

March 28, 1967

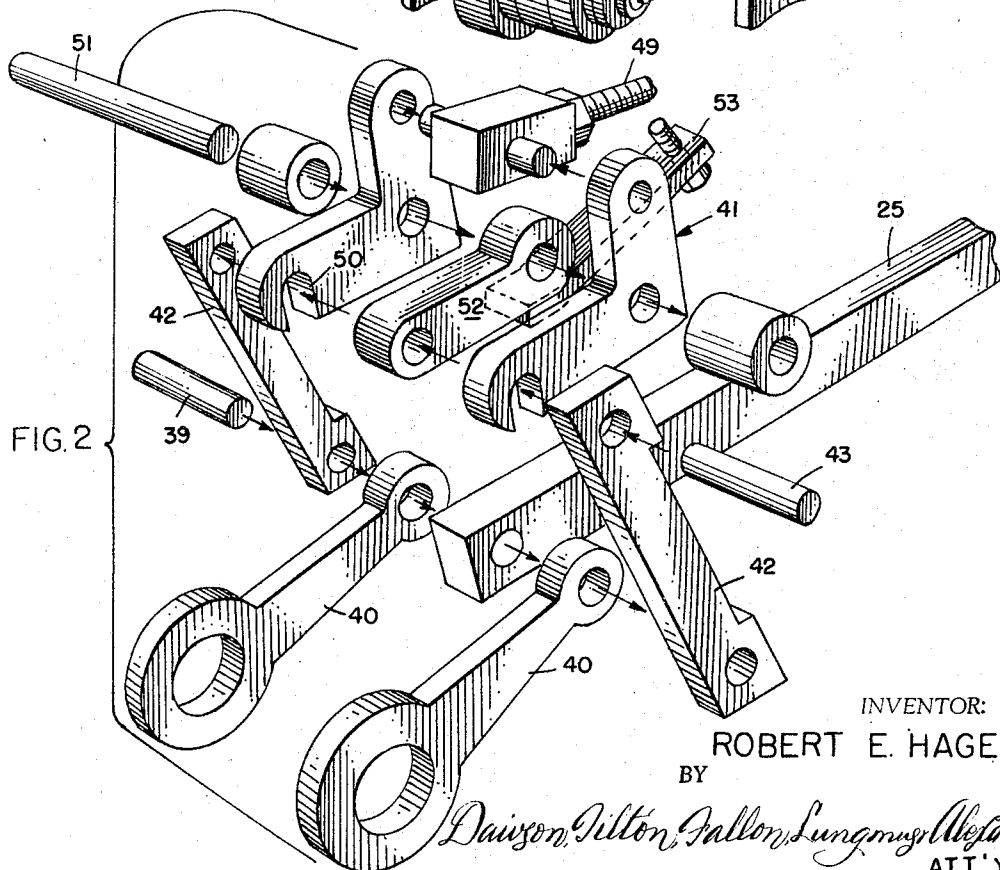
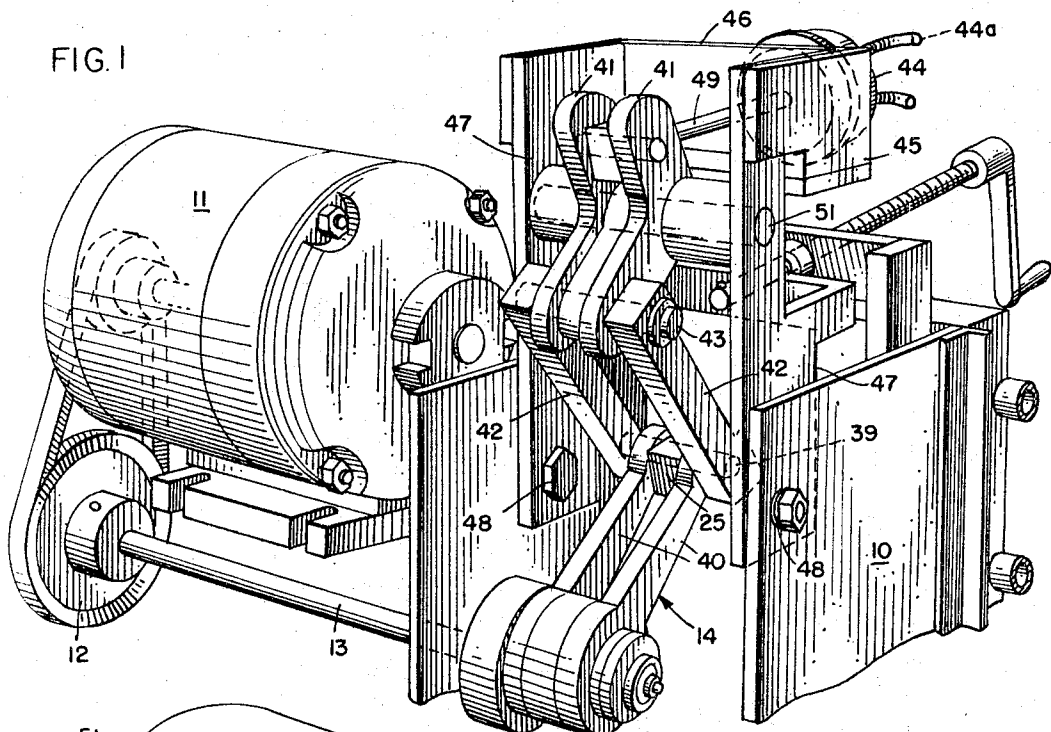
R. E. HAGER

