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PISTON PUMPS

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Fig. 1

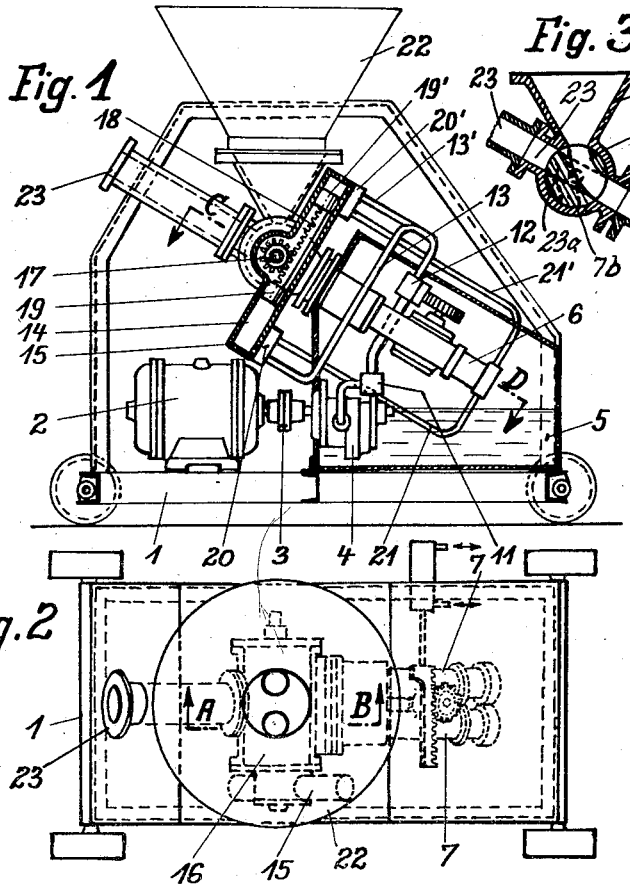

Fig. 3

Fig. 2

Fig. 4

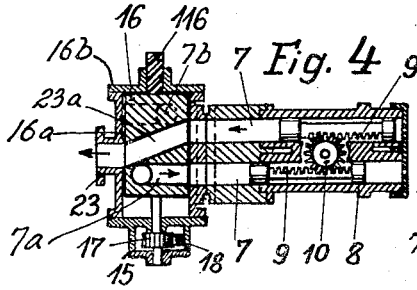

Fig. 5

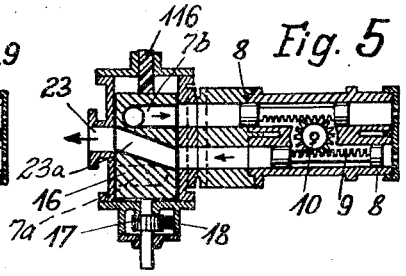

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Fig. 6

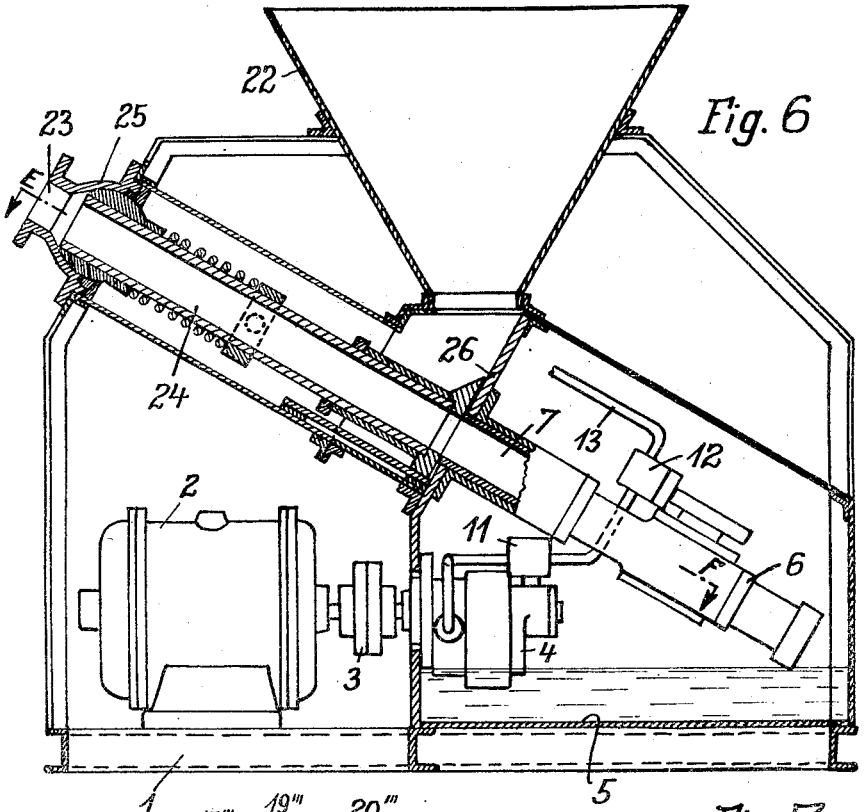
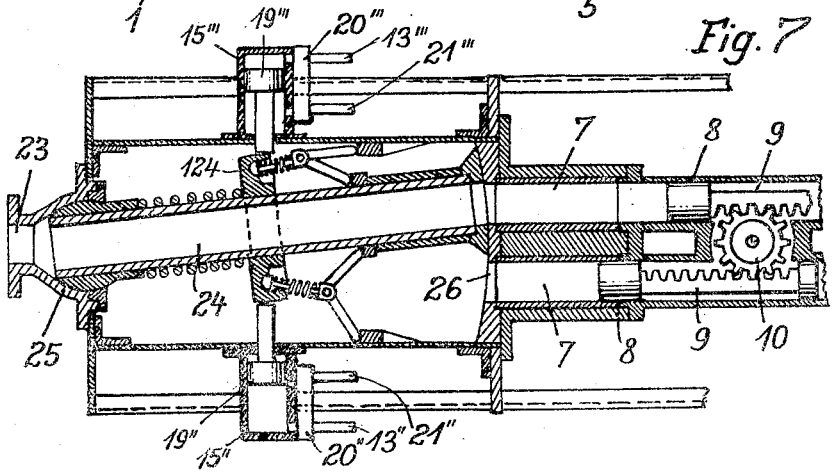


