United States Patent

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[72] Inventor Karl Schlecht
Bernhausen, Germany

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[73] Assignee Putzmeister G.m.b.H.
Chur, Switzerland
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[54] SLURRY PUMP ARRANGEMENT
13 Claims, 5 Drawing Figs.

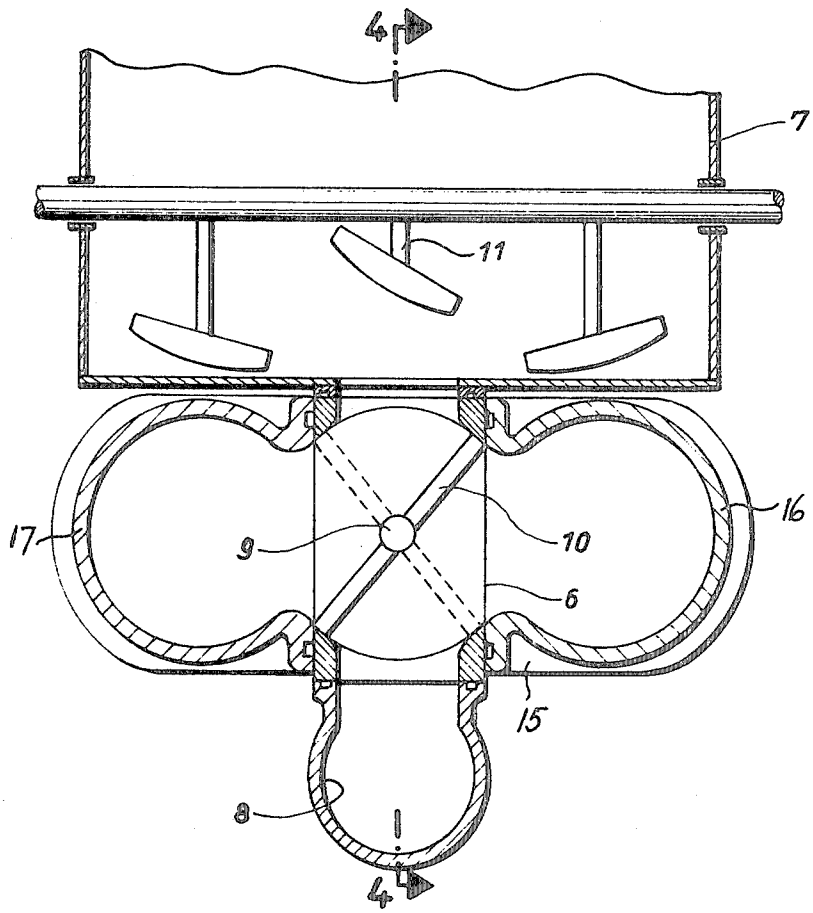
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[51] Int. Cl. F04b 7/00
[50] Field of Search ..... 103/227, 227 (C), 49, 153 (C), 170; 447/532, 900

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Primary Examiner—Robert M. Walker
Attorney—Kelman and Berman

ABSTRACT: A reciprocating duplex slurry pump is equipped with a four-way valve for alternatingly feeding concrete mixture to two cylinders arranged in a common horizontal plane whose pistons operate in phase opposition, and for discharging the mixture under pressure. The valve housing which connects the open front ends of the cylinders includes a central valve body connected with the cylinder ends by pivotally mounted wide and short elbows. Concrete mixture enters the valve body from above and is discharged downwardly as directed by a valve plate pivotally mounted in the valve body. The valve arrangement permits the pump elements to be mounted closely adjacent each other to shorten the path of concrete mixture and to minimize clogging by hardening concrete.