3,311,065

PUMPING APPARATUS

Filed Oct. 15, 1964

3 Sheets-Sheet 1



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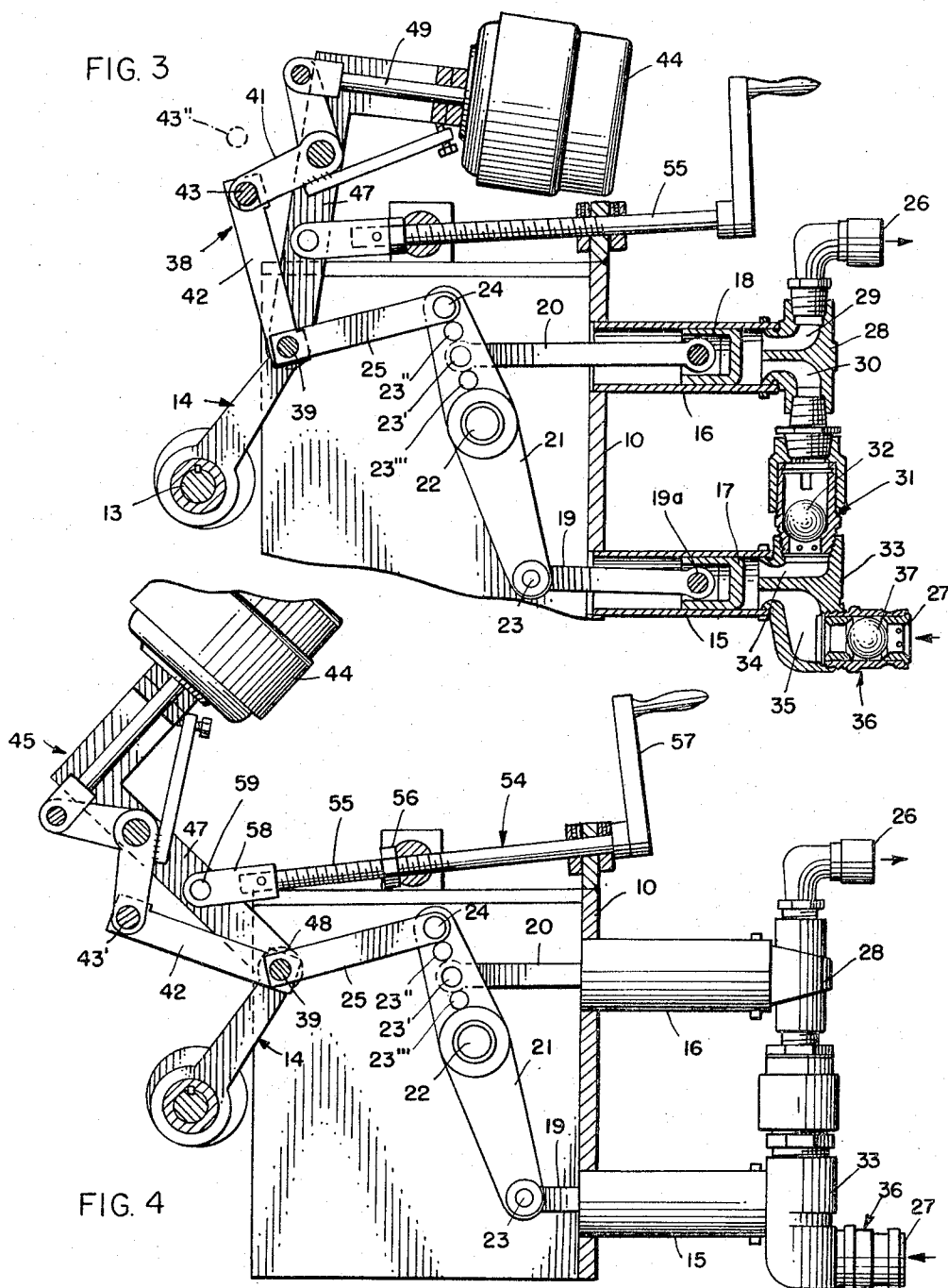
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