Fig. 7



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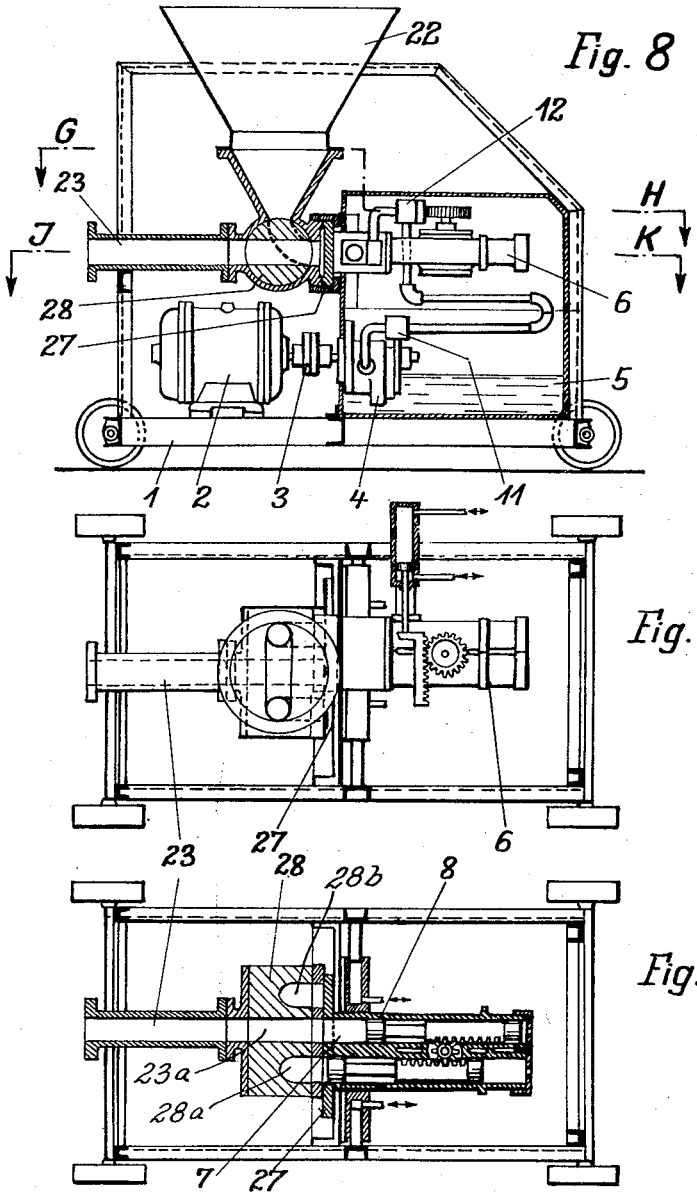

Fig. 8

Fig. 9

Fig. 10

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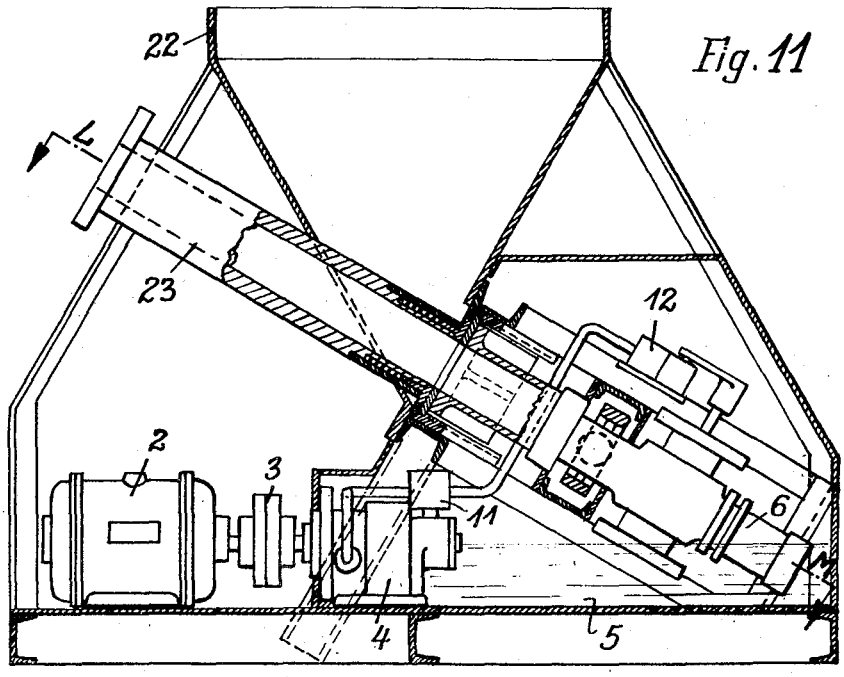

