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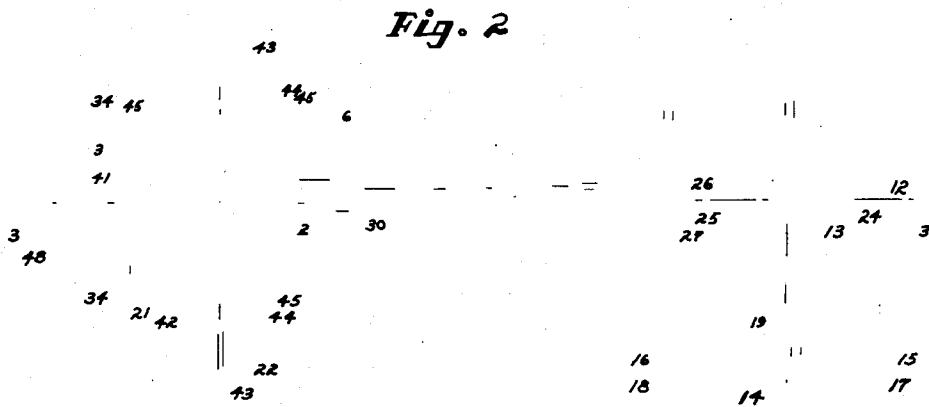
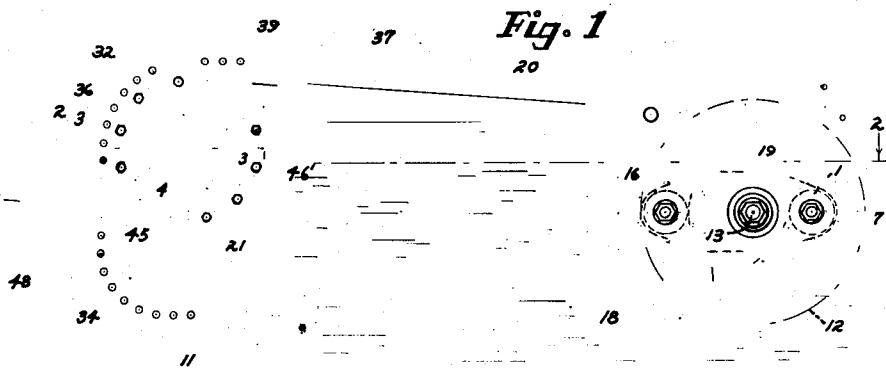
C. I. LONGENECKER

2,448,104

DIFFERENTIAL CONCRETE PUMP

Filed Dec. 6, 1945

2 Sheets-Sheet 1



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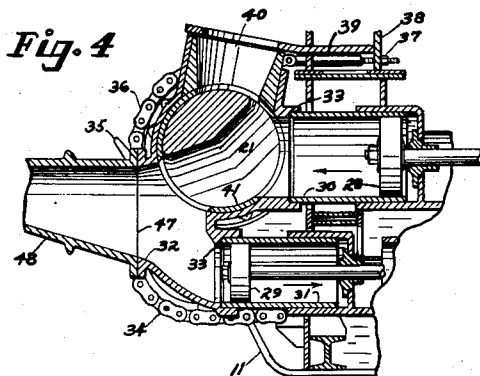
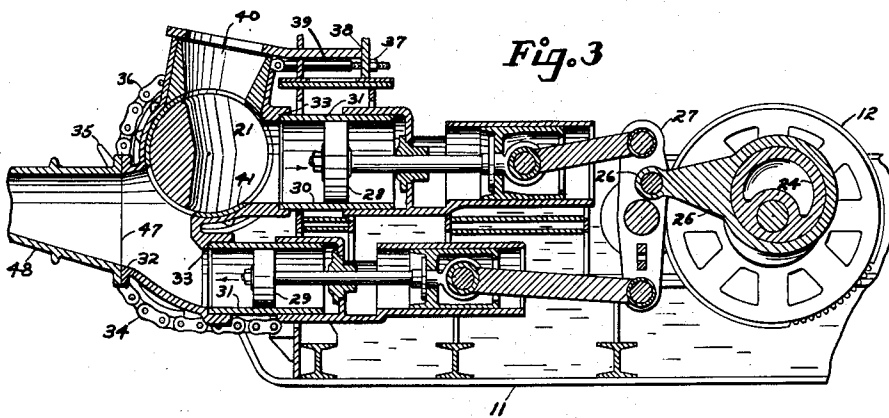
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UNITED STATES PATENT OFFICE

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DIFFERENTIAL CONCRETE PUMP

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Application December 6, 1945, Serial No. 633,091

10 Claims. (Cl. 103—168)

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This invention relates to a pump which may be utilized to force relatively dense, plastic material, such as concrete, through a pipe line to points of use a considerable distance from the source of supply of the material.

