

March 30, 1937.

E. BENEDEK

2,075,017

PUMP AND METHOD OF SILENCING AND OPERATING PUMPS

Filed April 27, 1932

3 Sheets-Sheet 1

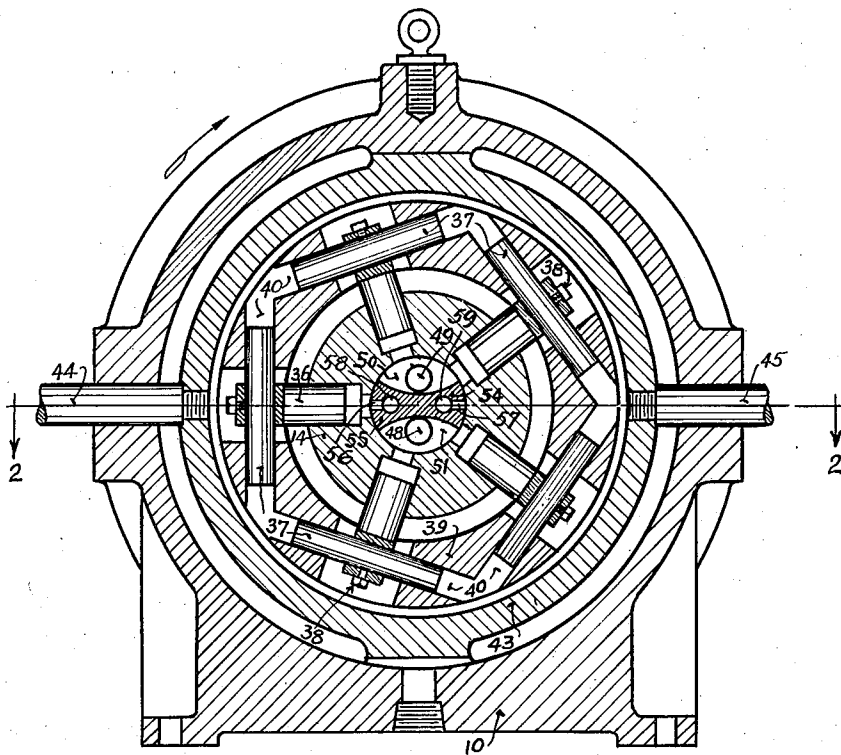


Fig. 1.

Witness:

L. Kent Beebe
H. Nitag.

Inventor

Elek Benedek

By

Attorney

March 30, 1937.

