Oct. 22, 1935.

J. C. KOOYMAN

2,017,975

CONCRETE PUMP

Filed Jan. 16, 1933

4 Sheets-Sheet 1

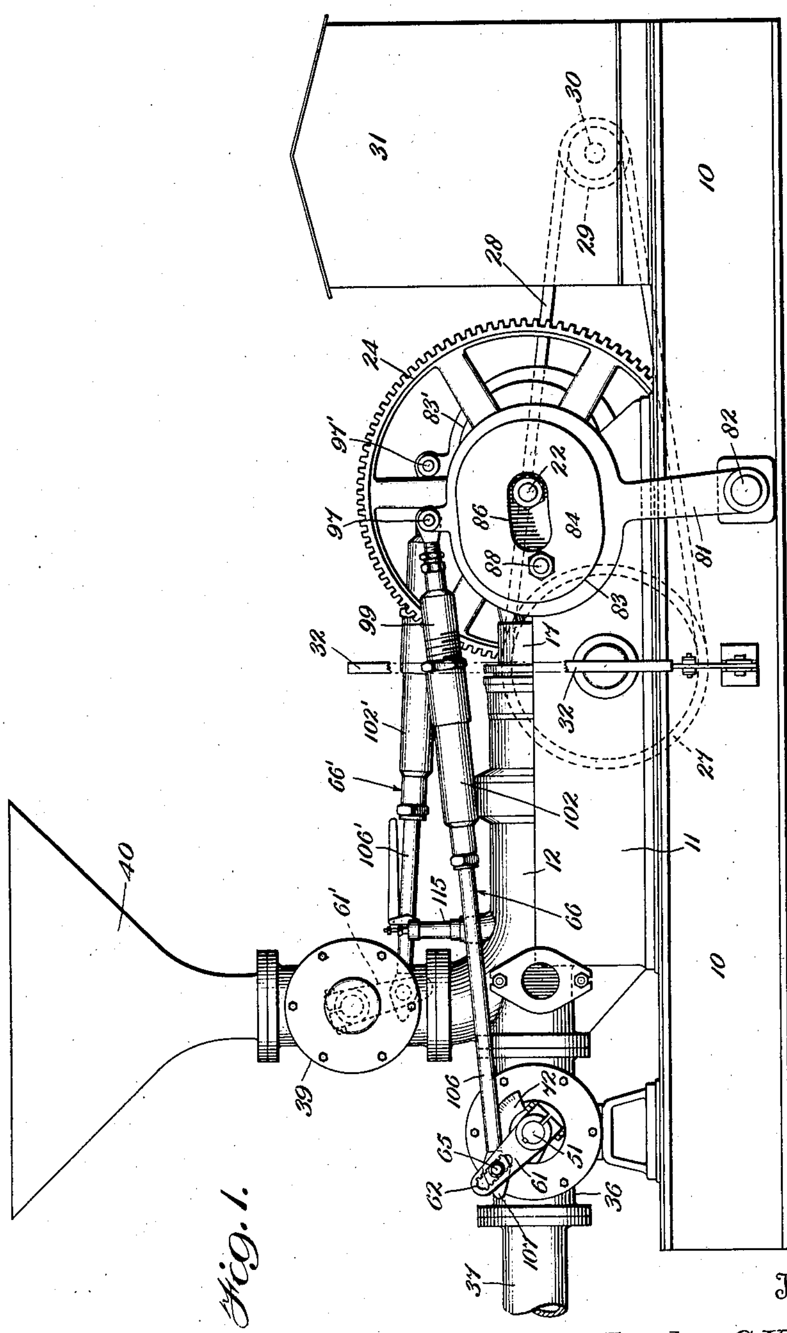

Fig. 1.

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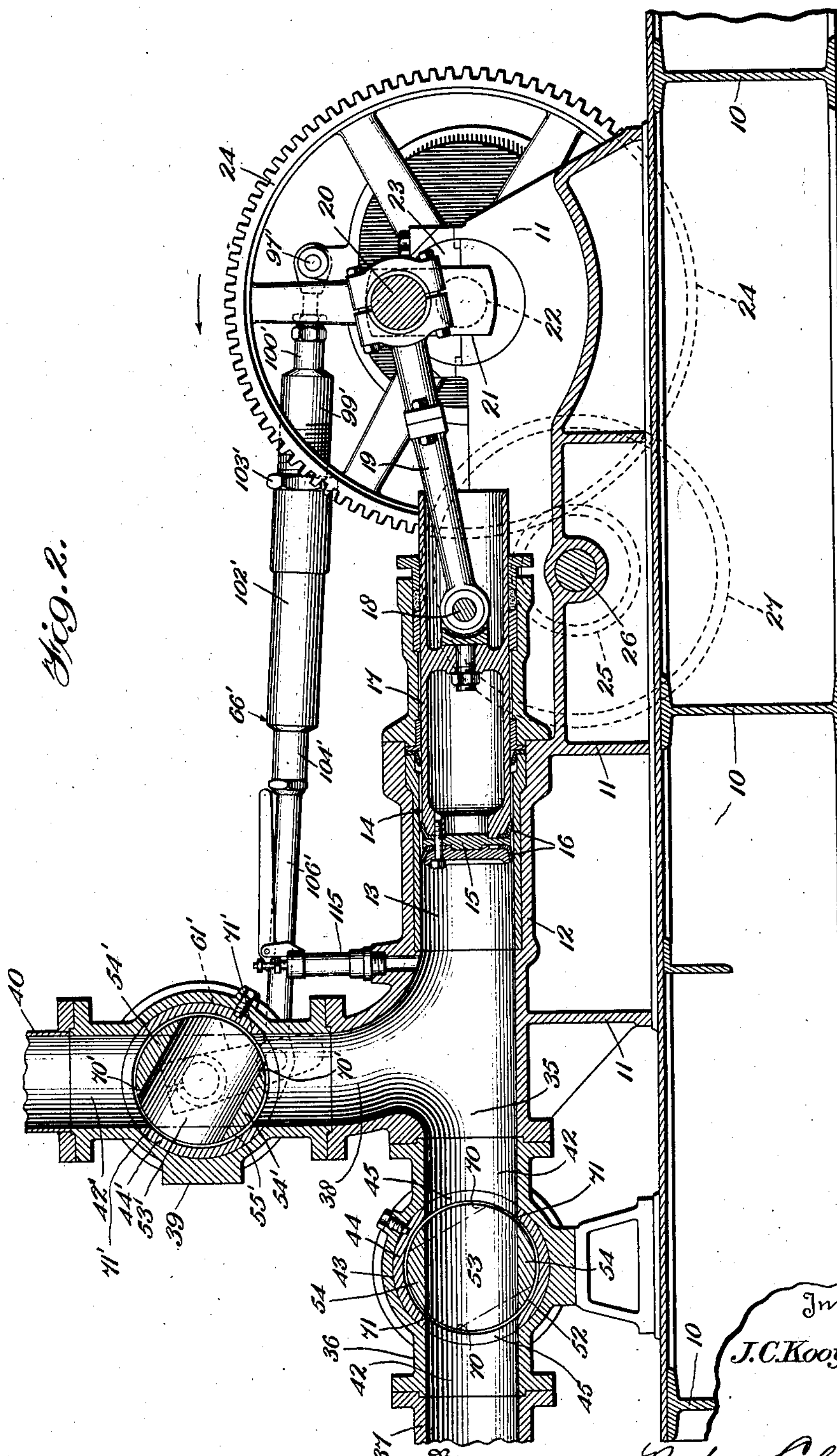
Fig. 2.



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CONCRETE PUMP

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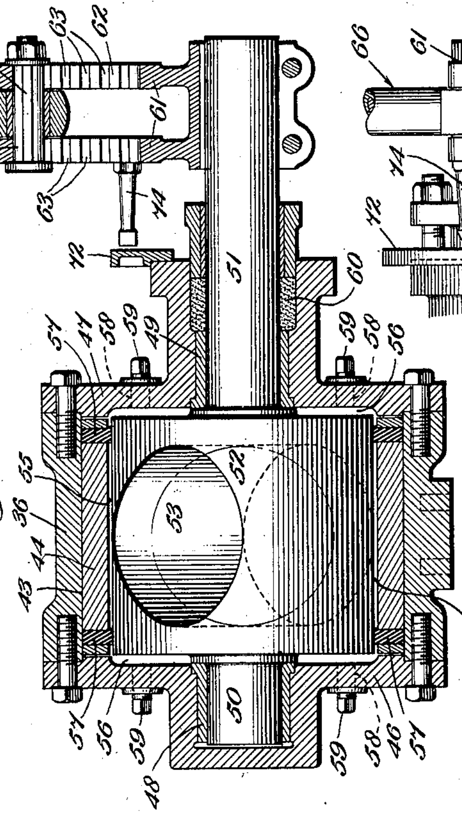

Fig. 4.