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SHEET 1 OF 3

Fig. 1

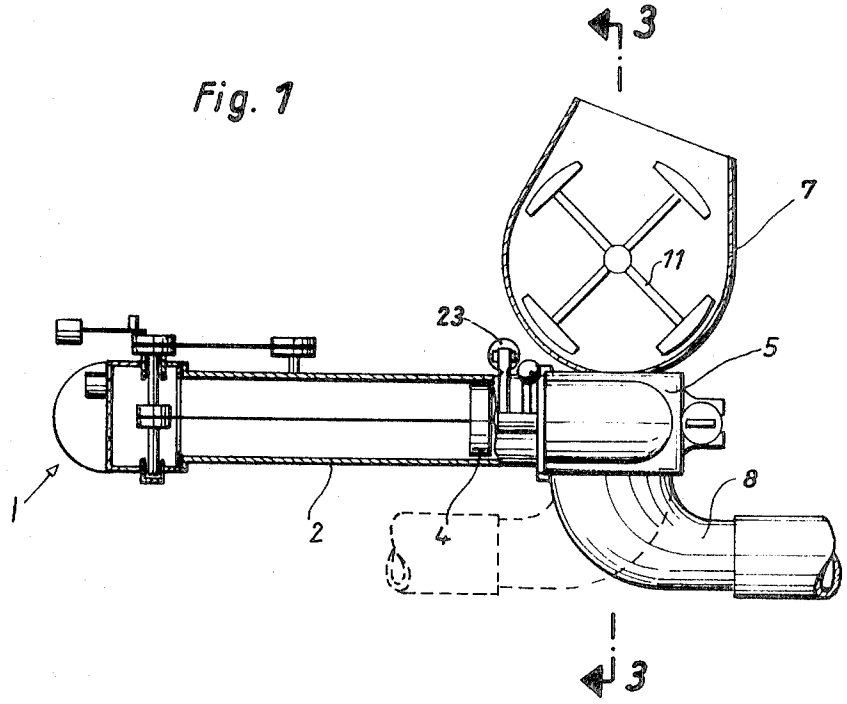
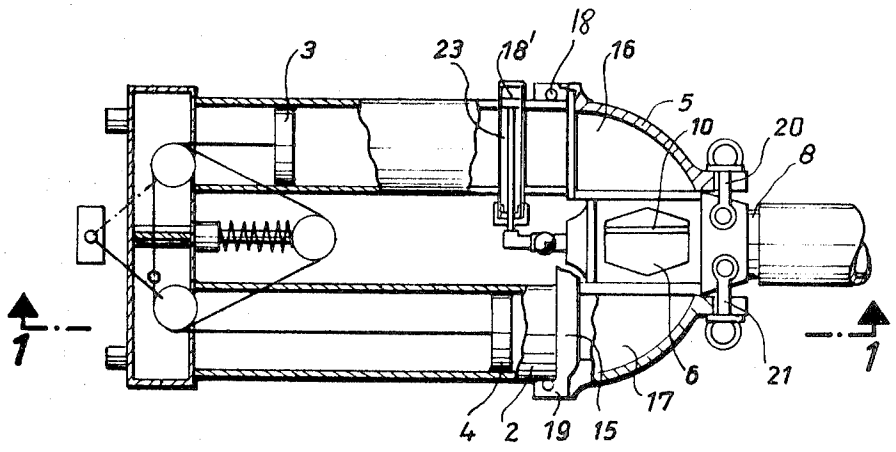