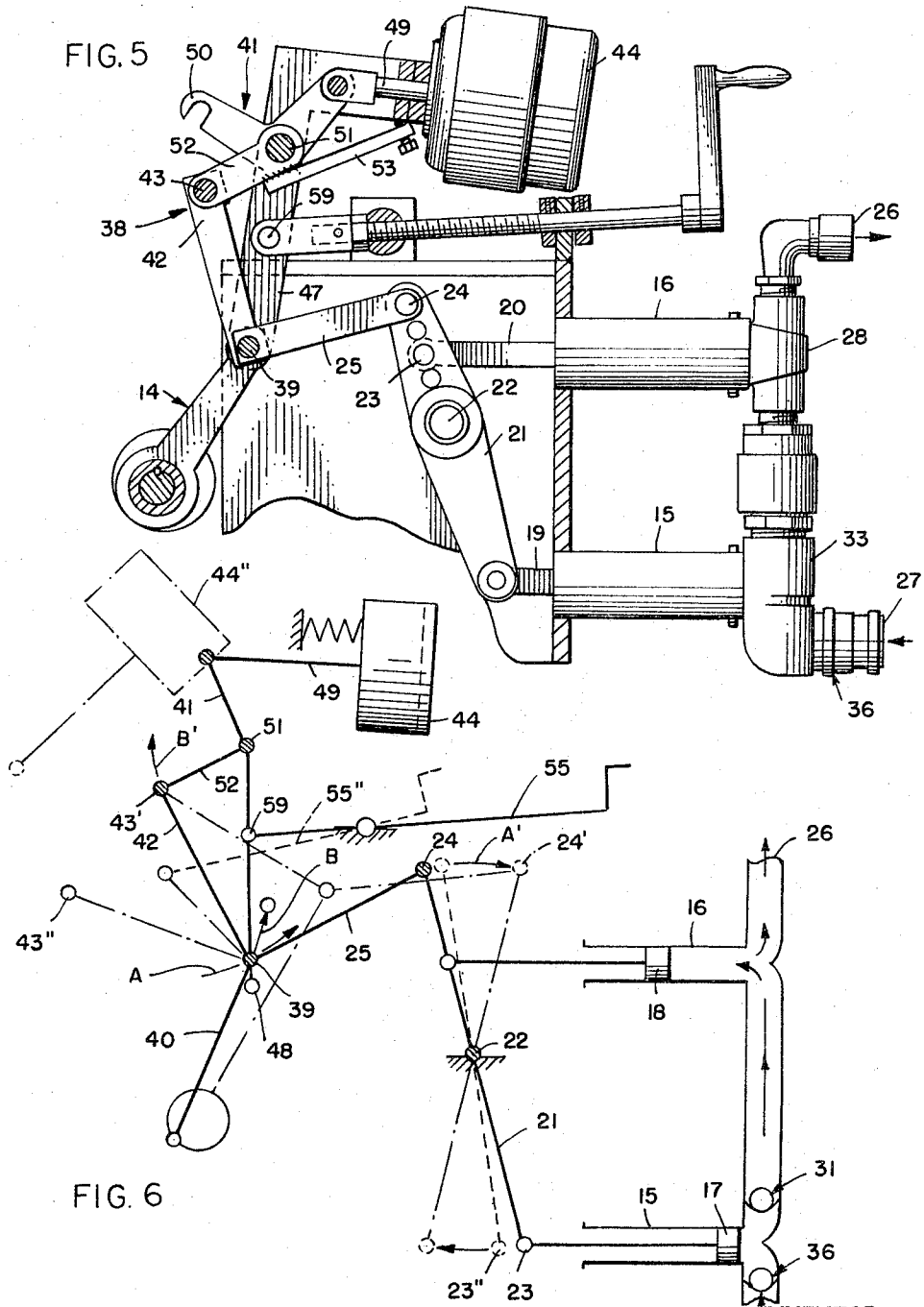


FIG. 6

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3,311,065

**PUMPING APPARATUS**

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1 Claim. (Cl. 103—167)

This invention relates to pumping apparatus and, more particularly, to apparatus particularly adapted to pump plaster.

In the pumping of plaster, it is important that close control of the pumped volume be maintained. This is particularly true of thin coat plastering, i.e., plaster layers of the order of about  $\frac{1}{16}$  of an inch. The importance of volume control can be appreciated from the fact that in many instances accelerator (to decrease the set time) is added to the pumped stream. Thus, by varying the volume of the plaster being pumped per unit time or the amount of accelerator added, it is possible to adjust the set time of the plaster on the wall. With a mechanical machine, this can be done by a three or four speed gear transmission with variable speed belts, but such are quite costly and not convenient or accurate in adjusting for a predetermined volume. In the past, however, other types of machines for this purpose have not proven reliable, and it is therefore an important object of this invention to provide a machine which is uniquely adapted for plaster pumping wherein the volume being pumped per unit of time can be varied quickly and simply.

Another object of the invention is to provide a pumping apparatus wherein the volume being pumped is changed by altering the length of the stroke in a discharge cylinder but not changing the actual clearance volume. The clearance volume in a pump can be defined as that volume between the end of the piston and the discharge valve which remains in this cavity when the piston retracts to pull in a new load. If the plaster in the clearance volume contains air, and all