(No Model.) 3 Sheets—Sheet 1.

A. G. FULLER & B. H. COFFEY.

METHOD OF AND APPARATUS FOR PUMPING GRITTY FLUIDS.

No. 547,576. Patented Oct. 8, 1895.

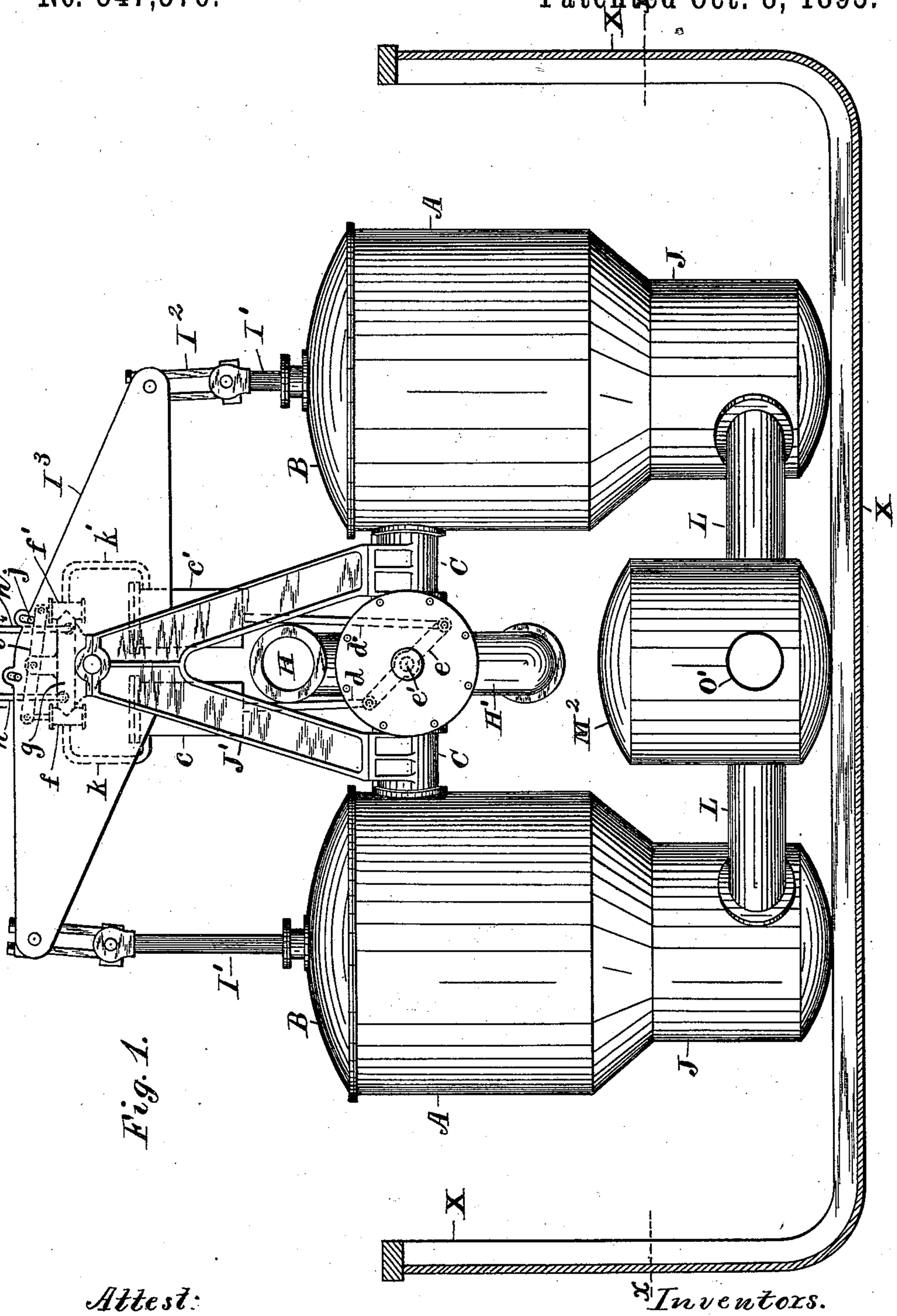

Fig. 1.

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Fig. 7.

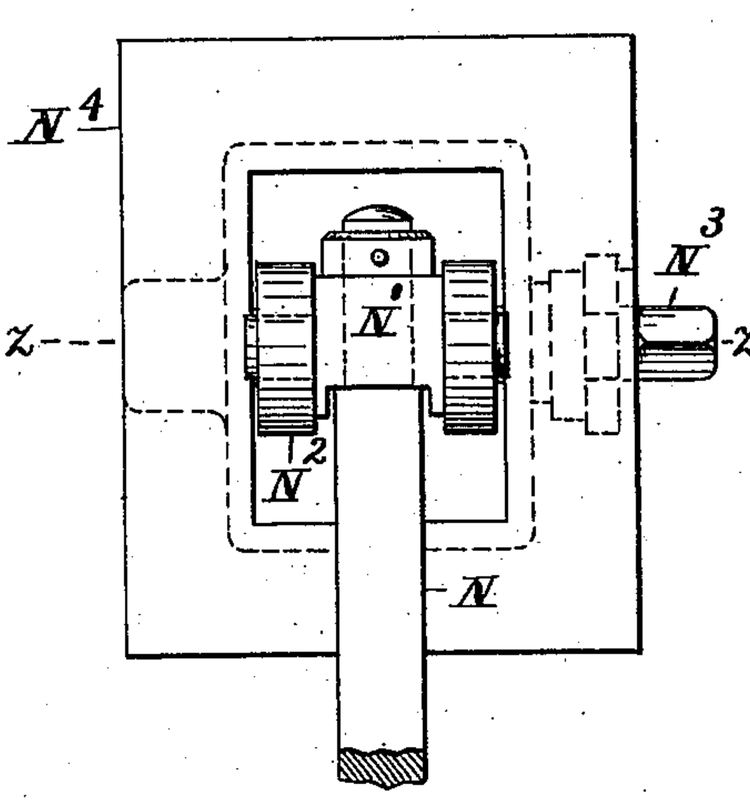


Fig. 3.