Fig. 11

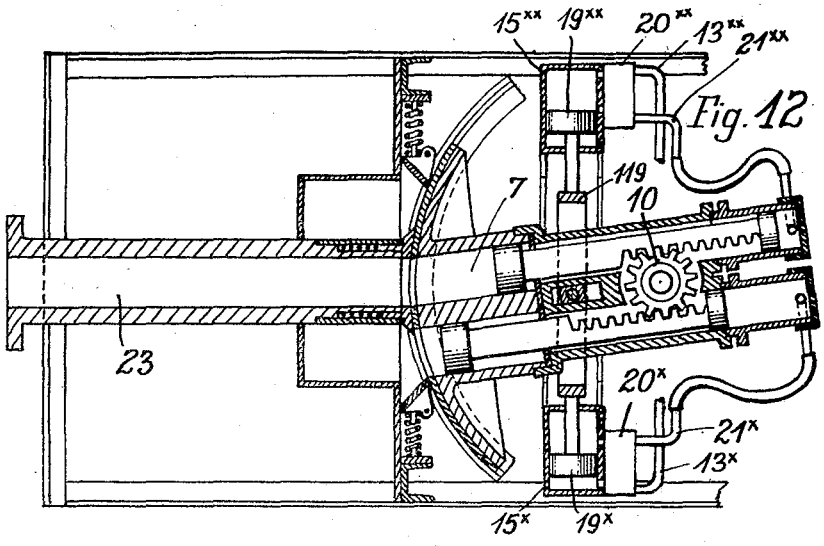

Fig. 12

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Fig. 13

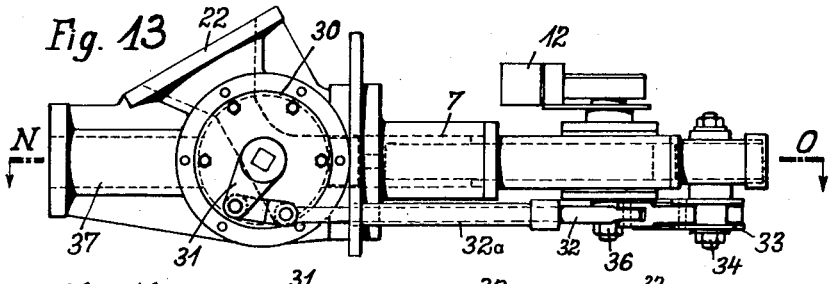

Fig. 14

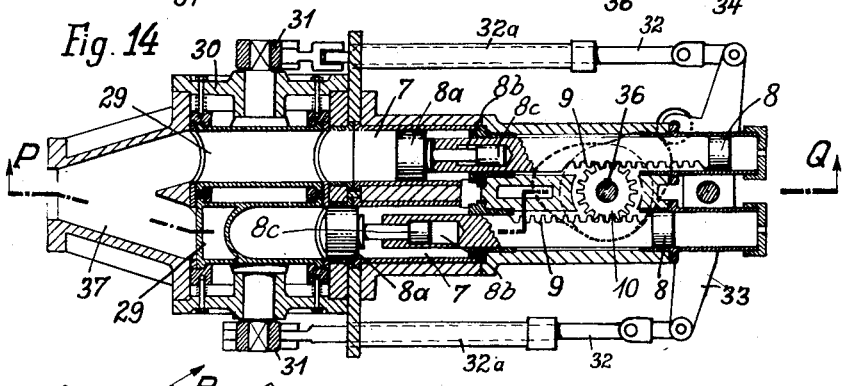

Fig. 15

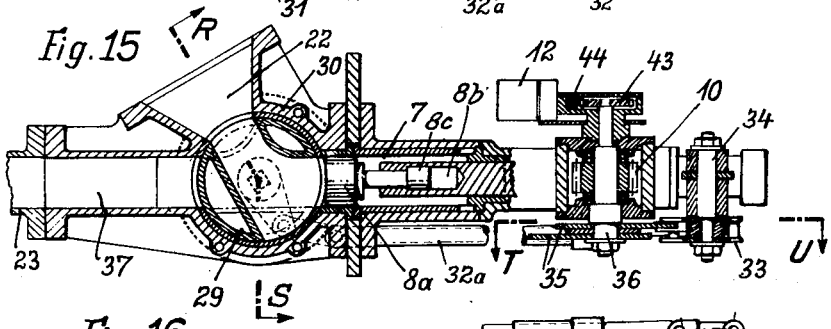

Fig. 16

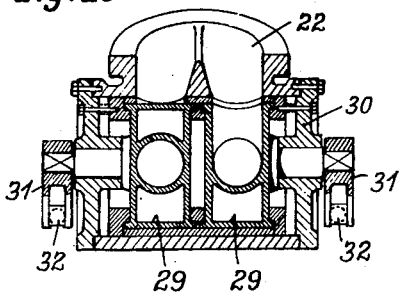

Fig. 17

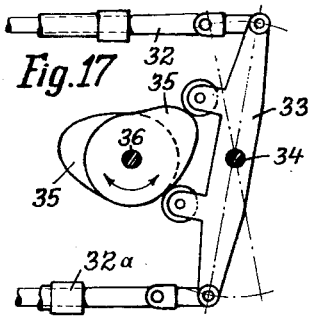

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Fig. 18

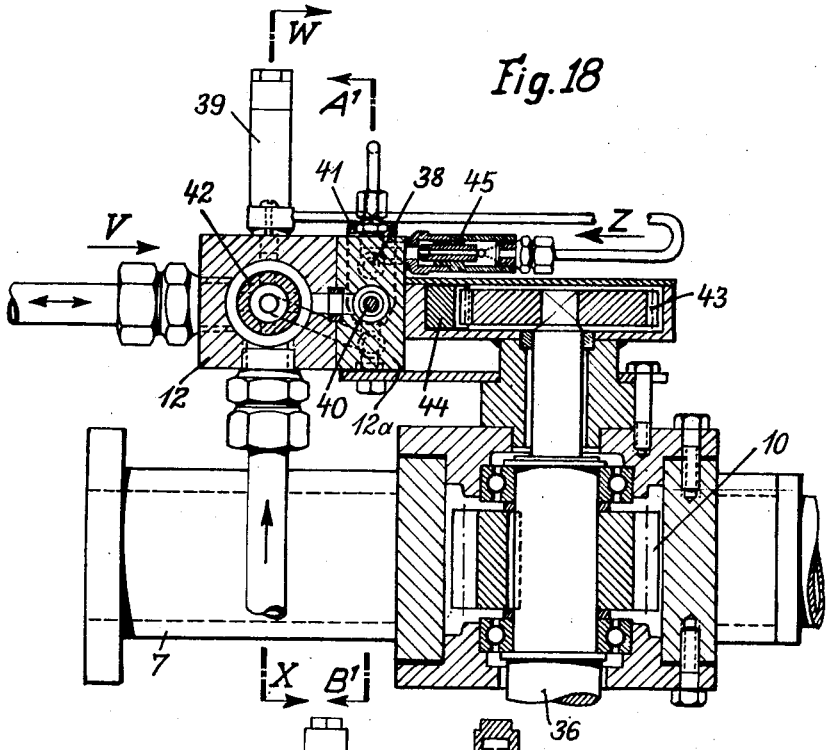
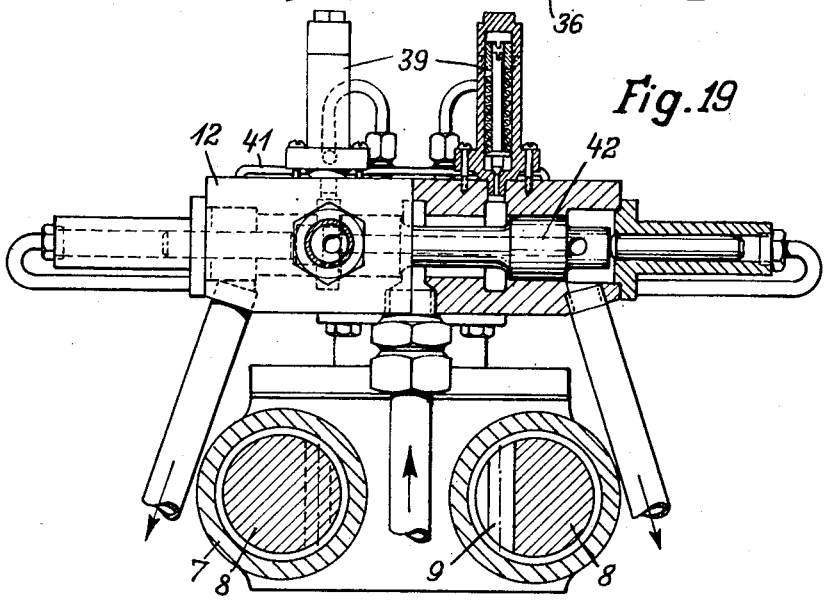


Fig. 19



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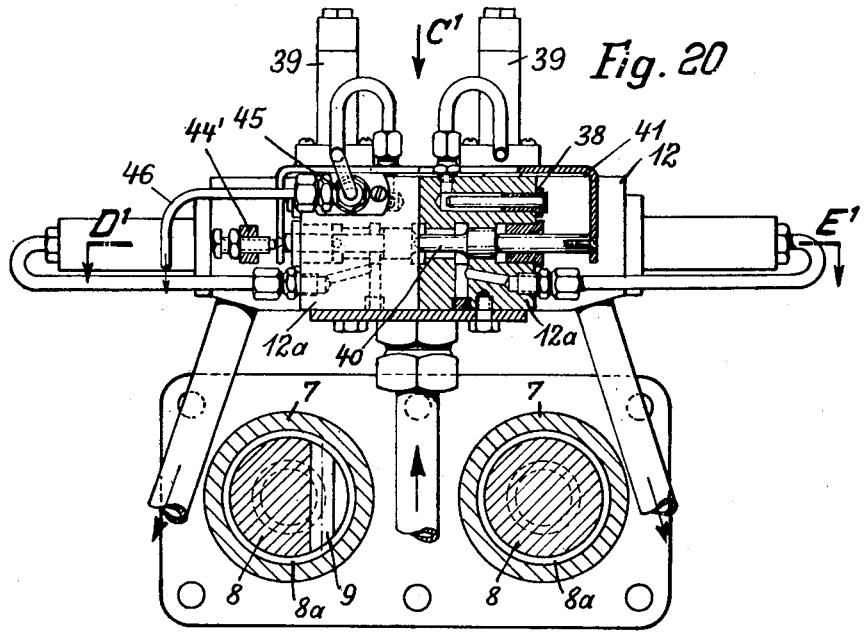

