March 9, 1954 C. L. PELHAM 2,671,402

ROTARY PUMP

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Fig. 1.

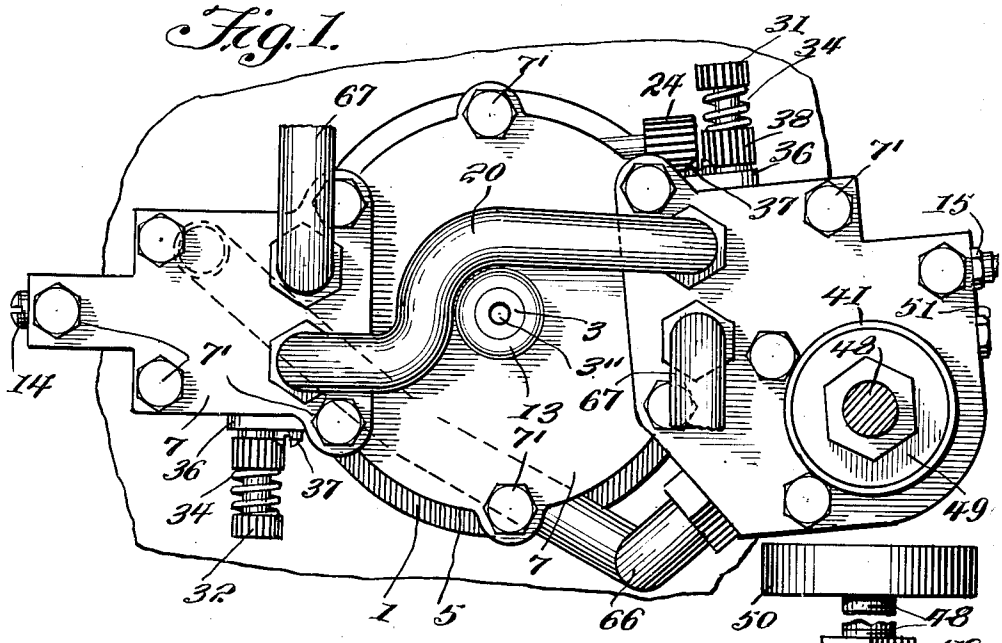
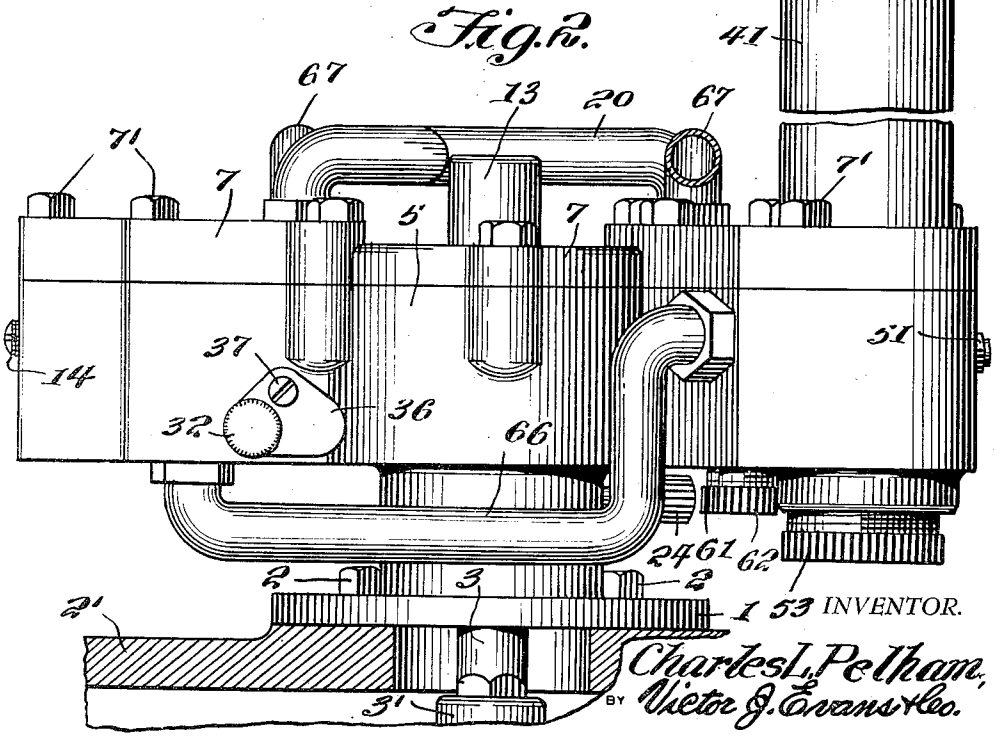