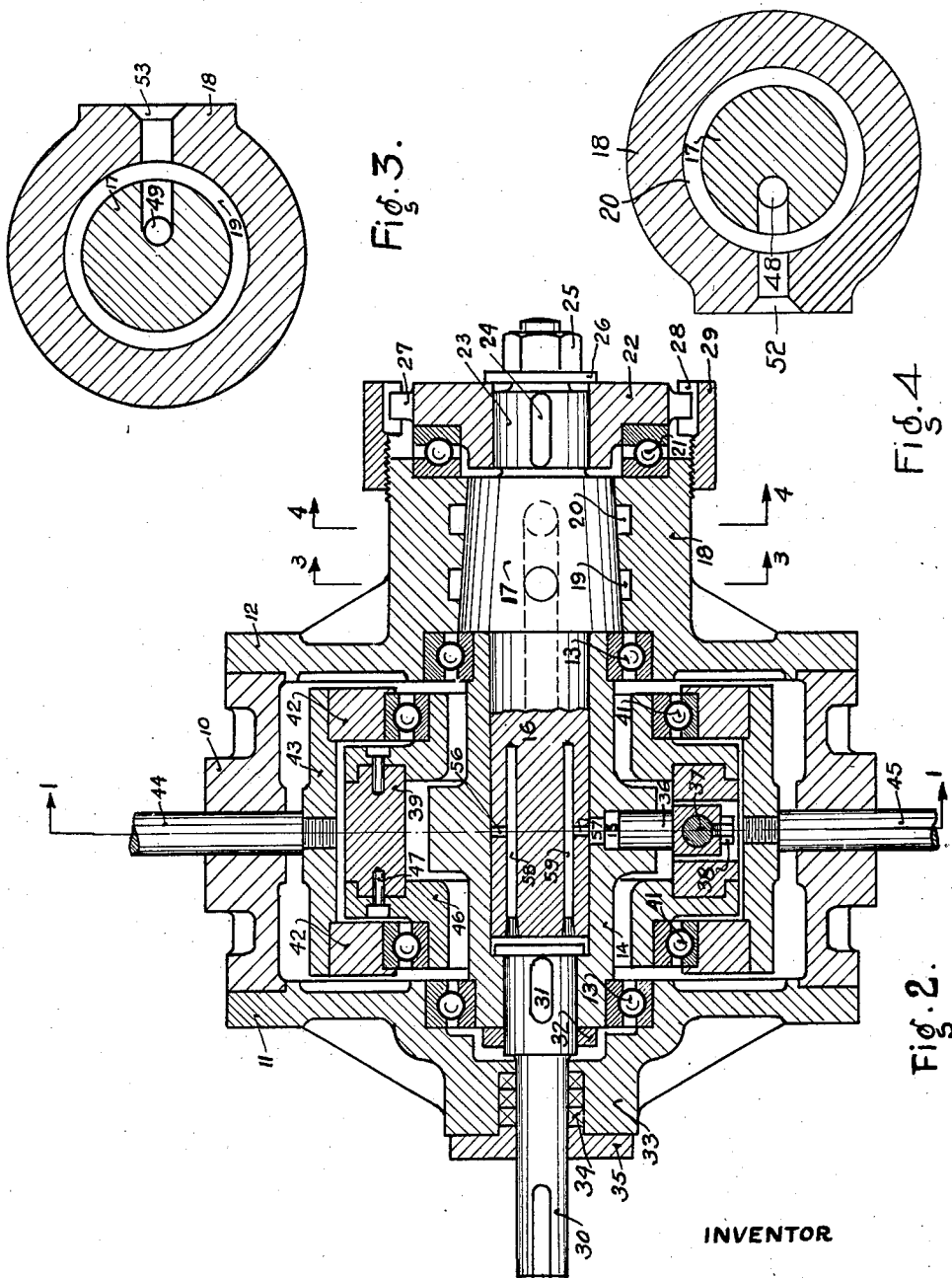
E. BENEDEK

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3 Sheets-Sheet 2



INVENTOR

E. Benedek

March 30, 1937.

E. BENEDEK

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3 Sheets-Sheet 3

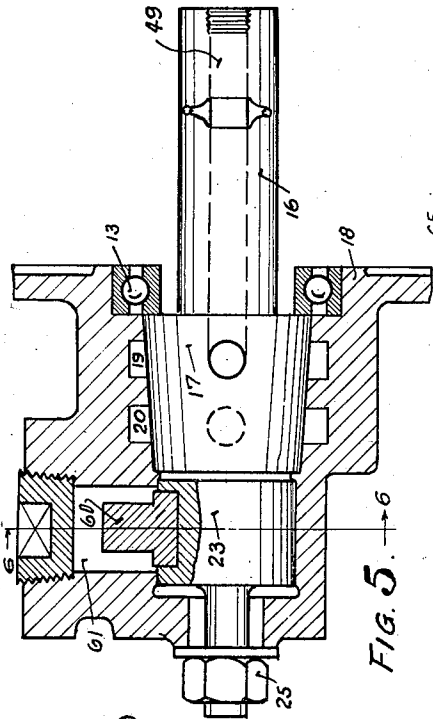


FIG. 5.

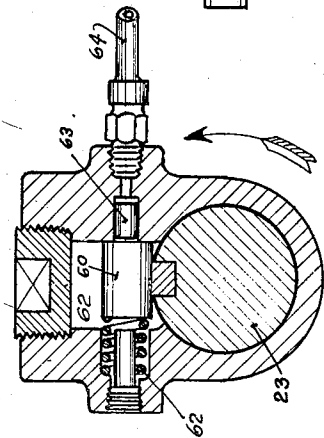


FIG. 6.

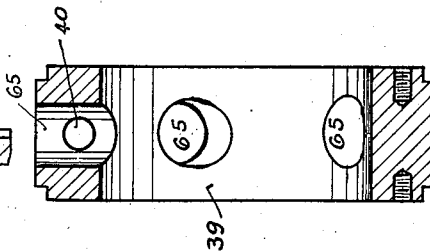


FIG. 8.

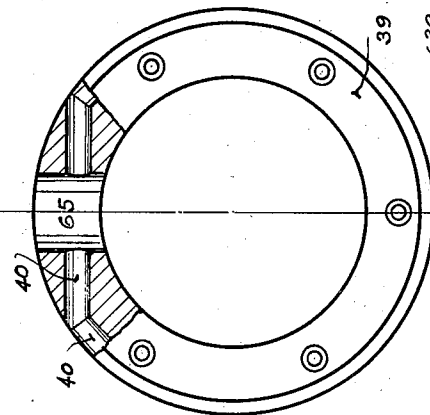


FIG. 7.

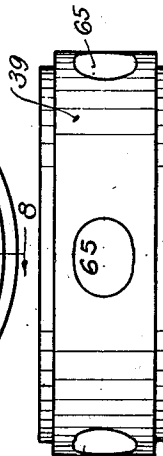


FIG. 9.

Inventor

Elek Benedek

Attorney

Witness:

S. Kent Beebe
N. M. Hagg

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UNITED STATES PATENT OFFICE

2,075,017

PUMP AND METHOD OF SILENCING AND
OPERATING PUMPS

Elek Benedek, Mount Gilead, Ohio

Application April 27, 1932, Serial No. 607,697

15 Claims. (Cl. 103—161)

This invention relates to variable displacement hydraulic pumps or motors of the rotary radial piston type.

Heretofore, in this type of pumps, high efficiencies and quiet operation at high pressure delivery have been prevented to a great extent by unsatisfactory valving relation between the valve pintle ports and the cooperating cylinder ports.

It is one of the principal objects of the present invention to increase the efficiency and render more quiet pumps of this type operating at high pressures by proper pre-compression and pre-expansion of the operating fluid preparatory to its communication with the respective pintle valve ports.

A correlative object is to maintain a more nearly constant degree of pre-compression and pre-expansion of the fluid throughout each interval of such conditions and to immediately utilize the energy thus stored for reducing noise and excessive hydrostatic unbalances.

Another object is to eliminate excessive peaks of pre-compression pressures and of negative pressures.

A more specific object is to control the degree of pre-compression and pre-expansion of the fluid at the higher pressures in a predetermined proportional relationship to the pressure delivery of the pump.

Another object is to provide a new and improved piston actuating assemblage and mounting whereby a high efficiency of transmission of applied forces may be obtained.