Fig. 20

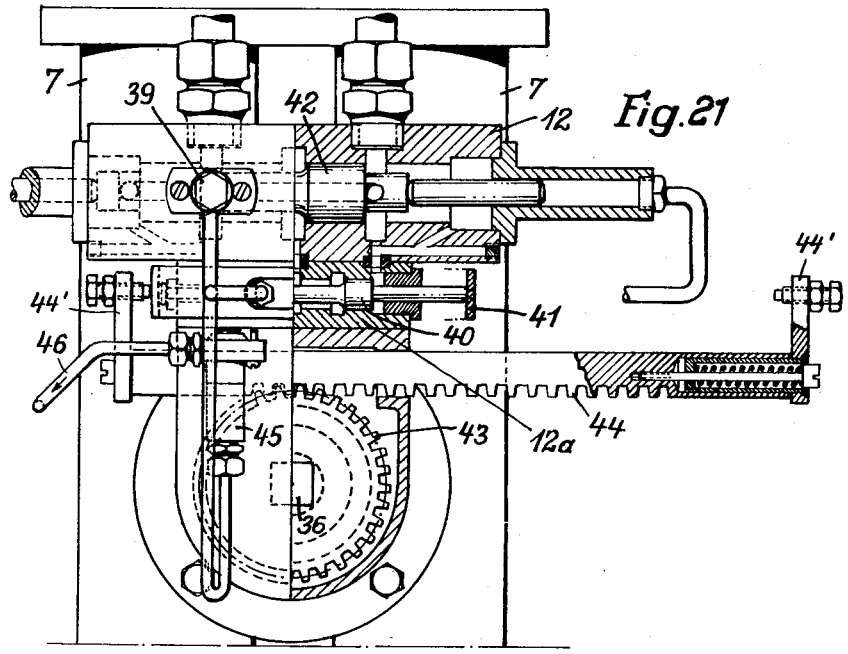

Fig. 21

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United States Patent Office

2,796,032

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PISTON PUMPS

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Application September 29, 1953, Serial No. 383,090

Claims priority, application Germany October 3, 1952

7 Claims. (Cl. 103—153)

The invention relates to hydraulically driven piston pumps for pumping thick liquid, pasty masses, for example concrete.