Fig. 2.



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Fig. 3.

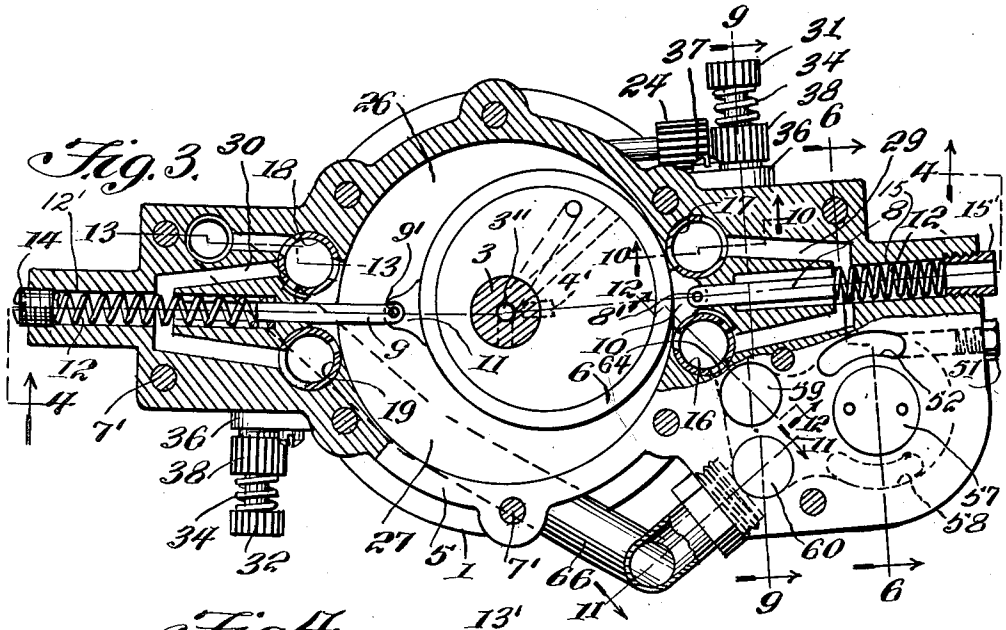
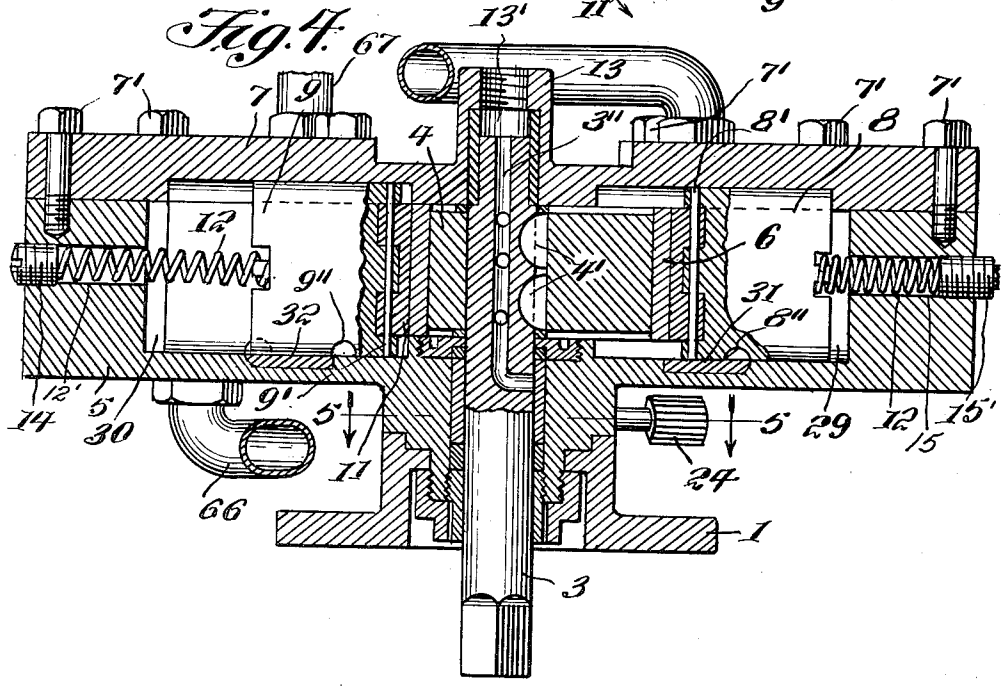