Other objects and advantages will become apparent from the following specification wherein reference is made to the drawings in which

Fig. 1 is a vertical cross sectional view through a pump or motor embodying the principles of the present invention;

Fig. 2 is a horizontal sectional view of the pump or motor and is taken on a plane indicated by the line 2—2 of Fig. 1;

Figs. 3 and 4 are cross sectional views of one end of the pump casing showing the manner of mounting the pintle and are taken on planes indicated by the lines 3—3 and 4—4 respectively of Fig. 2;

Fig. 5 is a longitudinal sectional view through the adjustable valve pintle mounting showing the means for automatic adjustment of the pintle;

Fig. 6 is a cross sectional view taken on a plane indicated by the line 6—6 of Fig. 5;

Fig. 7 is a side elevation, partly in section, of the reactance rotor of the pump and motor illustrated in Fig. 1;

Fig. 8 is a vertical sectional view taken on a plane indicated by the line 8—8 of Fig. 7; and

Fig. 9 is a top plan view of the reactance rotor illustrated in Figs. 7 and 8.

For the purposes of illustration, the present invention will be described as a pump, its operation as a motor being readily apparent from such description, and it is to be understood that in the specification and claims, the structure recited is meant to be either a pump or a motor, though referred to only as a pump. Correspondingly, the valve pintle ports are referred to as "suction" and "pressure", only for distinguishing the same from each other more readily, regardless of the fact that both are pressure ports when the structure is operated as a motor.

The pumping mechanism is enclosed in a housing 10, closed at the ends by rigid end covers 11 and 12 respectively, the cover 11 being disposed at the driving shaft end of the pump.

Mounted within the casing and coaxial therewith is a piston carrying rotor 14 having a set of circumferentially spaced radial pumping cylinders 15. The rotor is rotatably supported in the housing through the medium of coaxial sets of radial and axial thrust bearings 13, disposed near the ends of the rotor respectively, the outer races of the sets being snugly received in internal annular recesses in the respective covers 11 and 12.

The end cover 12 is provided with a heavy annular hub portion 16 having a bore extending axially of the rotor 14 and tapered radially inwardly from its inner toward its outer end for receiving and mounting the complementary tapered shank 17 of a valve pintle 18. A portion 23 of the pintle 18 extends beyond the hub portion 16 for receiving a pintle adjusting wheel 22. The adjustment wheel 22 is secured on the protruding end 23 and locked thereto by a key 24 for rotating the pintle. In order to draw the pintle shank firmly into the bore of the hub 16 while rendering the pintle radially rotatable, the wheel 22 is provided with an annular radial bearing shoulder which abuts the outer race of a set of ball bearings 21, the inner race of these bearings engaging a complementary radial annular bearing shoulder on the hub 16. A suitable nut 25 and washer 26 are secured on the outer end of the portion 23 of the pintle and by reactance on the wheel 22 draws the pintle shank outwardly and snugly in the bore of the hub 16. The bearings 21 thus transmit this thrust to the hub while preventing binding of the wheel thereagainst. The wheel 22 is provided with a plurality of radially extending lugs 27 which are received within

notches 28 in an annular lock sleeve 29 which is screw threaded onto the exterior of the hub 18 for holding the wheel 22 and consequently the pintle in predetermined rotated positions.

5 The hub 18 is provided with axially spaced annular recesses 19 and 20 which communicate with the usual longitudinal passages in the valve pintle and, in turn, communicate with the main fluid lines of the pump respectively.

10 The rotor 14 and pintle 16 are coaxial, the rotor being provided with the usual pintle bore into which from one end the pintle 16 protrudes and is snugly received. The pintle terminates in spaced relation to the opposite end of the rotor 15 bore. At the said opposite end, a main drive shaft 30 is provided, this shaft being secured for rotation with the rotor through a suitable key 31 and drawn firmly in place by a lock nut 32 so that the drive shaft and barrel form substantially a unitary structure. The drive shaft 20 terminates in spaced relation to the free end of the pintle 16 and is in sealed relation to the rotor bore wall in which it is received, so that the pintle bore is, in effect, dead end. The end cover 25

11 carries a hub portion 33 having a bore through which the shaft 30 protrudes, the bore in the hub 33 being counterbored to receive suitable packing washers 34 which are secured in place by the cap 35.

30 Mounted and reciprocable in the radial cylinders 15 of the rotor are respective radial pistons 36, the outermost ends of which are slightly enlarged to provide head portions carrying thrust pins 37 through the medium of which the pistons are reciprocated. The head portion of each piston is provided with a bore disposed at 90 degrees to the piston axis and extending fore and aft in the direction of travel. The pins 37 are snugly received therein and secured in place by suitable set screws 38. For actuating the piston 40 through the media of the pins, a reactance rotor or other suitable reactance means 39 is provided. The reactance rotor is provided with a plurality of chordal bores 40, one for each piston, these bores extending 90 degrees to the piston axis. 45 The bores 40 are preferably of sufficient length so that each intersects those adjacent at the ends, as well as extend at the ends through the circumferential wall of the secondary rotor 39 so as to permit ready insertion of the pins 37.

50 In order to mount the reactance rotor for rotation, a reactance housing 43, having inwardly projecting annular bearing elements 42, is mounted within the casing portion 10. The bearing elements 42 are provided with internal annular shoulders on which are received ball bearings 41, one set at each end of the reactance rotor housing. Annular flanged cooperating bearing elements 46 are secured to the rotor 39 through the medium of bolts 47, the annular flanged portion 60 of the members 46 cooperating with the bearings 41 for rotatably supporting the rotor 39 in the housing 43 and resisting axial displacement thereof.