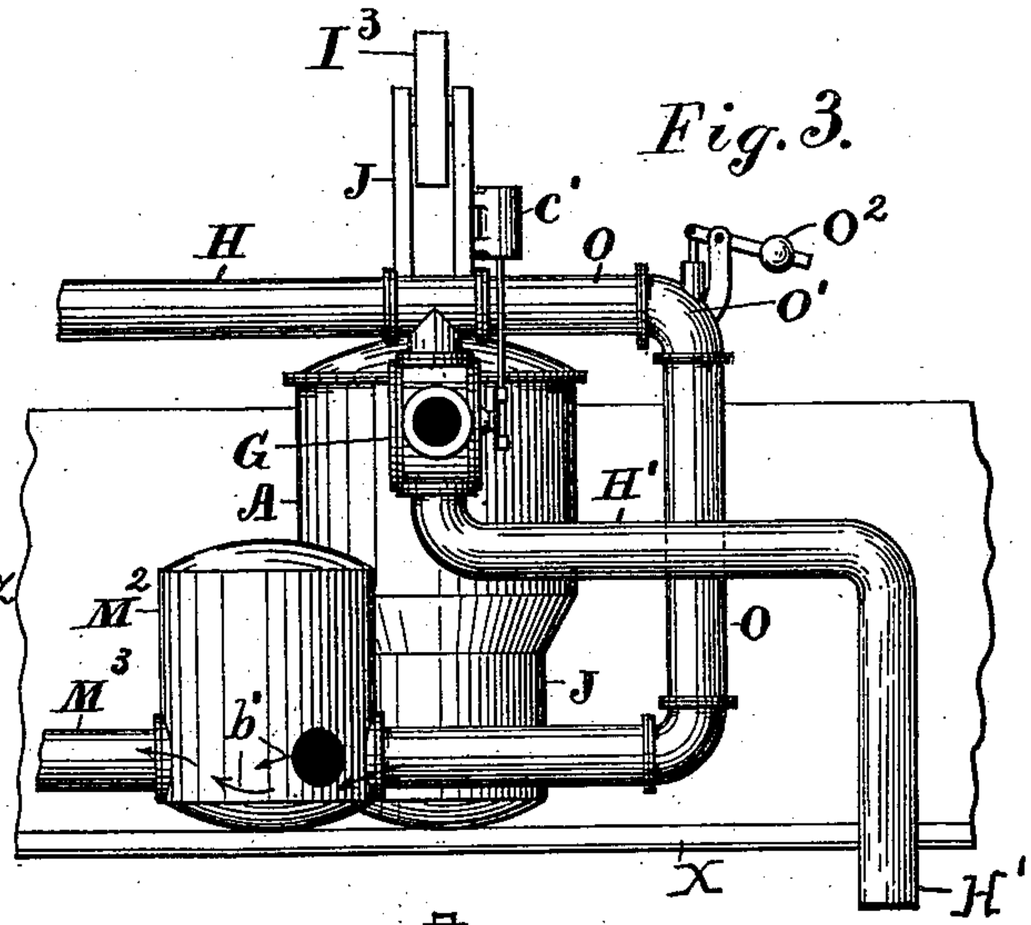


Fig. 8.

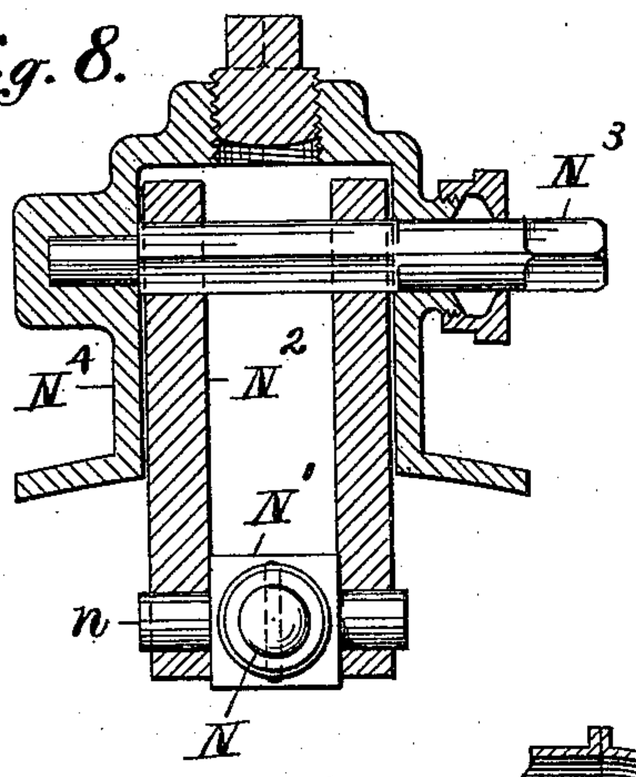
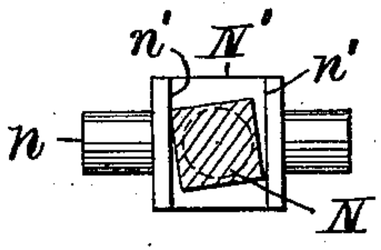


Fig. 9.



