of said means from said vessel; means operatively connecting said other of said means to said cutter mechanism; means for maintaining a fluid medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move longitudinally with respect to each other to provide an upwardly directed force on said cutter mechanism supporting at least a portion of the weight of said cutter mechanism and thereby retaining the drilling weight of said cutter device against the formation at a selected value; and means for maintaining said fluid medium in said cylinder means at a substantially constant selected pressure; said supporting means including means for raising and lowering said one of said means with respect to said vessel, said supporting means extending above and connected to the upper portion of said one of said means.

4. In dredging apparatus: a vessel floating in a body of water; a cutter mechanism carried by and extending forwardly from said vessel and movable with respect thereto, said mechanism including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; both of said means being located above and overlying said mechanism; means supporting one of said means from said vessel; means operatively connecting said other of said means to said cutter mechanism; means for maintaining a fluid medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move longitudinally with respect to each other to provide an upwardly directed force on said cutter mechanism supporting at least a portion of the weight of said cutter mechanism and thereby retaining the drilling weight of said cutter device against the formation at a selected value; and means for maintaining said fluid medium in said cylinder means at a substantially constant selected pressure; said one of said means being said cylinder means; said other of said means being said piston means; said supporting means including means for raising and lowering said cylinder means with respect to said vessel; said supporting means extending above and connected to the upper portion of said cylinder means.

5. In dredging apparatus: a vessel floating in a body of water; a cutter mechanism carried by and extending forwardly from said vessel and movable with respect thereto, said mechanism including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; means supporting one of said means from said vessel; means operatively connecting said other of said means to said cutter mechanism; means for maintaining a fluid medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move longitudinally with respect to each other to provide an upwardly directed force on said cutter mechanism supporting at least a portion of the weight of said cutter mechanism and thereby retaining the drilling weight of said cutter device against the formation at a selected value; said supporting means including means for raising and lowering said one of said means with respect to said vessel; and releasable lock means for securing said cylinder means and piston means to each other whereby raising and lowering of said one of said means raises and lowers said cutter mechanism with respect to said vessel.

6. In dredging apparatus: a vessel floating in a body of water; a cutter mechanism carried by and extending forwardly from said vessel and movable with respect thereto, said mechanism including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; means supporting one of said means from said vessel; means operatively connecting said other of said means to said cutter mechanism; means for maintaining a fluid medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move longitudinally with respect to each other to provide an upwardly directed force on said cutter mechanism supporting at least a portion of the weight of said cutter mechanism and thereby retaining the drilling weight of said cutter device against the formation at a selected value; said one of said means being said cylinder means; said other of said means being said piston means; said supporting means including means for raising and lowering said cylinder means with respect to said vessel; and releasable lock means for securing said cylinder means and piston means to each other whereby raising and lowering of said cylinder means raises and lowers said cutter mechanism with respect to said vessel.

7. In dredging apparatus: a vessel floating in a body of water; a cutter mechanism carried by and extending forwardly from said vessel and movable with respect thereto, said mechanism including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; both of said means being located above and overlying said mechanism; means supporting one of said means from said vessel; means operatively con-

necting said other of said means to said cutter mechanism; means for maintaining a fluid medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move longitudinally with respect to each other to provide an upwardly directed force on said cutter mechanism supporting at least a portion of the weight of said cutter mechanism and thereby retaining the drilling weight of said cutter device against the formation at a selected value; and means for maintaining said fluid medium in said cylinder means at a substantially constant selected pressure; said supporting means extending above and connected to the upper portion of said one of said means; said supporting means including one or more lower sheaves connected to said one of said means, one or more upper sheaves carried by said vessel, a winch, and cable means passing over said upper and lower sheaves and connected to said winch to be moved thereby for raising and lowering said one of said means with respect to said vessel.

8. In dredging apparatus: a vessel floating in a body of water; a cutter mechanism carried by and extending forwardly from said vessel and movable with respect thereto, said mechanism including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; both of said means being located above and overlying said mechanism; means supporting one of said means from said vessel; means operatively connecting said other of said means to said cutter mechanism; means for maintaining a fluid medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move longitudinally with respect to each other to provide an upwardly directed force on said cutter mechanism supporting at least a portion of the weight of said cutter mechanism and thereby retaining the drilling weight of said cutter device against the formation at a selected value; and means for maintaining said fluid medium in said cylinder means at a substantially constant selected pressure; said supporting means extending above and connected to the upper portion of said cylinder means; said supporting means including one or more lower sheaves connected to said cylinder means, one or more upper sheaves carried by said vessel, a winch, and cable means passing over said upper and lower sheaves and connected to said winch to be moved thereby for raising and lowering said cylinder means with respect to said vessel.

9. In dredging apparatus: a vessel floating in a body of water; a cutter mechanism carried by and extending forwardly from said vessel and movable with respect thereto, said mechanism including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; means supporting one of said means from said vessel; means operatively connecting said other of said means to said cutter mechanism; means for maintaining a fluid medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move longitudinally with respect to each other to provide an upwardly directed force on said cutter mechanism supporting at least a portion of the weight of said cutter mechanism and thereby retaining the drilling weight of said cutter device against the formation at a selected value; said supporting means including one or more lower sheaves connected to said one of said means, one or more upper sheaves carried by said vessel, a winch, and cable means passing over said upper and lower sheaves and connected to said winch to be moved thereby for raising and lowering said one of said means with respect to said vessel; and releasable lock means for securing said cylinder means and piston means to each other whereby raising and lowering of said one of said means raises and lowers said cutter mechanism with respect to said vessel.