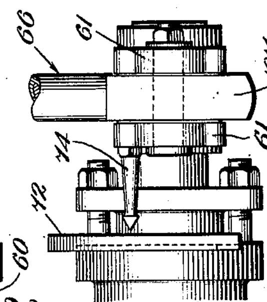

Fig. 5.

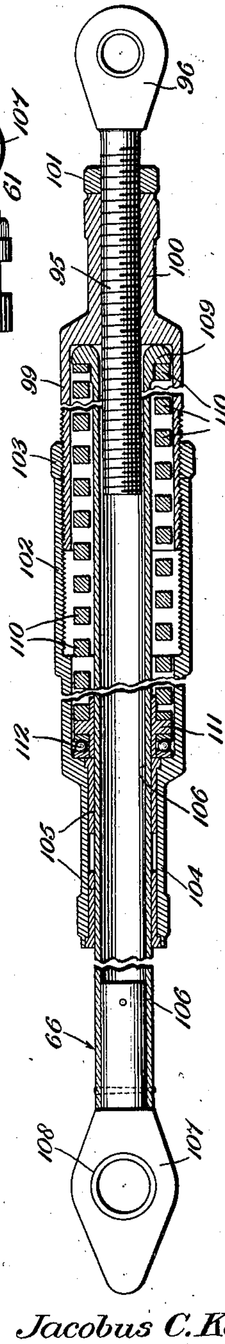

Fig. 6.

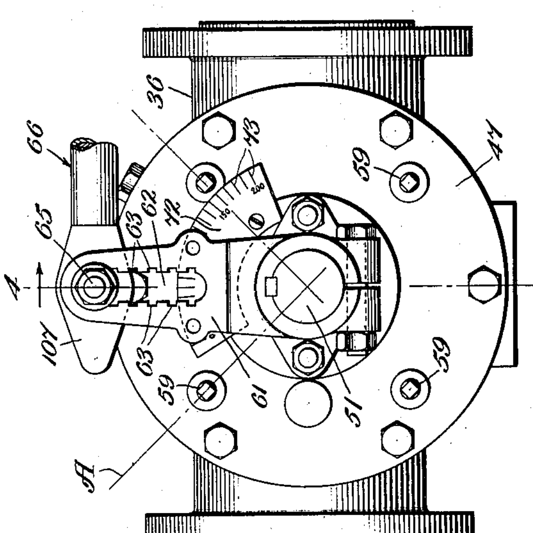

Fig. 3.

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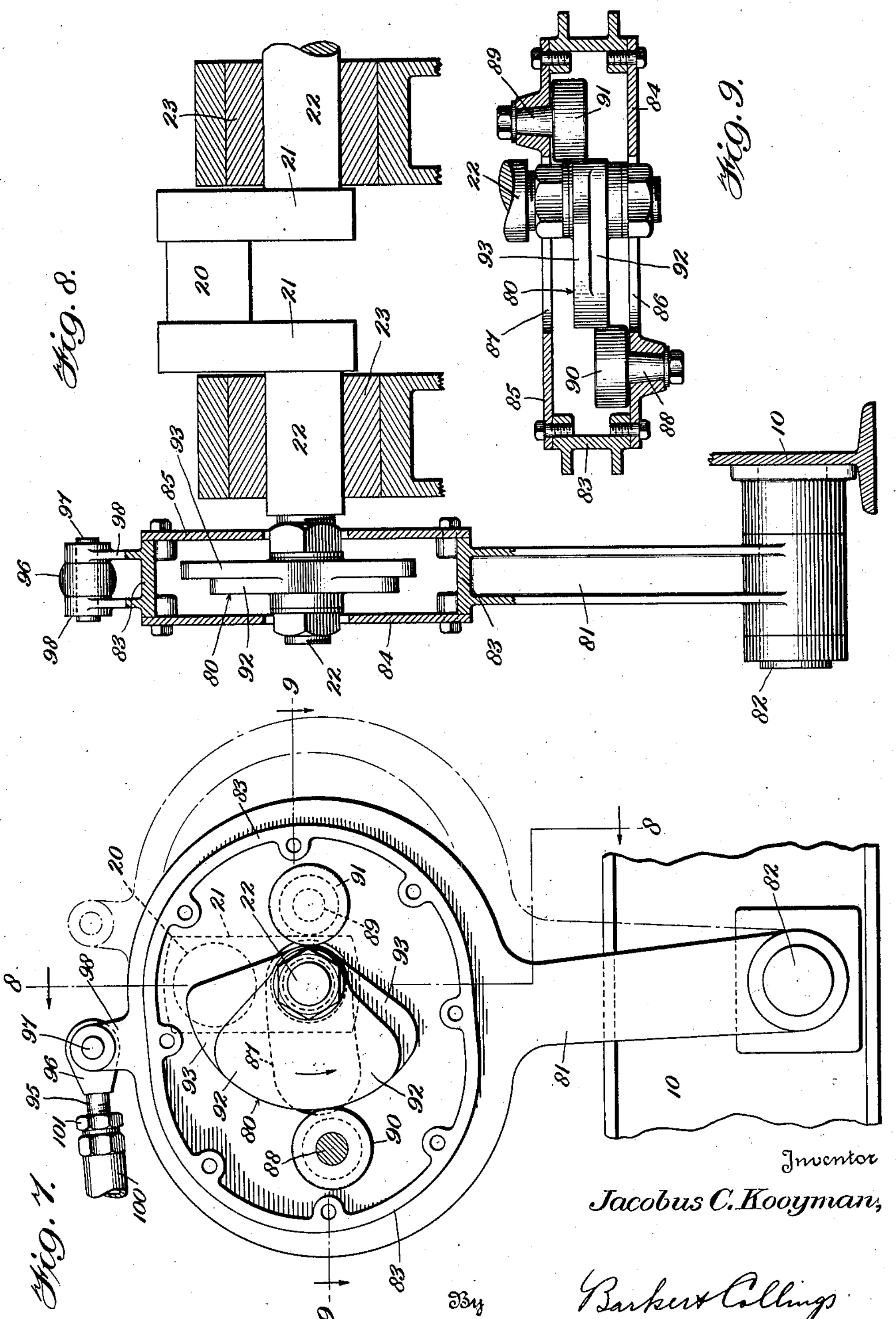

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Patented Oct. 22, 1935

UNITED STATES PATENT OFFICE

2,017,975

CONCRETE PUMP

Jacobus C. Kooyman, The Hague, Netherlands

Application January 16, 1933, Serial No. 652,077
In the Netherlands February 17, 1932

24 Claims. (Cl. 103—227)

The present invention relates to pumps for handling concrete and other plastic mixtures similar to concrete in respect to certain physical characteristics hereinafter referred to, and has for one of its objects to provide an improved pump for such service which will effectively pump not only wet, free-flowing mixtures containing relatively low percentages of coarse aggregate of small or medium size, but also concrete mixtures incorporating a high percentage of coarse aggregate, frequently of large size, as well as mixtures of a semi-dry nature, which by reason of their relative dryness are extremely difficult to pump. Another object is to provide a pump of this nature which is characterized by such durability, such avoidance of mechanical troubles heretofore encountered in handling these trouble-breeding mixtures, such accommodation of normal wear, and such ease of maintenance and reduction in cost thereof, that it will in practice out-perform any previous concrete pump of which I am aware. In short, my general object is to provide pumping means by which concrete, including small-slump mixes having a very high percentage of coarse aggregate which may be of the maximum sizes demanded by widespread present day commercial practice, may be pumped with greater economy and effectiveness, and with less deterioration of the pump, and less trouble in its operation and/or upkeep, than has heretofore been possible.

Concrete, as defined by the American Concrete Institute, is "a mixture in which a paste of Portland cement and water binds fine and coarse materials, known as 'aggregates' into a rock-like mass as the paste hardens through the chemical action of the cement and the water". This definition is somewhat more limited than the commonly accepted understanding of the word, which is widely used to designate mixtures in which the fine and/or coarse aggregates are held together by binders other than a cement-and-water paste, such for example, as the well known asphaltic concretes. The term "concrete" is also loosely applied, particularly by laymen, to mixtures of fine aggregate and cement-and-water paste, although technically such mixtures are more properly termed "mortar" or "grout". In the present specification and claims, the word "concrete" is intended to mean a conglomerate mixture of fine and coarse aggregates with a binder, but excluding the fine-aggregate-and-binder "mortars" or "grouts"; and the apparatus and method will be set forth principally with relation to Portland cement concrete, although not strictly limited thereto.

The "aggregates" above referred to are inert materials, which play no part in the chemical reactions between the water and cement which result in the hardening or "setting" of the mixture, and are employed principally to increase the mass and reduce the cost of the product. The larger or "coarser" the largest aggregates used, the cheaper is the concrete, generally speaking. The most commonly used form of fine aggregate is sand, while gravel and crushed rock are the most common forms of coarse aggregate. The size of the gravel or crushed rock used in concrete is commonly stated in terms of the size of the openings in the size-grading screen through which the material has passed. Any aggregate up to ¼ inch size is considered fine, while coarse aggregates in present commercial use may range from ¼ inch size up to 2½ or 3 inches, or even more. Aggregates ranging about 2 inches or above I will refer to as "very coarse" for convenience.