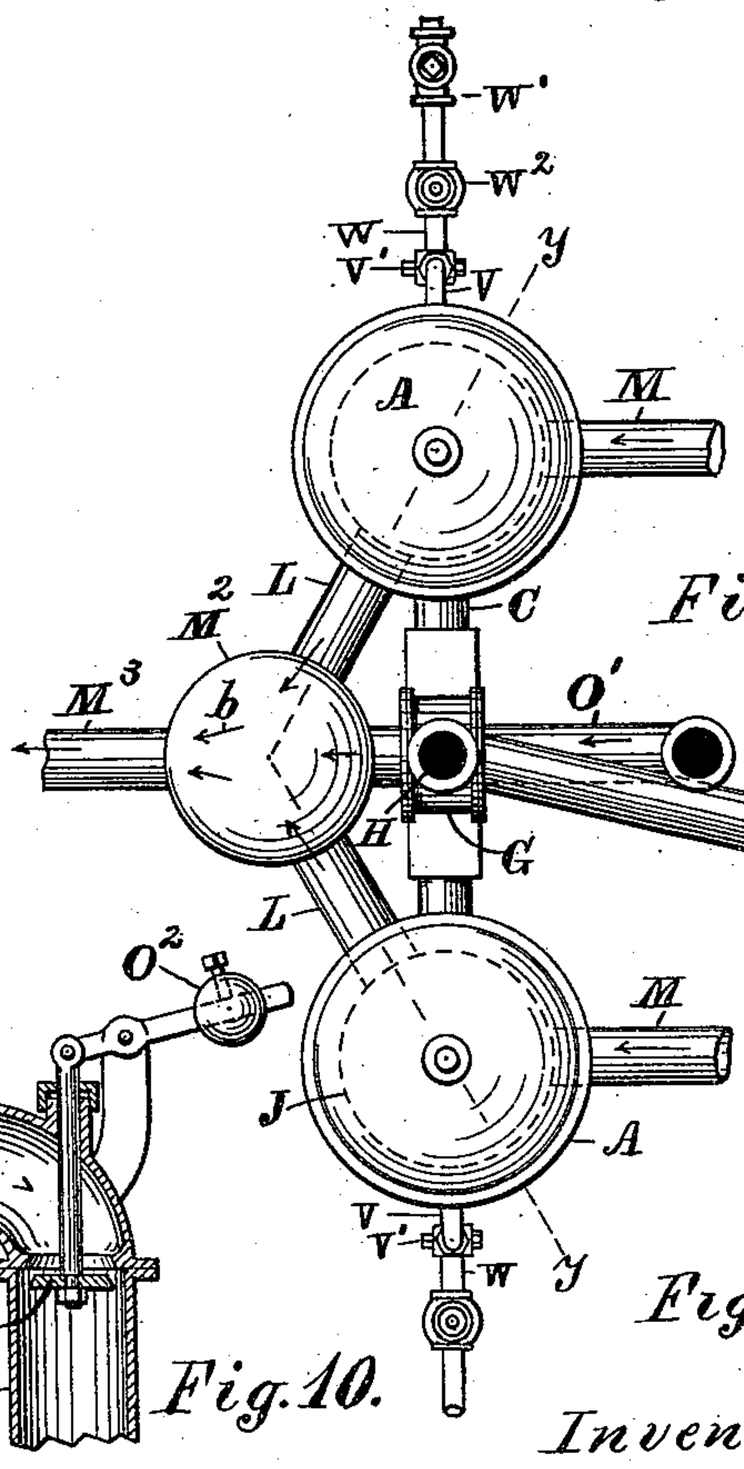


Fig. 2.

Fig. 10.

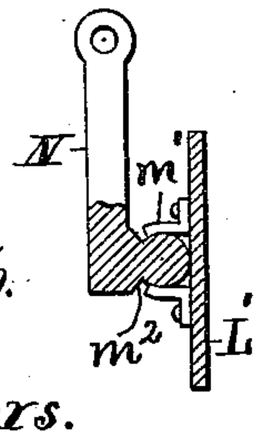


Fig. 6.

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(No Model.) 3 Sheets—Sheet 3.

A. G. FULLER & B. H. COFFEY.

METHOD OF AND APPARATUS FOR PUMPING GRITTY FLUIDS.

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Fig. 4.

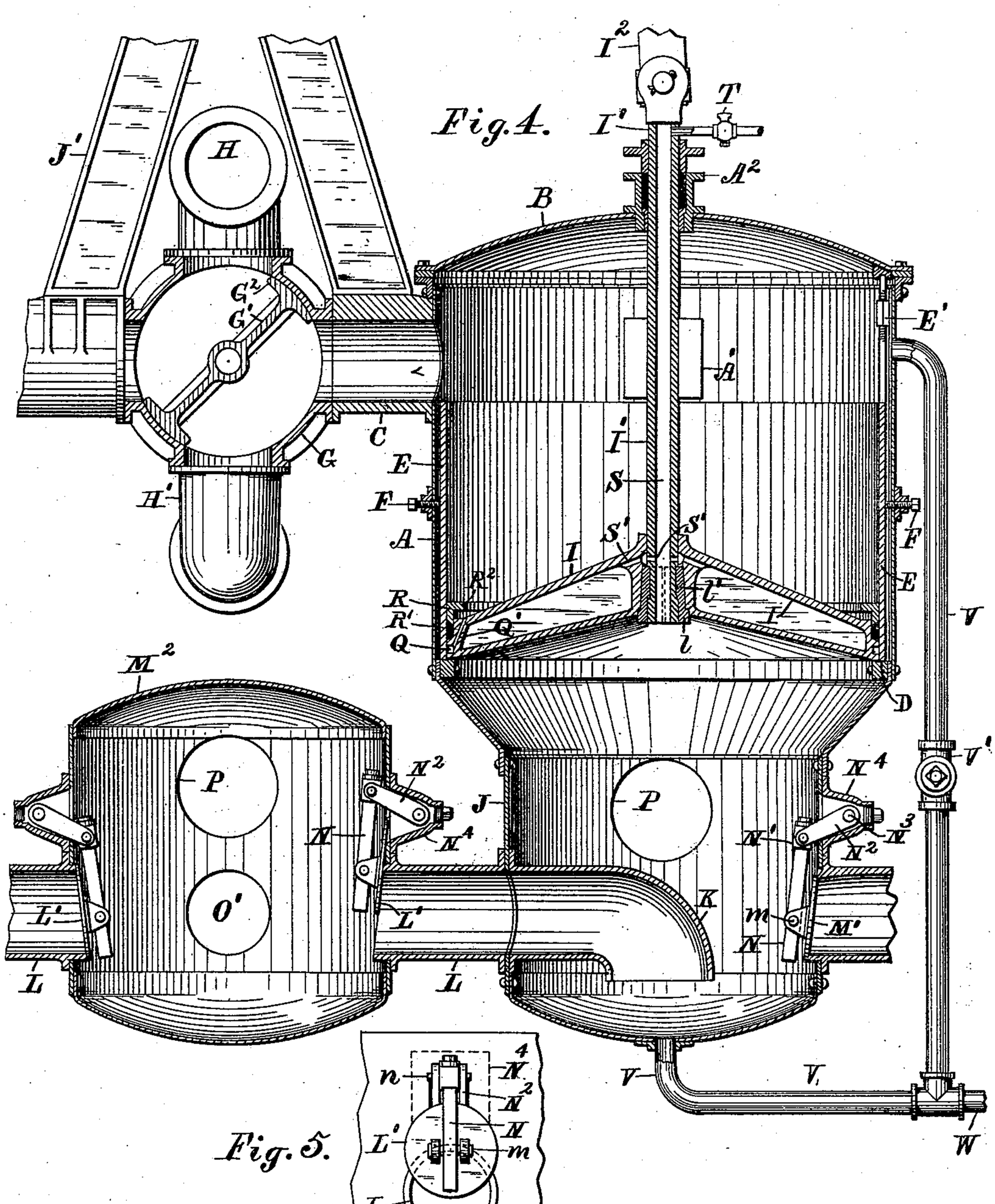

Fig. 5.