Fig. 2



Inventor:
Karl Schlecht
By: Kelman and Berman
AGENTS

Fig. 4

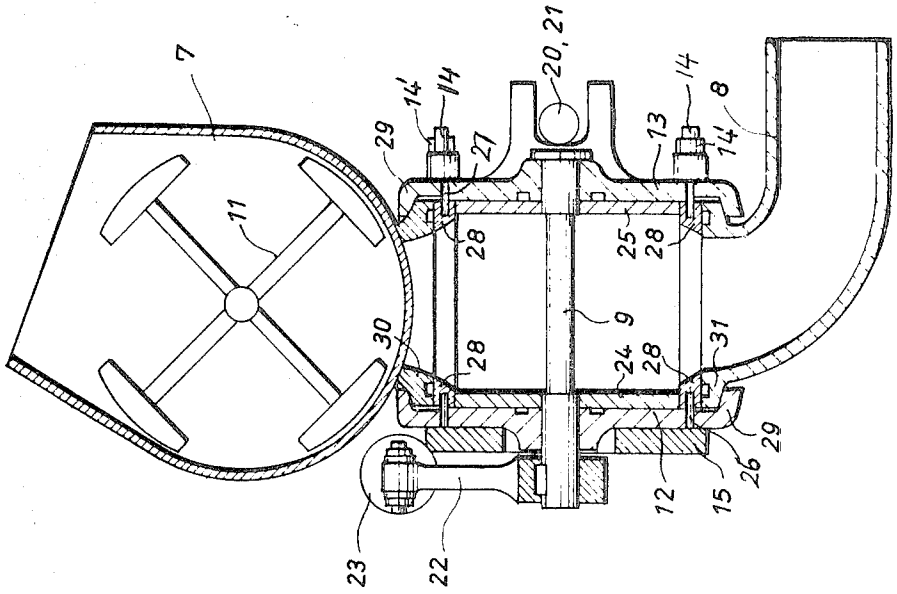
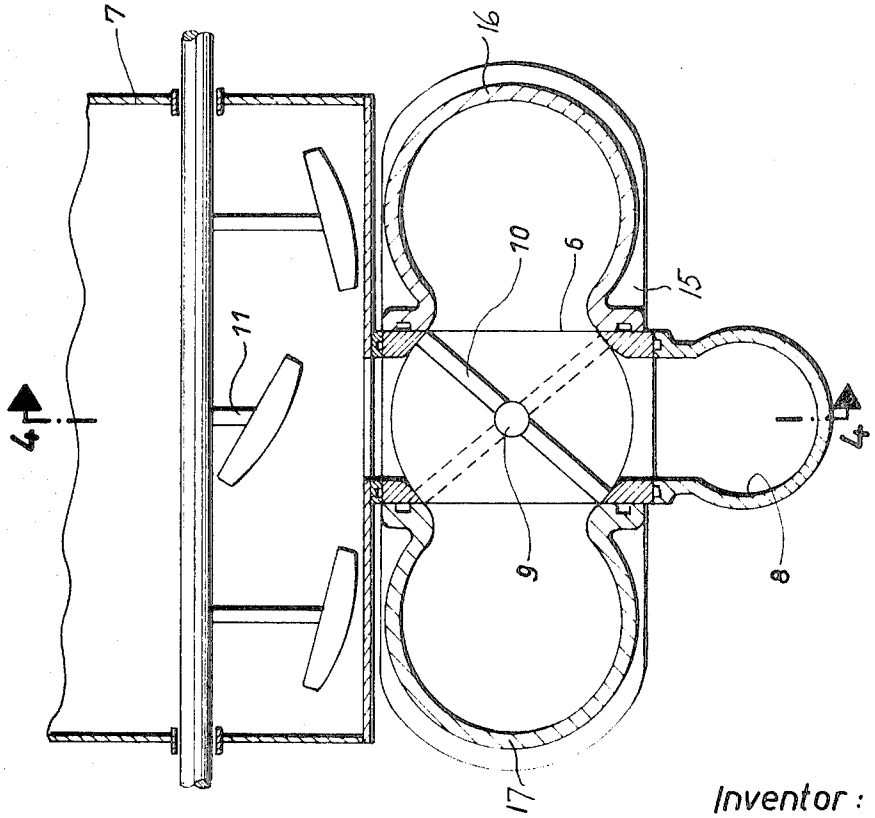
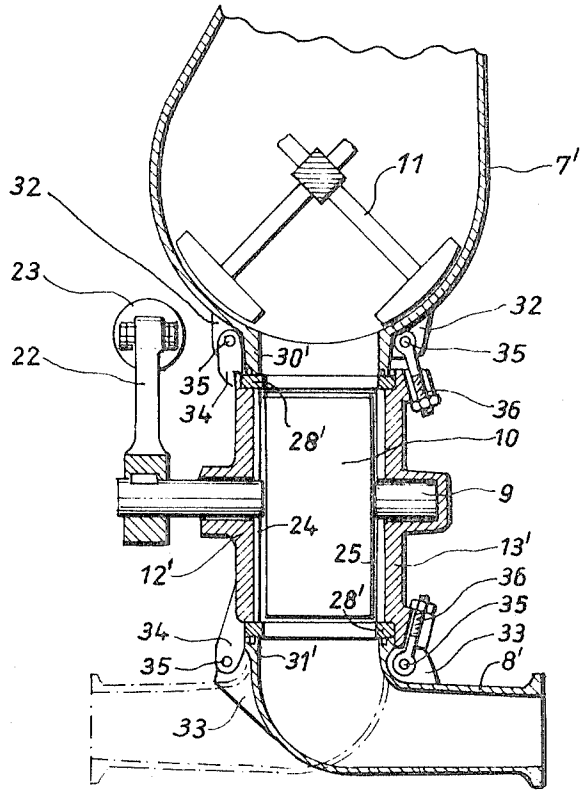