It is an object of the present invention to provide a pump for such purposes which is more economical in its construction and more efficient in operation than pumps heretofore employed.

In one of its essential features, the pump of the present invention utilizes a pair of reciprocating, differential-displacement pistons working in communication with a chamber having inlet and outlet portions and a single valve controlling the passage of material through the chamber in timed relation to the propulsive effects of the pistons.

The use of differential-displacement pistons reciprocating in 180 degree phase relationship, and arranged so that part of the discharge from the large piston is received within the cylinder of the small piston while the balance flows into the line, offers many advantages to a concrete pumping system. One of the most notable advantages is the ability to increase the capacity of the pump without increasing the size of the pipe line required to transmit the concrete.

Experience has demonstrated that there is a maximum velocity for pumping concrete which cannot be exceeded without causing so much friction in the line that pumping becomes impractical. The differential pistons increase the capacity of the pipe without increasing the velocity of flow, because of the increase in frequency of the working strokes of the pistons. Hence, a pipe of small diameter may be employed.

The initial cost of the pipe line is one of the important cost factors of a concrete pumping system. The present invention enables a reduction in the cost of pipe by approximately one-third for a system of given capacity. By enabling the use of smaller pipe, the individual pipe sections are reduced in weight by over 40 percent, whether weighed full or empty. When it is realized that a ten foot section of one of the most common sizes of pipe heretofore weighed as much as 230 pounds, when empty, and 780 pounds, when full of concrete, the tremendous advantage in laying out the pipe line preparatory to pumping, supporting it while concrete is being pumped, and taking it up at the conclusion of the operation, will be apparent.

The utilization of a single valve in such an arrangement is another important feature of the invention and results in considerable economy

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because the valve parts used to resist the abrasive action of a gritty material, such as concrete, are necessarily expensive, and where wear does occur requiring frequent replacement of parts, the present invention results in considerable saving.

The invention likewise provides means for transmitting concrete through the pipe line in impulses of less duration, thereby making for smoother operation and permits the capacity of the pump to be materially increased with the added advantage that it does not substantially affect the power requirements. Furthermore, the arrangement of the parts is such that a single valve can be employed with two pistons, and the working chamber is kept constantly clean of stagnant bodies of concrete which would otherwise set up, resulting in "channeling," and eventually disrupt operations.

Reference may be had to the accompanying drawing illustrating one embodiment of the invention, wherein:

Fig. 1 is a side elevation of the pump; Fig. 2 is a plan view taken in section on the line 2—2 of Fig. 1; Fig. 3 is a side elevation in section taken on the line 3—3 of Fig. 2; and Fig. 4 is a view similar to Fig. 3 showing the valve of Fig. 3 in the other position which it occupies.

The pump is mounted on any suitable frame or chassis 11 which may be provided if desired with wheels or other transporting means. A power source (not shown) causes rotation of a gear 12 mounted on a shaft 13 journaled on the frame 11, and the shaft 13 actuates the pistons and the valve.

Secured to one end of the shaft 13 is a cam 14 which actuates rollers 15 and 16 mounted on arms 17 and 18, one on either side of the cam. The arm 17 is pivotally hung from the frame above the cam and the arm 18 is pivotally mounted upon the frame at a point below the cam. The two arms are secured together by a yoke 19 which is slotted to permit the shaft 13 to extend through it and, hence, under the influence of the cam the arm 18 oscillates back and forth and imparts the desired reciprocatory movement to the valve rod 20 which actuates the pump valve 21. The surface of the cam provides the required dwell between movements of the valve and causes relatively rapid movement at the end of each stationary period. The amount of throw of the valve may be adjusted by connecting the rod 20 at different points on the arm 22, the latter being secured to the end of one of the trunnions extending from the oscillating valve.