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Albert G. Fuller, per
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UNITED STATES PATENT OFFICE.

ALBERT G. FULLER, OF NORTH WILBRAHAM, MASSACHUSETTS, AND BARTON H. COFFEY, OF NEW YORK, N. Y., ASSIGNORS TO THE INTERNATIONAL CONTRACTING COMPANY, OF NEW JERSEY.

METHOD OF AND APPARATUS FOR PUMPING GRITTY FLUIDS.

SPECIFICATION forming part of Letters Patent No. 547,576, dated October 8, 1895.

Application filed March 9, 1894. Renewed June 27, 1895. Serial No. 554,266. (No model.)

To all whom it may concern:

Be it known that we, ALBERT G. FULLER, of North Wilbraham, county of Hampden, and State of Massachusetts, and BARTON H. COFFEY, of New York, county and State of New York, citizens of the United States, have invented certain new and useful Improvements in Methods of and Apparatus for Pumping Gritty Fluids, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

The object of this invention is to furnish a method of and construction for moving gritty fluids by means of a cylinder and piston without permitting the intrusion of the grit into the piston-packing. In the present invention a single-acting pump is used, the piston of which is moved mechanically through its suction stroke to draw the sand or gritty fluid into a space upon one side of the piston and the piston being then moved through its discharge stroke by a pressure of clean fluid applied to its opposite side. By employing two cylinders and connecting the pistons to move simultaneously in opposite directions, the pressure of clean fluid upon one piston operates to pull the other piston through its suction stroke, thereby expelling the clean fluid from one cylinder as it is forced into the other. A pressure of clean fluid is thus constantly maintained upon one side of the piston at all times in excess of the pressure of the gritty fluid upon the opposite side, and by permitting a regulated leakage of the clean fluid past the edge of the piston the wall of the cylinder is washed by the clean water in advance of the piston throughout the discharge stroke of the latter.

The apparatus is especially adapted for use in dredging operations, where it would be located upon a boat floating in the water where the dredging was required, the sand-pipe being arranged to draw the mud from the bottom of the water. In such case a force-pump would be arranged with its suction-pipe immersed in the surface of the water and thus drawing a clean fluid to actuate the pistons. By arranging the cylinders vertically the clean fluid would be forced into the same at the upper end and directed alternately into either cylinder by a suitable shunt-valve. By discharging the clean fluid from the upper end of each cylinder through an outlet-pipe back to the water-level the power required to discharge the water from the cylinders would be greatly reduced, as the columns of clean fluid would thus balance one another. To prevent the intrusion of the sand into the piston-packing, the cylinder is preferably formed at the bottom with a sand-chamber and the cylinder, with the piston at the top, is preferably primed or filled with clean water before the pumping is commenced. The movement of the piston then draws the gritty fluid into the sand-chamber, while the cylinder itself above such chamber remains filled with the cleaner fluid. The suction-pipes for the sand are preferably extended inside of the sand-chambers to apply the check-valves thereto, and the valves are provided with means for sliding them transversely upon their seats when obstructed by an accumulation of sand or stones within the chamber. The two sand-chambers may produce a continuous discharge through the main delivery sand-pipe by connecting their outlet-pipes with an air-chamber, into which such pipes would be projected and provided with similar check-valves.

The invention also includes other details of constructions for renewing the worn surface of the cylinder, for discharging air when accumulated upon the under sides of the pistons, for flushing the outlet-pipes of the sand-chambers when clogged with sand, for relieving the pressure upon the force-pump when shifting the water-current from one cylinder to the other, and for directing the fluid from the force-pump (by a by-pass) into the main delivery sand-pipe when the pumps are obstructed.

These improvements will be understood by reference to the annexed drawings, in which—

Figure 1 is a side elevation of the apparatus. Fig. 2 is a plan of the apparatus; Fig. 3, a side elevation with one of the cylinders and sand-chambers removed; Fig. 4, a vertical section where hatched at the center line of one cylinder with the air-chamber in section on line *y y* in Fig. 2. Fig. 5 shows, in elevation, the inner wall of the air-chamber

with check-valve moved laterally. Fig. 6 is a view, partly in section, of an alternative construction for the check-valve joint; Fig. 7, the inner face of the bonnet and valve-shifting crank. Fig. 8 is a section where hatched on line *z z* in Fig. 7. Fig. 9 shows the under side of the trunnion-pivot with section of the valve-stem. Fig. 10 is a section of the by-pass valve. Figs. 2 and 3 are drawn upon a smaller scale than Fig. 1. Figs. 2, 3, 4, 5, and 10 are drawn upon a larger scale than Fig. 1, and Figs. 6, 7, 8, 9, and 11 upon a still larger scale.

The shell A of the cylinder is formed with removable head B and nozzle C at one side adjacent to the head. An annular seat or shoulder D is formed at the lower end of the cylinder, and a removable lining E is set in contact with the same and centered within the cylinder by screws F, inserted through shell A. Expansion-bolts E′ are provided to press the cylinders down. The two nozzles C have connection with the opposite sides of a cylindrical casing G, containing a shunt-valve G′. At the top of the casing is provided a water pressure pipe H to the force-pump and at the bottom a connection H′ to a discharge-pipe, termed the "siphon-pipe" herein.

I designates the pistons with rods I′, connected by links I^2 to the opposite ends of a beam I^3. The beam is pivoted upon frames J′, which are shown supported upon the nozzles C. A sand-chamber J is projected from the bottom of each cylinder and provided at one side with an outlet-pipe L, which is extended through the wall of an air-chamber M^2. Within the sand-chamber the pipe is formed with an elbow or mouth K, turned toward the bottom of the chamber, which is shown of concave shape.