Fig. 4.



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Fig. 5.

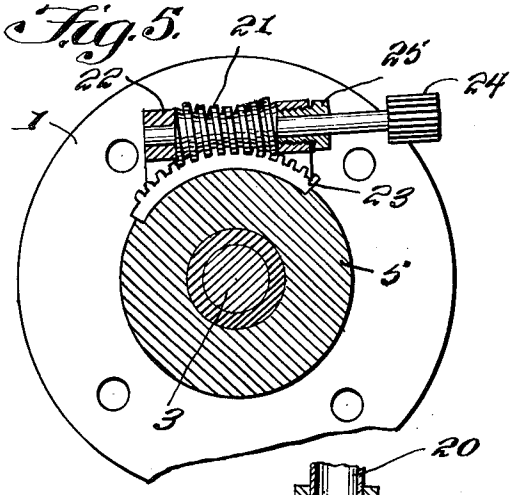


Fig. 6.

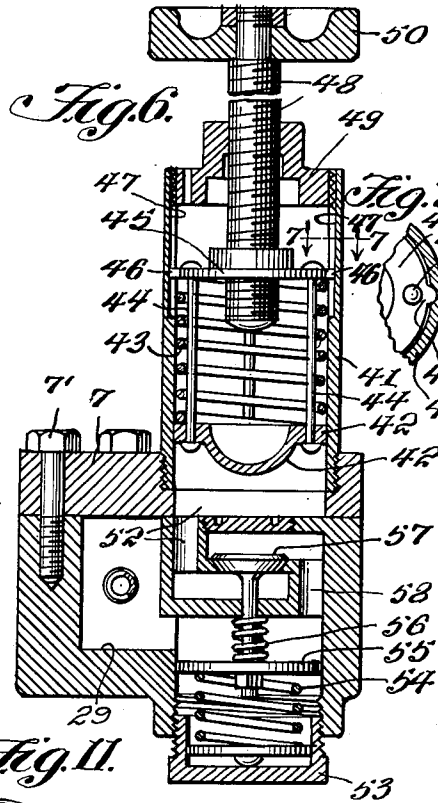


Fig. 7.

Fig. 10.

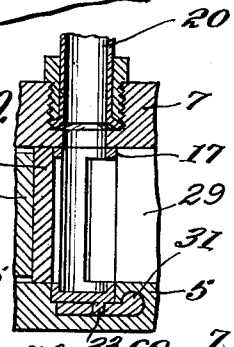


Fig. 8.

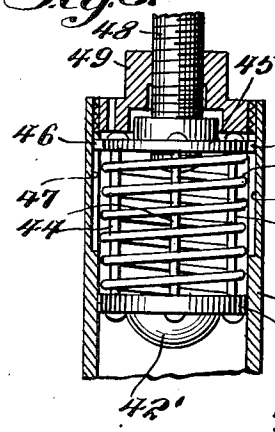


Fig. 11.