10. In dredging apparatus: a vessel floating in a body of water; a cutter mechanism carried by and extending forwardly from said vessel and movable with respect thereto, said mechanism including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; means supporting one of said means from said vessel; means operatively connecting said other of said means to said cutter mechanism; means for maintaining a fluid medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move longitudinally with respect to each other to provide an upwardly directed force on said cutter mechanism supporting at least a portion of the weight of said cutter mechanism and thereby retaining the drilling weight of said cutter device against the formation at a selected value; said supporting means including one or more lower sheaves connected to said cylinder means, one or more upper sheaves carried by said vessel, a winch, and cable means passing over said upper and lower sheaves and connected to said winch to be moved thereby for raising and lowering said cylinder means with respect to said vessel; and releasable lock means for securing said cylinder means and piston means to each other whereby raising and lowering of said cylinder means raises and lowers said cutter mechanism with respect to said vessel.

11. In dredging apparatus: a vessel floating in a body of water; a ladder pivotally connected to said vessel and extending therefrom; a cutter mechanism carried by said ladder and including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; both of said means being located above and overlying said ladder; means extending forwardly of said vessel and supporting said cylinder means from said vessel; means operatively connecting said piston means to said ladder; and means for maintaining a fluid medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move longitudinally with respect to each other to provide an upwardly directed force on said ladder and cutter mechanism to support at least a portion of the weight of said ladder and cutter mechanism and thereby retain the drilling weight of said cutter device against the formation at a selected value; and means for maintaining said fluid medium in said cylinder means at a substantially constant selected pressure.

12. In dredging apparatus: a vessel floating in a body of water; a ladder pivotally connected to said vessel and extending therefrom; a cutter mechanism carried by said ladder and including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; both of said means being located above and overlying said ladder; means supporting said cylinder means from said vessel; means operatively connecting said piston means to said ladder; and means for maintaining a fluid

medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move longitudinally with respect to each other to provide an upwardly directed force on said ladder and cutter mechanism to support at least a portion of the weight of said ladder and cutter mechanism and thereby retain the drilling weight of said cutter device against the formation at a selected value; and means for maintaining said fluid medium in said cylinder means at a substantially constant selected pressure; said supporting means including means for raising and lowering said cylinder means with respect to said vessel; said supporting means extending above and connected to the upper portion of said cylinder means.

13. In dredging apparatus: a vessel floating in a body of water; a ladder pivotally connected to said vessel and extending therefrom; a cutter mechanism carried by said ladder and including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; means supporting said cylinder means from said vessel; means operatively connecting said piston means to said ladder; means for maintaining a fluid medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move laterally with respect to each other to provide an upwardly directed force on said ladder and cutter mechanism to support at least a portion of the weight of said ladder and cutter mechanism and thereby retain the drilling weight of said cutter device against the formation at a selected value; said supporting means including means for raising and lowering said cylinder means with respect to said vessel; and releasable lock means for securing said cylinder means and piston means to each other whereby raising and lowering of said cylinder means raises and lowers said ladder and cutter mechanism with respect to said vessel.

14. In dredging apparatus as defined in claim **13**; said cylinder means including a guide; said piston means including a piston in said cylinder means, an upper piston rod portion secured to said piston and extending from said cylinder means, a lower piston rod portion pivotally connected to said upper rod portion and slidable in said guide; said lower rod portion being connected to said ladder; said releasable lock means securing said guide to said lower rod portion whereby raising and lowering of said cylinder means raises and lowers said ladder and cutter mechanism.

15. In dredging apparatus: a vessel floating in a body of water; a ladder pivotally connected to said vessel and extending therefrom; a cutter mechanism carried by said ladder and including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; means supporting said cylinder means from said vessel; means operatively connecting said piston means to said ladder; means for maintaining a fluid medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move laterally with respect to each other to provide an upwardly directed force on said ladder and cutter mechanism to support at least a portion of the weight of said ladder and cutter mechanism and thereby retain the drilling weight of said cutter device against the formation at a selected value; said cylinder means including a guide; said piston means including a piston in said cylinder means; an upper piston rod portion secured to said piston and extending from said cylinder means, a lower piston rod portion pivotally connected to said upper rod portion and slidable in said guide; said lower rod portion being connected to said ladder.

16. In dredging apparatus: a vessel floating in a body of water; a ladder pivotally connected to said vessel and extending therefrom; a cutter mechanism carried by said ladder and including a cutter device for cutting a formation submerged in the body of water; cylinder means; piston means slidable in said cylinder means; means supporting said cylinder means from said vessel; means operatively connecting said piston means to said ladder; means for maintaining a fluid medium under pressure in said cylinder means on one side of said piston means as said piston means and cylinder means move laterally with respect to each other to provide an upwardly directed force on said ladder and cutter mechanism to support at least a portion of the weight of said ladder and cutter mechanism and thereby retain the drilling weight of said cutter device against the formation at a selected value; said supporting means including one or more lower sheaves connected to said cylinder means, one or more upper sheaves carried by said vessel, a winch, and cable means passing over said upper and lower sheaves and connected to said winch to be moved thereby for raising and lowering said cylinder means with respect to said vessel; said cylinder means including a guide; said piston means including a piston in said cylinder means, an upper piston rod portion secured to said piston and extending from said cylinder means, a lower piston rod portion pivotally connected to said upper rod portion and slidable in said ladder; and releasable lock means for securing said guide to said lower rod portion whereby raising and lowering of said cylinder means raises and lowers said ladder and cutter mechanism.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,797,139 Dated March 19, 1974

Inventor(s) Edward Larralde

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 21: cancel "with" and substitute --within--.

Column 5, line 24: cancel "compressor" and substitute --compensator--.

Signed and sealed this 1st day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents