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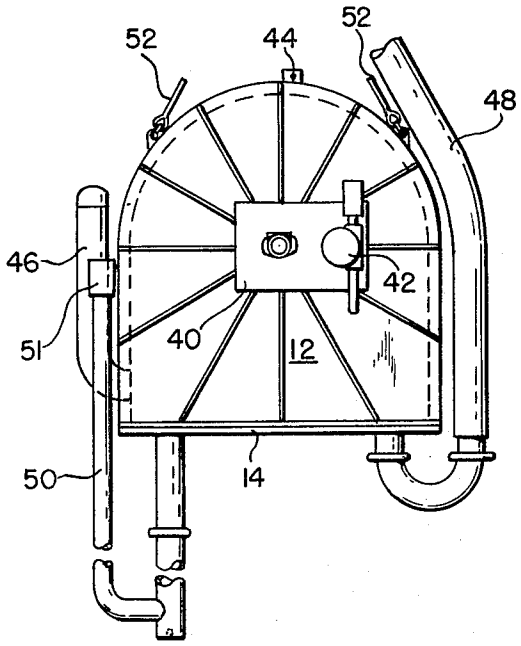
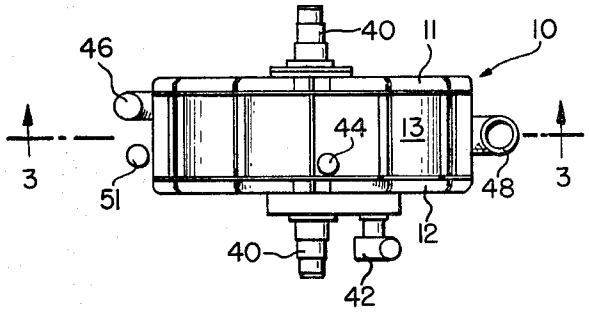
DEEP WATER PUMPING OF FLUIDS AND SEMI-FLUIDS

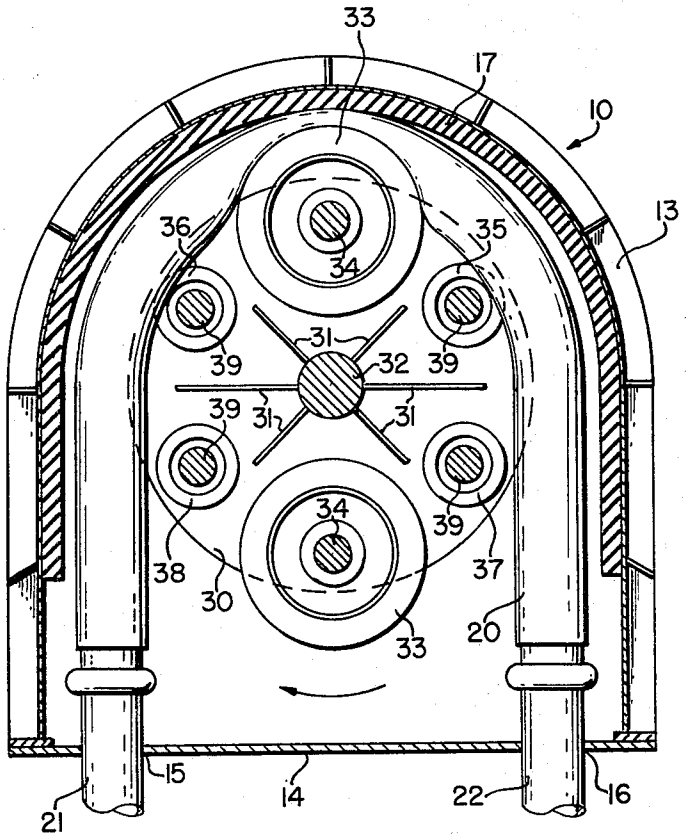
Filed March 18, 1970



FIG—1



FIG—2



FIG—3

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DEEP WATER PUMPING OF FLUIDS AND SEMI-FLUIDS

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ABSTRACT OF THE DISCLOSURE

A rotary peristaltic pump for pumping fluids and semi-fluids in underwater locations includes a semi-circular piece of compressible tubing disposed around the inner arcuate surface of a substantially water-tight housing with pump action obtained by a pair of power driven compression wheels. A check valve mounted on the housing and communicating with the interior thereof is used to maintain a predetermined pressure differential between the interior and exterior of the housing.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to a rotary peristaltic pump designed for deep water pumping of mud and other semi-fluids.