Fig. 3



Inventor:
Karl Schlecht
By: Kilman and Berman
AGENTS

Fig. 5



Inventor:
Karl Schlecht
By: Kelman and Berman
AGENTS

SLURRY PUMP ARRANGEMENT

BACKGROUND OF THE INVENTION

This invention relates to slurry pumps, and more specifically to an improved valve arrangement for a reciprocating duplex slurry pump of a basically known type.

Pumps of the type referred to have two cylinders whose pistons are driven in phase opposition so that one performs a suction stroke while the other piston expels material from the associated cylinder under pressure. A four-way valve alternatingly connects the cylinders with an intake for receiving the material to be pumped and with a discharge arrangement in the necessary timed sequence. A practically continuous stream of slurry enters the pump through the valve, and another, practically continuous stream is discharged from the valve under pressure. Such pumps are used for transferring a fluid concrete mixture from a mixing bin to a pressure line leading to an area in which the mixture is poured or to intermediate transporting vessels.

The known pumps are equipped with valves which are rather bulky and arranged in such a manner as to require relatively long and complexly shaped connecting conduits between the mixing bin and the valve intake, between the valve and the cylinders, and between the valve outlet and the pressure line.

Because of the length and configuration of the path traveled by the pumped material within the pump proper and the associated valve, clogging of the known pumps is a common problem, and becomes particularly serious when unskilled operators are used, as is often unavoidable. When the known pumps become clogged, they are not readily cleaned, and need to be disassembled and disconnected from the intake and discharge lines. The time lost during cleaning is a significant factor in the operating cost of the known concrete pumps.

It is an object of the invention to provide a slurry pump of the type described with a four-way valve constructed in such a manner as to permit close coupling of the several pump elements and of the pump elements to the mixing and storage bin from which the material to be pumped is fed. More specifically, the invention aims at shortening and widening the path of the concrete mixture through the valve, and between the valve and the associated intake, discharge, and cylinders of the pump.

With these and other objects in view, the invention, in one of its specific aspects, provides a reciprocating duplex slurry pump with a valve body having four openings, one of the openings being directed upwardly and communicating with the pump intake, the other three openings respectively communicating with the pump discharge and the front ends of the pump cylinders. The valve body is a portion of the valve housing which connects the front ends of the cylinders and encloses a shaft which may turn about a pivot axis extending in the common direction of the pump cylinder axes and is located below the first-mentioned opening. It supports a valve plate which may be pivoted with the shaft between two positions. The valve, in the two positions of the valve plate, alternatingly connects one cylinder with the intake while connecting the other cylinder with the pump discharge.

