April 27, 1965 — J. T. BROADFOOT — 3,180,272

DEFORMABLE-HOSE FLUID PUMP

Filed July 9, 1963 — 3 Sheets-Sheet 1

FIG. 3

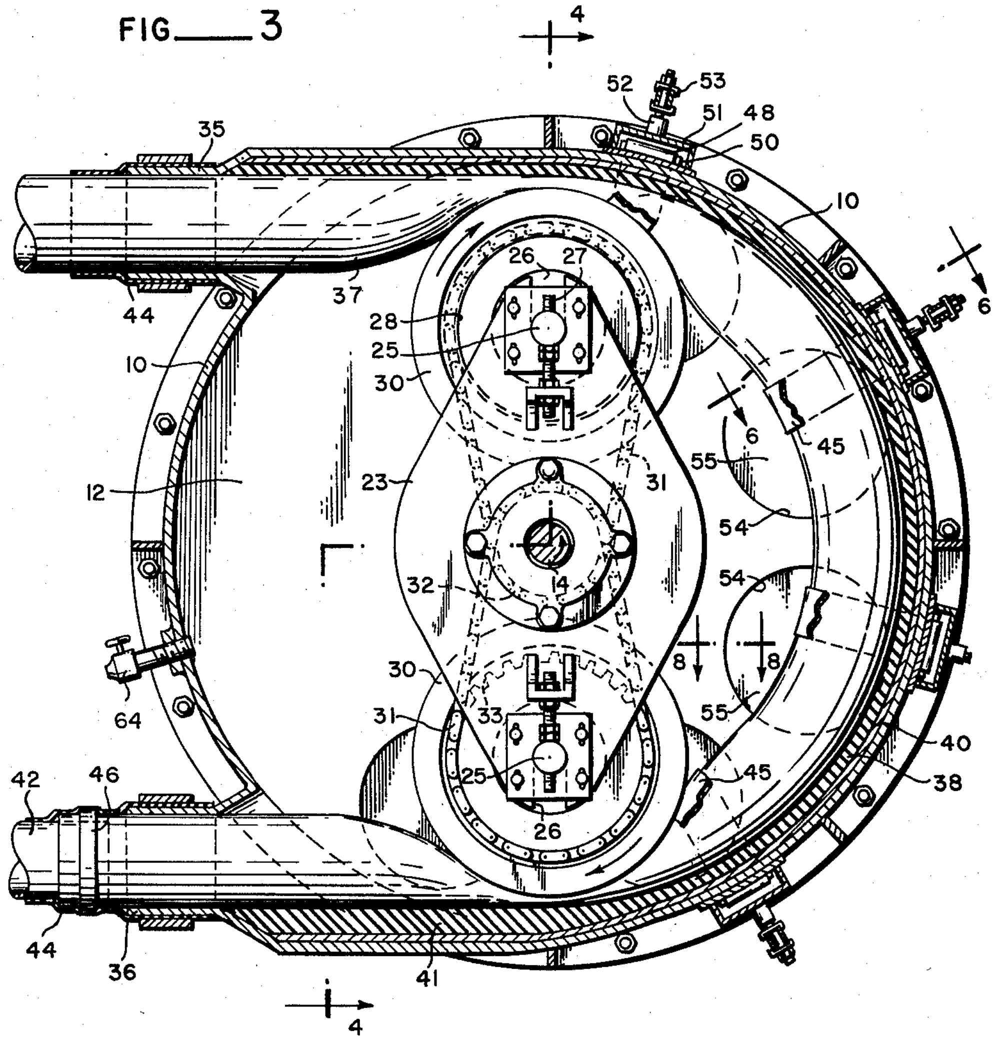
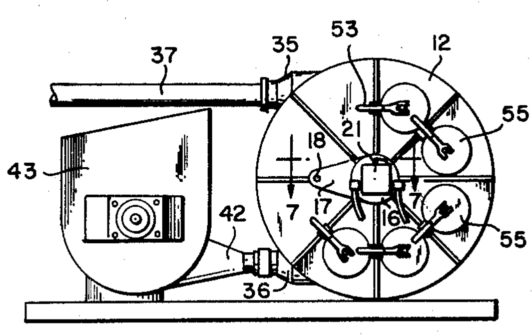