PRIOR ART RELATING TO THE DISCLOSURE

Rotary pumps of the type which employ a loop of compressible tubing disposed around the inner surface of the housing with pumping action obtained by compressing the tubing in regular cycles are known. Pumps of this type have been used to pump fluid and semi-fluids of various kinds. As far as is known, pumps of this type have not been used in pumping fluids and semi-fluids in deep underwater locations where the exterior pressure exerted on the pump is relatively high. Efficiency of pumping action in pumps of this type is dependent on the elasticity or memory of the compressible tubing and on the pressure differential between the interior and exterior of the housing. The pressure differential in addition to the elasticity of the tubing enables the tubing, once compressed, to return to its original configuration almost immediately. When operating in deep water, for example, at a depth of 1200 to 1500 feet, the external pressure exerted by the water on the pump is considerable. To work efficiently the pump must have an internal pressure less than that of the external pressure. If the pressure differential becomes too great, however, serious problems in the integrity of the compressible tubing result.

SUMMARY OF THE INVENTION

This invention relates to a submergible rotary peristaltic pump for pumping fluids and semi-fluids in underwater locations. The pump may be used in assisting recovery of sunken objects from the bottom of bodies of water, such as the ocean floor, where the objects are many times buried in mud. To retrieve such objects it is necessary to remove a certain amount of the mud and muck surrounding the object. This is usually accomplished by pumping the mud surrounding the object to a different location. Conventional pumps such as centrifugal pumps are easily clogged by occasional objects in the mud and debris found on the sea floor. A great deal of expense and time are necessary to unclog them. The pump of this invention is able to pump fluid and semi-fluids containing occasional solids having a diameter as great as that of the compressible tubing without difficulty. This pump is also capable of operating efficiently at any desired depth.

The pump of this invention has a self-regulating feature which maintains the pressure differential between the interior and exterior of the pump housing substantially constant even though the depth of the pump is changed with a corresponding change in the external pressure exerted on the pump.

The pump comprises a substantially water tight housing having inlet and outlet ports cut therethrough, a continuous compressible tube extending through the inlet and outlet ports and disposed around the interior wall of the housing, and compression means mounted in the housing for rotation around the inner surface of the housing for progressively compressing the tube to closure against the interior wall thereof. The pressure differential between the interior and exterior of the pump is maintained substantially constant by a check valve interconnecting the interior and exterior of the housing. A hydraulic motor or other suitable means is used to drive the compression means compressing the compressible tube. A suction pump integrally mounted on the peristaltic pump and driven by the hydraulic motor connects with the interior of the pump housing and is used to assist in maintaining a predetermined pressure differential between the interior and exterior of the housing.

It is a principal object of this invention to provide a rotary peristaltic pump capable of pumping fluids and semi-fluids in underwater locations.

A further object of this invention is a submergible rotary peristaltic pump having means for maintaining the pressure differential between the interior and exterior of the pump substantially constant.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of the pump of this invention;

FIG. 2 is a plan view of the pump shown in FIG. 1;

FIG. 3 is a sectional view along section line 3—3 of FIG. 2 showing the interior of the pump and the location of the compressible tube.

DETAILED DESCRIPTION OF THE INVENTION

The pump of this invention comprises pump housing **10** within which is mounted compressible tube **20** and compression means **30** for compression successive contiguous areas of the tube to closure against the interior walls of the pump. Power means **40** moves the compressing means around the interior walls of the housing. Water or other fluid is admitted to the interior of the pump housing under regulated conditions through valve **44**. Power means **40** also drives suction pump **42** which connects to the interior pump housing **10**.