plasters do to some extent, when the piston starts back, the air in the plaster expands and no new material is drawn from the hopper into the cylinder until the air in the plaster is expanded to below atmospheric pressure. This, of course, introduces an objectionable variable into the operation of the machine. In the inventive machine, the arrangement is such that the pumping piston always comes to the same place in the forward stroke to obtain minimum clearance volume, regardless of the length of the stroke.

Still another object of the invention is to provide a novel pressure-limiting device in pumping apparatus. In any mechanical machine used for pumping plaster or similar fluidized solids, a pressure-limiting device is essential. In the past, where belt drives have been used, slippage has been intentionally introduced to perform this function. In other cases, a centrifugal clutch is employed. In the case of a high pressure or a stopped hose, clutch linings burn out.

For example, when a gasoline engine or an electric motor is used to drive a mechanical pump, there is always a speed reduction. An electric motor may be 1800 or 3600 r.p.m.; gasoline engines normally run from 2400 to 2800 r.p.m., while the maximum speed of the pump might be 150 to 200 r.p.m. One can obtain high pressure protection of sorts by slipping a centrifugal clutch, by allowing a belt to slip, or by using a torque plate which will slip at a certain torque. However, all of this protection depends upon torque and torque can vary with pressure. Assume a speed reduction between engine and pump of 6 to 1 and assume that the belt or other torque limiting device will slip at 500 p.s.i., then if speed reduction is changed either by a variable pitch pulley or by

a gear shift lever to 18 to 1, the pressure would be 1500 p.s.i. before the belt would slip at the same torque.