M designates the inlet-pipe of each sand-chamber, which is projected inside of the wall of the same and suitably connected with a suction-nozzle, which would be suitably supported in the mud or sand to be pumped. Check-valves L′ and M′ are applied, respectively, to the inner ends of the pipes L and M, being formed upon the back with a transverse joint *m*, to which is hinged a pivot-arm N. The outer end of the arm is swiveled in a trunnion-socket N′, which is hinged by pivot *n* in the end of a crank N^2, which is formed of two arms with the socket N′ fitted between their outer ends. Stones and gravel are frequently mixed with the sand in dredging operations, and such stones frequently lodge beneath the check-valves and prevent their approach to the seat. The pivot *n* forms a hinge on which the check-valve swings to and from its seat so long as it is unobstructed, but when stones lodge beneath the valve the swiveling of the arm within the trunnion-socket permits the arm to turn, and thus enables the valve to bear partly upon its seat and thus close the aperture approximately in spite of such obstruction. When the pumping is stopped, the stones or sand often accumulate behind the valve, so that it is unable to swing back from its seat, and the crank N^2 is provided to slide the valve across its seat in such emergency and thus clear the outlet. A priming of water then serves to wash away the stones or sand through such opening and clears the way for the valve to operate normally. The crank N^2 is shown mounted upon a shaft N^3, secured transversely within a removable bonnet N^4, adjacent to the inlet-pipe, the end of the shaft being projected outside the bonnet and fitted to apply a wrench or handle to turn it when required. The walls of the bonnet serve to limit the movement of the crank in both directions, and thus operate to set the crank with the arm N and its attached valve in an operative position. The bonnet is provided, as shown in Figs. 7 and 8, with a closed bearing upon one side and a stuffing-box upon the other, and the shaft N^3 is squared between the bearings and the arms of the crank N^2 are fitted to such squared portion, which greatly facilitates the introduction of the parts into their places or their removal for repairs. The shaft N^3 may be prevented from longitudinal motion by any convenient means, but such means is not shown in the drawings, as it is already well understood that a collar or screw may be used for such purpose. Such fixtures are shown applied to all the check-valves. As shown in Fig. 4, the sand-outlets L both enter obliquely one side of the air-chamber near its lower end. A delivery sand-pipe M^3 is connected with the air-chamber at about the same level, the space above the pipes serving as an air-reservoir to equalize the flow of the fluid in such delivery-pipe. By this arrangement the alternate flow of fluid from the pipes L is directed obliquely toward the delivery-pipe M^3, as indicated by the arrows *b* in Fig. 2, and serves to scour the bottom of the air-chamber, as indicated by the arrows *b′* in Fig. 3.

By applying the check-valves L′ and M′ to the inner ends of the pipes L and M they are located within the chambers J and M^2, and may thus be inspected and repaired much more readily than if located in the pipe itself intermediate to the chambers. In Fig. 4 manholes P are shown upon the chambers to afford access for such inspection. It will be observed that the valves are connected with their hinge-pivots *n* by a universal joint, which is formed by the swiveling of the arm N and the connection of the valve therewith by the transverse joint *m*. The valve is thus enabled to turn or tip in any plane and to thus seat itself approximately when an obstruction opposes its movement at any point. To prevent an excessive tipping of the valve, the arm N is extended beyond the joint *m* and thus limits the tipping of the valve in both directions upon such joint. The twisting of the arm in the trunnion-socket is limited by making the arm square below the socket and providing stops *n′* upon the bottom end of such socket adjacent to the sides

of the arm, as shown in Fig. 9, where the arm is shown in section turned in contact with such stops. It is obvious that any other form of universal joint could be used, and in Fig. 6 I have shown the arm N connected with the valve by a ball-and-socket joint m' with opposed shoulders m^2 to limit the movement, in which case the arm would not need to be swiveled at its upper end. Water under pressure would be supplied through the water-pressure pipe H from any suitable source, as by a duplex steam force-pump. The vibrating plug of the shunt-valve is shown as a plate which operates with the passages in the casing G as a four-way valve, being adapted to direct the fluid from the connection H into either of the nozzles C, the other nozzle being at the same time connected with the siphon-pipe H′. The plug G′ is shown in Fig. 1 turned to direct the fluid into the right-hand cylinder A, but in Fig. 4 is turned oppositely to discharge the fluid from such cylinder to the siphon-pipe H′. The valve-plug G′ is fixed to a spindle e', which may be oscillated automatically by a suitable connection with the walking-beam I, and thus directs the fluid under pressure alternately upon the tops of the pistons I. The downward movement of the right-hand piston, which would be effected by the adjustment of the shunt-valve, (shown in Fig. 1,) then operates to elevate the opposite piston mechanically and to discharge the clean water above such piston from the cylinder. The face of the valve-plug is formed as a cylindrical segment G^2, made a little narrower than the receiving-passage from the supply-pipe H, and thus permits a certain portion of the fluid to enter the casing G as the plug moves over such passage. The complete stoppage of the water-current in the water-pressure pipe H would subject the same to a needless shock or jar, and if such current were propelled by a positive force-pump it would also impose a violent shock or strain upon such pump. By making the face of the valve-plug narrower than the passage a complete stoppage of the flow is avoided, with very little loss of the water.

Sand-pumps are very liable to accidental stoppage, and when this results in a stoppage of the flow through the delivery sand-pipe the latter becomes obstructed by the settling of the sand therein. Means is therefore provided to preserve a flow of water in such delivery-pipe. For this purpose a pipe O, with by-pass valve O′, is extended from the pipe H above the shunt-valve to the air-chamber M^2. In case of any stoppage in the movement of the pistons the water under pressure is then delivered to the sand-pipe M′ and prevents the settling of the sand therein. Such outlet for the water under pressure also relieves the pumps from injury by any sudden stoppage of their discharge. To prevent the clogging of the air-chamber in such an event and the choking up of the check-valves L′ therein, the pipe O is carried, as shown in Figs. 2 and 3, to the same side of the air-chamber as the pipes L, and is inserted into the chamber between the same opposite the delivery-pipe M^3. The clean fluid from the pipe O then operates to effectually scour the bottom of the air-chamber, and may be used to maintain the flow in the delivery-pipe M^3 until it is wholly cleared of sand.

From the above statements it will be seen that the by-pass valve thus performs the triple function of preventing over-pressure in the pipe H if the pump be obstructed, of preventing shocks and jars in the pipe H during the shifting of the shunt-valve, and of preventing the settling of the sand within the sand-discharge pipe M′.