FIG. 1



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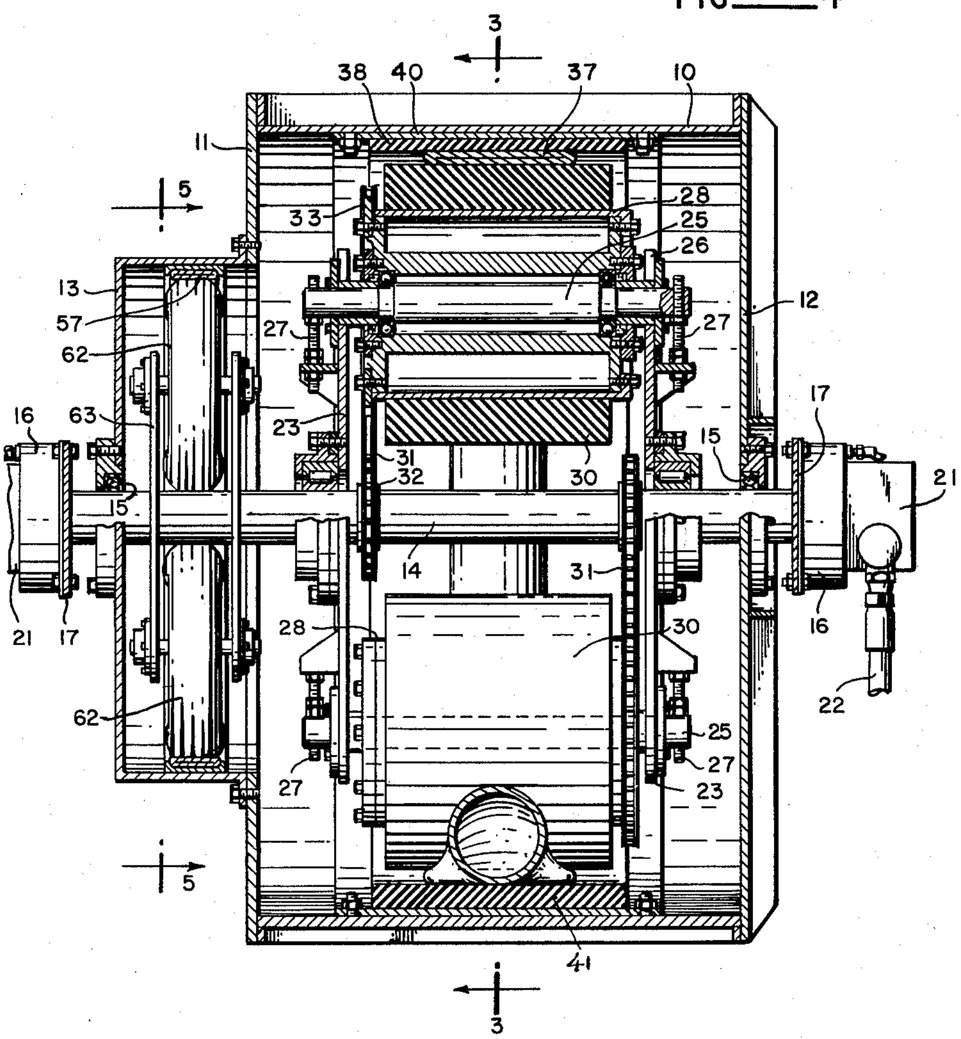
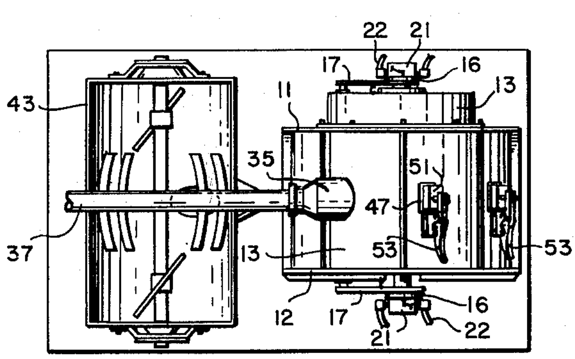
FIG—4