It should be noted in connection with the reactance rotor that its housing 43 is shiftable for 65 varying the effective stroke of the pistons and consequently the volumetric and pressure delivery of the pump. For shifting the secondary rotor 39, its housing 43 is provided with rods 44 and 45 extending through the suitable bores in the wall of the casing portion 10. Likewise, as better illustrated in Fig. 1, the housing 43 carries at its diametrically opposite portions, spaced 90 degrees from the rods 44 and 45, suitable flat bearing 75 surfaces. These surfaces are cooperable with

complementary flat bearing surfaces in the housing portion 10 for maintaining the housing 43 and the reactance rotor with their common axis parallel to the axis of the primary rotor 14 while permitting shifting thereof to render the rotors 14 and 39 coaxial or to dispose their axes parallel and offset from each other.

As above mentioned the valve pintle 16 is received in the bore of the rotor 14 with a snug fit for valving cooperation therewith, and is provided with valve ports 50 and 51 which are spaced diametrically opposite each other and positioned longitudinally of the pintle to be aligned successively with discharge ports communicating the cylinders 15 with the bore of the primary rotor 14. The ports 50 and 51 are separated by diametrically opposite bridge portions 54 and 55 which extend circumferentially a distance considerably greater than the discharge ports of the cylinders 15 so that, upon rotation of the primary 20 rotor with respect to the pintle for positioning each cylinder discharge port successively in communication with the ports 50 and 51, each cylinder port successively is completely blocked by the bridges during part of its passage thereover. In the illustrative example, the ports 50 and 51 are suction and pressure ports respectively. The ports, in turn, are in communication with the usual longitudinally extending pintle passages 49 and 48 respectively. As better illustrated in Figs. 30 3 and 4, the passages 48 and 49 communicate respectively with the passages 20 and 19 in the hub 18 of the end cover 12. The passages 19 and 20, in turn, communicate respectively with the radial passages 53 and 52 respectively in the hub 18 and through the passages 53 and 52 to the usual fluid lines of the mechanism.

Efficient lubrication and smoothness of operation must be obtained as also must be effective application of the reactance thrusts to the pistons. It is apparent that under high pressures a terrific thrust would be developed between the reactance rotor and the piston assemblages. If flat reactance surfaces were provided between the two, this thrust would tend to squeeze out all lubricant. Further, this loss of lubricant would be augmented by centrifugal forces. By providing the round chordal bores 40 and round pins 37, however, the entire surfaces of each pin and the bore wall associated therewith is not subjected to the full pressure and therefore the film of oil may be retained within the bore and around the pins with the possible exception of a relatively small surface under direct heavy pressure contact. This film is thus readily available so that when the pressure is relieved in the slightest, as when the opposite stroke of the piston is begun, this film may quickly envelope the pin and immediately relubricate pin and bore contact surfaces. Furthermore, the film of lubricant tends to remain even on the contact surfaces thus permitting the pins 37 to shift axially in the bores 40 so as to compensate for the lead and lag in tangential travel of the pistons relative to the reactance due to eccentricity of the rotors. Suitable oval radial passages 65 are provided in the reactance rotor for accommodating the head portions of the pistons as they shift to and fro in the direction of travel during this compensating action.

It is apparent that with this construction, especially when a long stroke, small diameter piston is used, extremely great pressures can be developed. Here it should be emphasized that the pump is primarily for very high pressures and 75

that its delivery is controlled by changing the eccentricity of the reactance rotor 39 relative to the primary rotor 14. The eccentricity results in reciprocation of each piston in one direction throughout 180 degrees of angular travel of the rotor and in the opposite direction throughout the remaining 180 degrees of angular travel. In order to utilize the full efficiency of the pump and to prevent discharging of the fluid under pressure from any cylinder into the suction port of the pintle, and to prevent relieving the suction in any cylinder by communication thereof with the high pressure port of the pintle, the bridges 54 and 55 of the pintle must extend a material distance circumferentially of the pintle. Necessarily, therefore, with a rotating reactance, and for some stationary reactances, the pistons cannot complete either stroke while their cylinders are in communication with either of the ports 50 and 51.

Referring to Fig. 1, and assuming, for example, the direction of rotation of the pump is clockwise, the port 50 the intake or suction port and the port 51 is the discharge or pressure port, it will be seen that the changes in the direction of reciprocation for each piston occur when the piston axis is disposed horizontally. The bridges 54 and 55, however, are aligned with the cylinder ports at these times, respectively. Assuming that the rotor housing 43 has been shifted to the right, then, when a piston is disposed horizontally at the right, it is at dead center, having completed its suction stroke and not yet having begun its pressure stroke. Since the bridges necessarily extend circumferentially of the pintle a distance greater than the cylinder ports so as to prevent undue fluid slip and passage of fluid from the pintle pressure port through the cylinder and directly into the pintle suction port, the bridges necessarily block and seal each cylinder port, in turn, as the port approaches and recedes from horizontal or dead center position. Consequently, the cylinder ports are sealed and the fluid drawn into the cylinder is trapped. In high pressure pumps requiring wider bridges for elimination of slip and by-pass, the interval and travel during which the piston is so sealed is greatly increased. If the piston continues on the suction stroke after the cylinder port is sealed by a bridge, energy is expended in creating useless and detrimental sub-atmospheric pressure in the cylinder. Upon continued rotation, the piston returns on the pressure stroke, the cylinder remaining sealed. Thereupon, the piston moves part way entirely unopposed by fluid and strikes the fluid with a sudden sharp impact resulting in vibration, noise, and stresses of the working parts. Having struck the fluid, compression begins and continues for an interval while the cylinder remains sealed. Since the volume of the small quantity of fluid in the cylinder cannot be reduced appreciably by compression, an extremely excessive pressure is immediately created in the cylinder and more noise, stress and vibration results, often "locking" the rotor and damaging the pump parts. Upon continuance of this stroke, the cylinder port communicates with the pintle pressure port in which the pressure is far below that instantaneous excessive pressure in the cylinder. Here again, a detonation results which causes a surge in the delivery pressure of the pump and additional noise and vibration. This almost instantaneous release also reduces the resistance to rotor rotation suddenly and a surge in angular velocity of the rotor results. If the pump should be so