The shaft 13 also carries an eccentric 24 on

which is journalled a connecting rod 25, which is pinned at 26 to a walking beam 27, the ends of which are connected to pistons 28 and 29 working in cylinders 30 and 31 respectively. Cylinder 30, which is arranged directly above cylinder 31, has a cross sectional area, as herein shown, of approximately twice that of cylinder 31 and since the stroke of each piston is the same, it will be clear that the displacement of the large piston is twice that of the smaller.

The valve housing, or working chamber 32, is arranged to be readily assembled or disassembled in communication with the ends of the cylinders 30 and 31, and for this purpose openings are provided in the valve housing which will register with the ends of the cylinders, and gaskets 33 may be employed to seal the connection. A pair of chains 34 are secured to the frame below the valve housing and may be drawn over suitable tracks on the exterior of the housing and coupled by quick acting levers 35 secured to chains 36 extending over the top of the housing to points of securement on the frame.

Adjustment of the length of each chain strand may be made by taking up a nut 37, which bears against a suitable bracket 38 mounted on the frame and is threaded on a rod 39 secured to one end of the chain and extending through an aperture in the bracket. Ready disassembly of the valve housing from the cylinder is highly desirable in order to permit replacement of the entire valve chamber and valve with a new assembly where job conditions require continuous, uninterrupted operation. The present invention permits replacement to be made in as short a time as fifteen minutes, which ordinarily permits resumption of pumping without requiring a clean-out of the entire pipe line.

The top of the valve housing 32 is provided with an inlet opening 40, which is of the same order of size as the cross section of the large cylinder 30. This opening leads downward and communicates with the inlet portion of the working chamber, the latter including a portion which is cylindrical in shape about a horizontal axis extending at right angles to the direction of movement of the pistons 28 and 29. The axis of the cylindrical portion is in nearly the same horizontal plane as the axis of the cylinder 30. Mounted tightly in the cylindrical portion of the valve housing is a cylindrical liner 41 of hard, abrasion-resisting material having three ports which communicate with: first, the inlet to the pump; second, the passage leading to the large cylinder 30; and third, the outlet which communicates with the smaller cylinder 31 and the discharge outlet from the pump. The last mentioned port is disposed in the lower left hand quadrant of the liner 41, as shown in Fig. 3, and the upper end of it is substantially above the bottom of the cylinder 30.

Mounted for oscillating movement within the valve housing is a plug valve 21 having suitable clearance with the liner 41 referred to above. The end portions 42 of the valve plug are provided with trunnions 43 journalled in bearings mounted by spiders 44 secured by bolts 45 to the housing. Attached to the outer end of one of the trunnions is the aforementioned arm 22 which oscillates the valve.

The end portions of the valve 21 are full cylinders and the intermediate portion is channeled out at 46 to provide passages for flow of material through the valve. The ends of the liner 41 are retained by rings 46' to which the spiders 44 are

secured and extending through these rings are the bolts 45 which support the valve in the housing 32. If desired, packing may be inserted between the ends of the valve plug and the housing.

In Fig. 3 the valve is shown in the position it occupies while concrete is being drawn into the large cylinder 30. It will be seen that in this position the valve does not entirely close the outlet port in the liner 41, but it blocks it sufficiently so that when pumping material, such as concrete, there is no back-flow from the line because of the stowing characteristic of concrete. When in this position, the piston 28 is drawing concrete through the inlet opening 40 and into the piston working cylinder 30.

As previously stated the amount of movement of the valve may be adjusted so that the degree of closure may vary to meet the requirements of different concrete mixtures. In some cases it may be desirable to close the openings entirely and the invention is therefore not to be limited in this respect.

The lower part of the working chamber is provided with an outlet 47, the top of which is only slightly below the top of the outlet port in the valve liner plate 41, and the bottom of which slopes downward to the bottom of the small cylinder 31. The top of the small cylinder 31 is arranged closely adjacent the bottom of the valve plug, but is offset as shown in Fig. 3 from the end of the cylinder 30 so that the entrance to the cylinder 31 is substantially in vertical alignment with the lower edge of the outlet opening of the liner sleeve 41. With the valve as shown in Fig. 3, the smaller piston 29 is expelling concrete through the outlet 47 through a channel, which is not materially larger in cross section than the cross section of the piston 28, and back-flow into the larger cylinder is effectively prevented by the aforesaid valve.