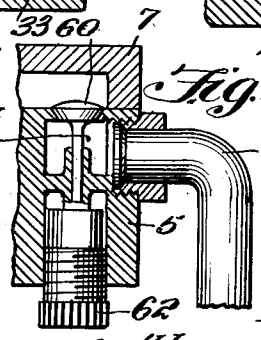


Fig. 9.

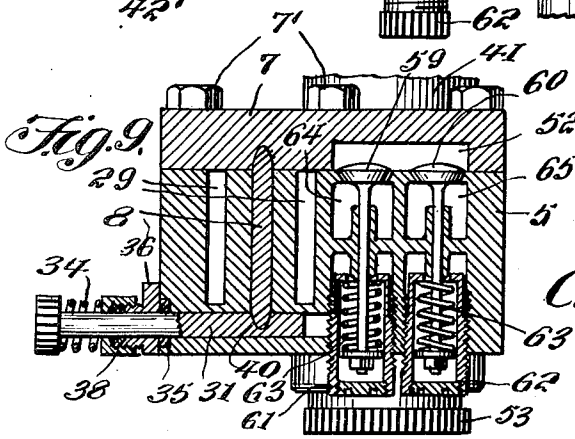
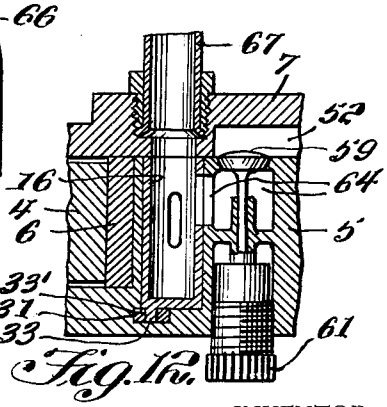


Fig. 12.



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Fig. 13.

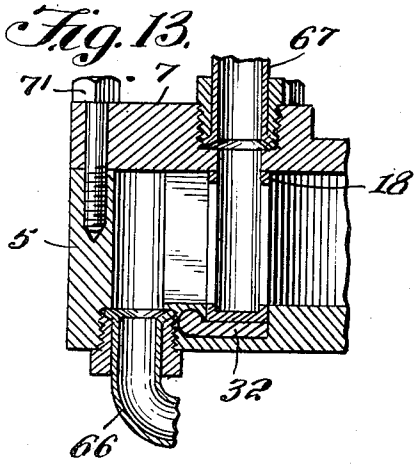


Fig. 14.

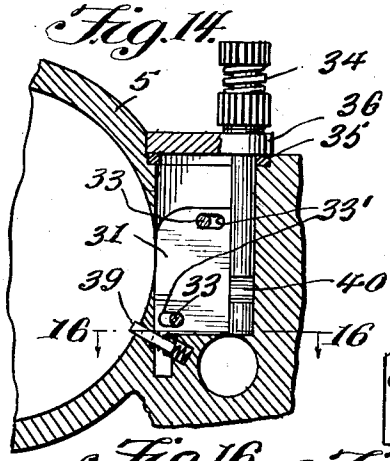


Fig. 15.



Fig. 16.

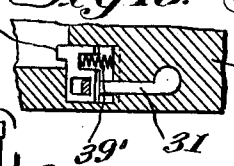


Fig. 17.

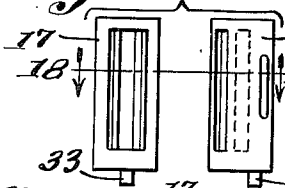


Fig. 19.

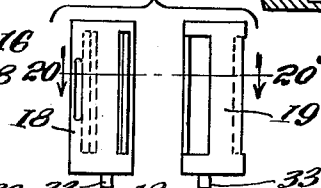
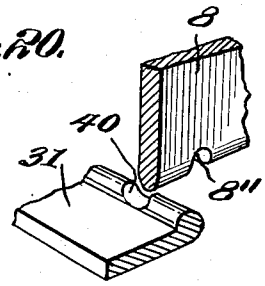


Fig. 18.