In Fig. 2 of the drawings the pipe H is omitted to fully expose the lower part of the pipe O and the pipe M^3; but in Fig. 3 the connection between the pipe H and the air-chamber is fully shown, the pipe H being extended over the top of the shunt-valve and thence downward to enter the air-chamber at the same level as the pipes L. The by-pass valve is shown in Figs. 3 and 10, located in the downward bend of the pipe O. The pipe M^3 would in practice deliver the sandy fluid at any desired elevation, thus offering a certain resistance to the pistons I, and the pressure of fluid required in the pipe H to actuate the pistons would be adapted to drive the pistons against such resistance. The by-pass valve O′ is loaded, as by a weight O^2, with only sufficient force to balance the frictional resistance of the pistons, with their rods and walking-beam, and the friction of the sandy fluid through the outlet-pipes and the air-chamber M^2. Such frictional resistance is, however, very small in proportion to the work actually done by the pistons, and as the by-pass valve requires loading only to balance such frictional resistance it imposes very little additional load upon the force-pump when the pistons I are suddenly stopped. When operating the apparatus upon a dredging-boat X, as shown in Fig. 1, the clean fluid for the force-pumps would be drawn from the surface $x\,x$ of the water about the boat and the pipe H′ would discharge to the same level. The water-line $x\,x$ may represent the surface of a river, bay, or other body of water that requires dredging, and where the apparatus is thus located it is obvious that the clean water required to actuate the pistons may be drawn by a force-pump from the surface of the water-body, while the sand-pump is drawing the mud or silt from the bottom of the same water-body. By discharging the pipe H′ to the same level from which the clean water is drawn, the pipe acts as a siphon-pipe, its length being much greater than the height of the fluid in the cylinders A above the pistons, and thus operating to diminish the pressure above the piston when moving upward upon its suction stroke. In Fig. 1 the pipe H′ is shown extended downward through the bottom of the boat X, but the pipe may be

carried overboard and extended downward to or below the water-line as the pressure within the pipe at the water-level would be the same in any case, and its operation as a siphon upon the fluid in the upper end of the cylinder A would be the same with any arrangement in which the pipe discharges to the same body of water from which the pressure fluid is drawn. The chief pressure above the piston during such stroke is that due to the inertia of the water and the friction in the water-passages. During the forcing stroke the pressure upon the upper side of the piston is produced by the fluid under pressure from the pipe H, and is not only sufficient to discharge the sand from the apparatus to any required elevation, but to overcome the friction of the pistons, their rods, their walking-beam, and of the water in its pipes and passages. The excess of pressure during such downward stroke affords a means of washing the inner wall of the cylinder by a discharge of clean water from the periphery of the piston during the forcing stroke, when the gritty fluid might otherwise force itself upward into the packing R. To discharge such a film of water the piston is formed near its lower end with an annular groove Q, and above such groove with a space adapted to receive a fibrous packing R′, over which an adjustable ring R is fitted. The ring is formed with a flange R^2, which projects inwardly over the top of the piston to receive bolts for compressing the packing as it wears. Such bolts are not shown, as their operation is already well known. The periphery of the piston adjacent to the lower groove is so fitted to the wall of the cylinder that a slight film of water may constantly escape from the groove to the lower side of the piston. During the downward movement of the piston when any sand or gritty fluid would be encountered such film of clean water tends to wash the wall of the cylinder in advance of the piston's movement and thus prevents the intrusion of grit into the packing.

We are aware that water-pressure engines constructed for compressing air have been made with pistons destitute of packing to produce a cheap and durable construction. In such cases the leakage past the piston is an inconvenience and necessitates the provision of special means for disposing of the water as it accumulates in the air-passages. In our construction the leakage is especially desired upon the downward stroke, while it is also necessary (to secure economy of operation with a large pump) to carefully pack the piston. We therefore provide, in addition to the packing, a means for discharging the film of water against the wall of the cylinder during the forcing stroke, and thus secure economy of operation from freedom from cylinder abrasion. We are also aware that pistons have been used with two cup-leather packings and a water-passage leading from the upper side of the piston to the space between the packings. Such a piston when actuated by a reciprocating piston-rod operates, in a single-acting pump, to discharge a film of water downward around the lower packing during the upstroke, but during the downward or forcing stroke the lower cup-leather packing expands and thus arrests the downward discharge. It is during the downward or forcing stroke that the grit tends most strongly to enter the piston packing, and our construction provides means for maintaining the discharge of the water-film during such downward stroke, and thus wholly protects the cylinder from abrasion. We disclaim the constructions just referred to, in which an accidental leakage of water past the piston is tolerated, and in which the wall of the cylinder is washed during the upward stroke only. The cylinder A and sand-chamber J are shown in the drawings formed of sheet-metal shells united by a funnel-shaped connection, which is riveted to the bottom of the shell A and the top of the shell J, the bottom of the latter having a convex head riveted therein. To form the seat or shoulder against which the lower end of the lining E is pressed, a ring is placed within the bottom of the shell A and secured by the rivets which hold the shell and the conical connection together.

The apparatus shown in the drawings represents a cylinder seven feet in diameter, which, with its attached sand-chamber, would weigh several tons. The removable lining E is provided to avoid the handling of such large weights, and to avoid the expense of renewing the entire cylinder when the wearing surface becomes worn. Such lining is very much lighter than the whole cylinder and therefore costs much less to renew, and obviates the finishing of the cylinder internally at any point. By seating the lower end of the lining upon the shoulder D, a joint is readily formed between the lining and the sand-chamber, and none is required at the upper end of the lining, as the nozzle C is connected with the shell of the cylinder above the top of such lining. A manhole A′ is shown in the shell above the top of the lining to afford access when required. With a cylinder of such dimensions having access through a manhole, the lining E may be pressed upon the shoulder D by expansion-bolts E′, which are jammed at one end inside of the head B and at the other end against the top of the lining E. The use of such expansion-bolts avoids the necessity of perforating the head to insert screws, as is required with the screws F in the sides of the shell A, to center the lining E. The piston is shown domed or of conical shape to give it strength, and the air, which is liable to accumulate upon the suction side of a piston, is discharged through an aperture S, extended through the piston-rod for such purpose. The lower end of the aperture is closed by a plug and the aperture is connected with the interior of the piston at the highest point by holes S′. An outlet-pipe with cock T is con-