Because of its initial plastic nature, hydraulic cement concrete is usually, although not always, introduced into forms of suitable shape, acquiring their configuration, and retaining it after setting. Originally, the placement of plastic mixtures was a hand operation, accomplished with the aid of shovels, wheelbarrows, and wheeled carts or concrete buggies. This method of placement is in use today to a large extent on small structures, but with the advent of plastic mixtures in the building of structures of large magnitude, either in length, area, or height, the so-called "tower" method of placement has come into rather wide use. This method involves the erecting of one or more skeleton towers which serve as an elevator framework, in which elevator cars, usually in the form of receptacles for the concrete mixture, are raised and lowered by means of a cable and winding drum. Near the top of the tower, the upper end of an inclined chute is secured, the lower end of which is positioned above the form which is to receive the mixture. The concrete is elevated in the tower receptacle and dumped into the upper end of the chute, down which it flows by gravitational action into the form.

A modified "tower" method has also gained rather wide use in which the chute is dispensed with. The concrete is hoisted in the usual manner in the tower and discharged from the tower car into hoppers or receiving receptacles from where it is drawn off into concrete buggies and wheeled manually to the forms to be filled with the mixture. The several tower methods and apparatus, while in rather extensive use, are objectionable from the standpoint of the cost of the tower structure, and its erection and dismantling on each job; also, when using the distributing chute, because of the tendency of the larger and heavier aggregate of the concrete mixture, if it be wet enough to flow in the chute under the action of gravity, to segregate from the smaller and lighter constituents, so that the two are deposited separately, with a resultant non-uniform texture in the hardened structure. The apparatus furthermore is not particularly adapted to the handling of dry mixes, unless the chute can be inclined at a relatively steep angle, for otherwise they will not flow therein. In the tower and buggy method, there is necessarily an increased cost as it requires at least one, and, in many cases, two men to handle each concrete buggy.

In special cases, requiring the placing of a great quantity of concrete, as in a dam, or in an extensive area, as in buildings and industrial plants, belt conveyors, motor trucks, and small narrow gauge railroad cars have been used to transport concrete to the forms.

It has also been proposed to force concrete and mortar mixtures through pipes, both by pneumatic and by mechanical pressure. The pneumatic method has proven too costly for use except in very difficult placements, such as the arch portion of concrete lining for tunnels; the major portion of the concrete in the tunnel lining being placed by other means, and only the top portion of the arch of the lining being placed pneumatically. The fact that pneumatic power is mechanically very inefficient and too costly for use to any great extent, is well known.

Beside the mechanical inefficiency of pneumatic pressure means of placing concrete, there are other draw-backs to this method; e. g. the concrete in many cases is apt to be so wet as to separate in the pipe, with the result that the gaseous pressure blows the lighter constituents (the water, sand and cement) through faster than the coarse aggregates.

The pneumatic systems generally discharge only intermittently, as pneumatic pressure must be built up back of the concrete before it can be forced through the pipe. The usual practice is to charge a batch of concrete into the charging tank of the system, which is then tightly closed and the concrete is blown through the pipe, after which the flow of air is stopped, the tank is opened to receive the next batch of concrete, and the operation is repeated. The discharge of concrete from the end of the pipe is difficult to control. Stoppage of the pipe frequently occurs, excessive pressure is built up within the system, and if it finally overcomes the resistance, the material is shot out in a wholly uncontrollable manner.

It has furthermore been proposed to force grout mixtures and even concrete in which the coarsest aggregates are quite small, though pipes by means of centrifugal pumps, but up to the present, no commercially practical way of accomplishing this has been devised to the best of my knowledge.

On the other hand, there has been developed in Europe, within the last few years, a pressure pump of the reciprocating piston type which has, within a limited range of "wet" "oversanded" mixes wherein no very coarse aggregates were used, successfully handled concrete, discharging the same in a substantially continuous but pulsating stream. Because of limitations on the possible field of use imposed by the costly nature of such mixes, and because of troubles arising from the pumping method, this practice never became extensive.

These pumps last referred to employed ball check valves, working in valve chambers of much greater size than the balls, which latter were designed to seat tightly during proper portions of each cycle of the piston to prevent back flow. These valves, however, were a never-ending source of trouble because of the inherent character of concrete; and while the pumps, as above stated, were successful in a measure in handling "wet" "over-sanded" mixes, where the coarse aggregates with rare exceptions did not exceed 1¼ to 1½ inches in size, and constituted a relatively small percentage of the mixture, under which circumstances they could be considered as "floating" in the sand and cement paste mixture, they were incapable of handling such mixtures as are most commonly used wherein the coarse aggregate normally exceeds 50% of the constituents of the mix and frequently contains pieces 2½ or 3 inches, or even more, in size.

There are several reasons why pumps using ball check valves are severely limited as to the mixes which they are capable of pumping. With the ball type valve—and the same is true of flap valves, mushroom valves, and other types in which the flow of material opens the valve and reverse flow, or gravity, tends to close it—it is necessary to allow sufficient clearance between the movable valve member and the valve housing when open, to permit the largest sized materials to pass. For example, the above mentioned pumps are provided with 90 mm. (3.54 in.) passages or ports, and 110 mm. (4.33 in.) balls controlling them, while the valve chambers, which are tapered, range from 235 mm. (9.20 in) to 285 mm. (11.25 in.) in diameter. As a result the net area of the valve chamber is so much greater than that of the port that the concrete tends to "channel"; i. e., it takes the path of least resistance around the obstructing valve member, while the mix in the annulus outside of this zone becomes dormant, hardens, and builds up until the ball can no longer move back and forth to perform its function. This condition is also aggravated by the presence of the guides necessary to center the ball valve.

A normal concrete mixture, which has a large percentage of solid pieces of irregular shape, even in the so-called "wet mixes" does not follow the well recognized law of fluids. For example, a liquid or gas flowing through a closed pipe or conduit at a given rate, upon encountering a restriction in such conduit, will increase its velocity at that point in passing the obstruction, whereas a normal concrete mixture, upon encountering a sudden restriction, while passing through a closed conduit, will reduce its velocity and tend to pack or "stow" at such point so as to completely stop the flow.

In valves of the above mentioned type, the movable valve members and the guides therefor, are of necessity positioned in the line of flow and constitute obstructions about which the mixture must be forced. In consequence, the passages through which the concrete is forced must be of a comparatively irregular, locally restricted, and tortuous nature, so much so that the normal mixes (having a high percentage of coarse aggregate, frequently of large size and/or of a semi-dry nature) tend to pack or "stow" in these passages. This "stowing" may suddenly occur in any part of the passages and when it once takes place, the pump soon becomes wholly inoperative.

Advantage has been recently taken of this property of concrete mixtures, with respect to the construction and operation of the valves of concrete pumps, whereby the range of large-aggregate mixtures capable of being handled by such pumps, and their reliable efficiency, has been very materially increased over those before proposed. That is to say, a concrete pump has been developed in which the valves are so constructed and arranged as to present, in their open positions, free and unobstructed passageways for the mixture, and these valves are purposely only partially closed, in their proper sequence and relation to the workings of the piston or other pressure member, so as only to partially restrict and never to completely cut off said passageways. The mixture "stows" at such restrictions and completely prevents back flow, and the necessity for completely-closing, accurately seated valves is obviated, with the consequent elimination of most of the valve trouble previously experienced.

Such a pump is described and claimed in the co-pending application of Otto M. Kastner, filed January 16, 1933, Serial No. 652,081, entitled "Method of and apparatus for pumping concrete" and forms of valves capable of successfully carrying out the above principle are shown and described. One form comprises sliding gates or dampers which are alternately moved transversely of the passageways from positions wholly clearing said passages to positions partially but never completely closing them, and back again. In another form, the passageways are provided with flexible or resilient sections, normally of the same diameter as the passageways, which may be partially collapsed and restricted by pressure exerted on their exterior by one or more movable jaws or levers, to serve as a valving restriction.

While such valve structures, as above stated, are quite capable of successful operation, actual experience has shown that the first mentioned form requires a relatively large amount of power, particularly in the closing movements, and in the case of the second mentioned form, the resilient conduit sections are subject to comparatively rapid wear, necessitating frequent replacements, which of course means that the machine must be shut down.