In the inventive mechanism, there is a direct ratio between the outlet pressure of the pump and the force placed on the clutching device, and this ratio remains substantially the same irrespective of the length of the stroke. Therefore, by using a pressure regulator to hold a determined pressure on the clutching or coupling device, the inventive machine can limit very accurately the maximum pressure that the pump will deliver. Therefore, yet another object of the invention is to provide a novel clutching or coupling device for a plaster pump, or the like, wherein air pressure is employed to maintain the machine in operation but wherein relief is conveniently obtained when maximum allowable pressure is exceeded.

A further object is to provide a unique on-off control for a pump, more particularly by employing air pressure for engaging a latch type coupling or clutch. In the inventive construction, compressed air is used for this purpose as well as for introducing accelerator into the plaster stream. The air line from the air control circuit is run to the nozzle and by opening and closing the valve on this line at the nozzle, pumping action can be started or stopped by putting pressure on the air clutch cylinder or by removing pressure from the air clutch cylinder.

Other objects and advantages of the invention may be seen in the details of construction and operation set down in this specification.

The invention is explained in conjunction with an illustrative embodiment in the accompanying drawing, in which:

FIG. 1 is a fragmentary perspective view of pumping apparatus constructed according to the teachings of this invention;

FIG. 2 is an enlarged perspective view of a portion of the apparatus of FIG. 1—more particularly, the clutching and pressure-limiting component;

FIG. 3 is a fragmentary sectional view of the apparatus of FIG. 1 showing the clutching mechanism in a condition to deliver a maximum volume of plaster;

FIG. 4 is a view similar to FIG. 3 (being a fragmentary sectional view of the apparatus), but with the clutching mechanism arranged to deliver minimum volume;

FIG. 5 is again a view similar to FIGS. 3 and 4 but in which the clutching mechanism is unlatched so that operation of the prime mover results in lost motion and no pumping of plaster; and

FIG. 6 is a diagrammatic view of the various linkages employed in the inventive machine.

Referring now to FIG. 1, the numeral 10 designates a frame for the apparatus and which supports a motor 11—this being the prime mover previously referred to. The motor 11 is equipped with a V-belt drive 12 for rotating a shaft 13 suitably journaled in the frame 10. At one end, the shaft 13 carries a crank or orbiting member generally designated 14, and the function of which can be appreciated better from a consideration of FIG. 3.

Referring now to FIG. 3, the numerals 13 and 14 again designate the drive shaft and crank, respectively. The function of the crank is to discharge plaster from cylinders 15 and 16 (see the right hand portion of FIG. 3). The cylinders 15 and 16 are rigidly mounted on the frame 10, and it will be seen that the main or pumping cylinder 15 slidably carries a piston 17, while the accumulator cylinder 16 carries a piston 18.

Motive power to the piston 17 is delivered by means of a piston or connecting rod 19 secured to the piston 17 in pivotal fashion by means of a wrist pin 19a. In like fashion, the piston 18 is driven through the piston rod 20. Tandem operation (i.e., push-pull) of the pistons 17 and 18 is achieved through a first linkage means con-

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sisting of a lever 21. The lever 21 is rotatably fixed to the frame 10 by means of a shaft 22, and the piston rods 19 and 20 are pivotably connected to the lever 21 as at 23 and 23' respectively. Completing the connection between the crank 14 and the lever 21 is a link 25.

In operation, as the shaft 13 rotates, the crank 14 oscillates or reciprocates, imparting a similar motion to the link 25. This oscillates the lever 21 about the shaft 22 and alternately pushes and pulls the pistons 17 and 18.

The numeral 26 in the upper right-hand corner of FIG. 3 designates the fluid plaster stream outlet from the apparatus, while at the lower right-hand portion of the view the numeral 27 designates the fluid plaster intake—as from a reservoir (not shown). The apparatus in FIG. 3 is shown in condition for the "accumulator" cylinder 16 to discharge plaster through the outlet 26. As the piston 18 is moved to the right, the plaster stream encounters a branch fitting 28 having passages 29 and 30. Flow of plaster through the passage 30 is restricted by virtue of a check valve fitting generally designated 31 and which includes a ball 32. Thus, movement to the right of the piston 18 results in discharge of plaster through the outlet fitting 26.