FIG—2

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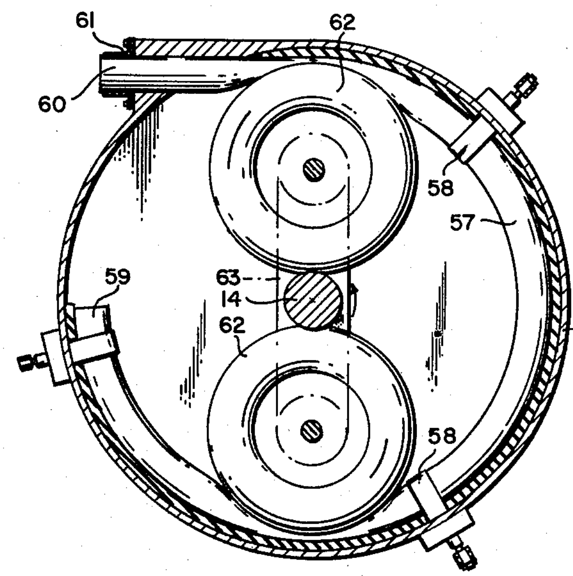

FIG. 5

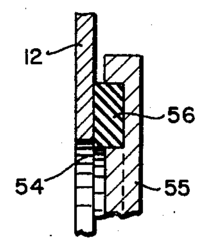

FIG. 8

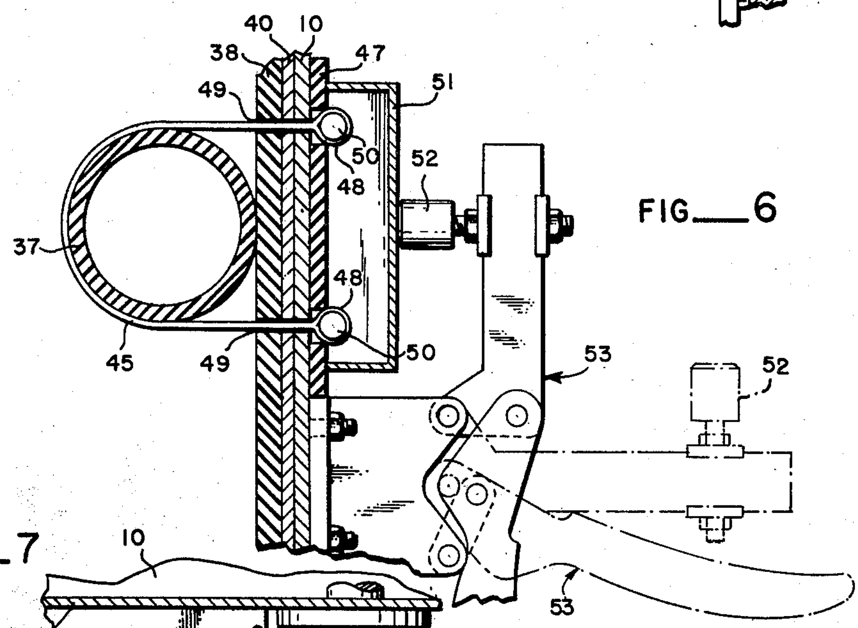

FIG. 6

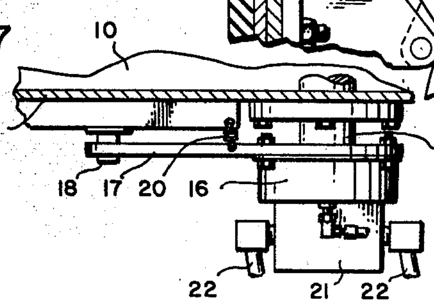

FIG. 7

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United States Patent Office

3,180,272

Patented Apr. 27, 1965

3,180,272

DEFORMABLE-HOSE FLUID PUMP

John T. Broadfoot, Seattle, Wash., assignor of forty-five percent to Roger L. Culbertson, King County, Wash.

Filed July 9, 1963, Ser. No. 293,652
15 Claims. (Cl. 103—149)

The present application is a continuation-in-part of my abandoned application filed Dec. 21, 1962, Ser. No. 246,609.

This invention relates to a fluid pump, being particularly engineered to efficiently handle fluids of heavy consistency and those in which solids are entrained and thus being especially applicable to the pumping of concrete.