timed that the pressure in a cylinder on compression is less than the pintle port pressure at the instant of communication, obviously a surge from the pintle port into the cylinder would result.

Again, continuing this stroke as the cylinder port approaches the opposite bridge, some fluid remains in the cylinder after the port is again blocked thereby. Thereupon, another sudden excessive compressive pressure is developed and continues until the piston axis is horizontal with the piston disposed at the left in Fig. 1. Thereupon begins the suction stroke, but since no fluid can enter the cylinder port, due to the bridge 55, considerable negative pressure is developed in the cylinder. As soon as the cylinder port communicates with the port 50, a negative pressure compartment is exposed to the fluid and there is an instantaneous inrush of fluid causing additional noise and vibration.

The above conditions, though not so pronounced in low pressure pumps, are so exaggerated in high pressure pumps as to become almost fatal defects. To reduce these undesirable effects substantially to the point of complete elimination is the principal object of the present invention.

The structure for effecting this reduction and ameliorating the resulting conditions is predicated on the principle that the cylinders should be communicated with the pintle pressure port and with the pintle suction port only when the fluid pressures in the cylinders are equal to the fluid pressure in the particular pintle port with which to be communicated and that during the passage of each cylinder across the intervening bridges, no excessive pressures, either positive or negative, are developed. All of these results may be realized and silent, smooth operation afforded by proper pre-compression and pre-expansion of the operating fluid. This is accomplished by advancement of the angular position of the pintle in the direction of rotor rotation from its normal position and by the provision of fluid compression chambers.

Referring to Figs. 1 and 2, the fluid compression chambers for accomplishing more uniform pre-compression and pre-expansion pressures are illustrated. These chambers may comprise large capacity fluid tight bores 56 and 59 preferably formed directly in the valve pintle 16 and extending longitudinally thereof. The chambers are provided with ports 56 and 57 respectively which open onto the bridge surfaces 55 and 54 respectively. Since the chambers may be the same in form and function, the chamber 59 only will be specifically referred to.

The port 57 which is the only opening into the chamber 59 is preferably positioned on the bridge 54 midway between the circumferential limits of the bridge. The port is of such size relative to bridge and cylinder ports that it will be partially aligned with each passing cylinder port before the cylinder port has been discommunicated from the leading pintle port, port 50 in the present instance, and will remain in such communication until the cylinder port is in communication with the trailing pintle port 51.

Tracing the operation of the chambers, it is apparent that slightly before any cylinder reaches the horizontal position, its port comes into communication with one of the compression chambers 59 while yet in communication with the pintle suction port 50. When the piston axis is horizontal and to the right in Fig. 1, the cylinder port is in communication only with the chamber

59 and is blocked from communication with ports 50 and 51 by the bridge portion 54. Consequently, as the piston starts upon its compression stroke, the fluid is trapped in the cylinder and chamber 59 and is pre-compressed in the cylinder and in the compression chamber 59. The chamber 59 is of capacity such that a sufficiently large amount of fluid can be compressed therein without a disproportional increase in the fluid pressure, to accommodate that discharged by the cylinder before it communicates with port 51. If the chamber were of too limited capacity, substantially the only reduction in volume of fluid that could occur would be that due to compression of the fluid directly in the cylinder. The latter is so limited that an excessive pressure peak would immediately result. The chambers 58 and 59, therefore, are analogous, in operation, to long springs in which a high and substantially constant pressure can be stored and maintained substantially uniform during a considerable portion of the compressive stroke. With the chambers omitted, the action is analogous to a short spring which is fully compressed by a very slight portion of the compression stroke and an excessive and sudden disproportional increase in pressure thereupon results. Thus the operating fluid is pre-compressed to a predetermined degree with reasonable uniformity of higher pressure to a pressure substantially equal to that in the port 51. Immediately upon communication of the cylinder port with the port 51 of the pintle, the fluid is discharged at this pressure without a sudden drop in the cylinder pressure which would result upon release of a slight volume of fluid at excessive compression. During initial communication, some re-expansion of fluid in the chamber 59 maintains a flow therefrom whereupon it is in condition for cooperation with the next cylinder. The pressure in the chamber 59 may become slightly above that of line delivery but this is immediately relieved and all of its energy utilized.