In more detail pump housing **10** comprises two parallel spaced apart sidewalls **11** and **12** between which are placed end wall **13** and bottom wall **14**. The configuration of the pump housing is typically cylindrical. At the lower end of the housing are located inlet and outlet ports **15** and **16** respectively. The pump housing is made substantially water tight by conventional means. Around the arcuate inner surface of the pump housing is placed a liner **17** of resilient material such as rubber, the function of which is to prevent damage to the compressible tube by cushioning it against coarse or sharp objects which may be present in the pumped material.

A loop of compressible tube **20** of uniform cross section is placed around the inner arcuate surface of the pump housing **10**. One end of the compressible tube **20** is connected to suction pipe **21** extending through port **15** of the pump housing and the other end of the compressible tube is connected to discharge pipe **22** extending through outlet port **16** of the pump housing.

Within the pump housing is a rotor comprising a pair of parallel plates **30** held apart by reinforcing members **31** and rigidly attached in axially-spaced relation to the drive shaft **32** which extends through the end walls of the housing. Diametrically opposed compression wheels **33** are journaled for rotation on shafts **34** carried by plates **30**. The compression wheels **33** are mounted in the same plane such that on rotation of the plate **30** they progressively compress successive contiguous areas of the compressible tube to closure against liner **17** and the inner surface of the end wall **13** of pump housing **10**. The compression wheels **33** are suitably pneumatic tires mounted on hubs. The compressible tube **20** is maintained in alignment with compression rollers **33** by guide rollers **35, 36, 37** and **38**. The guide rollers are of smaller diameter than the compression wheels and are journaled for rotation on shafts **39** carried by pump plates **30**. Guide rollers **35** and **38** are diametrically opposed to one another and are mounted so as to contact opposite sides of the compressible tube. Likewise, guide rollers **36** and **37** are mounted so as to contact opposite sides of the tube.

Plates **30** and compression wheels **33** thereon are rotated by means of hydraulic motors **40** connected to the shaft **32** on each side. Other means of powering the pump rotor can be used if desired.

Connected to one of the motors of the pump rotor is suction pump **42** of conventional design which has its intake end in communication with the interior of the housing. The function of the suction pump is to assist in maintaining the pressure differential between the interior and exterior of the pump housing at a predetermined pressure differential should the means for maintaining the pressure differential not be adequate.

Mounted on and communicating with the interior of the pump housing is valve **44** which may be made adjustable or not. The function of valve **44** is to allow water to enter the interior of the housing when the pressure differential between the interior and exterior of the housing becomes greater than desired. Usually the valve is adjusted to open when the pressure differential between the interior and exterior of the housing is from 15 to 30 p.s.i.

Also connected to and communicating with the interior of pump housing **10** is pipe **46** which extends upwardly from the lower end of the pump housing a short distance. The end of the pipe is capped. Air is trapped in the pipe **46** and functions to even out pressure fluctuation which occur as the pump rotor rotates about its axis. The expansion chamber created by pipe **46** evens out the pressure fluctuations which, otherwise, cause an unstable condition in the pump.

Outlet pipe **22** extending through outlet port **16** is connected to discharge hose **48** which carries the pumped material to the desired discharge location.

If the suction pipe **21** of the pump should become clogged provision is made for unclogging the pump if the material clogging the pipe is mud or other material which will dissolve readily on contact with water. An L-shaped pipe **50** attached to the lower end of suction pipe **21** extends upwardly a short distance. On the upper end of pipe **50** is a dilution valve **51**, opening and closing of which is remotely controlled by suitable mechanical or electrical means. When suction pipe **21** becomes clogged dilution valve **51** is opened allowing water to enter pipe **50** and suction pipe **21** where it dissolves the mud or other material clogging the pipe.