At the same time that the piston 18 is moving to the right, the piston 17 is being retracted, i.e., being moved to the left, for intake of plaster into the cylinder 15. To achieve this function, the work end of the cylinder 15 is equipped with a branch fitting 33 providing passages 34 and 35. Plaster is permitted to flow through the passage 35 by virtue of the check valve fitting generally designated 36 and which includes a ball valve element 37. No plaster is taken from the passage 30 during left work movement of the piston 17 because of the check valve 31.

To complete the cycle of operation—when the lever 21 is returning to the position shown and the piston 17 moves to the right—the check valve 36 is closed while the check valve 31 is open. Thus, plaster from the cylinder 15 is forced past the check valve 31 through the passage 30 and into the cylinder 16. This results in loading the cylinder 16, with the excess plaster being forced out of the outlet 26. The piston 18 has a stroke approximately four-tenths that of piston 17, and thus serves to accumulate a portion of the discharge from the cylinder 15 for discharge of plaster when the cylinder 15 is being loaded.

It will be appreciated that the upper cylinder 16 operates at line pressure while the lower cylinder takes in plaster at atmospheric pressure. Since the plaster is a compressible material—say of the order of 20% compressible, to deliver through outlet 26 one-half the plaster from cylinder 15, the stroke of the cylinder 16 is adapted to take in one-half of the compressed volume of the plaster in cylinder 15. Cylinder 15 therefore only develops line pressure when the entrained gases are compressed to line pressure.

If, for example, the compressibility of the material taken into the cylinder 15 is of the order of 50%, then the stroke of piston 18 is set at about one fourth of the stroke of the piston 17. When the material is incompressible, the stroke of piston 18 is set at one half of that of piston 17. This is achieved by relocating the fulcrum point 23' to the position 23'' while a shorter stroke is obtained by relocating the fulcrum point to 23'''.

To achieve the operation of the linkages heretofore described, clutching means generally designated 38 (see FIG. 3) are provided. The clutching mechanism serves to confine the pivot shaft 39 (still referring to FIG. 3) against substantial vertical movement (in the orientation shown). The pivot shaft 39 interconnects the crank 14 (more properly, the connecting rods 40, see FIGS. 1 and 2, of the crank 14) with the link 25. Here, it will be appreciated that if the pivot point 39 moves in essentially a vertical path, there will be substantially no force applied to the pivot point 24 on the link 21.

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Further, there is considerable inertia in the cylinders 17 and 18, so that should the pivot shaft 39 be permitted to move essentially vertically, there will be no movement of the link 21 about the shaft 22. The means for confining the pivot shaft 39 to generally horizontal movement is provided in the form of idler cranks generally designated 41 (see the upper left-hand corner of FIG. 5).

In the condition of the apparatus shown in FIG. 5, the clutching mechanism 38 is "unlatched," so that movement of the crank 14 will not result in movement of the pistons 17 and 18. In the condition seen in FIG. 3, the clutching mechanism is latched, and rotation of the shaft 13 results in reciprocation of the pistons 17 and 18.

The precise means for confining or releasing the pivot shaft 39 can be seen in FIGS. 1 and 2, wherein the shaft 39 is constrained by means of a pair of clutch links each designated 42 and which also are pivotally connected at their lower ends to the shaft 39, the links 42 and 25 constituting a second linkage means coacting with the first linkage means (the lever 21) in delivering power from the crank 14 to the pistons 17 and 18. At their upper ends, the clutch links 42 are connected by means of a horizontally-extending shaft 43 which is engaged in the FIG. 3 showing by the clutch idler cranks 41.

The latching or unlatching of the clutch idler cranks 41 is achieved through an air cylinder 44 supported within a superstructure generally designated 45, not a part of frame. The superstructure 45 is seen to be essentially L-shaped, including a cylinder-supporting section 46 and depending legs 47. The legs 47 are pivotally supported on the main frame 10 as by bolts 48 (shown only in FIG. 1).

The cylinder 44 is equipped with an extensible piston rod 49 which may be retracted from the FIG. 3 showing to the FIG. 5 showing, whereupon the clutch idler cranks 41 are pivoted so as to disengage the slot 50 (designated only in FIGS. 2 and 5) from the shaft 43.