It is one of the principal objects of the present invention to improve the valve structure and operation of concrete pumps of the type referred to above, and I have found from actual experience in building and operating these pumps that, contrary to the opinions heretofore held by recognized concrete pump engineers, oscillating plug valves may be successfully and efficiently employed in such pumps with excellent results if the plug be axially supported at its ends, and the valve be made "seatless"; that is, without provision for any close fit (or approximation thereof) between the ported zone of the housing and the corresponding zone of the movable member; provision being made, instead, for complete circumferential clearance between the plug and housing, in at least the zone of their ports,—which is ample in depth or radial dimension freely to accommodate inflow and outflow therethrough of what I will term the "paste-flowable" constituents of the mixture; that is to say, the fluid paste of water and cement together with such small solid particles of the aggregate (being chiefly the finer sand grains) as float in the paste or are tenaciously carried by it and are therefore almost inseparable from its flow and that such employment gives marked conservation of power and greatly increased length of life. Such valves may be made with replaceable parts so that when unduly worn, due to the abrasive action of the cement and fine aggregates, they may be replaced with new parts; however, due to the fact that complete closure of the passages is not necessary, as in liquid and gas pumps, considerable wear and increase in the clearances between the parts may be tolerated before the valves become so inefficient as to require replacement. The use of an oscillating plug, with a passage through it, provides two spaced solid or passage-restricting elements, which when the valve is turned to restricting position, constitute a double restriction within the passage, thus practically doubling the efficiency of the valve, and greatly prolonging its effective life.

I have found it to be highly important, for capability of the apparatus to handle, and its efficiency in handling, commercial mixtures and particularly those characterized by small-slump and/or large percentage of very coarse aggregate, to have the outlet and inlet passages (including the passageways through the outlet and inlet valves) of the same cross-sectional shape and nearly the same cross-sectional area as the pump cylinder, so that the passage walls neither afford dead pockets in which the concrete may lag and harden, nor abrupt restrictions compelling rearrangement of the coarse aggregates and in which the concrete may stow; and also to have the outlet passage axially alined with the pump cylinder, to receive each pump-ejected mass of concrete from the cylinder with substantially minimum change of relative positions of the pieces of the coarser aggregates; while the inlet passage is desirably so arranged relative to the cylinder that the sectional shape which its walls give to the concrete about to enter the cylinder also tends to minimize the necessity for the coarser aggregates to rearrange themselves on entering the cylinder. For like reasons permanent restrictions or enlargements and also abrupt changes of cross-sectional shape and area of the distribution piping should be avoided, after the concrete leaves the outlet valve.

Further, it is very advantageous in the operation of the pump that the cylindrical working chamber, the walls of which are solid throughout the entire range of piston travel, shall provide a single axial end-opening that is of full cylinder-diameter and through which the concrete is both received on the intake stroke of the piston and ejected on the piston's discharge stroke and to have the walls of the valved inlet and outlet passages, both of which open to the cylinder's end-opening, struck on radii of approximately the same length as the radius of the cylinder, such walls merging at a point very close to the cylinder's end-opening; this branched structure being conducive to best handling of the mixture into and out of the working chamber of the pump, good life of the pump-parts, and pumping efficiency.

In substantial effect the closing action of my valve may be described as that of quickly displacing that section of a column of concrete which is within the valve at the time of its movement, out of alignment with the rest of the column (which is contained in the passages leading from the pump cylinder to the valve or from the valve to the pipe line, as the case may be) and the opening action of my valve may be described in the same sense as the bodily replacement of the displaced section of the column into alignment with the contiguous, passage-contained concrete, re-constituting a straight column. In my pump the fixed passages above mentioned and as well the orifice through the valve, are so shaped that, when the valve is open, the column of concrete walled about by them is of uniform cross-section throughout its length. In displacing the stated valve-carried section of the column (which is done in timed relation to the piston travel, of course) back-flow of the concrete is prevented. This is done chiefly by the portions of the valve which close off portions of the ends of the contiguous fixed passages, but is dependent also on the stowing of the concrete at the restricted openings which are left, due to the valve never completely closing. Of course it cannot be said, in the most rigorous meaning of the words, that the valve-contained section is bodily displaced from alignment with the passage-contained part of the column and bodily restored intact, since the valve action is not absolutely instantaneous nor is stowing, to completely stop the flow, absolutely instantaneous. In substantial effect, however, no such continuation of concrete flow occurs during valve closure or through the intentionally-left partial opening of the valve aperture as will prevent re-formation of the concrete into a continuous and uniform column promptly upon restoration of the valve to open position. In short, this utilization of a "plug" type of valve, with its orifice of equal diameter with the passages it controls, and the rapid actuation thereof—but actuation that intentionally leaves a partial through-opening to be closed by stowing of the concrete,—is one that is peculiarly effective for taking advantage of the characteristics of the concrete and for handling this difficult material with greatest facility.

For moving the valves to open and restricting positions, I prefer to employ double acting cams, so shaped and positioned on the crank shaft of the pump as to provide in timed relation to the piston travel, the proper dwell or time interval during which the valves remain motionless in their respective open and restricting positions to permit the substantially complete filling or emptying, as the case may be, of the pump cylinder, after which the said cams quickly and positively move the respective valves from open position to restricting position, and vice versa, as the piston travels away from the end of the cylinder. These movements are accomplished by the engagement of the cams with one of two diametrically opposed rollers positioned within a housing which is formed on the cam rocker arm.

It has been my experience that because of the heavy nature and composition of concrete (largely composed of solid particles of various sizes) it is important that the valves be positively and quickly opened and the use of springs to actuate the valves has been found to be unsatisfactory. Should a spring break, or lose its force to such extent as to fail to open the outlet valve, for instance, great damage might be done to the machine on the pressure stroke of the piston, due to the inability of the cylinder contents to escape; or should an inlet valve fail to open, the supply of mixture to the cylinder would fail and the pumping action cease.

It is equally important that the valves be actuated to restrict the passages quickly and positively so as to prevent reverse flow of the mixture and loss of pump efficiency. However because of the high precentage of coarse aggregates in the concrete, and frequent pieces of large size, it may happen that these large pieces of aggregate are caught between the valves and valve housing during the restricting movement of the valve and when caught, will tend to jam or stop the valve before its restricting movement is completed by the cam. I therefore provide a resilient means in the rod connecting the valve arm to the cam rocker arm so that when a piece of aggregate is thus caught, the connecting rod will extend and permit the cam to complete its travel; otherwise, without the resilient means, serious damage or breakage to the mechanism might take place.

As in the Kastner pump, provision is made for adjustment of the amount of restriction imposed by each valve, which in commercial practice is the minimum restriction consistent with the stowing characteristics of the concrete being pumped. An adjustment leaving a normal opening approximately the average size of the largest aggregate in the mixture works well with the commonly used mixes, e. g. mixes which are proportioned one part by volume of cement, two parts of sand, and four parts of well graded gravel, with sufficient water to give a slump of from 125 to 175 mm. in 300 mm., (approximately 5 to 7 inches in 12) although mixes having a greater tendency to "stow" than the mixes above mentioned may be accommodated by providing for less restriction by the valve, and conversely, mixes with a lesser tendency to "stow" may require a somewhat greater restriction by the valve. In order to facilitate these valve adjustments, an indicator is associated with each valve to show its position and amount of restriction.

I have discovered that with my mechanically operated concrete pump valves it is not desirable to use an air dome or other pressure equalizing means on the discharge side of the pump, as commonly used with piston pumps in fluid or gas pumping systems. At the end of the pressure stroke the discharge valve is actuated to partially restrict, but never completely cut off, the discharge passage, and before the piston has traveled a great distance on the suction stroke, the inlet valve is moved to release the restriction of the inlet passage. While the actuation of the valves is as rapid as practicable, nevertheless there may be a period in their actuation where there is overlapping of the movement of the valves; that is to say, the discharge valve may not reach its ultimate "stowing" position until after the inlet valve has been partially moved from its "stowing" position. At this period in the movement of the valves, an air dome on the discharge side of the pump would compel a portion of the mixture to return through the discharge valve into the pump and pass the inlet valve into the supply hopper. This reverse movement, termed "back slip", is undesirable as it may greatly decrease the pump's delivery of concrete. Without the use of an air dome on the discharge side of the pump, I find that the inertia of the mixture at the end of the pressure stroke of the piston when pumping concrete horizontally or even vertically, will go far toward minimizing "back-slip" during that period of valve relationship aforementioned, and the provision of passages and piping of the size and relationships heretofore stated is conducive to this helpful inertia effect.

One form of concrete pump constructed in accordance with the present invention, and embodying the above features and objects, is illustrated in the accompanying drawings, forming a part of this specification, in which like reference characters designate like parts in all the views, and in which:—

Figure 1 is a side elevational view of the apparatus.