In the piston pumps hitherto known which serve for pumping thick liquid, pasty masses and which have hitherto been driven purely mechanically, the pumping of the mass still takes place even during the movement of the control members whereby the difficulty arises that the mass to be pumped is forced not only into the discharge pipe, but is also forced back into the supply hopper. Thereby the useful stroke of the pump is reduced and its volumetric efficiency is greatly diminished. Moreover the mechanically driven pumps have the further disadvantage that the piston pressures actually required can not be determined accurately because the conditions of friction in the pipes are unknown.

It is a principal object of the invention to provide a hydraulically driven piston pump for the pumping of thick liquid, pasty masses, for example of concrete, which obviates the aforesaid difficulties in a simple and safe manner.

It is a further object of the invention to provide a pump of the kind referred to which allows to perform a continuous output of practically 100% by passing the mass to be pumped into the discharge pipe then only when the latter is properly connected to the pressure chamber.

It is another object of the invention to provide a pump as aforesaid in which after the termination of the pumping operation the control member controlling the discharge of the mass can be readily dismantled for the purpose of cleaning the same and the discharge pipe.

It is moreover an object of the invention to provide a pump as aforesaid in which any jamming of the control member by bulky or cumbersome pieces contained in the mass is automatically prevented by auxiliary hydraulic control means.

With these and other objects in view I provide a piston pump having pump cylinders arranged in duplicate, serving alternately as a suction and as a pressure chamber and being at any time brought into communication with the supply duct and with the discharge duct for the mass to be pumped by means of a pressure oil controlled switch-over member, periodically in such a manner that the movements of the hydraulically driven pistons can take place then only, when the communication of the suction ducts in question and of the pressure duct, respectively, with the actually operative pump chamber has been established.

Preferably the arrangement is made in such a manner that two suction ducts and a single pressure duct are provided in a rotary slide valve which is subjected, in addition to a 180° to-and-fro rotary movement to a reciprocating displacement in its longitudinal axis. For example by the action of pressure oil on a gear pinion driven for example through a toothed rack, simultaneously with its turning 180° the axial displacement thereof is effected, as required, for example through a thread having a high helical pitch,

so that alternately the suction ducts are brought into communication with the actually operative suction chamber of the stationary pump cylinder in question, and through the pressure channel the actually operative pressure chamber of the pump is brought into communication with the discharge chamber.

Owing to this construction of the rotary slide valve in which both suction ducts and the pressure duct are arranged, it is made possible in a simple manner by the aid of the axial movement thereof taking place in addition to the rotary movement to bring the actually operate suction and/or pressure ducts into an accurately timed communication with the actually operative chambers of the pump aggregate.

According to a development of the invention the pump referred to may be modified in such a manner that the suction and/or pressure chambers of the stationary double-acting pump cylinders used are brought alternately into direct communication with the supply container of the mass in such a manner that the actually operative suction chamber is cleared by a pressure tube tiltably arranged in front of it, which carries the mass and is in communication with the discharge pipe, the movement of the said pressure tube being effected hydraulically by the aid of a pressure oil controlled member.

According to another modification of the invention the double-acting pumps may be mounted slidably transversely to the piston axes, and their suction and pressure chambers, respectively, may at any time be brought into communication for one cylinder with the suction duct which leads through a stationary connecting piece mounted on the mass container, and at the same time for the other cylinder with the stationary discharge pipe, in such a manner that one of the suction ducts located laterally to the right and left of the pressure pipe is put into communication with the suction cylinder, and the discharge pipe with the pressure cylinder owing to the actual displacement of the pump aggregate. The said stationary connecting piece containing the suction ducts and the pressure duct may be formed cylindrically and may be so arranged that after the termination of the pumping operation it may be taken off laterally for the purpose of being cleaned.

According to yet another modification the hydraulically operated pump aggregate may be pivoted, and rocked to-and-fro hydraulically by the pressure oil control of a piston effecting this movement, in such a manner, that the suction space of one of the pump cylinders is put into communication with the mass container, and the pressure space of the other pump cylinder with the stationary discharge pipe, the rocking movement of the pump aggregate being terminated, before the action of the suction or pressure space, respectively commences.

Yet another modification of the invention consists in that the movement of the rotary slide valves is effected directly by the pumping piston, the novelty being constituted in that in the hydraulically driven piston pump each of the two alternately acting pistons disposed parallel to one another has a separate rotary slide valve associated with it, the rocking movement of which is effected at any time by a linkage which receives its drive from gear pinions meshing with toothed racks of the pumping pistons and connected with cam discs or similar means.

In order to initiate this rocking movement of the rotary slide valves at the correct moment, one part of the stroke of the pumping piston concerned serves for moving the linkage for the rocking of the rotary slide valve, and for this purpose the head of the pumping piston is freely shiftable in the pumping piston the length of this part of the stroke. In this way the pumping pistons can start their sucking or pressing stroke then only when

the rotary piston valves have assumed the positions required therefor.

The mass emerging at the corresponding rocking movement of the rotary slide valves therefrom is passed into a forked pipe piece connecting the discharge openings of the rotary slide valves, and from there into the pipe line leading to the place of consumption.