Other features, additional objects and many of the attendant advantages of this invention will readily become apparent from the following detailed description of preferred embodiments when considered in connection with the attached drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 shows a pump of the invention with an associated bin in side elevation and partly in section on the line I–I in FIG. 2;

FIG. 2 illustrates the pump without the bin in top plan view and partly in section in a plane through the axes of the pump cylinders;

FIG. 3 shows the apparatus of FIG. 1 in enlarged, fragmentary, front-elevational section on the line III–III;

FIG. 4 illustrates the device of FIG. 3 in side-elevational section on the line IV–IV; and

FIG. 5 shows a modified pump in a view corresponding to that of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawing in detail, and initially to FIGS. 1 to 4, there is seen a pump of the invention which may be mounted on a truck for delivering mixed concrete to a construction site.

The pump has two identical cylinders 2 whose axes are parallel in a common, normally horizontal plane. Pistons 3,4 are axially reciprocated in the two cylinders by a drive mechanism 1 more fully described in my copending application for a "reciprocating duplex slurry pump," Ser. No. 812,744, filed on Apr. 2, 1969. The pistons 3,4 simplified in the instant drawing, are also illustrated and described in greater detail in the copending application.

The open front ends of the two cylinders 2 are fixedly connected by a flat plate 15 which is perpendicular to the cylinder axes and provided with apertures axially aligned with the open cylinder ends in sealing engagement. The apertures in the connecting plate 15, and thus the open cylinder ends, are connected by a valve housing 5 which is approximately semicircular in the top view of FIG. 2. The housing 5 essentially consists of a central valve body 6 and two elbows 16,17 symmetrically arranged on either side of the valve body. Opposite lateral openings in vertical walls of the valve body 6 are connected by the elbows 16,17 to the apertures in the connecting plate 15.

As is best seen in FIGS. 3 and 4, an upwardly directed opening in the valve body 6 communicates with a square intake flange 30 fixedly fastened to the bottom of a bin 7. A fourth, square opening in the valve body 6 is directed downwardly into a discharge or pressure line 8 which turns into a horizontal direction below the valve housing 5.

A horizontal shaft 9 arranged below the intake flange 30 between the lateral openings of the valve body 6 carries a flat valve plate 10. In the position of the valve plate 10 fully drawn in FIG. 3, material may flow from the bin 7 through the valve body 6 into the elbow 17 and the associated cylinder 2, whereas the other cylinder is connected to the discharge line 8 by way of the elbow 16.

The bin 7 is equipped with a rotary, paddle-type stirrer 11 which mixes the ingredients of the concrete mixture before the same flows into a cylinder 2 during the suction stroke of a piston 3 or 4, to be discharged during the pressure stroke into the line 8, each piston being moved forward by hydraulic fluid during the pressure stroke while the other piston is being retracted for suction as is basically known and more fully described in the aforementioned application.

The valve body 6 has two end plates or walls 12,13 which are spaced apart along the axis of the shaft 9 so as to receive the valve plate 10 therebetween, the shaft 9 being journaled in the walls 12,13. Two square, horizontal frames 28 define the upper and lower openings of the valve box 6 and are held fast between the end walls 12,13 by stay bolts 14 fixedly fastened to the connecting plate 15 and passing through aligned openings in the walls 12,13. Nuts 14' on the bolts 14 may be released to disassemble the valve body 6.

The connecting plate 15 is flanged to the open, axial, front ends of the cylinder 2 in a conventional manner not shown in detail. The elbows 16,17 are attached to the plate 15 by vertical hinge pins 18,19 which permit the elbows to be swung away from their illustrated operative position for access to the lateral openings in the valve box 6 between the frames 28. The elbows are held in the operative position by a quick-release fastening mechanism consisting of two eyebolts 20,21 pivoted on the end wall 13, passing through notches in lugs on the elbows, as is best seen in FIG. 4, and provided with nuts on their free ends, as is conventional, which permit the elbows 16,17 to be clamped tight to the sidewalls of the valve body 6.