Continuing the movement in a clockwise direction, the piston moves upwardly toward the horizontal position at the left of the pump to complete its compression stroke and begin its suction stroke. The fluid in the chamber 58 is at ordinary atmospheric pressure, consequently it tends to reduce the pressure in the cylinder as the cylinder communicates therewith. However, the cylinder port communicates with the chamber while remaining in communication with the port 51. Consequently, some fluid is compressed a given amount in the chamber 58. As the cylinder continues traveling upwardly and begins its suction stroke, this fluid re-expands concurrently and is passed back into the cylinder so as to fill the portion of the cylinder in advance of the piston and maintain it at substantially atmospheric pressure, the same as port 50, at the instant that it communicates with the port 50. Therefore, the noise due to a sudden release of highly compressed fluid and due to a sudden rush of fluid into a comparatively great negative pressure in a cylinder will be eliminated.

From the foregoing it can readily be seen that for a given operating pressure of the pump, pounding, vibration and noise can be so greatly reduced as to be unnoticeable. However, as the pressure at which the pump is operating is increased, the degree of pre-expansion and pre-compression must necessarily be increased for maintaining this balance, otherwise noise and vibration will again result. The operating fluid pressure of the pump is increased and decreased

solely by shifting the secondary reactance through the medium of the rods 44 and 45. The pre-compression for effecting silent operation, however, is provided by rotating the pintle through different angular distances, the pintle being advanced in the direction of rotation for silencing operation at higher pressures and returned toward normal operating position for silencing operation at lower pressures. For example, as the pintle is advanced in the direction of rotation, due to the accelerated rate with which the piston moves inwardly after it passes dead center for a given angular rotation of the piston, a greater movement of the piston is occasioned during the interval in which the piston cylinder is blocked by its cooperating pintle bridge. Thus necessarily a higher pre-compression results. The same is true upon expansion on the suction stroke. The chambers 58 and 59 therefore must be of sufficient capacity for receiving this greater amount of fluid at the higher compression and longer portion of stroke to prevent excessive pressure peaks during these relations. Here, again, at the higher pressures, if the pressure in the cylinder is equal substantially to that in the port with which it is to be communicated, no pounding and vibration will result nor will there be any sudden release of pressure which would tend to make the rotor increase in velocity. While this arrangement is satisfactory for most instances, it often happens that the particular apparatus being driven by the pump or motor is blocked or jammed with the result that the flow in the forward line 64 is suddenly decreased accompanied by a sudden increase in pressure. If the pump continued to operate with a given setting of the pintle at this higher pressure or lower pressure, as the case may be, excessive pounding and noise would again result. Consequently, for silencing the pump, it is desirable that the pintle be rotated to different angular positions in response to line pressures, for example, being rotated to advance the same as the pressure increases and to return the pintle toward normal position as the pressure decreases.

For accomplishing this purpose, the pressure delivery of the pump itself is utilized through a structure illustrated in Figs. 6 and 7. In this structure, instead of the hand wheel 22, a key 60 is fixed for rotation with the pintle 23, a suitable notch 61 being provided in the hub portion 18 to permit limited movement of the head of the key 60. At one end of the key 60 in the direction of advance movement of the pintle, there is provided a spring 62 of predetermined strength which abuts the corresponding end of the key and urges it in the opposite direction to normal position. At the opposite end, a plunger 63 operating in a suitable fluid pressure bore is provided, the plunger bore being communicated with the working fluid of the pump through the line 64. Thus as the pressure in the line 64, increases it may overcome the force of the spring and shift the key 60 in the direction for rotating the pintle 16 through the medium of the end portion 23 to advance position. When, however, the pressure is reduced in the line 64, the spring will turn the key and pintle in the opposite direction. The limits within which the pintle can be rotated may be fixed by the side walls of the notch 61. The elements are so arranged that when low line pressure is provided, the pintle will lie in its theoretical position in which, when the dead center position of each piston is reached, its cylinder port will occupy the center of its cooperating

bridge. However, as the pressure in the working line 64 increases, the advancement of the pintle will be increased also so that rotation of the pintle will be sufficient to pre-compress and pre-expand the fluid to a pressure substantially the same as that of the pintle ports. It should be noted that the spring is designed for the maximum allowable working pressure of the pump and consequently a maximum but limited rotation of the pintle is provided for, five degrees usually being all that is required. This maximum is determined by the compressibility of the particular working fluid used, however. Thus not only is the mechanism silenced, but sudden fluctuations of pressure of delivery are eliminated.

Having thus described my invention, I claim:

1. The combination with a hydraulic rotary radial piston type pump, or motor, including a rotatably adjustable valve pintle having fluid ports, a rotor having radial cylinders with ports cooperable successively with the pintle ports, piston assemblages respective to the cylinders, adjustable reactance means cooperable with the piston assemblages for reciprocating the same, and means for adjusting the reactance means to different positions for varying the delivery fluid of the pump, of means responsive to changes in the delivery pressure of the pump for rotatably adjusting the pintle to different angular positions for silencing operation of the pump.

2. The combination with a hydraulic rotary radial piston type pump, or motor, including a rotatably adjustable valve pintle having fluid ports, a rotor having radial cylinders with ports cooperable successively with the pintle ports, piston assemblages respective to the cylinders, reactance means cooperable with the piston assemblages for reciprocating the same, means for adjusting the reactance means to different positions for varying the delivery of the pump, of means operated by the fluid pressure delivered by the pump to adjust the angular position of the pintle in the direction of rotation of the rotor in a predetermined proportional relationship to increases in the fluid delivery pressure of the pump to thereby silence the operation of the pump at the different delivery pressures.