When bulky or cumbersome pieces contained in the mass pass through the supply hopper into the path of the closing movement of the rotary slide valve actually in operation after the termination of its suction position, they would hamper the rocking movement of the said rotary slide valve and would interrupt the pumping process. In order to prevent this, the control member for the movement of the pumping pistons has been developed additionally in such a manner that two auxiliary pistons are arranged therein which are put under pressure via two associated safety valves then when the latter are operated by excess pressure occurring behind the pumping piston in consequence of the rocking movement of the rotary slide valve being jammed, the restoring of the auxiliary piston thus operated into its initial position being effected by the switch-over means serving for the operation of the control member in general. In this manner the excess pressure is utilized for quickly switching-over the pump, whereby the jamming body is moved away from the mantle zone of the rotary slide valve; the rotary slide valves then return to their suction and pressure position, respectively, and the pump can consequently continue its pumping operation at once. This switch-over operation takes place so quickly that the pumping process is practically left uninterrupted.

In order that the invention may be clearly understood and readily carried into effect, several embodiments thereof will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a lateral elevation, partly in section, of a pump having stationary cylinders and a rotatable and laterally slidable control slide valve;

Fig. 2 is a plan view of the pump according to Fig. 1;

Fig. 3 is a section of the control slide valve along the line A—B of Fig. 2;

Fig. 4 is a section along the line C—D of Fig. 1 with the control slide valve in the right hand side position;

Fig. 5 is a section corresponding to Fig. 4 with the slide valve turned 180° with respect to the position shown in Fig. 4, and in its left hand side position;

Fig. 6 is a lateral elevation, partly in section, of a second embodiment of a pump according to the invention, having a tiltable discharge tube and stationary cylinders;

Fig. 7 is a section along the line E—F of Fig. 6;

Fig. 8 is a lateral elevation, partly in section, of a third embodiment of the invention, having laterally slidable pressure cylinders;

Fig. 9 is a section along the line G—H of Fig. 8;

Fig. 10 is a section along the line J—K of Fig. 8;

Fig. 11 is a lateral elevation, partly in section, of a third embodiment of a pump according to the invention, having a stationary discharge pipe and tiltable cylinders;

Fig. 12 is a section along the line L—M of Fig. 11;

Fig. 13 is a lateral elevation of a fourth embodiment of a pump according to the invention having two rotary slide valves;

Fig. 14 is a section along the line N—O of Fig. 13;

Fig. 15 is a section along the line P—Q of Fig. 14;

Fig. 16 is a section along the line R—S of Fig. 15;

Fig. 17 is a plan view of the linkage in section along the line T—U of Fig. 15;

Fig. 18 is a section, corresponding to Fig. 15, of the control device of the embodiment according to Figs. 13 to 17, on a larger scale;

Fig. 19 shows, on the left hand half, a view in the direction of the arrow V, and on the right hand half a section along the line W—X, of Fig. 18;

Fig. 20 shows, on the left hand half a view in the direction of the arrow Z, and on the right hand half a section along the line A^1—B^1, of Fig. 18;

Fig. 21 shows, on the left hand half a plan view in the direction of the arrow C^1, and on the right hand half a section along the line D^1—E^1 of Fig. 20.

Corresponding parts are denoted in all figures by equal reference numerals.

Referring first to Figs. 1 to 5, on the frame **1**, which in the present case is shown to be movable, the driving motor **2** is mounted which drives through a clutch **3** a pressure oil pump **4**. The latter is arranged in an oil container **5**, which is fixed to the frame structure **1** to which also the concrete pump aggregate **6** is fixed. This pump aggregate consists of the pump cylinders **7** arranged parallel to one another, which have pistons **8** whose piston rods have gear teeth **9**. These toothed racks **9** are in mutually opposed relationship through the gear pinion **10** with which they are in mesh.

The pressure oil supplied by the pump **4** is passed through a check valve **11** firstly to a control member **12** (an embodiment of which will be described later with reference to Figs. 18 to 21), and from there through the pipes **13**, **13'** to the actually operative pressure chamber **14** of the control device **15** for the rotary slide valve **16**. As shown in Figs. 4 and 5, the valve **16** is mounted in a casing **16***a* having a detachable lid **16***b*. The switching-over of this rotary slide valve **16** is effected at any time through the gear pinion **17** arranged on its longitudinal axle by means of toothed rack **18** meshing therewith, which is moved by the pressure oil operated pistons **19**, **19'**. Two pairs of parts **20**, **20'** are arranged at each end of the cylinder **15**, which are controlled by the pistons **19**, **19'**, respectively, and which accordingly admit pressure oil through the pipes **21**, **21'**, respectively, to one of the cylinders **7** containing the pistons. The rotary slide valve **16** has two arcuate suction ducts **7***a* and **7***b* for connecting the respective suction space **7** with the hopper **22** as shown in Figs. 3 and 4. The slide valve **16** has also a horizontal oblique pressure duct **23***a* for connecting the respective pressure space **7** with a discharge pipe **23**. See Figs. 4 and 5.

In order to put the suction space actually in operation of one of the pump cylinders **7** in communication with the supply hopper **22** through the rotary slide valve **16**, and at the same time to connect the pressure space of the other pump cylinder **7** with the discharge pipe **23**, the rotary slide valve **16** performs, in addition to its turning movement of 180°, an axial displacement as is apparent from Figs. 4 and 5.

A threaded spindle **116** is in screw engagement with a tapped bore in the right hand side lid of the casing of the rotary slide valve **16**, the thread having a high helical pitch. Accordingly when turning the pinion **17** which is coupled for rotation by splines or keys (not shown) to the shaft on the left hand side of the valve **16**, the latter is shifted laterally. The supply of pressure oil to the pump cylinders **7** is so arranged that at any time only that piston **8** of a pump cylinder is exposed to oil pressure which exerts pressure on the liquid concrete paste, while the opposed suction movement carried out by the piston **8** of the other cylinder is effected mechanically by the intermediary of the toothed rack gearing **9**, **10**.

After the termination of the pumping operation and loosening of the cover lid, the rotary slide valve body **16** can be removed for the purpose of cleaning the same as well as the discharge pipe.

In the embodiment illustrated in Figs. 6 and 7, the oil pump **4** is likewise arranged in the oil container **5**, and the control of the pump pistons **8** is effected similarly to the embodiment described with reference to Figs. 1 to 5.