The shaft 9 projects rearwardly from the end wall 12 and the connecting plate 15, and its outer end carries a radial arm

22 which extends upwardly beyond the cylinders 2 in all positions of the valve plate 10, the two extreme positions being shown in FIG. 3 in solid and broken lines respectively. The cylinder 23 of a hydraulic motor is mounted horizontally above one of the cylinders 2 at right angles to the common direction of the axes in the cylinders 2. A double-acting piston 18' in the cylinder 23 is hingedly fastened to the arm 22 and pivots the shaft 9 with the plate 10 in unison with the reversal of movement of the pistons 3,4 in the cylinders 2, as more fully described in the aforementioned copending application.

The concrete mixture flowing at relatively high speed and high pressure through the valve body 6 is extremely abrasive, and the opposite faces of the end walls 12,13 are protected against wear by means of lining plates 24,25. The shaft 9 passes through openings in the plates 24,25 and thereby holds them in position. They are swept by the valve plate 10 during normal valve operation.

The upper and lower frames 28 further contribute to the releasable fastening of the lining plates 24,25. The end wall 12, 13 have inturned top and bottom edges 29 whose inner surfaces slope toward each other and obliquely outward of the valve body 6 in a vertical direction and cammingly engage correspondingly sloping outer contact faces of the intake flange 30 on the bin 7 and on a corresponding discharge flange 31 on the pressure line 8. The frames 28 are vertically interposed between the flanges 30,31 and the horizontal edges of the lining plates 24,25.

When the nuts 14' are tightened, the flanges 30,31 are pushed vertically inward of the valve body 6 against the frames 28, thereby pushing the frames into abutting engagement with the lining plates 24,25. Resilient gaskets and packings provided in the contact areas of the several clamped elements of the valve body 6 in the usual manner have been omitted from the drawing for the sake of clarity. Pins 26,27 project from the end walls 12,13 into oversized openings in the frames 28 for facilitating the assembly and disassembly of the valve body 6.

During normal operation of the pump, the pistons 3,4 move in opposite directions in the associated cylinders 2, and reverse their directions at the axial ends of the cylinders, one piston being driven by hydraulic fluid under pressure to discharge previously received concrete mixture while the other piston is being retracted by the drive mechanism 1. The hydraulic circuit of the cylinders 2 is connected to the cylinder 23 to pivot the valve plate 10 in proper timed sequence with the reversal of piston travel so that a stream of fluid concrete mixture is practically continuously drawn from the bin 7 into the pump, and another stream is continuously discharged through the pressure line 8, the flow of the mixture being assisted by gravity.

The valve arrangement described above with reference to FIGS. 1 to 4 permits the cylinders 2 and associated elements of the pump to be packed closely together so as to hold the path traveled by the concrete mixture from the bin 7 to the pressure line 8 very short. The horizontal mounting of the shaft 9 in the vertical end walls 12,13 makes the top wall of the valve body 6 available for an intake opening, and the conduit which connects the bin 7 to the valve body 6 consists essentially of the flange 30 whose length is but a small fraction of its horizontal dimensions, as is best seen in FIGS. 3 and 4. When the pump starts operating, and the valve housing 5 and the portions of the cylinders 2 ahead of the pistons 3,4 are filled with air, concrete flows from the bin into the valve body and thence into the cylinders 2 in a path so short that clogging of the pump by hardening concrete during start-up is safely avoided. Gravity assists the rather weak suction effect of the pistons 3,4 which cannot be sealed airtight in the cylinders 2 under the prevailing operating conditions.

The concrete mixture travels from the body 6 to the open front ends of the cylinders 2 through the elbows 16,17 in an arc of 90° about a vertical axis of curvature which is in or closely adjacent the wall of the elbow, as is evident particularly from FIG. 2. The width of each elbow is practically as great as the radius of curvature of its outer wall. Clogging of the elbows 16,17 is practically impossible with a minimum of caution on the part of the operator.

If any portion of the valve housing 5 should be clogged, or when the housing is to be flushed free from concrete mixture after a run, the eyebolts 20,21 are quickly released, and the elbows 16,17 may thereafter be swung on the pins 18,19, to give free straight-line access to the valve body 6 and also to the cylinders 2. It is not necessary to disconnect the intake and discharge lines from the valve body, and these lines are readily flushed through the valve body, if so desired.