With the clutch cylinder 44 in the FIG. 5 condition (unlatched), and when the crank 14 is rotated, this movement moves the connecting rod portion 40 of the crank 14 generally vertically, causing the pivot rod 39 to pivot essentially about the pivot 24. This causes generally vertical movement of the clutch link 42 and the upper end of the clutch links 42 and the shaft 43 moves about the axis of the rod 51 (see particularly FIG. 2). Interconnecting the shafts 43 and 51 is an idler link 52 which is supported on the superstructure 45 by means of a bar 53. When the apparatus is in this condition, there will be no motion of the lever 21, and with no motion of the pistons 17 and 18, no fluid will be pumped and the pump will be in the "Off" position.

It is believed that an understanding of the mechanical linkages just described will be facilitated by elucidation of the same relative to a diagrammatic view, and the following is that, with reference to FIG. 6.

As shown in the diagram, the clutch cylinder 44 is in a position with the machine engaged, that is, air pressure on the clutch cylinder. The clutch cylinder piston rod 49 is coupled to the clutch idler cranks 41 and holds the idler link 52 in contact with the stop bar 53 so that the clutch links 42 are pivoted about shaft 43.

When the crank 14 is rotated, the crank rods 40 (being connected to links 42 and link 25 at shaft 39) will be forced to move in an arc A about the shaft 43, thus moving the link 25 generally horizontally—so that the right-hand end of link 25 moves from the position 24 through the arc A' to the heavy chain line position designated 24'.

This causes the lever 21 to oscillate about its pivot point 22, and has the effect of reciprocating the pistons 17 and 18, moving the piston 17 to the left by virtue of moving the pivot 23 to the left will draw a fluid material through the inlet valve 36. While the piston 17 is moving to the left, and drawing in a supply of fluid material, the piston 18 is moving to the right, pumping fluid material

5 into the supply line (outlet 26), the outlet check valve 31 being closed.

When the clutch cylinder 44 has its piston in the retracted position (see FIG. 5), the clutch cylinder piston rod 49 holds the end of the clutch idler cranks 41 so as to position the slot 50 as shown in FIG. 5. This allows the idler link 52 free pivotal movement about the shaft 51. When the crank 14 is rotated, this movement moves the connecting rod portions 40 of the crank 14, and causes the shaft 39 to pivot about the shaft 24, i.e., through the arc B. Further, this causes a generally vertical movement of links 42, causing the upper ends of the links 42 (at shaft 43) to pivot around the shaft 51. This causes the end of the idler arm 52 to oscillate in a generally vertical arc B' and there will be no motion of the lever 21 under this condition.

#### ON-OFF CONTROL

The On-Off condition can also be appreciated from a consideration of FIG. 2. When the machine is "On," i.e., pumping, there is generally horizontal movement of the link 25. This stems from the fact that the clutch idler cranks 41 constrain the shaft 43 against vertical movement. Therefore, the movement of the cranks 40 produces a pivot action of links 42 and shaft 39 about the shaft 43.

In the "Off" condition, the shaft 43 is not constrained but is coupled by means of the idler arm 52 to the shaft 51 so that movement of the cranks 40 develops a pivoting motion around the shaft 51.

Switching from one condition to the other, i.e., from "Off" to "On," is achieved simply by extending the piston rod 49, causing the clutch idler cranks 41 to pivot about the shaft 51. This results in engagement of shaft 43 which is coupled to the shaft 51 by means of the idler link 52. The idler link 52 and the clutch idler cranks 41 being journaled on the same shaft insure quick and positive engagement of the system when pressure is applied to the cylinder 44—as through the line 44a (see FIG. 1).

#### OVERLOAD RELEASE

By the same token, an overload feature is provided automatically, since the air pressure within the cylinder 44 can be mechanically overcome should the pistons 16 and 17 be unable to move—as, for example, where the outlet line 26 is blocked. Thus, there is no possibility of rupture of clutches, wearing of clutch plates, and more particularly bursting a hose.