Figure 2 is a central longitudinal sectional view, on a somewhat larger scale, through the pump cylinder and piston, and the inlet and outlet passages and valves;

Figure 3 is an enlarged side elevational view of the outlet valve, the inlet valve being in all respects a substantial duplicate thereof;

Figure 4 is a central vertical sectional view, partly in elevation, of the valve shown in Figure 3, taken approximately on the plane indicated by the line 4—4 of the said figure, looking in the direction of the arrows, and with the valve plug shown in restricting position;

Figure 5 is a top plan view of the right hand portion of the valve shown in Figure 4, illustrating the indicating arm and scale;

Figure 6 is a longitudinal sectional view of one of of the connecting rod assemblies employed between the valve arms and the cam rocker-arms, and showing the longitudinal adjustment, and yielding connections associated therewith;

Figure 7 is an enlarged side elevational view of the outlet valve cams, and the rocker-arm or lever and housing associated therewith;

Figure 8 is a vertical sectional view, partly in elevation, of the parts shown in Figure 7, taken approximately on the plane indicated by the line 8—8 of the said figure, looking in the direction of the arrows; and

Figure 9 is a horizontal sectional plan view, taken approximately on the plane indicated by the line 9—9 of Figure 7, looking down.

Referring more particularly to Figures 1 and 2 there is shown a pump mounted upon a suitable base or framework 10, comprising a bed 11 which may take the form of a casting secured to the said base and which supports the cylinder 12 having a working chamber 13 in which is mounted the piston 14. This said piston preferably comprises a head 15 provided with packing washers 16 and a hollow skirt portion 17 within which is journalled as by the piston pin 18, one end of the connecting rod 19. The other end of the said connecting rod is journalled upon crank pin 20 carried by the crank throws 21 of the crank shaft 22 journalled in suitable bearings 23 provided upon the bed 11, which crank shaft also carries gear 24 which meshes with the pinion 25 rigidly carried by a jack shaft 26. A pulley or sprocket 27 is also mounted upon the jack shaft 26 for receiving power through a belt or chain 28 from the pulley or sprocket 29 carried by the power shaft 30 of an internal combustion or other motor (not shown) mounted within the housing 31. A suitable clutch (not shown) is interposed between the pulley or sprocket 27 and the jack shaft 26 whereby the transmission of power from the motor to the pump may be controlled at will, such clutch being operable by means of a clutch lever or handle 32, as shown in Figure 1.

The cylinder 12, which is here shown as being disposed in a horizontal position, is provided with an outlet port 35 to which is connected a housing 36 of the outlet valve which in turn discharges into the pipe or conduit 37 through which the material may be conducted to the point of use; the outlet passage 42 being here shown as axially aligning with, and of the same diameter as, the pump-cylinder 13.

The cylinder 12 is also provided with an intake passage 38 which approaches the cylinder from above at substantially right angles to the axis thereof and which is preferably curved substantially as shown in Figure 2 to gradually merge therewith; the inlet passage being here shown as of the same diameter as the pump cylinder. The intake extension is surmounted by the housing 39 of the intake valve which in turn supports the lower portion of the supply hopper 40 into which the concrete mixture may be introduced either direct from the mixture or from a transporting mixing or agitating container.

The inlet and outlet valves are best shown in Figures 1, 2, 3 and 4, and as they are in all respects duplicates of one another, the outlet valve will be described in detail with the corresponding parts of the inlet valve indicated by corresponding primed reference characters. As is best shown in Figures 2, 3 and 4 said outlet valve comprises the housing 36 which may take the form of a casting having the longitudinal passage 42 therein and provided with transverse bore 43 in which is preferably mounted the tubular liner 44 having diametrically opposed ports 45 in communication with said passage 42. The valve housing is provided with removable end plates 46 and 47, see Figure 4, having bearing bushings 48 and 49 respectively, to serve as journals for the stud shafts 50 and 51 which project from opposite ends of the valve plug member 52. The said plug member 52 is provided with a non-storage-inducing passageway 53 extending through it, which is adapted to register with the ports 45 of liner 44 and passage 42 through the valve housing when the valve is in open position as shown in Figure 2. The passageway 53 through the plug member 52 produces a pair of oppositely disposed solid portions 54, each of which serves to partially restrict the pasageway through the valve housing when the plug member is turned to restricted position as indicated in broken lines in Fig. 2 and as is shown in Figure 4. There is thus provided the double restriction of the passageway such as 42 above referred to, which increases the efficiency of the valve as well as its length of life, for should the solid portion 54 which is nearer the piston in Figure 2 become worn through abrasion by the smaller aggregates after long continued use, the element 54 which is farther from the piston and which has not been subjected to so much wear would still serve to provide the necessary restriction of the passage required to prevent reverse flow of the mixture and thereby practically double the life of the valve plug.

As is clearly indicated in Figures 2 and 4, the valve plug 52 is seatless or non-dependent on close fit between any portions of the ported zone of the housing and the corresponding zone of the movable member, it being somewhat smaller than the inner diameter of the liner 44 so as to provide in such zone a complete circumferential clearance 55 between the outer surface of the plug and the inner surface of the liner. This clearance is advantageous in the present case, because of the fact that tight fitting and accurately seating valves, in operation, are immediately scored or grooved by the fine particles of cement and sand, regardless of how hard or wear resisting may be the plug and liner surfaces. Thereafter the cement-and-sand paste caught in these grooves is drawn between the surface of the plug and liner to such extent that the two are intimately bound together, so much so that it becomes impossible to move the plug without breakage of some part thereof.

This clearance when the valve is new is preferably about $\frac{1}{16}$ of an inch or slightly more, and considerable increase of the clearance, due to the slow abrasive wear, does not decrease the effectiveness of the pump. The water and cement, together with portions of the sand or other fine aggregate, that find their way into this clearance have sufficient space to minimize scoring and wear, and the water-and-cement mixture carrying or coating the small solid particles of these "paste-flowable" constituents will serve as a sort of lubricant between the particles of fine aggregate and the metallic valve-surfaces, with results which seem in no wise detrimental, provided the paste is not permitted to harden when the machine is not in operation. These constituents will of course produce some abrasive action upon the surfaces, but since the clearance permits the constituents to roll over on themselves, and the water-and-cement paste to act as a lubricant, the wear is relatively slow and is not detrimental until the clearance approaches or reaches the maximum size of the fine aggregate, say ¼ of an inch. In other words the valves may continue to function without appreciable loss of efficiency until the wear occasioned by the abrasive action of the fine aggregates upon the complementary surfaces has increased the clearance to approximately ¼ of an inch.

Clearance **56** is also provided between the ends of the valve plug **52** and the end plates **46** and **47**, as this also reduces friction and the power required for the valve actuation. Resilient or yielding rings **57** are preferably provided encircling the end portions of the valve plug **52** which rings serve to a great extent to keep the sand or other abrasive aggregate out of the end clearances **56** and thus out of the bearings **48** and **49**, although portions of the water and cement mixture will eventually find their way past these packings and into such clearances. However, as above explained the water and cement mixture alone is not particularly detrimental unless permitted to harden, but on the other hand, serves as a sort of lubricant between the adjacent surfaces. In order that these clearances may be flushed out to prevent hardening, the end plates **46** and **47** are provided with apertures **58** normally closed by plugs **59** through which apertures flushing water or other medium may be introduced and evacuated by means of detachable hose or conduits, not shown.

The valve shaft **51** extends beyond the end plate **47**, being provided with a suitable gland or stuffing box **60**, and carries at its outer end an actuating arm **61** by means of which the shaft and plug **52** may be oscillated through mechanism to be hereinafter described. As best shown in Figures 3 and 4 this said arm may take the form of a bifurcated construction, each leg thereof being provided with an elongated slot **62**, and the side walls of these slots are preferably serrated or provided with recesses **63** for engagement by keys **64** carried by a pin **65** which journals one end of the valve rod assembly **66**. By positioning the pin **65** with its keys **64** in engagement with different recesses **63** in the slots **62** it is possible to vary the arcuate movement of the actuating member **61**, and consequently of the valve plug **52** whereby the degree of restriction imposed by the elements **54** of the valve plug may be varied. That is to say, as will hereinafter appear, the linear travel of the valve rod assembly **66** always remains the same with the result that if the pin **65** be moved to the outermost end of the slots **62** as is illustrated in Figures 3 and 4, the arcuate travel of the actuating member **61** and of the plug **52** will be reduced to a minimum, say 45°, or from the position shown in Figure 3 to that indicated by the line A therein. On the other hand if the position of the pin **65** be changed so as to move it inwardly of the slots **62**, as is illustrated in Figure 1, with the same linear travel of the rod **66**, the arcuate travel of the plug **52** will be increased and in the construction shown may reach as high as 90°. However, such a travel in the present instance would result in a complete closing of the passage **42** by the members **54**, which would only be desirable in the event the pump was being used for handling grout mixtures as above defined, and for ordinary purposes in the handling of concrete mixtures embodying large aggregates, the arcuate travel of the plug **52** should be less than 90° so that the maximum restriction produced by elements **54** will be only substantially as is illustrated in broken lines in Figure 2. In other words the arcuate travel of the arm **61** and plug **52** in practical handling of concrete mixtures will range from between 45° to say 75°.