The relatively sensitive valve operating mechanism including the cylinder 23 is shielded against contamination or mechanical damage during the cleaning operation by its location atop one of the cylinders 2.

The pressure line 8 may be set between the end walls 12,13 in any one of four angular positions relative to a vertical axis through the centers of the frames 28 because of the square configuration of the frames 28 and of the associated flange 31. Two of these positions are shown in FIG. 1 in solid and broken lines respectively. The length of the discharge line 8 and the number of turns in the line may be reduced by setting the line into the valve body 6 in the most favorable orientation, thereby holding the risk of clogging in the line 8 to a minimum without making it necessary to position the concrete truck in a specific manner relative to a working area or to a container into which the concrete mixture is to be discharged. It is relatively simple to loosen the nuts 14' sufficiently to permit the line 8 to be turned 90° or 180° in the lower or discharge opening of the valve body 6.

Loosening of the nuts 14' also permits the withdrawal and replacement of the frames 28 which are exposed to the abrasive action of the concrete mixture, and replacement of the lining plates 24,25 is achieved in almost as simple a manner, but requires withdrawal of the shaft 9.

The modified valve arrangement in an otherwise practically identical pump shown in FIG. 5 permits an even quicker and easier disassembly and reassembly of its constituent elements.

The bin 7' is equipped with a stirrer 11 as described above and carries lugs 32 on its outer bottom wall contiguously adjacent a short downwardly directed spout 30' which is the intake conduit to the valve body mainly constituted by end walls 12', 13' and square frames 28' about the intake and discharge openings of the valve body. Similar lugs 33 are provided on the upwardly directed terminal portion 31' of the discharge line 8'. Lugs 34 on the top and bottom ends of the end wall 12' are hingedly fastened to corresponding lugs 32,33 of the spout 30' and the discharge line portion 31' by pins 35.

Similar pins 35 fasten eyebolts 36 to lugs 32,33 near the end wall 13'. The eyebolts are received in forked flanges of the end wall 13' and held tight by means of nuts. The portions of the bin 7' and of the discharge line 8' not visible in FIG. 5 carry additional pairs of lugs 32,33 offset 90° from the illustrated lugs so that the discharge line 8' and the bin 7' may be fastened to the valve body in four positions as described above, a second position of the line 8' being indicated in broken lines in FIG. 5.

Other elements of the valve shown in FIG. 5 are practically identical with the corresponding elements described above with reference to FIGS. 1 to 4 so as not to require further description, and the valve illustrated in FIG. 5 is operated in the same manner as described above. A tight seal between the valve body, the bin 7' and the discharge line 8' is achieved by tightening the nuts on the eyebolts 36, and by thereby compressing square frames 28' between opposite, normally horizontal faces of the end walls 12', 13' and of the spout 30' and the discharge line portion 31'.

I claim:

1. In a pump including two cylinders having respective axes extending in a common horizontally extending direction; a piston in each cylinder; drive means for axially reciprocating said pistons in the associated cylinders, respective axial front ends of said cylinders being open; a valve housing connecting

said open front ends and having intake means and discharge means; and a valve in said housing for connecting each cylinder to said intake means for receiving material to be pumped while the other is connected to said discharge means for discharge of the pumped material; the improvement in the valve which comprises:

a. a valve body formed with four openings, one of said openings being directed upwardly and communicating with said intake means, a second opening being directed downwardly and communicating with said discharge means, and the other openings respectively communicating with said front ends, said valve body constituting a portion of said valve housing;

b. a shaft mounted in said valve body for movement about a pivot axis extending in said common direction and located below said one opening;

c. a valve plate member mounted on said shaft;

d. actuating means for pivoting said shaft about said pivot axis between two positions,

1. said valve in one of said positions of said shaft connecting said intake means to one of said front ends while connecting the other front end to said discharge means,

2. the valve in the other position of said shaft connecting said intake means to the other front end while connecting said one front end to said discharge means.