As the pistons are completing their respective strokes, i.e., the large piston drawing in concrete while the small piston is expelling it, the valve is oscillated to the position shown in Fig. 4, in which position the inlet 40 to the pump, while not entirely closed for pumping concrete, is sufficiently closed so that the full propulsive effect of the large piston 28 causes movement of the concrete from the cylinder 30 through the valve and the outlet passage in the liner 41.

Not all the concrete expelled by the large cylinder goes into the pipe line 48 which communicates with the outlet opening 47, but instead approximately half of this expelled concrete is forced into the smaller cylinder 31 during the return stroke of the latter. Since the two pistons are each connected to the walking beam 27, the pressure which the concrete exerts on the face of the piston 29 reduces by substantially one-half the load which the engine would otherwise have to exert on concrete in the large cylinder.

The remainder of the concrete expelled by the large cylinder i.e., the excess which does not go into the cylinder 31, passes through the outlet 47 into the pipe line, and as previously stated, the amount of concrete so discharged is quantitatively equal to the amount expelled by the small piston during its propulsion stroke. The pipe line need only be large enough in cross section to accommodate the displacement of the small piston, and in practice it should be of the same order as the cross sectional area of the cylinder in which the small piston operates.

By providing a continuously open and substantially unobstructed passage in the lower or outlet

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portion of the working chamber connecting the outlet section and the pipe line with the smaller cylinder, concrete may flow in a direct path to the outlet when the small piston is exerting pressure. When the valve is shifted to its other position, thereby providing a lateral opening in this passageway, concrete under pressure from the large piston may flow through the valve in a substantially straight path to the outlet section. This results from the disposition of the outlet section on the opposite side of the working chamber from the pressure members and in substantially parallel but overlapping relation with respect to each. The arrangement of these passages is an important feature of the invention as it is applied to the art of pumping material such as concrete, for unless properly arranged, the pump may clog and cause an interruption of operations.

The invention having been described, what is claimed is:

1. A pump for concrete and the like comprising a working chamber having an inlet portion and an outlet portion, a pair of cylinders communicating with said respective portions, reciprocating pistons operating in timed relation in said cylinders to create pressure alternately in said chamber portions, the piston creating pressure in the inlet portion having greater displacement than the piston creating pressure in the outlet portion, and a single valve disposed within the inlet portion movable to check alternately back-flow during the pressure strokes of the respective pistons, said valve during the suction stroke of the larger piston providing communication between the inlet of the pump and the cylinder containing the larger piston and during the suction stroke of the smaller piston providing communication between the two cylinders.

2. A pump for concrete and the like comprising a working chamber having an inlet portion and an outlet portion, a pair of cylinders communicating with said respective portions, reciprocating pistons operating in timed relation in said cylinders to create pressure alternately in said chamber portions, the piston creating pressure in the inlet portion having greater displacement than the piston creating pressure in the outlet portion, means interconnecting the pistons so that pressure exerted on the piston having lesser displacement reduces the load on the other piston, and a single valve disposed within the inlet portion movable to check alternately back-flow during the pressure strokes of the respective pistons, said valve during the suction stroke of the larger piston providing communication between the inlet of the pump and the cylinder containing the larger piston and during the suction stroke of the smaller piston providing communication between the two cylinders.

3. A pump for plastic concrete mixtures, comprising adjacent open-ended primary and secondary working cylinders; a chamber adjoining and communicating with the open ends of the respective cylinders, said chamber also having an inlet and an outlet, the latter being in constant open communication with said secondary cylinder and disposed to receive substantially unobstructed discharge from each cylinder; means for alternately expelling the plastic mixture from the respective cylinders in differential quantities, those discharged from the primary cylinder being greater than those discharged from the secondary cylinder; a single valve in said chamber for placing the primary cylinder in communication with the chamber inlet during the discharge period of

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the secondary cylinder while preventing back-flow of the mixture from the chamber to said primary cylinder, whereby mixture discharged from the secondary cylinder will traverse the chamber to the outlet, said valve during the discharge period of the primary cylinder cutting off communication between such cylinder and the inlet, and establishing communication between said cylinder and the chamber, whereby a portion of the mixture discharged from the primary cylinder may pass through the chamber to the secondary cylinder while the remaining portion will traverse the chamber to the outlet; and means for actuating said valve.