Instead of using a rotary slide valve the arrangement of this embodiment is, however, made in such a manner that a discharge tube **24** is pivotally mounted in a ball joint **25** provided at the inner end of the discharge pipe

23, and this tube 24 is slidable with its free end on the segment shaped scaling face 26 arranged in front of both cylinders 7 of the pump aggregate.

The tilting of the discharge tube 24 is for example effected by two pistons 19'', 19''', movable in two cylinders 15'', 15''' transversely to the pistons 8 in the cylinders 7. Each cylinder 15'', 15''' has pairs of ports 20'', 20''' controlled by the pistons 19'', 19''' respectively and connected alternately to oil pressure by the pipes 13'', 13''' respectively, or the oil sides of the pistons 8 by the pipes 21'', 21''' respectively. The piston rods of the pistons 19'', 19''' engage a double cam 124 which is slidably mounted on the discharge tube 24 and spring biased towards the face 26. A spring biased toggle lever is arranged on both sides of discharge tube 24, bearing with its apex on the end face of the said double cam 124, and with its two legs on a shoulder of the fixed casing and a shoulder of a slidable end piece of said discharge tube 24, respectively. Accordingly, by applying oil pressure to the cylinder 15'', 15''', respectively, the discharge tube 24 is shifted and turns from one side to the other in ball joint 25. At the same time its slidable end piece, tightly pressed on the scaling face 26, slides from side to side.

In the embodiment illustrated in Figs. 8 to 10, the pump aggregate 6 having the two pump cylinders 7 is arranged transversely slidable on a guide 27 fixed to the oil container 5. The connection required of the suction and pressure space of the cylinders 7 with the concrete container 22 and the discharge pipe 23, respectively, is effected through a cylindrical stationary connector piece 28 having a discharge duct 23*a*, and suction ducts 28*a* and 28*b*. After the termination of the pumping operation, piece 28 can be taken off in its axial direction for the purpose of being cleaned.

In the embodiment illustrated in Figs. 11 and 12 the arrangement is such that the pump aggregate 6 can swivel to-and-fro about the axis of the gear pinion 10, the end face of the cylinders 7 sliding on the segment-shape end face of the discharge pipe 23 which consist of two halves which are spring biased in opposite directions transversely to the said discharge pipe. The two hydraulic pistons 19^{x}, and 19^{xx} are connected with one another by a frame 119 having a central transverse pin on which a slider block is pivoted which is guided in a longitudinal slot between the two cylinders 7. The pistons 19^{x}, 19^{xx} move in cylinders 15^{x}, 15^{xx}, respectively, which are connected by pairs of ports 20^{x}, 20^{xx}, respectively, and pipes 13^{x}, 21^{x} and 13^{xx}, 21^{xx}, respectively, to oil pressure and to the oil spaces of the cylinders 7, respectively. The operation is similar to that described hereinabove with reference to the embodiment illustrated in Figs. 8 to 10.

In the embodiment represented in Figs. 13 to 21 in which the pump cylinders 7 arranged parallel to one another the pumping pistons 8 are slidable, and have toothed racks 9 which mesh with the gear pinion 10. To each of these pump cylinders 7 a separate rotary slide valve 29 is co-ordinated which is adapted to be swivelled about 60° to and fro in the casing 30 which has also the supply hopper 22. The swivelling movements of the rotary slide valves 29 are effected by levers 31 which engage each of them separately and which are moved by push rods 32 guided in tubular guides 32*a* and receiving their motion from a double-armed lever 33 which is pivoted on a center 34. The swivelling movement of this lever 33 is effected positively by two cam discs 35 which are fixed on the axle 36 of the gear pinion 10.

By the action of the pressure oil on one of the pumping pistons 8 at the beginning of the working stroke the other pumping piston 8 is moved in the opposite direction through the toothed racks 9 and the gear pinion 10 meshing with them, and would at once begin to pump the liquid concrete. Since, however, pumping should commence then after the respective rotary slide valve 29 has assumed its end position, according to the invention the arrangement is made that the first part of the stroke is used for swivelling the rotary slide valve 29 by the aid of the linkage 31, 32, 33. To prevent a pumping action before valves 29 are shifted, a lost-motion device is provided.

Each pumping piston means 8 includes a piston head 8*a* slidably mounted in an axial bore 8*b* by means of a small piston 8*c* which can travel a distance corresponding to the fraction of the stroke required for operating valves 29. Consequently, while the piston means 8 travel this distance, the piston heads 8*a* are at a standstill so that the pumping action on the mass by piston heads 8*a* takes place only after the rotary slide valves have assumed the appropriate positions, that is the suction, and pressure position, respectively.

In order that the mass issuing from the discharge openings of the rotary slide valves 9 may be able to pass into the discharge pipe 23, a forked pipe length 37 is provided which connects the said discharge openings with one another.

In case cumbersome or coarse grained bodies are contained in the mass introduced through the supply hopper 22, whereby the swivelling movement of the rotary slide valves 29 might be jammed, care is taken according to the invention, that by means of the pressure oil operated control member 12 and instantaneous switching over of the working movement of the pistons 8 is effected, namely in that in the control member 12*a* additionally two auxiliary pistons 38 (Fig. 20) are arranged which are subjected to the action of safety valves 39, which, owing to excess pressure occurring behind the pumping piston 8 as a consequence of the jamming of the swivelling movement of the rotary slide valves, expel by their pressure the auxiliary piston 38 and thereby effect the switching over of the main control piston 42 through a loop 41 connected with an auxiliary control piston 40. Thereby the instantaneous reversal of movement of the pumping pistons 8 is effected, so that the rotary slide valves 29 are in turn swivelled in the opposite direction and the pumping can be effected again unhampered.

The control member 12*a* is connected positively with the gear pinion 10 of the toothed rack drive of the pumping pistons in that on the axle 36 of the gear pinion 10 another gear pinion 43 is mounted which meshes with a toothed rack 44 (Fig. 21) having resiliently mounted arms 44' at both ends which abut on the loop 41 from outside and thereby switch over the auxiliary control piston 40 in due course.