3. In a hydraulic rotary radial piston pump or motor including a rotor having circumferentially spaced radial cylinders and piston assemblages respective thereto, and ports respective to said cylinders, reactance means cooperable with said piston assemblages to reciprocate the same, a valve pintle in valving relation to the rotor and having a suction port and a pressure port cooperable successively with each cylinder port as the rotor rotates, bridges intermediate the pintle ports for blocking each cylinder port when such cylinder port is aligned therewith, whereby fluid is temporarily entrapped in the particular aligned cylinder, a fluid tight chamber having a port opening onto one of said bridges for communication with the cylinder ports when aligned with said bridge, said chamber being otherwise sealed and filled with operating fluid, and having sufficient fluid capacity to temporarily receive from the cylinder and accommodate without an excessive increase in pressure a portion of the fluid trapped in the cylinder by virtue of compression of the fluid filling said chamber to thereby reduce the noise incident to operation of the machine.

4. In a rotary radial piston hydraulic pump or motor including a rotor having a series of radial cylinders, piston assemblages respective thereto, cylinder ports respective to the cylinders, a valve

pintle received in the rotor in valving relation and having a suction port and a pressure port, said pintle ports being successively cooperable with each cylinder port, bridges intermediate the pintle ports for blocking each cylinder port when aligned therewith, reactance means for the pistons positioned relative to the pintle to drive the piston assemblages to the respective ends of their strokes while their associated cylinder ports are blocked from communication with the pintle ports by said bridges respectively, said pump having fluid tight chambers with ports respective to said bridges and opening thereonto for communication with the cylinders when the pistons thereof are at the said ends of their strokes, whereby pre-compression and pre-expansion of fluid in the cylinders may be effected without excessive instantaneous increases in pressure, by expansion and compression of the fluid in said chambers, and said chambers being continuously filled with operating fluid, whereby the instantaneous flow thereinto and therefrom is equal and reversible.

5. In a hydraulic rotary, radial piston pump or motor including a valve pintle having a pressure port and a suction port, a rotor having radial cylinders with ports cooperable successively with the pintle ports, pintle bridges between the pintle ports, piston assemblages respective to the cylinders, reactance means cooperable with the piston assemblages for driving them to the ends of their strokes and into alignment with the respective bridges, means mounting said pintle for limited rotation to different adjusted positions, means cooperable with the pintle and cylinder ports for relieving excessive pre-compression and pre-expansion respectively of operating fluid in the cylinders while the ports thereof are passing said bridges respectively and preparatory to and at the instant of communication of the fluid in the cylinder ports with the pintle ports, and said bridges extending a sufficient distance circumferentially of the pintle to remain in cooperative relation to the cylinder ports at the ends of the piston strokes of the associated pistons of said cylinders in the various adjusted positions of the pintle and thereby prevent reversal of any piston stroke at an instant while its cylinder port is in communication with a pintle port.

6. In a rotary radial piston pump including a rotor having radial cylinders, piston assemblages and cylinder ports respective to the cylinders, reactance means cooperable with said piston assemblages for reciprocating the assemblages, a valve pintle extending within the rotor and having a suction port and a pressure port successively cooperable with each cylinder port, bridges intermediate the pintle ports for preventing concurrent communication of any cylinder with both pintle ports, whereby each cylinder port is blocked when aligned with the bridges and fluid is trapped in the cylinder, and a fluid tight chamber opening onto one of said bridges for communication with each cylinder port when aligned therewith, said chamber being filled with fluid and having sufficient fluid capacity to receive a material amount of the fluid trapped in the cylinders by compression of the fluid already filling said chamber to less than an amount which would cause excessive resistance to compression.

7. In a hydraulic rotary, radial piston pump or motor including a valve pintle having a suction port and a pressure port, a rotor having radial cylinders with ports cooperable successively with the pintle ports, piston assemblages respective to

the cylinders, reactance means cooperable with the piston assemblages for reciprocating the same consequent upon rotation of the rotor, bridges on said pintle intermediate the ports thereof, fluid tight compression chambers having ports opening onto said bridges for cooperation successively with the cylinder ports, said chamber ports terminating circumferentially of the pintle a sufficient distance from the bridge limits to communicate with the cylinder port cooperating with the bridge only while the same cylinder port is uncommunicated with the pintle ports.

8. In a hydraulic rotary, radial piston pump or motor including a valve pintle having a suction port and a pressure port, a rotor having radial cylinders with ports cooperable successively with the pintle ports, piston assemblages respective to the cylinders, reactance means cooperable with the piston assemblages for reciprocating the same consequent upon rotation of the rotor, bridges on said pintle intermediate the ports thereof, fluid tight compression chambers having ports opening onto said bridges for cooperation successively with the cylinder ports, said bridges extending circumferentially of the pintle a distance sufficient to prevent concurrent communication of any cylinder port with both pintle ports, and said chamber ports extending circumferentially of the pintle bridge a sufficient distance to communicate with the cylinder port cooperating with the bridge only while the cylinder port is uncommunicated with a port of the pintle.