For its general objects the invention aims to provide a pump of this nature in which the pumpage is completely isolated from the moving parts of the pump, one which will not be damaged should the same run dry or become plugged, nor from the lodging of an oversize solid in the pump or an attempt to lift the pumped fluid to a height exceeding the capabilities of the pump, which can be readily reversed to aid in clearing a plugged condition, and which permits damaged portions of hose through which the fluid has been pumped to be replaced with ease and expedition.

Other more particular objects and advantages, together with the foregoing, will appear and be understood in the following description and claims. The invention consists in the new method of pumping a fluid and in the novel construction and the adaptation and combination of parts hereinafter described and claimed.

In the accompanying drawings:

FIGURE 1 is a side elevational view illustrating a fluid pump constructed to embody preferred teachings of the present invention, with the delivery hose shown fragmentarily. Also shown fragmentarily are the circulation lines leading to and from hydraulic motors which power each of the two ends of the pump's drive shaft.

FIG. 2 is a top plan view thereof.

FIG. 3 is a fragmentary transverse vertical sectional view on line 3—3 of FIG. 4 with the scale enlarged from that of FIGS. 1 and 2.

FIG. 4 is a fragmentary longitudinal vertical sectional view on the jogged section line 4—4 of FIG. 3.

FIG. 5 is a transverse vertical dead section on line 5—5 of FIG. 4.

FIG. 6 is a detail fragmentary sectional view drawn to an enlarged scale on line 6—6 of FIG. 3.

FIG. 7 is a detail fragmentary sectional view on line 7—7 of FIG. 1 and employing the same scale as that of FIGS. 3 and 4; and

FIG. 8 is a detail fragmentary sectional view on line 8—8 of FIG. 3 with the scale corresponding to that of FIG. 6.

Referring to said drawings, the housing in which the pump of the present invention operates is shown as a fabricated structure and is comprised of a cylindrical shell designated by the numeral **10** having headers **11** and **12** bolted thereto as closures for the ends. A cylindrical communicating case **13** is bolted to the external face of the header **11** in centered relation thereto. While not shown sealing gaskets are employed. The header **12** and the outer wall of such case are each centrally apertured to accommodate a live rotary shaft **14**.

Respective air-seals **15** surround the shaft within these apertures, which have a diameter somewhat larger than the shaft to permit a moderate degree of lateral deflection. External pressure-lubricated journal boxes **16** support the protruding ends of the shaft, each being carried for floating movement upon the free end of a respective arm **17** having its other end pivoted, as at **18** (FIG. 7), to the

header **12** or to the case **13** for swing motion about an offset axis paralleling the rotary axis of the shaft. Springs **20** yieldingly resist endwise motion of the shaft. A respective hydraulic motor **21** is fixed to each of the two journal boxes and has its rotor keyed or otherwise fixed to the respective end of the shaft. One of two hydraulic lines **22** for each of these motors is fed from a power-driven pump (not shown) common to both while the other line returns to an oil reservoir from which the oil pump draws its fluid.

Within the pump housing a pair of plates **23** are journaled in axially-spaced relation upon the drive shaft **14**. These plates serve as the carrier for two spindles **25** placed diametrically opposite one another. Ends of the spindles fit in slots **26** which are provided by the plates and admit of being set in radially adjusted positions by means of jam nuts working on screws **27**. The spindles function as dead axles and each has a respective planetary wheel **28** journaled for rotation thereon. Each planetary wheel has a wide band **30** of elastic rubber vulcanized as a tire thereto. Endless chains **31** trained about sets of sprocket wheels **32–33** drive the planetary wheels, one sprocket wheel of each set being fixed to the drive shaft and the other sprocket wheel being fixed to a respective one of the two planetary wheels.

Disposed tangent to a circle which has a diameter somewhat less than the inner wall of the cylindrical shell **10** and is projected about shaft **14** as a center, and occupying positions median to the width of the tires one above and the other below the horizontal plane of said shaft, the cylindrical shell is formed with outwardly pointing tubular snouts **35** and **36**. A flexible hose **37** is received through these snouts, having a loose slide fit therein, and within the housing seats upon an elastic pad **38**. Such pad is applied as a liner to the inner wall of the shell and is secured in place by the expedient of vulcanizing the pad to a backing plate **40** which is in turn bolted to the shell.