4. A pump for forcing plastic concrete material and the like through a pipe line, comprising a cylinder having an open end; a piston reciprocable in said cylinder; means connected to the cylinder providing a continuously open substantially unobstructed passageway leading from said open cylinder end to the pipe line, said passageway having a lateral port through which the material may be supplied thereto; a valve controlling said port; means for actuating said valve in timed relation to the movements of said piston, whereby to substantially close the port during the pressure stroke of the piston to prevent back-flow of the material through the port, and to open the port during the return stroke of the piston; and mechanism operable while the valve is open to force through said port and passageway a quantity of material in excess of the displacement of the piston, whereby to supply a charge of material to said cylinder and simultaneously discharge a portion of the material to the pipe line.

5. A pump for concrete and the like comprising a working chamber having an upper portion communicating with an inlet and a lower portion in constantly open communication with an outlet to which a pipe line may be attached, a pair of open-ended cylinders communicating with said portions, pistons exerting pressure alternately in said cylinders, the piston exerting pressure in the cylinder connected to the lower portion of said chamber having less displacement than the other piston, and a single valve disposed within the upper portion of the chamber arranged to check backflow from the lower to the upper portion of the chamber during the pressure stroke of the piston having less displacement while providing communication between the inlet and the cylinder containing the other piston, said valve being movable to another position for checking back-flow through the inlet while directing flow from the upper portion into the lower portion during the pressure stroke of the piston having greater displacement.

6. A pump for pumping concrete and the like through a pipe line comprising a working chamber having an inlet portion and an outlet portion, said outlet portion having an open passageway leading into the pipe line and a lateral port communicating with the inlet portion of the chamber, a cylinder communicating with the end of the passageway and forming an extension thereof, a second cylinder of larger cross sectional area communicating with the inlet portion of the chamber, pistons operating in said cylinders in 180 degree phase relation, and a single valve disposed within the inlet portion arranged to alternately check back-flow from the pistons during their pressure strokes.

7. A pump for pumping plastic material such as concrete comprising a working chamber having an inlet and an outlet portion, substantially

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parallel cylinders communicating with said portions, the cylinder communicating with the inlet portion having a greater cross-sectional area than the cylinder communicating with the outlet portion, the outlet portion having an outlet section remote from but substantially parallel to the aforesaid cylinders and in overlapping relation to each, pistons operating alternately in said cylinders, and a valve disposed within the inlet portion of the chamber arranged to check back-flow from the pistons during their respective pressure strokes, said valve when checking back-flow from the larger piston providing a substantially straight path from the larger cylinder to the outlet section.

8. In a pump for plastic concrete mixtures and the like, a working chamber having an upper inlet portion and a lower outlet portion, an outlet section in the outlet portion extending from one side of the chamber, substantially parallel cylinders communicating with said portions respectively and extending from the opposite side of the chamber, the cylinder communicating with the inlet portion of the chamber having greater cross-sectional area than the other cylinder, pistons operating alternately in said cylinders, and an oscillating plug valve disposed within the inlet portion of the chamber arranged to check alternately back-flow from the pistons, said valve when checking back-flow from the larger piston providing a substantially straight path from the larger cylinder to the outlet section.

9. In a differential piston concrete pump having an inlet and an outlet and a working chamber

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including a pair of cylinders with alternately operating pistons disposed therein whose face areas are in the ratio of substantially two to one, a single mechanically operated valve disposed within the chamber arranged to alternately check back-flow from the pistons during their respective pressure strokes, said valve while checking back-flow from the smaller piston admitting concrete through the inlet of the pump, and while checking back-flow from the larger piston, providing communication between said cylinders.

10. In a differential piston concrete pump having an inlet and an outlet and a working chamber including a pair of cylinders with alternately operating pistons disposed therein whose face areas are in the ratio of substantially two to one, a single oscillating plug valve disposed within the chamber arranged to alternately check back-flow from the pistons during their respective pressure strokes, said valve while checking back-flow from the smaller piston admitting concrete through the inlet of the pump, and while checking back-flow from the larger piston, providing communication between said cylinders.

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