nected with the aperture upon the side of the piston-rod above the stuffing-box A^2 to discharge the air when required. A water-supply is provided for priming the sand-chamber and its connecting-pipes to produce the required suction when the piston is set in motion, and such supply is arranged for flushing the bottom of the sand-chamber with water when the sand becomes clogged. Such supply is provided in a pipe V, connecting the upper part of the cylinder A with the bottom of the sand-chamber. Such pipe is directed toward the mouth of the elbow K and thus operates to loosen the sand and throw it into such pipe. A cock V′ is provided to open such pipe when required, and a branch pipe W is shown to drain off all the water from the sand-chamber when desired. A cock W′ would be placed in the pipe W to keep it closed at other times and a steam-siphon W^2 be used to drain out the water. (See Fig. 2.) It is immaterial how the shunt-valve is actuated, but means for shifting the same by the pressure of a fluid is shown in Figs. 1 and 3 consisting of hydraulic cylinders *c c′*, which would be provided with trunk-pistons connected by rods *d d′* with a double-armed lever *e* upon the shaft *e′* of the shunt-valve.

Boxes *f f′* for piston-valves are shown connected with a chamber *g*, having inlet and outlet pipes *h h′* for the water-supply. The valve-boxes are connected by pipes *k k′* with the cylinders *c c′*, and the piston-valves are connected by a walking-beam *i*, operated by tappets *j* upon the walking-beam I^3. The tappets operate alternately near the end of the stroke of the pistons I to shift the beam *i* and valves within the boxes *f f′*, thus actuating the rods *d d′* alternately and shifting the shunt-valve in the desired manner. The tappets *j* are shown fitted in slots in the walking-beam I^3 and may be adjusted therein and clamped in a suitable position to operate the shunt-valve in the proper relation to the movements of the pistons I. Any other suitable means may be used to shift the shunt-valve.

The piston-rod I is shown connected with the piston by a device of especial value where the piston is liable to be obstructed by sand or gravel in its downward movement. As the piston is moved downward exclusively by water-pressure, the rod I requires only to lift the piston, and may thus be made detachable from the same in its downward movement. A detachable connection is therefore shown in Fig. 4, consisting of a bushing *l*, having a shoulder *l′* at its lower end and divided longitudinally and fitted to a socket in the hub of the piston. The piston-rod is formed with an annular groove, and the interior of the bushing is fitted to such groove upon the rod and held from longitudinal movement in the piston by the shoulder. The bushing *l* may be applied to the groove upon the rod before the rod is inserted in the piston, and the introduction of the bushing into the hub of the piston then locks the bushing upon the rod. The collar at the lower end of the bushing engages the end of the hub and serves to support the entire weight of the piston, while the loose connection of the bushing with the hub permits the rod to push the bushing downward through the same and detach itself automatically if the piston be obstructed in its downward movement. Such connection also furnishes a means of detaching the piston-rod and drawing it upwardly through the piston, when necessary for repairs, without removing any nut or key. The bushing would be made of non-corrosive metal.

It is obvious that no material change occurs in the volume of fluid circulated in opposite directions through the shunt-valve, as the movement of the pistons I in opposite directions discharges the same amount from one of the cylinders that is admitted to the other. The clean fluid for actuating the pistons may, therefore, be supplied by a force-pump having its suction connected with the pipe H′, so as to draw the water from one cylinder which is forced into the other. In such case means would be required to compensate for the fluid supplied to the water-packing grooves Q in the pistons I, and such necessity is avoided, with the arrangement shown herein, by feeding the force-pump from a given body of water and discharging from the cylinders to the same water-body.

From the above description it will be seen that the apparatus affords an efficient means of moving a gritty fluid by a piston without exposing the piston or the cylinder-lining to contact with such fluid. It also furnishes means for maintaining the flow of fluid in the delivery sand-pump M^3 in case the pumps are obstructed, and for clearing away all such obstructions in the most convenient manner by a water-current.

The arrangement of the shunt-valve chamber G between the sides of the cylinder shells A at their upper ends produces very short connections C to such cylinders and forms very direct passages from the same to the pressure-pipe H and discharge-pipe H′. The arrangement of the gallows-frames J′ upon the pipe connections C between the cylinders and the shunt-valve chamber G produces a very light and cheap construction, which, in connection with the union of the air-chamber M^2 with the sand-chambers J by the short pipes L, renders the entire apparatus self-contained and adapted to preserve the mutual relation of all the parts when set upon a dredging-boat.

The apparatus may be arranged within the boat to rest upon the bottom of the same, or the shells A may be attached to the framing of the boat in any suitable manner.

Having thus set forth the nature of the invention, what is claimed herein is—

1. The method herein described for cleansing the wall of the cylinder in pumping gritty fluids within a cylinder having a moving pis-

ton, which consists in discharging a film of water past the edge of the piston during the forcing stroke, as herein set forth.

2. The method of pumping gritty fluid from a body of water containing both clean and gritty water by means of two cylinders having pistons connected mechanically, which consists in drawing the clean fluid from the water level, forcing the same alternately into the two cylinders upon the upper surfaces of the pistons, alternately drawing in and discharging the gritty fluid to and from the lower sides of such pistons, and discharging a film of water downward at the edge of each piston during the forcing stroke, substantially as set forth.

3. A sand pump comprising the cylinders A having pistons with rods I′ at the top, nozzles C upon the adjacent sides of the cylinders, the shunt valve casing G connected at opposite sides to the two nozzles, the gallows frames J′ supported upon the nozzles C with walking beam I^3 connected to the piston rods, the water pressure pipe H connected with the top of the casing, a siphon pipe H′ connected with the bottom of the casing, sand chambers at the lower ends of the cylinders with inlet and outlet pipes for sand, and suitable check valves upon such inlet and outlet pipes, the parts being arranged as set forth, and the shunt valve operated to direct the water from the pipe H alternately into the upper ends of the cylinders and thence into the siphon pipe H′, substantially as herein set forth.

4. In a sand pump, the upright cylinder formed with sheet metal shell A having suitable head with stuffing box upon the top, the sand chamber J of smaller diameter with conical connection riveted to the bottom of the shell A, the ring D secured within the shell by the same rivets, inlet and outlet pipes to the sand chamber, the removable lining E seated upon the ring, means for centering the lining within the shell, means for forcing the lining downward upon the ring, and the connection C at the side of the shell above the top of the lining, substantially as herein set forth.