The hose end which lies at the bottom serves as the ingress for fluid pumpage, and within the shell the portion of the pad **38** which underlies such ingress end is substantially thickened, as at **41**, to appreciably augment the cushioning action. This I find to be extremely important in that hose damage, where coarse or unduly sharp rock is contained in aggregate of pumped concrete, is found to largely occur at this point.

The hose which I prefer to employ has a considerabl portion of its length protruding from the egress snout. On difficult pumpage, it is recommended that the hose be given an endwise shift of a foot or so after the pump has been in operation for several hours, advancing the egress end into its snout while withdrawing a corresponding length of the ingerss end to be cut off and discarded. Such ingress end is secured by a hose clamp **46** to the discharge nipple **42** of a supply hopper **43** which lies alongside the fluid pump. Elastic sleeves **44** are clamped to the snouts, and cuff-like prolongations of these sleeves invest the protruding hose and tightly grip the latter to form air-tight seals as a vacuum condition (produced by a vacuum pump hereinafter to be described) is created within the fluid pump. The hose is anchored within the pump housing by means of flexible saddling straps **45**, also hereinafter to be described. When it is desired to shift the hose these straps are loosened and the cuffs turned back upon the snouts.

It is desirable that the hydraulic motors be reversible, and this is readily accomplished by providing a suitable control valve in the hydraulic circuit.

Proceeding now to describe said straps the same occur at spaced intervals of the length of the housed section of hose and each has its two ends passed through wall slots

49 provided in the seating pad and its backing, and registering slots formed in the shell and in rubber facing pads 47 which are cemented to the external surface of the shell. Each such strap end has a terminal eye 48 extending longitudinal to the concerned slot. Pins 50 are removably inserted through these eyes with the ends projecting and bearing upon the facing pads at opposite ends of the slots. Recessed caps 51 fit over the facing pads, bearing upon the marginal edges of the latter, and are pressed inwardly to establish an air seal by means of respective hammers 52 leveraged against the caps by quick-release toggles 53.

Hand-holes 54 are provided in the header 12, giving access to the interior of the pump for purposes of inspection and feeding the strap ends into the slots. Covers 55 for these hand-holes have rubber sealing rings 56 upon their underside, and counterparts (not shown) of the leveraged hammers are provided for holding the covers in place.

The referred-to vacuum pump occupies the case 13. Such pump is comprised of a section of compressible hose 57 held in place by straps 58. One end 59 of the hose is open to the interior of the case and the other end 60 is exposed to the exterior atmosphere. An elastic cuff 61 invests said exposed end. Pneumatic tires 62 are mounted as planetary wheels upon a carrier 63 journaled for rotation upon the drive shaft 14. The drive shaft acts by friction to turn the planetary wheels, and the wheels responsively walk about the inner perimeter of the case, progressively squeezing the hose between the wheels and the case. The direction of orbital travel is reversed from that of the concrete pump but both are the same, functionally considered, in that the progress is from the ingress toward the egress end of the concerned hose.

Hose 57 perforce evacuates air from within the case and the housing as such air enters behind a wheel 62 and is forced by a following wheel from the egress end. This evacuation of air is continuous and of major importance to the functioning of the main pump, with the vacuum controlled by a valve 64 (FIG. 3) so as to lie in a range of 15 to 30 inches of mercury desirably. As each of the planetary wheels passes over the ingress end of the hose 37 it becomes necessary for the squeezed hose to expand in order to receive pumpage, and it is to insure this function that a continuous vacuum is maintained. Without vacuum, the pump in order to draw semi-fluids such as low-slump concrete, which creates extremely high friction losses in piping, would of necessity be forced to rely entirely upon elasticity or "memory" of the hose. To handle the type of pumpage for which the present invention is primarily engineered, vacuum is vital as is an absence of sharp corners or abrupt bends which deter free travel.