Accordingly the restoration of the auxiliary pistons 38 to their original position is effected by the movement of the auxiliary control piston 40 by means of its loop 41, the oil contained behind the auxiliary piston 38 flowing back to the oil container through an overflow valve 45 and the pipes 46.

While I have hereinabove described, and illustrated in the accompanying drawings what may be considered typical and particularly useful embodiments of my said invention, I wish it to be understood that I do not limit myself to the particular details and dimensions described and illustrated for obvious modifications will occur to a person skilled in the art.

I claim:

1. A piston pump for thick liquid pasty masses, comprising in combination: a pair of stationary hydraulic cylinders located parallel to one another, a pair of pumping cylinders for the pasty mass arranged in alignment with the said pair of hydraulic cylinders, a pair of pistons each having a portion slidable in one of the said hydraulic cylinders and a portion slidable in one of the said pumping cylinders, gearing means coupling the said pistons with one another for mutually opposed motion, supply means and discharge means for the said pasty mass, a rotary and axially slidable valve body having two suction ducts and one pressure duct, a source of hydraulic pressure, hydraulically operated driving means geared to the

said valve body and simultaneously turning and axially shifting the same to and fro, the said valve body having two end positions alternately connecting one of the said pumping cylinders to the said discharge means through its said pressure duct and the other one of said pumping cylinders to the said supply means through one of its said two suction ducts, and hydraulic control means operatively connected to the said hydraulically operated driving means and alternately connecting the said hydraulic cylinders to the said source of hydraulic pressure after their associated pump cylinder has been connected by the said valve body to the said discharge means.

2. A pump as claimed in claim 1 comprising a casing into which the said slidable and rotary valve body is fitted, and a detachable lid closing the said casing at one end, wherein the said rotary and axially slidable valve body is adapted to be pulled out of said casing after removal of the said lid in the axial direction, after the termination of the pumping operation for the purpose of cleaning the said body and the said discharge means.

3. A piston pump for thick liquid pasty masses, comprising in combination: a pair of hydraulic cylinders located parallel to one another, a pair of pumping cylinders for the pasty mass arranged in alignment with the said hydraulic cylinders, a pair of pistons each having a portion slidable in one of the said hydraulic cylinders and a portion slidable in one of the said pumping cylinders, gearing means including a pinion and said gearing means coupling the said pistons with one another for mutually opposed motion, supply means and discharge means for the said pasty mass, a source of hydraulic pressure, a pair of independently arranged and operated rotary slide valves, each slide valve being formed with ducts and adapted for connecting one of the said pumping cylinders alternately to the said supply means and to the said discharge means respectively, mechanical linkage means connecting each of said rotary slide valves with the said gearing means, said linkage means including cam follower lever means connected to said pinion for rotation therewith and operating said cam follower lever means, and hydraulic control means mechanically connected to the said gearing means and alternately connecting the said hydraulic cylinders to the said source of hydraulic pressure after their associated pumping cylinder has been connected by its associated rotary slide valve to the said discharge means, the other pumping cylinder being put in communication to the said supply means by its associated rotary slide valve.

4. A pump as claimed in claim 3, and including a pair of lost-motion devices connecting the portions of the said pistons slidable in the said pumping cylinders with the portions thereof slidable in the said hydraulic cylinders with a predetermined lost motion, the said hydraulic cylinders moving through the said gearing means the said rotary slide valves between two end positions while said piston portions in said pumping cylinders are at a standstill due to the action of said lost motion devices, and carrying along the piston portions in the said pumping cylinders after the said rotary slide valves have attained either of their end positions.

5. A pump as claimed in claim 3, comprising a forked connecting tube connecting said ducts of said two rotary slide valves with the said discharge means.

6. A pump as claimed in claim 3 wherein said hydraulic control means comprise a pair of auxiliary cylinders, a pair of auxiliary pistons respectively slidably arranged in said auxiliary cylinders for movement between a retracted position and an advanced position, conduit means respectively connecting said hydraulic cylinders with said auxiliary cylinders, so that liquid may flow from said hydraulic cylinders to said auxiliary cylinders, a pair of safety valves respectively located in said conduit means and being movable between a closed position closing said conduit means and an open position opening said conduit means, said safety valves tending to assume said closed position and respectively moving from said closed position to said open position when the pressure in the corresponding hydraulic cylinder exceeds a selected level so that liquid flowing in said open position of one of said safety valves from the respective hydraulic cylinder to the corresponding auxiliary cylinder moves the respective auxiliary piston from said retracted position to said advanced position, and coupling means operatively connecting said auxiliary pistons with said rotary slide valves, respectively, to reverse the position of said rotary slide valves whenever one of said auxiliary pistons moves to said advanced position.

7. A piston pump for thick liquid pasty masses comprising, in combination, a pair of stationary hydraulic cylinders located parallel to each other, a pair of pumping cylinders for the pasty mass respectively arranged in alignment with said hydraulic cylinders, a pair of pistons each having a first portion slidable in one of said hydraulic cylinders and a second portion slidable in one of said pumping cylinders, gearing means coupling said pistons with each other for movement in opposite directions, supply means for the pasty mass, discharge means for the pasty mass, rotary valve means formed with passages therethrough for alternately connecting each of said pumping cylinders with said supply means and with said discharge means and being movable between a first position in which said passages connect one of said pumping cylinders with said supply means and the other of said pumping cylinders with said discharge means and a second position in which said passages connect said one pumping cylinder with said discharge means and said other pumping cylinder with said supply means, a source of hydraulic pressure, hydraulically operated drive means operatively connected to said rotary valve means for moving said rotary valve means between said positions, and hydraulic control means operatively connected to said drive means and alternately connecting said hydraulic cylinders to said source of hydraulic pressure after their associated pumping cylinder has been connected by said rotary valve means to said discharge means.

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