This variation in the travel of the valve plug and the consequent degree of restriction of the passage **42** as above explained is desirable in order that such restriction may be changed in accordance with the average maximum size of the large aggregates being handled. In other words, it is preferred to so set the valve that when it reaches its restricting position the opening still remaining between the points **70** of the members **54** and points **71** of the liner **44** will be approximately equal to or slightly greater than the average size of the largest aggregate in the mixture. It thus results that if a piece of large aggregate is present in the line of travel of the elements **54** as they move to restricting position such elements will not be called upon to crush such piece of aggregate but will stop at a point short of actual crushing engagement. On the other hand, should a piece of aggregate greater than average size be present so that it would be caught between the edges **70** and **71** as the valve closes, provision is made in the valve rod assembly **66** for absorbing the strain thus imposed and for relieving the crushing action in order to prevent damage to the valve and other portions of the machine, all as will be more fully hereinafter described.

In setting the valves for aggregates of different sizes the fully open position shown at the left of Figure 2 and indicated by the line A in Figure 3 is employed as the zero point and in order to quickly show this point, as well as the degree to which the valve may restrict the passage **42**, the end plate **47** of the valve housing is provided with a sector **72** having a series of graduations **73** thereon, and the actuating member **61** carries an arm or pointer **74** arranged to co-act with the said graduations to quickly visibly indicate the position of the valve plug **52**. This feature is best shown in Figures 3, 4 and 5.

As was above pointed out, it is preferable that the valves be rapidly and positively moved from one position to the other which makes the use of springs for accomplishing the movement undesirable and it is therefore preferred to employ cam action for moving the valves in both directions. One practical form of cam mechanism for actuating the valves is illustrated in Figures 1, 7, 8 and 9 and will be described in detail with reference to the mechanism for actuating the outlet valve, it being understood, however, that substantially the same mechanism is employed for the operation of the inlet valve, the only difference being that the cams for the inlet valve are of slightly different shape, and are set at approximately 180° from those for the outlet valve as will be readily understood.

Referring more particularly to Figures 7, 8 and 9 there is provided at or adjacent the respective ends of the crank shaft 22 the valve actuating cam such as 80 rigidly secured to the said crank shaft. A rock arm or lever 81 is pivoted as at 82 to the frame or base 10 and its upper end is provided with a hollow enlargement 83 which serves as a housing for the said cam. This said enlargement is provided with removable side plates 84 and 85, slotted as at 86 and 87 respectively to accommodate the end of the crank shaft 22. The said side plates support studs 88 and 89 respectively upon which are rotatably mounted rollers 90 and 91, as will be clear from Figures 7 and 9.

The cam 80 is formed in two adjacent sections which may be machined from a single piece of material or each section may be separately formed and the two rigidly connected together in any desired manner. The section 92 of the cam 80 is disposed in such position that it will be engaged by the periphery of the roller 90 while the companion section 93 of the cam is arranged so that it will be engaged by the periphery of the roller 91. Assuming the parts to be in the positions shown in Figure 7 and the crank shaft and cams rotating in the direction indicated by the arrows, the cam section 92 has through its engagement with the roller 90 moved the rock lever 81 about its pivot 82 in a counter-clockwise direction and it is obvious that further rotation of the crank shaft and the cam 80 will cause the section 93 thereof, through its engagement with roller 91, to produce a positive reverse movement of the rock lever 81 to a position such as that indicated by the broken lines in Figure 7. The cam sections are so designed and constructed that the movement toward the right, as viewed in Figure 7, imparted by cam section 93 will not take place until the high portion of cam section 92 has cleared the roller 90, and vice versa, the return movement of the parts will not be accomplished until roller 91 has been cleared from the high portion of cam section 93. A positive oscillating movement in each direction is thus imparted to the rocker lever 81 in timed relationship to the movements of the crank shaft 22, which movement is transmitted to the actuating arms such as 61 of the valve in order to produce the necessary oscillation thereof to move it from open to restricting position and back again.

The motions of the rock lever 81 are transmitted to the valve actuating arms 61 through connecting rod assemblies 66 such as are shown in detail in Figure 6. That is to say, a threaded rod 95 has one of its ends such as 96 pivotally connected as at 97 to the ears or lugs 98, carried by the upper portion of the rock lever 81. A hollow sleeve 99 provided with a reduced portion 100 threadedly engages the rod 95 and a lock nut 101 may be provided for securely locking these two parts in any desired adjusted position. A hollow cap member 102 is threaded upon the exterior of the sleeve 99 and a lock nut 103 is provided for maintaining these two parts in adjusted relation to one another. The cap member 102 is provided with a reduced extension 104 which has suitable bearing bushings 105 serving as bearings for a tubular member 106, one end of which is provided with a head 107 having a bearing 108 adapted to receive the pin 65 which serves as a connection between the connecting rod assembly 66 and the valve actuating arm 61 as above set forth.

The other end of the tubular member 106 is provided with a flange or enlargement 109 against which abuts one end of a coil spring 110, the other end of which abuts against a collar 111 provided with a suitable thrust bearing 112 to take the end thrust.

In the movement of the connecting rod assembly from right to left, as viewed in Figures 1, 6 and 7, the force is transmitted from the threaded rod 95 to the sleeve member 99 threaded thereon and from it directly through the flange or enlargement 109 to the tubular member 106 and thence through the pin 65 to the valve actuating arm 61, thereby producing positive motion of the valve from closed to open position. In the reverse movement of the parts the pull upon the rod 95 is transmitted to the sleeve 99 threaded thereon and through it to the cap member 102, thence through the thrust bearing 112, and collar 111 to the spring 110, and in turn to the flange 109, tubular member 106 and valve actuating arm 61. Should an extraordinarily large piece of aggregate be in the path of either closing valve member 54, upon engagement therewith the spring 110 will yield and be compressed so that movement of the threaded rod 95 and the rock lever 81 through action of the cam section 93 may continue while the movement of the tubular member 106, actuating arm 61 and valve plug 52 may be arrested, thereby obviating any danger of damage to the various parts through strain imposed by the presence of the large piece of aggregate in the path of the closing valve member. Obviously the force exerted by the spring 110 may be varied by adjustment of the cap member 102 relative to the sleeve 99 through the threaded connection between the two.

In adjusting the valve travel as above explained to accommodate the valve restriction to different sizes of aggregate, movement of the position of the pins 65 in the slot 62 calls for a lengthening or shortening of the length of the connecting rod assembly 66. That is to say, if we assume the valve actuating arm 61 to be in the position shown in Figure 1 in which the valve is fully open, and the apparatus at rest, as it must be in order to change the setting of the valves, if the pin 65 is moved outwardly in the slot 62, the arm 61 will be swung in a clockwise direction since the pin 65 and connecting rod assembly 66 will swing about the pivot 97, as will be readily understood, thus moving the valve from the completely open or zero position. In other words, unless a change be made in the length of the connecting rod assembly 66 the valve would then never reach completely open position and would impose partial restriction in the passage 42 at all times, which of course would be detrimental.

In order to compensate for this the lock nut 101 is backed off and the sleeve 99 together with the cap 102 is rotated relative to the rod 95 and tubular member 106 in the proper direction to cause the threaded engagement between the rod 95 and the extension 100 to produce an overall lengthening of the connecting rod assembly. In this manner the beginning of the valve stroke or zero point may always be maintained at the point illustrated in Figure 1 and indicated by the line A in Figure 3, which is the maximum open position of the valve, irrespective of the arcuate travel of the valve as determined by the position of the pin 65 in the slot 62.

The actual operation of the pump is similar to the usual piston pumps, it being understood of course that upon the outward or suction stroke of the piston 14 in the working chamber 13 the inlet valve is opened through its cam while the outlet valve is maintained in maximum restricted position through its cam. When the direction of travel of the piston is reversed the inlet valve is moved to restricting position while the outlet valve is moved to completely open position and the concrete mixture which has been drawn into the working chamber 13 through the inlet valve upon the suction stroke is forced out through the passages 35, 42 and 53 into the pipe or conduit 37. The partial restriction of the passages by the members 54 and 54' of the valves during the time they are in restricted position causes the concrete mixture to stow at such points and prevent reverse movement thereof, as will be readily understood.

The cylinder 12 may be provided with a suitable relief valve 115 in communication with the working chamber whereby excess pressure within the chamber may be relieved and damage prevented to the apparatus should by any chance an outlet valve fail to open.

Pumps constructed in accordance with the above disclosure and the accompanying drawings, having a single piston of 7'' diameter, and a piston travel of 10'' have under actual working conditions, such as are commonly met with, forced 1-2-4 concrete mixtures of both wet and dry consistencies to heights of 75 feet and over a horizontal distance of 500 feet with no detrimental effect to the pump or concrete, and showing nothing to indicate that these distances may not be greatly increased without unduly overloading the pump or adversely affecting the concrete. Such pumps employ a 20 H. P. motor and when operated at from 40 to 55 strokes per minute are capable of handling from 15 to 20 cubic yards of concrete per hour. They have worked continuously from 8 to 12 hours per day, and may be worked continuously for longer periods, without requiring attention other than an occasional flushing out of the ends of the valve housings. They may be stopped, as at meal time, for periods of 30 minutes or more, and when started up thereafter will immediately function with maximum efficiency, and without any cleaning out. They should of course be completely cleaned and flushed throughout at the final completion of a pumping operation, or if shut down for considerable periods of time, as overnight.