One of the several important features of the invention is that the drive from the shaft 14 to the hose-compressing wheels is planetary. In its preferred embodiment, as herein illustrated, the carrier floats (turns freely upon the drive shaft) while the drive shaft performs as a sun member in that it functions as the power agency for passing a direct positive reduction drive to the planetary wheels. The wheels "walk" by friction about the circumference of the hose and thus do not create any scuffing which is perforce objectionable from the standpoint of imposing axial thrust upon the hose, with a consequent fatigue problem, as well as causing unnecessary wear both upon the tires of the planetary wheels and upon the hose. The orbital speed of the spindles about the center of the drive shaft as an axis is slow by comparison with the shaft's rotion. This and the float mounting of the shaft journals is important from the standpoint of reducing radial thrust on the bearings. Passing the drive into the shaft 14 from both ends eliminates, to all practical purposes, torsional stress.

A feature of the invention is the referred-to reversibility of the pump by reversing the direction of rotation

of the drive shaft 14. This is significant for several reasons. Should it become necessary to remove any part of the hose, which for concrete pumping can be as much as 300′ in length, pressure on the hose can be relieved by reversing the pump. On an operation lifting concrete, for example, to a raised level, when all concrete needed is in place the concrete within the hose can be removed by reversing the pump. Also, even though the pump can handle concrete with oversize rock as long as such rock is scattered throughout the mix it may happen that several such rocks will enter the pump at the same time, in which event the hose may plug. These oversize rocks can be pumped back into the mixing hopper by reversing the pump, whereupon normal pumping can be resumed. With the hose freed from the straps 45, the cuffs turned back, and the ingress end of the hose disengaged from the hopper, power can be applied from the hydraulic motors to shift the hose in either endwise direction, selectively.

The ease with which access may be had to the interior of the pump, after first bleeding air by valve 64 into the vacuum chamber to create an atmospheric or near-atmospheric condition, and then quickly freeing and shifting the hose or performing other maintenance operations, will have been apparent from the foregoing description. It will be understood that the pump is in no sense limited to the pumping of concrete, being applicable to any fluid or semi-fluid or any properly sized solid suspended in a fluid or semi-fluid medium. Changes in the details of construction may be resorted to without departing from the spirit of the invention and it is accordingly my intention that no limitations be implied and that the hereto annexed claims be given the broadest interpretation to which the employed language fairly admits.

What I claim is:

1. In a fluid pump, in combination, an air-tight casing, a section of compressible hose contained therein, ingress and egress conduits for fluid pumpage received through openings in the wall of the casing and connecting with opposite ends of said hose section, and means including a power-driven rotor to perform the following operations in concert: (1) squeeze said hose section in repeating cycles starting at the ingress end and working progressively toward the egress end, and (2) continuously evacuate air from within the casing, the rotor being powered by companion hydraulic motors driven in unison by hydraulic fluid which is received from a common source of pressure supply and mounted so that one motor powers one end and the other motor powers the other end of the rotor.

2. A rotary fluid pump comprising, in combination, a stationary ring, a compressible hose extending about and bearing against the interior surface of said ring and within its circumferential span having two circumferentially spaced ports one serving as an ingress to and the other as an egress from the interior of the hose, a plate received for free rotation about the center of the ring as an axis, a power-driven rotor mounted for rotation about the center of the ring as an axis, means acting in complement with said rotor and the plate to produce a planetary drive in which the rotor operates as a sun member and the plate serves as a carrier, said complementing means comprising a planet wheel carried by the carrier for orbital travel about its own center as an axis, and at its outside bearing upon the hose so as to walk about the latter while at the same time compressing the hose and responsively producing a fluid pocket moving about the circumference of the ring progressively from the inlet port to the outlet port.

3. Structure according to claim 2 in which the ring is made a part of an air-tight housing and having means for drawing air from within the housing so that the hose and planetary drive are enveloped in a low-pressure atmosphere.

4. Structure according to claim 3, the pressure condition being maintained at a predetermined constant between 15 and 30 inches of mercury.

5. Structure according to claim 2 having an air-tight casing in which the hose and planetary drive are housed, and having a hand-hole in the casing fitted with a quick-opening cover to give access to the interior of the casing.