Fig. 20.

Fig. 21.



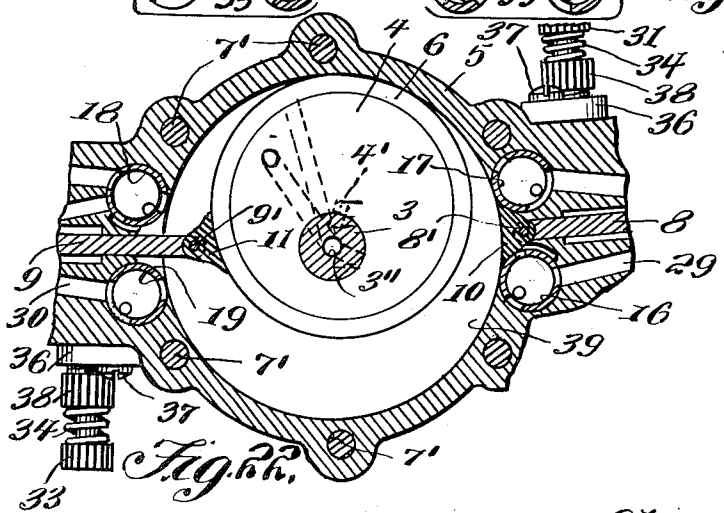


Fig. 22.

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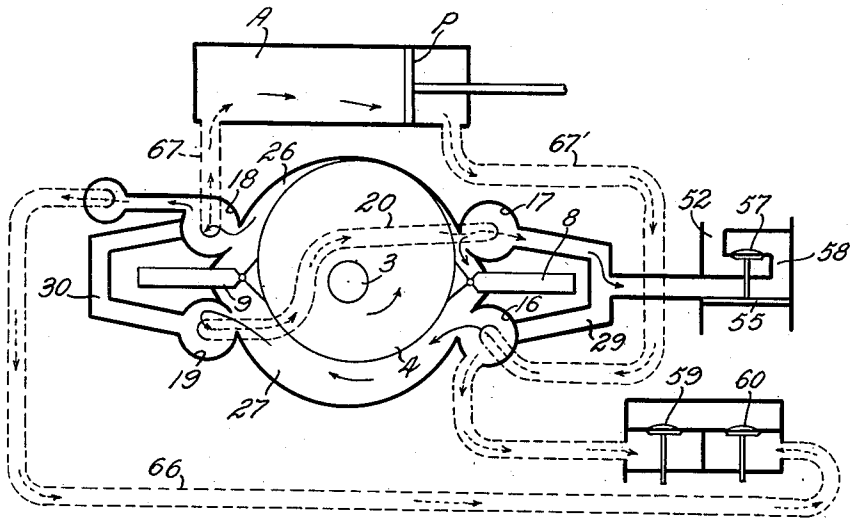


FIG. 23.

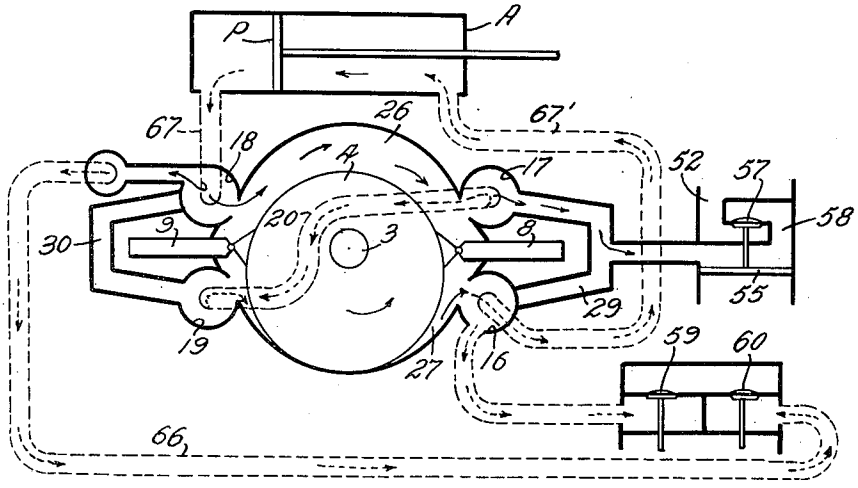


FIG. 24.