5. In a sand pump, the combination, with a chamber for receiving the gritty fluid, of a valve seat projected inward from the wall of the chamber, the removable bonnet N^4 having the spindle bearing upon one side and the stuffing box upon the opposite side, the spindle N^3 extended through the same and squared between the bearings, the crank arms N^2 fitted to the squared portion of the spindle and projected within the chamber, and carrying at their inner ends the trunnion socket N′ hinged therein by pivot *n* and provided with the stops *n′*, the pivot arm N swiveled in the trunnion socket and fitted to the stops, and the valve connected to the arm by transverse joint *m*, the whole arranged and operated to swivel the valve in any direction in relation to the seat and to slide the valve laterally when desired, substantially as herein set forth.

6. In a sand pump, the combination, with a suitable seat, of a check valve having a transverse joint upon the back, a trunnion socket pivoted adjacent to the edge of the seat, and an arm hinged to the joint upon the check valve and swiveled within the trunnion socket, the valve being thereby adapted to yield in every direction, substantially as set forth.

7. In a sand pump, the combination, with a suitable seat, of a check valve hinged to swing to and from its seat, and provided with joints to oscillate in any plane, and stops to limit its movement, as and for the purpose set forth.

8. In a sand pump, the combination, with a suitable seat, of a check valve hinged to swing to and from its seat, and provided with joints to oscillate in any plane, stops to limit its movement, and means for sliding the check valve laterally upon its seat when obstructed in its swinging movement, substantially as herein set forth.

9. In a single acting sand pump, the combination, with the cylinder having piston I and means for supplying a motive fluid to the cylinder above the piston, of the sand chamber J having an inlet and outlet near the bottom, and the pipe V with cock V′ connecting the opposite ends of the cylinder and chamber to flush the bottom of the chamber when desired, substantially as herein set forth.

10. In a single acting sand pump, the combination, with the cylinder A having piston I movable therein, and sand chamber with suitable inlet and outlet for the sand, of the pipe V and cock V′ connecting the opposite ends of the cylinder and chamber, and the pipe W with cock W′, provided with steam siphon W^2 to discharge all the water from the cylinder and chamber, substantially as herein set forth.

11. In a sand pump, the combination, with an upright cylinder and a piston movable therein, of a sand chamber below the same, a suitable inlet with check valve, and an outlet pipe extended through the side of the chamber and having its mouth K projected downwardly toward the bottom of the chamber, and the pipe V with cock V′, adapted to discharge fluid from the top of the cylinder into the bottom of the sand chamber beneath such mouth, as and for the purpose set forth.

12. In a sand pump, the combination, with two cylinders having pistons connected to move in opposite directions, of an air chamber having the sand outlets from such cylinders connected with the same, the shunt valve chamber connected upon opposite sides with the upper parts of the said cylinders, a water pressure pipe H with passage leading into the shunt valve, the pipe O connecting such pressure pipe with the air chamber, the by-pass valve O′ inserted in the said pipe, and the shunt valve G′ arranged and operated to direct water alternately into the cylinders, and having face G^2 narrower than the passage from the pipe H, the whole arranged and operated as herein set forth.

13. In a sand pump, the combination, with

the cylinders and pistons connected to move in opposite directions, of a shunt valve arranged and operated to direct water alternately into the cylinders, a delivery pipe for supplying water to the shunt valve, a by-pass pipe connecting the delivery pipe with the discharge of the sand pump, and a slightly loaded valve in the by-pass pipe to perform the triple function of preventing overstrain in the delivery pipe if the pump be obstructed, to prevent shocks and jars in the delivery pipe when the shunt valve is shifted, and to maintain a constant flow of water in the sand discharge pipe M′ to prevent the settling of the sand therein, as herein set forth.

14. In a sand pump, the combination, with two cylinders having pistons connected to move in opposite directions, of the air chamber M having the sand outlets L from such cylinders connected with one side of the same near the bottom, the sand delivery pipe M^3 connected with the opposite side of the air chamber near the bottom, a shunt valve G′ arranged and operated to direct water alternately into the cylinders, a water pressure pipe H for supplying water to the shunt valve, the pipe O connecting such water pressure pipe with the air chamber between the pipes L, and the by-pass valve O′ inserted in the pipe O, as and for the purpose set forth.

15. A sand pump comprising the vertical cylinders A having pistons with rods projected from the top, and connected by walking beam I^3, each cylinder having an inlet for clean water above the piston, and an inlet for the sand below the same, an annular groove for water packing near the lower edge of the piston, a space for fibrous packing R′ and the ring R fitted to the same and provided with flange R^2 for the application of bolts, and apertures Q′ extended from the groove Q to the upper side of the piston, to produce a continuous discharge of clean water from the outer side of the groove Q, so as to wash the wall of the cylinder below the piston, the whole arranged and operated substantially as herein set forth.

16. The combination, with two cylinders A having pistons connected by a walking beam I^3, of the nozzles C at the upper ends of the cylinders connected by a shunt valve casing G, the shunt valve G′ having shaft *e′* with double armed lever *e*, the hydraulic cylinders *c*, *c′*, connected to the arms of the lever *e*, and means actuated by the walking beam for admitting the water alternately to such hydraulic cylinders, substantially as herein set forth.

17. The combination, with two cylinders and pistons connected by a walking beam I, of a shunt valve adapted to direct the water alternately into the cylinders, hydraulic cylinders with pistons connected to the shunt valve in opposite relations, piston valves connected by the walking beam *i* and delivering fluid under pressure respectively to the hydraulic cylinders, and tappets fixed adjustably upon the walking beam I^3 to actuate the walking beam *i*, substantially as herein set forth.

18. In combination with the vertical cylinder A and piston I actuated by water pressure upon its upper side, of the piston rod I′ having annular groove, and bushing *l* divided longitudinally and fitted internally to the groove in the rod and externally to the bore of the piston, and provided with the shoulder *l′* to bear upon a shoulder on the piston, as and for the purpose set forth.

In testimony whereof we have hereunto set our hands in the presence of two subscribing witnesses.

ALBERT G. FULLER.
BARTON H. COFFEY.

Witnesses:
THOMAS S. CRANE,
L. LEE.