As has been previously stated the inlet and outlet passages such as 38, 40, 35 and 37 are preferably of the same diameter as that of the working chamber 13 and the passages such as 42, 45 and 53 of the valves are likewise of the same diameter so that there are no restrictions anywhere in the system when the valves are in open position at which the flow of the concrete might be impeded, thereby causing it to "stow"; nor are there any pockets forming dead spaces in which concrete is not at all times moving and in which it would harden and build up. In the pumps above referred to the inlet and outlet and valve passages are all of 7'' diameter, the same as that of the working chamber 13, although a slight oversizing of the pump's cylinder-diameter, gradually merged into its outlet extension 35, and a slight reduction, very gradually made, of the diameter of the delivery passage 42 or adjacent piping 37, beyond the outlet valve 53, may be used with some advantages by way of lower cost of the correspondingly-smaller delivery piping and the decrease in labor-cost of moving it around on the job,—although with some resultant limitation as to size of aggregates and dryness of mixtures to be handled, distances to which they are to be delivered, increased wear on the equipment, etc.

While one form of the invention has been illustrated and described it is obvious that those skilled in the art may vary the details of construction as well as the precise arrangement of parts without departing from the spirit of the invention and therefore it is not wished to be limited to the above disclosure except as may be required by the claims.

What is claimed is:

1. In a concrete pump having a pressure chamber, a pressure member working therein, and a material passage communicating therewith, a seatless valve for controlling said passage including a housing and an oscillatory valve plug having complete circumferential clearance in the zone of its ports between itself and said housing at all times through which paste-flowable constituents of the mixture may find their way, said plug having an aperture providing a pair of spaced elements at opposite sides thereof; said aperture being of a size and shape to provide a stowage-avoiding continuation of said material passage when alined therewith; and means for intermittently oscillating said valve plug between an open position, in which its aperture is in axial alinement with the passage to afford unrestricted communication with the pressure chamber, and a position in which said aperture is angularly disposed relative to the passage and each of said spaced elements at least partially restricts said passage.

2. In a concrete pump, the combination with a working chamber, a material passage communicating therewith, and means in said chamber for imparting movement to the material, of a seatless valve for controlling said passage, including a ported valve member having complete clearance in the zone of its ports between itself and its surrounding structure, through which paste-flowable constituents of the mixture may find their way.

3. In a pump for plastic concrete mixtures containing a substantial proportion of coarse aggregates which give to the mixture a strong tendency to stow at restrictions, said pump having a cylinder with a substantially full-diameter end-opening, a pressure member working therein, a mixture outlet-passage of stowage-avoiding sectional area and contour relative to that of the cylinder and communicating axially with the open end thereof; a seatless valve in said outlet-passage including a ported housing member and a ported rocking plug member, these members providing a valve-passageway of stowage-avoiding sectional area and contour relative to that of the cylinder, said valve members providing between them throughout the zone of their ports constantly open peripheral clearance of suitable depth to permit passage therethrough of only the paste-flowable constituents of the mixture; and means for moving said plug member to bring its passageway into and out of register with the ports of its housing in timed relation to the movements of the pressure-member.

4. In a pump for plastic concrete mixtures containing coarse aggregates and paste-flowable constituents, a horizontally disposed cylinder with a full-diameter end opening, a piston work-

ing in said cylinder, mixture outlet and inlet passages each of sectional area and contour approximating that of the cylinder for respectively receiving mixture from and delivering mixture to said open end of said cylinder, respective valves for said outlet and inlet passages each including a housing and a rocking plug valve member therein providing a valve-passageway of sectional area and contour also approximating that of the cylinder, there being at all times free clearance between each said housing and its valve-plug through which the paste-flowable constituents only of the mixture may freely pass, and means for moving said valve-plugs to and from open position in appropriate timed relation to movements of said piston.

5. In a concrete pump for handling coarse aggregate concrete, having a cylinder, an outlet passage connected therewith, and a piston in said cylinder for forcing material through said passage, the combination of a seatless valve controlling said passage, including a rocking plug valve-member and its housing, there being complete clearance in the zone of said passage between said valve-member and housing through which paste-flowable constituents of the mixture may freely pass for avoidance of lodgment and sticking; there also being clearance between the ends of said valve member and the housing; packing between the housing and valve member separating said passage-zone clearance from said end clearances and tending constantly to prevent escape of said constituents from the former into the latter; and openings through which a medium may be introduced into said end clearances to prevent the hardening therein of such said constituents as may find their way past said packing.

6. In a pump for plastic concrete mixtures embodying substantial proportions of coarse aggregates, said pump having a pressure chamber, a pressure member working therein, and a mixture passage communicating therewith, a seatless valve for controlling said passage, including a housing and an oscillatory valve member provided with an unobstructed passageway therethrough having a cross sectional area and contour affording a stowage-avoiding continuation of said mixture passage when alined therewith, there being complete circumferential clearance at all times in the zone of the passage ports between said valve member and housing through which paste-flowable constituents of the mixture may find their way; and means for moving said valve member to bring its passageway into and out of register with said mixture passage.

7. In a pump for plastic concrete mixtures embodying substantial proportions of coarse aggregate which give to said mixtures a strong tendency to stow at restrictions, said pump having a pressure chamber, a pressure member working therein, and a mixture passage communicating therewith, a seatless plug valve for controlling said passage, including a plug member having an unobstructed passageway therein, providing a pair of spaced cut-off elements, said passageway being of substantially the same contour and of equal cross sectional area as said mixture passage, there being complete circumferential clearance at all times between said plug and its enclosing structure in the zone of said passageway; and means for moving said valve member from an open position in which its passageway is alined with said mixture passage forming a smooth continuation thereof, to a position in which each of said elements at least partially restricts said passage.

8. In a pump for plastic concrete mixtures embodying substantial proportions of coarse aggregates, said pump having a working chamber, a pressure member working therein, and a mixture passage communicating therewith, a seatless valve, including a housing having a port communicating with said passage, and a movable valve member within said housing having a stowage-avoiding mixture passage and a cut off element arranged to be moved at least partially across said port, there being complete clearance at all times between said valve member and housing in the zone of said port through which paste-flowable constituents of the mixture may find their way; and means for moving said valve member.

9. In a concrete pump having a pressure chamber, a pressure member working therein, and material inlet and outlet passages communicating therewith, seatless valves for controlling said passages including housings and oscillatory valve members therein, there being at all times free clearance between said housings and oscillatory valve members larger than the fine, paste-flowable constituents of the aggregates and through which such paste-flowable constituents may freely pass without binding said oscillatory valve members to said housings.

10. In a pump for plastic concrete mixtures which embody substantial proportions of coarse aggregates which give to such mixtures a strong tendency to stow at restrictions, a horizontal working chamber; a pressure member working therein; an inlet passage communicating with said chamber from above, said passage having a stowage-avoiding cross sectional area and contour relative to that of said chamber; a horizontal outlet passage in axial alinement with said working chamber, of substantially the same cross sectional area and contour as said chamber, forming a smooth continuation thereof; valve means for controlling said passages; and means for actuating said valve means in timed relation to the movements of said pressure member to open said passages alternately to said chamber, said valve means being arranged to provide in open position an unobstructed communication passage substantially as large in cross sectional area as said chamber.

11. In a pump for handling concrete including large aggregates, a working chamber with an open end, a pressure member working therein, inlet and outlet passages both communicating with said working chamber at its said open end; valves for controlling said passages, each valve including an oscillatory valve member having a passageway therein which in the open position of the valve is aligned with its respective passage, said passages and valve passageways being of a substantially uniform diameter throughout which is substantially equal to that of said working chamber, whereby the concrete mixture being pumped may pass into and out of said working chamber with a minimum of disturbance of the large aggregates of its mass, and mechanical means for operating the valves in timed relation to the operation of said pressure-member.

12. In a pump for handling concrete mixtures having a strong tendency to stow upon restriction, a pressure chamber, a pressure member working therein, a mixture conduit communicating with said chamber which is of storage-avoiding cross-sectional area and contour relative to

that of said chamber, a plug-valve member to control said conduit having a passage therein to permit unrestricted movement of said mixture therethrough when said passage is aligned with said conduit, and mechanical means for rapidly and positively moving said valve member to positions, alternately, in one of which its passage is aligned with said conduit, and in the other of which its passage is partially misaligned with respect to said conduit whereby mixture in said valve passage is partially but not wholly cut from mixture in said conduit to cause the mixture therein to stow, all in timed relation to the working of said pressure member.