9. In a hydraulic rotary, radial piston pump or motor including a valve pintle having a suction port and a pressure port, a rotor having radial cylinders with ports cooperable successively with the pintle ports, piston assemblages respective to the cylinders, reactance means cooperable with the piston assemblages for reciprocating the same consequent upon rotation of the rotor, bridges on said pintle intermediate the ports thereof extending circumferentially of the pintle a sufficient distance to prevent concurrent communication of any cylinder port with both pintle ports, fluid tight compression chambers having ports opening onto said bridges respectively for cooperation successively with the cylinder ports, each chamber port extending circumferentially of the bridge with which associated a sufficient distance to communicate with the cylinder port cooperating with the bridge while the cylinder port is uncommunicated from the pressure port of the pintle, and means for rotating the pintle in the direction of rotation of the rotor for increasing the degree of pre-compression of the fluid in said chamber preparatory to communication of the cylinder port and pintle pressure ports.

10. In a rotary radial piston and cylinder pump, a valve pintle having a suction port and a pressure port, a rotor having a cylinder and a cylinder port successively cooperable with said ports as the rotor rotates, a piston reciprocable in the cylinder, reactance means cooperable with the piston for reciprocating the same, a bridge on the pintle between the pintle ports having a valve surface blocking the cylinder port when aligned therewith, a fluid chamber having a port in the surface of said bridge for communication with the cylinder port when aligned therewith, and being continuously filled with the operating fluid of the pump, said chamber being sealed except for said port and of adequate fluid capacity for receiving and accommodating a predetermined quantity of fluid from the cylinder by compressive reduction of the volume of the fluid in the

chamber during said communication with said cylinder port and for redelivering the fluid so received through said chamber port by expansion of the fluid when the fluid pressure thereon from the cylinder is relieved.

11. The combination with a fluid pressure pump or motor including a casing, a rotatably adjustable valve having fluid ports, a rotor relatively rotatable with respect to the valve and having a cylinder, a piston in the cylinder, adjustable reactance means for reciprocating the pistons, and means for adjusting the reactance means for varying the delivery of the pump, of means responsive to changes in the operating fluid pressure for rotatably adjusting the valve, and means associated with the valve and cooperable with the cylinder in all of the adjusted positions of the valve for effecting pre-compression and pre-expansion of the operating fluid in the cylinder for reducing the noise incident to operation of the pump or motor by synchronizing the operating pressure with the pressure of the working fluid of the cylinder.

12. In a fluid pressure pump or motor, a casing, a rotary barrel having a cylinder, said cylinder having a port, a piston in the cylinder, adjustable reactance means to reciprocate the piston, means to adjust the reactance means for varying the stroke, a rotatably adjustable valve for the cylinder, said valve having fluid circuit ports for valving cooperation with the cylinder port, bridge means between the valve ports providing positive overlap in each direction from the center line of the bridge means with respect to the cylinder port, a sealed fluid chamber for receiving and delivering fluid from and to the cylinder by compressive reduction and expansion of the volume of the fluid in the chamber during communication of the cylinder and chamber, said chamber redelivering the fluid by expansion thereof when the chamber is relieved from the fluid pressure in the cylinder, and means for communicating said chamber and cylinder port during relative passage of the cylinder port and valve bridge.

13. In a fluid pressure pump or motor, a rotary barrel having a cylinder, a piston in the cylinder, adjustable reactance means to reciprocate the piston, means for adjusting the reactance means, a valve for the cylinder, said valve having fluid circuit ports for valving cooperation with the cylinder, bridge means between the ports of the valve providing positive overlap in two directions with the cylinder port, means mounting the valve for rotation to different adjusted positions, and means responsive to changes in delivery pressure of the pump for rotating the valve to different adjusted positions for effecting predetermined pre-compression and pre-expansion of the operating fluid in the cylinder during relative passage of the cylinder port and bridge means.

14. In a fluid pressure pump or motor, a casing, a rotary barrel having a cylinder, a piston in the cylinder, adjustable reactance means to reciprocate the piston, means for adjusting the reactance means, a valve pintle for the cylinder and rotatable relative to the casing, said valve pintle having fluid circuit ports for valving cooperation with the cylinder, bridge means between the ports of the valve, positive overlap associated with said bridge means at each side of the center line of the bridge, means mounting the valve for rotation in the casing to different adjusted positions, and means associated with said valve and responsive to delivery pressure of the pump for rotating said valve to different adjusted positions

- and in the direction of rotation of the pump for effecting predetermined compression and expansion respectively of the working fluid in the individual cylinder during the time element in
- 5 which the cylinder passes the bridge and the associated positive overlap, said time element being determined by the amount of rotation of the valve pintle and the operating pressure of the pump respectively, and being sufficient to compress the
- 10 segregated working fluid of the individual cylinder to the delivery pressure thereby providing communication between the discharge of the individual cylinder and the delivery port of said valve at an equalized pressure.
- 15 15. In a fluid pressure pump or motor the combination of a casing, a cylinder barrel having a cylinder, a piston in the cylinder, adjustable reactance means to reciprocate the piston, means for adjusting the reactance means, a rotatably
- 20 adjustable pintle for the cylinder, said cylinder having a port, said pintle having fluid circuit ports in valving cooperation with the cylinder port, bridge means between the ports of the pintle, positive overlaps associated with said bridge means to control the time element of communication of the cylinder port with the pintle ports, means mounting the pintle for rotation in the casing to different adjusted positions, and means responsive to changes in delivery pressure of the pump for rotating the pintle to different adjusted positions for effecting predetermined pre-compression and pre-expansion of the working fluid in the cylinder respectively, during the passage of the cylinder port and the said bridge means, and thereby to adjust the pressure in said cylinder to the working pressure of said pintle ports respectively prior to the communication of the cylinder port with the respective pintle ports.

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