6. Structure according to claim 2 in which an elastic tire rims the planet wheel to bear upon and compress the hose.

7. Structure according to claim 2, two of said planet wheels being provided placed diametrically opposite one another.

8. In a fluid pump, in combination, an air-tight casing providing an arcuate internal wall, bearings arranged to occupy co-axial positions at each of the two ends of the casing in positions generally concentric to the center about which the arc of said internal wall is developed and each supported from the casing in a manner which permits the bearing to float, a length of compressible hose bearing upon said wall, ingress and egress conduits for fluid pumpage attached to the opposite ends of said hose, means for evacuating air from within the casing, means mounted for orbital travel about the center on which said arcuate wall is developed and operating in repeating cycles for squeezing said hose starting at the ingress end and working progressively toward the egress end, and power means including a rotor journaled for rotation in said bearings for moving said squeezing means in its said orbital travel.

9. A pump according to claim 8 in which the squeezing means comprises a tire bearing upon the hose and caused to walk circumferentially thereof, the tire being carried upon the rim of a positively driven wheel and relying upon frictional engagement with the hose for its walking travel.

10. Structure according to claim 8 having a pad extending as a liner about said wall between the wall and the hose, said pad and the squeezing means being each elastic, and wherein the thickness of said pad is substantial at least in the portion thereof which underlies the ingress end of the hose.

11. In a fluid pump, in combination, an air-tight casing providing an arcuate internal wall, a length of compressible hose bearing upon said wall, ingress and egress conduits for fluid pumpage attached to the opposite ends of said hose, means for evacuating air from within the casing, means mounted for orbital travel about the center on which said arcuate wall is developed and operating in repeating cycles for squeezing said hose starting at the ingress end and working progressively toward the egress end, power means for moving said squeezing means in its said orbital travel, and flexible straps saddling the hose to secure the hose in place upon the wall, the wall of the casing providing respective slots through which at least one end of each strap is received, means being provided accessible from the exterior of the casing for detachably anchoring said strap end.

12. A pump according to claim 11 having a removable cap covering said anchoring means and formed so as to seal the slot against access of air.

13. In a fluid pump, in combination, an air-tight casing providing an arcuate internal wall, a length of compressible hose bearing upon said wall, ingress and egress conduits for fluid pumpage attached to the opposite ends of said hose, means for evacuating air from within the casing, means mounted for orbital travel about the center on which said arcuate wall is developed and operating in repeating cycles for squeezing said hose starting at the ingress end and working progressively toward the egress end, power means for moving said squeezing means in its said orbital travel, the squeezing means comprising a tire bearing upon the hose and caused to walk circumferentially thereof, the tire being carried upon the rim of a positively driven wheel and relying upon frictional engagement with the hose for its walking travel, and means for detachably anchoring the hose in its operating position bearing upon the wall, the power means being reversible to permit the hose to be shifted in either endwise direction, selectively, by freeing the hose from the wall and so energizing the power means that the tire is turned in a rotary direction corresponding to the direction in which it is desired to shift the hose.

14. In a fluid pump, in combination, an air-tight casing providing an internal wall, a length of compressible hose bearing upon said wall, ingress and egress conduits for fluid pumpage attached to the opposite ends of said hose, means for evacuating air from within the casing, means operating in repeating cycles for squeezing said hose starting at the ingress end and travelling progressively toward the egress end, power means for moving said squeezing means in its said travel, and means for detachably anchoring the hose in said position bearing upon the wall, said travel of the squeezing means exerting upon the hose a force which would shift the hose in an endwise direction in the absence of said anchor.

15. In a machine for pumping a fluid containing a non-compressible aggregate, in combination, an air-tight casing providing an internal wall, a length of compressible hose bearing upon said wall, two openings in said wall spaced circumferentially thereof and through which opposite ends of the hose project, one of said ends serving as a point of ingress at which fluid to be pumped enters said length of hose, the other end serving as a point of egress at which pumped fluid is expelled from said length of hose, means for evacuating air from within the casing, means operating in repeating cycles for squeezing said hose starting at a point thereon closely adjacent to said point of ingress and travelling progressively toward the point of egress for pumping fluid from the point of ingress to the point of egress, and a reversible motor operatively connected with the squeezing means for powering said squeezing means in its pumping travel, said motor when reversed causing the squeezing means to reverse direction and thereby return to the point of ingress hose-plugging aggregate which has been carried into the hose with the fluid being pumped.

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