13. In a pump for plastic concrete mixtures containing substantial proportions of coarse aggregates, a working chamber perimetrally closed throughout its length and having an axial end opening of stowage-avoiding cross-sectional area and contour relative to that of said chamber, a piston working in said chamber, an inlet passage and an outlet passage for the mixture adapted to be alternately fully opened into communication with said end opening of the working chamber, the cross-sectional area and contour of each of said passages relative to that of the working chamber being such as to avoid stowing of the mixtures, and mechanically actuated valve means beyond said open end of the working chamber for valving the concrete mixture from said inlet passage to said working chamber and from said working chamber to said outlet passage alternately in timed relation with the movements of said piston.

14. In a pump for plastic concrete mixtures containing substantial proportions of coarse aggregates giving the mixture strong tendency to stow, a substantially horizontal cylinder having a single opening in its end which is of stowage-avoiding cross-sectional area and contour relative to that of the cylinder; a piston working in said cylinder for moving the concrete; an outlet passage and an inlet passage opening in common to said cylinder's end opening and the walls of each whereof nowhere include substantially less or more sectional area for concrete confinement than the sectional area of said end opening of the cylinder, whereby both unwanted stowing and dormancy of the mixture are substantially minimized, said outlet passage extending in axial alignment with the cylinder and said inlet passage extending upwardly from said axis; and rocking-plug valve means operating in timed relation to said piston for fully opening and thereafter at least partially closing said inlet and outlet passages alternately.

15. In a pump for plastic concrete mixtures containing substantial proportions of coarse aggregate giving the mixture strong tendency to stow, a cylinder having a single end opening of substantially the sectional area of the cylinder, a piston in said cylinder for moving the concrete, two passages opening in common to said cylinder opening and the walls of each whereof nowhere include substantially less sectional area than that of said cylinder, and respective seatless rocking plug valve means for said passages operable in timed relation to said piston for fully opening and thereafter at least partially closing said passages alternately, and each said valve having constantly open circumferential clearance for passage of only the paste-flowable constituents of the mixture.

16. A pump for moving concrete that embodies substantial proportions of coarse aggregates, having a piston; a horizontally disposed cylinder in which the piston works having an end opening; a branched pipe structure for directing the concrete into and out of the cylinder, having a horizontally disposed outlet portion and an inlet portion branched upwardly therefrom and merging therewith for common communication of the branches with the end opening of the cylinder, said inlet branch having a smooth longitudinal curve toward horizontality below its upper circular inlet end to substantially the cylinder's end opening, and the outlet branch having a circular opening at its delivery end approximately of cylinder diameter, the walls of each said portion being of substantially uniform cross-sectional curvature throughout and the merged portions thereof smoothly connecting with the respective bottom and top portions of the cylinder opening; and valving means for said inlet and outlet branches respectively, each openable to the full cross-sectional area of its respective branch.

17. In a concrete pump having a pressure chamber and a pressure member working therein; a mixture inlet passage and a mixture outlet passage communicating with said pressure chamber, each being of a stowage-avoiding cross-sectional area and contour relative to that of the pressure chamber; a valve in each said passage movable from non-restricting position to position at least partially restricting said passage; mixture-conveying piping connected to the outlet passage and of substantially the same sectional area and contour as the latter and therefore conducive to continuance of movement of the material in said piping due to its inertia, during at least the end portion of the pressure stroke of the pressure member, and means for positively and rapidly operating said valves, in appropriate timed relation to the movements of the pressure member, to cause the valve in the outlet passage to move to restricting position and the inlet valve to move to non-restricting position with an overlap of their nearly-semi-open positions occurring during such period of inertia movement of the mixture, thereby minimizing return or back-slip of said ejected mixture through the outlet and inlet passages.

18. In a pump for plastic concrete mixtures containing substantial proportions of large aggregates giving the mixture a strong tendency to stow, a pressure cylinder, a reciprocating piston therein for imparting motion to the mixture, a mixture outlet passage opening axially to the end of said cylinder and of stowage-avoiding cross-sectional area and contour relative to that of said cylinder, a rocking plug valve controlling the passage and having a plug-opening of the full passage-area, and means for reciprocating said piston and rocking said valve, between respective positions that fully open said passage and at least partially restrict it, in appropriate timed relation; said means including, in combination, a piston-driving crank-shaft; camming means receiving rotation from said shaft and having distinct cam-portions for respectively causing movements of said valve from each of its respective positions to the other thereof; a rocker arm and valve-rocking connections between said arm and the valve plug, said arm having distinct portions coacting with said respective cam-portions to receive rapid and positive movement therefrom in respectively opposite directions; whereby powerful and quick movement of the plug in each direction may respec-

tively provide for prompt stowing of the aggregates and full freeing thereof from restraint, in closely timed relation to the piston travel.

19. In a pump for plastic concrete mixtures containing substantial proportions of large aggregates giving the mixture strong tendency to stow, a substantially horizontal cylinder having a single opening in its end which is of stowage-avoiding cross-sectional area and contour relative to that of the cylinder; a piston working in said cylinder; an outlet passage of stowage-avoiding cross sectional area and contour relative to that of said cylinder coaxial with the cylinder and opening to its end; a rocking plug valve for said passage which in one position fully opens said passage and in another position at least partially restricts said passages to cause the concrete to stow; and means for actuating said piston and quickly and positively rocking said valve from each of its said positions to the other in appropriate timed relation to the pressure stroke of the piston, comprising, in combination, a piston driving crank shaft; a rocker arm provided with a housing; connections between said rocker arm and valve to rock the latter as the arm is moved; a two-section cam secured on said crank shaft and positioned within said housing; and a pair of oppositely disposed rollers carried by said rocker arm within said housing, each engageable by one respective section of said cam and through movement thereof by the cam imparting positive and rapid motion to said arm and valve in a corresponding direction only, all in predetermined timed relation to the reciprocation of the piston.

20. A seatless valve for handling plastic concrete mixtures of paste, fines and large aggregate, comprising a housing having a port of substantially larger area than that of a grading-screen opening through which the largest aggregate will pass, and a movable valve member in said housing controlling said port and having a passage which in one position fully opens the port, there being complete clearance at all times between said valve member and its housing in the ported zone of the latter through which the paste-flowable constituents of the mixture may freely pass.

21. A seatless valve for handling under pressure plastic concrete mixtures that include cement-paste, fines, and large aggregates, comprising a housing having large opposed ports, and an oscillatory plug valve-member in said housing for controlling said ports and having a passageway through it of cross-sectional area adequate to fully open said ports; there being complete circumferential clearance at all times between said plug and its housing in the zone of said ports through which paste-flowable constituents only of the mixture may freely pass without sticking or binding the valve.

22. The steps in the method of transporting plastic concrete mixtures embodying substantial portions of coarse aggregates which give to the mixture a strong tendency to stow, which comprise imparting motion by respective pressure applications to successive confined portions of such mixture; combining said successive portions into a continuous confined stream; and thereafter, in definite timed relation to the pressure applications, moving respective sections of such stream out of alignment with the remainder thereof without entirely severing their connection therewith, and while preserving substantially their original contour, thereby producing respective stowings of the material, and respectively bodily replacing the so-moved sections to restore continuity to the stream, thus relieving the respective stowing actions and permitting resumption of movement of the stream.

23. The steps in the method of transporting plastic concrete mixtures embodying substantial proportions of large aggregates which give to the mixture a strong tendency to stow, which comprise delivering successive confined charges of the mixture for pressure application; applying pressure successively to confined portions of said delivered mixture; combining by said pressure applications such successive portions into a continuous confined stream; at predetermined times, and alternately, bodily moving sections of the material being delivered to the pressure means and sections of the material being moved beyond said pressure means, out of alignment with the respective portions of the mixture of which they are immediate parts, at the same time preserving substantially the original contours of said sections, thereby producing stowing actions alternately in said parts where each said out-of-alignment movement is respectively effected, and subsequently and alternately bodily restoring said respective so-moved sections into continuity with the respective portions of the material of which they were immediately a part, thereby relieving stowing action and permitting forward movement of the material, such out-of-line move-of sections of material being made in timed relation to the successive pressure applications.

24. The method of transporting plastic concrete mixtures embodying substantial proportions of coarse aggregates which give to the mixture a strong tendency to stow, which comprises, in alternate steps, delivering under suction successive charges of the material from transverse confinement that gives it definite cross-sectional area and contour into transverse confinement that gives it substantially the same cross-sectional area and contour, and thereafter imparting longitudinal motion to successive portions of the material while under said second-mentioned confinement through the application of pressure initially and directly along the line of such motion to eject them past the point of the material's delivery to said second-mentioned confinement; combining said pressure-ejected successive portions into a continuous stream under transverse confinment of substantially the same cross-sectional area and contour aforesaid for transportation under such confinement to destination, thereby minimizing pressure-compelled rearrangement of the relative positions of the large aggregate pieces in delivery to and ejection from the second mentioned confinement; and alternately interrupting the movements of the confined material being respectively delivered to and ejected from said second mentioned confinement in timed relation to the alternate applications of pressure and suction.

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