It is impractical to use a hose with a burst pressure rating higher than the maximum pressure that might be developed by a pump where the pump has no pressure limiting device. If the pump is being operated at very low speeds by means of a greater speed reduction between the engine or motor and the pump, tremendous pressures can be developed and, in addition, there is the force of momentum of the engines, gears, pulleys, etc., that could develop a higher instantaneous pressure than might be developed continuously because of torque limitations of the motor or engine. A hose that would stand all of this pressure would not only be costly but it would be very heavy and unwieldy and almost impossible to use as a portable conveying device. Therefore, all manufacturers must use a hose that can be ruptured by the pressure a pump will develop. The consideration in bursting a hose is not the cost of the hose but the lost time or the danger to personnel involved.

In operation, the adjustment of the air pressure applied to the clutch cylinder 44 controls the amount of force applied to the clutch idler cranks 41 holding the clutch idler link 52 in operating position. The machine ordinarily allows a hose pressure (at the outlet 26) of 500 p.s.i. when the air pressure is set at 70 p.s.i. The reduction in the air pressure from 70 p.s.i. downward reduces the allowable hose pressure to something less than 500 p.s.i. to a point where the clutch will not engage. 500 p.s.i. is taken as a reasonable limit for commercially

6 available hose. Thus, if the force required to move either of the pistons is such that the force restraining the links 42 at the axis of the shaft 43 were less than the required force for moving the pistons, then the link 25 is caused to rotate about the axis of the pivot 24 and the end of the links 42 would move the idler arm 52 from the point designated 43 in FIG. 3 to the point designated 43". This compresses the air in the clutch cylinder 44 so that the upper ends of the crank idler arms 41 would retract.

#### VOLUME CONTROL

The mechanism illustrated in conjunction with the clutching means permits variation of the stroke length to control volume. In this connection, it will be appreciated that the stroke variation is such as to always start the piston 16 from the discharge end of the pumping cylinder 15, whereby the actual clearance volume remains unchanged. The mechanism for achieving control over the length of the stroke includes a screw mechanism (now referring to FIG. 4) which is generally designated 54 and which is seen to include a threaded shaft 55 mounted on the frame 10 by virtue of a nut 56 weldably secured to the frame 10. The upper end of the threaded shaft 55 is equipped with a handle as at 57 for ease in turning the same. The lower end of the threaded rod 55 is equipped with a clevis 58 which engages one of the arms 47 of the superstructure 45 as at 59. Comparison of FIGS. 3 and 4 reveals that extension of the threaded rod 55 (movement of the clevis 58 to the left) results in pivoting the superstructure 45 about the point 48. Now when the crank 14 is rotated, clutch links 42 are rotated again about the shaft 43, but in a much lower position as at 43' in FIG. 4. This means that the end of the link 25 is given a very short oscillation.

In FIG. 6, the "short stroke" operation can be appreciated from the light dashed line showing. For example, the pumping piston 17 moves only from the point designated 23 to the point designated 23". This is achieved by moving the threaded shaft 55 from the solid line showing so designated to the dotted line showing designated 55". This moves the cylinder 44 to the position 44" and the pivot shaft 43 to the position designated 43'. Thus, although the pivot shaft 39 still pivots around the pivot shaft 43, there is much less of a horizontal component due to the fact that the pivot shaft 43 has now moved to the position 43'.

While in the foregoing specification a detailed description of an embodiment of the invention has been set down for the purpose of explanation, many variations in the details herein given may be made by those skilled in the art without departing from the spirit and scope of the invention.

I claim:

In a mechanism for operating tandem cylinders, a frame, a pair of cylinders mounted on said frame, first linkage means pivotally mounted on said frame and coupling said cylinders for tandem operation, crank means rotatably mounted on said frame, second linkage means coupling said crank means and first linkage means, and clutch means releasably and adjustably fixing said second linkage means, said clutch means including a superstructure pivotally secured to said frame, a first pivot rod mounted on said superstructure, an idler link pivotally mounted on said first rod, a second rod constituting said pivot and carried by said idler link and floatingly related to said superstructure, and a clutch link connecting said second rod, and means for immobilizing said second rod relative to said superstructure.

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