In operation the pump of this invention is lowered to the bottom of the ocean floor or river as the case may be by a cable **52** attached to the housing. Running along the cable **52** are hydraulic lines (not shown) leading to hydraulic motors **40**. Valve **44** is adjusted to open at a pressure differential between the interior and exterior of the pump housing of approximately 15 p.s.i. As the pump is lowered the pressure exerted on the exterior of the pump becomes greater than that on the interior. When the pressure differential exceeds 15 p.s.i. valve **44** opens allowing water to flood the interior of the pump housing. When the pump reaches the operating depth the hydraulic motors are started by remote control. Revolution of the hydraulic motors rotates plates **30** and compression wheels **33**. The hydraulic motors also turn suction pump **42** which assists in maintaining the pressure differential between the interior and exterior of the pump at the preset pressure differential. Mud and other debris are sucked into suction pipe **21** and is discharged through the discharge hose **48**.

The advantage the pump of this invention offers over other known pumps for deep sea operations is that it is capable of pumping semi-fluids having occasional solids of a diameter as great as that of the compressible tubing without damage to the pump and without any substantial clogging thereof. Additionally, the pressure differential maintained between the interior and exterior of the pump housing by the combination of suction pump and valve enables the pump to be used at various depths without modification or change of any kind.

In summary, the pump of this invention constitutes an efficient and easy to maintain pump for use in assisting in the recovery of objects from the ocean floor, from the bottoms of rivers, and other inaccessible underwater locations.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A submergible, self-regulating rotary peristaltic pump for pumping fluids and semi-fluids at varying depths in underwater locations while maintaining a substantially constant pressure differential between the interior and exterior of the pump with changes in operating depth, enabling the pump to work efficiently, comprising:

a water-tight housing initially filled with air, having an interior wall portion,

a section of compressible tubing contained therein,

inlet and outlet ports in the housing for receiving opposite ends of the compressible tubing,

power driven compression means rotating in a path around the interior wall of the housing with successive areas of the periphery of the compressing means compressing successive contiguous areas along the length of the compressible tube against the interior wall of the housing during the cycle of rotation,

one way pressure differential valve means mounted on the housing allowing water to enter the housing and increase the air pressure therein when the exterior water pressure exerted on the housing exceeds a preset pressure differential value between the pressure on the interior and the exterior of the housing,

a water suction pump mounted on the housing having its intake communicating with the interior of the housing for removing water from the housing to decrease the pressure therein so as to maintain the pressure differential between the interior and exterior of the housing at said preset value as the depth of the pump is changed during operation, the differential pressure valve means and suction pump working together to maintain the pressure differential at said preset value regardless of the depth of operation of the pump and changes in the depth occurring during operation.

2. A submergible, self-regulating rotary peristaltic pump for pumping fluids and semi-fluids at varying depths in underwater locations while maintaining a substantially constant pressure differential between the interior and exterior of the pump with changes in operating depth, enabling the pump to work efficiently, comprising:

a water-tight housing initially filled with air, having an interior wall portion,

a section of compressible tubing contained therein,

inlet and outlets ports in the housing for receiving opposite ends of the compressible tubing,

power driven compression means rotating in a path around the interior wall of the housing with successive areas of the periphery of the compressing means

compressing successive contiguous areas along the length of the compressible tube against the interior wall of the housing during the cycle of rotation,

one way pressure differential valve means mounted on the housing allowing water to enter the housing and increase the air pressure therein when the exterior water pressure exerted on the housing exceeds a preset pressure differential value between the pressure on the interior and the exterior of the housing,

a water suction pump mounted on the housing having its intake communicating with the interior of the housing for removing water from the housing to decrease the pressure therein so as to maintain the pressure differential between the interior and exterior of the housing at said preset value as the depth of the pump is changed during operation, the differential pressure valve means and suction pump working together to maintain the pressure differential at said preset value regardless of the depth of operation of the pump and changes in the depth occurring during operation, and

means forming an expansion tube partially filled with air mounted on the housing and communicating with

the interior thereof for evening out pressure fluctuations created by rotation of the compression means.

3. The pump of claim 2 including an open-ended conduit communicating with the inlet port of the pump, a remote controlled valve covering the open end of the conduit, the valve, when opened, receiving water surrounding the pump housing in the conduit and inlet port to dilute clogged material in the inlet port of the pump.

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