2. In a pump as set forth in claim 1, said actuating means including a hydraulic motor mounted above one of said cylinders, and motion transmitting means connecting said motor to said shaft.

3. In a pump as set forth in claim 1, a protective lining releasably mounted in said valve body, said valve plate member sweeping said lining during the pivoting movement of said shaft.

4. In a pump as set forth in claim 1, a connecting plate formed with two apertures axially aligned with said cylinders respectively in sealing engagement with the respective open front ends, respective portions of said valve housing connecting said apertures with said valve body, the valve body including two end walls spaced in the direction of said pivot axis and receiving said valve plate member therebetween, a plurality of stay bolts, each stay bolt engaging said end walls and said connecting plate, said intake means and said discharge means including respective conduits and respective, terminal, annular flanges on said conduits, said stay bolts holding said end walls in a position in which said flanges are clampingly received between said end walls.

5. In a pump as set forth in claim 4, said end walls having edge portions cammingly engaging said flanges and receiving respective frame portions of said intake means and of said discharge means therebetween, each frame portion being juxtaposed to one of said flanges, and threaded tightening means on said stay bolts for tightening said edge portions against said flanges and for thereby pressing the flanges against the associated frame positions.

6. In a pump as set forth in claim 5, said flanges defining substantially square openings.

7. In a pump as set forth in claim 4, a lining releasably mounted on a face of each end wall opposite the corresponding face of the other end wall.

8. In a pump as set forth in claim 1, a connecting plate formed with two apertures axially aligned with said cylinders respectively in sealing engagement with the respective open front ends, said valve housing including two elbow members pivoted to said connecting plate for movement toward and away from respective operative positions in which the elbow members connect an associated aperture of the connecting plate with an opening of said valve body.

9. In a pump as set forth in claim 8, said valve body including two end walls spaced in the direction of said pivot axis and receiving said valve plate therebetween, and quick-release fastener means for fastening each of said elbow members to one of said end walls in the operative position of the elbow member.

10. In a pump as set forth in claim 1, said discharge means including a discharge line and means for securing said discharge line to said valve body in communication with said downwardly directed opening in a plurality of positions angularly offset relative to each other about an upright axis. 11. In a pump as set forth in claim 1, said plate member being substantially flat.

12. In a pump including two cylinders having respective axes extending in a common horizontally extending direction; a piston in each cylinder; drive means for axially reciprocating said pistons in the associated cylinders, respective axial front ends of said cylinders being open; a valve housing connecting said open front ends and having intake means and discharge means; and a valve in said housing for connecting each cylinder to said intake means for receiving material to be pumped while the other cylinder is connected to said discharge means for discharge of the pumped material; the improvement in the valve which comprises:

a. a valve body formed with four openings, one of said openings being directed upwardly and communicating with said intake means, and the other openings respectively communicating with said discharge means and said front ends, said valve body constituting a portion of said valve housing;

b. a shaft mounted in said valve body for movement about a pivot axis extending in said common direction and located below said one opening;

c. a valve plate member mounted on said shaft;

d. actuating means for pivoting said shaft about said pivot axis between two positions;

1. said valve in one of said positions of said shaft connecting said intake means to one of said front ends while connecting the other front end to said discharge means,

2. the valve in the other position of said shaft connecting said intake means to the other front end while connecting said one front end to said discharge means;

e. a connecting plate formed with two apertures axially aligned with the open front ends of said cylinders respectively, said connecting plate being fixedly fastened to said cylinders, said axis of said cylinders extending in a common, normally horizontal plane, and said valve housing including

f. two elbow members extending in respective arcs of approximately 90° about normally vertical axes of curvature from said apertures to two of said openings in said valve body directed from the same in opposite directions, the radius of curvature of the wall of each elbow member remote from the associated axis of curvature being not substantially greater than the width of said elbow member in said plane.

13. In a pump as set forth in claim 12, a container arranged above said valve housing, said intake means including an intake conduit connecting said container to said valve body, the upright length of said intake conduit being substantially smaller than the horizontal width of the same.