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Patented Mar. 9, 1954

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UNITED STATES PATENT OFFICE

2,671,402

ROTARY PUMP

Charles L. Pelham, Los Angeles, Calif.

Application April 5, 1948, Serial No. 19,110

1 Claim. (Cl. 103—3)

1

This invention relates to a rotary pump that is reversible automatically as part of its cycle, or in regular sequence, not a part of its cycle, when a reversing gear is linked to a mechanical device moving in such sequence, or at will and means is provided for controlling the flow pressure, in accordance with the characteristics and volume of the fluid drawn through it.

The pump embodying the invention is adapted for use with my power transmission cylinder covered by my pending application Serial No. 12,491, filed March 2, 1948, now abandoned, or when the power transmission cylinder is used with my multiple sickle mower covered by my pending application Serial No. 12,492, also filed March 2, 1948, now Patent No. 2,603,052, issued July 15, 1952.

The pump is intended primarily for power transmission with a liquid propellant at moderate speed, as will be later described, claimed and illustrated in the accompanying drawings in which:

Figure 1 is a top plan view of an embodiment of the invention;

Figure 2 is a side elevational view thereof;

Figure 3 is a horizontal, sectional view of Figure 2 with the device arranged for dual intake and compression;

Figure 4 is a sectional view on the line 4—4 of Figure 3;

Figure 5 is a sectional view on the line 5—5 of Figure 4;

Figure 6 is a sectional view on the line 6—6 of Figure 3;

Figure 7 is a sectional view on the line 7—7 of Figure 6;

Figure 8 is a detailed, elevational view of the pressure control with its barrel in section;

Figure 9 is a sectional view on the line 9—9 of Figure 3;

Figure 10 is a sectional view on the line 10—10 of Figure 3;

Figure 11 is a sectional view on the line 11—11 of Figure 3;

Figure 12 is a sectional view on the line 12—12 of Figure 3;

Figure 13 is a detailed, sectional view on the line 13—13 of Figure 3;

Figure 14 is a detailed, sectional view of one of the interruptors;

Figure 15 is a detailed, elevational view of the keeper for the interruptor shown in Figure 14;

Figure 16 is a sectional view on the line 16—16 of Figure 14;

Figure 17 is an elevational view of the pair of valves at the right hand end of the device;

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Figure 18 is a sectional view on the line 18—18 of Figure 17;

Figure 19 is an elevational view of the pair of valves at the left hand end of the device;

Figure 20 is a sectional view on the line 20—20 of Figure 19;

Figure 21 is a detailed perspective view of a portion of the coacting edges of the vane and interruptor shown in Figure 14;

Figure 22 is a horizontal, sectional view similar to Figure 3, with the device arranged for single intake and compression;

Figure 23 is a diagrammatic view of the device showing the direction of flow in accordance with the arrows; and

Figure 24 is a similar view showing the opposite direction of flow in accordance with the arrows.

Referring more in detail to the drawings, the pump embodying the invention comprises a base 1, which, by bolts 2, is affixed to a power take-off housing 2' of a power source 3', as shown in Figure 2, and a shaft 3 is connected to the power source 3' by spline fittings or similar construction. The shaft 3 is keyed to a cam 4 by keys 4' and the shaft 3 rotates cam 4 in a casing 5, which is integral with base 1. Cam 4 is made in two sections, an inner core which is fixed to shaft 3, and an outer shell 6 which, in turn, rotates about the core, eliminating scraping friction against the inner wall of the casing 5. The core of the cam 4 is made narrower than the casing 5, so that the clearance between a cover 7, which is secured by bolt 7' to the casing 5, and a bearing housing 13 on the cover 7, as well as the clearance around the bearing below the cam 4 and the clearance between the casing 5 and the cam may be kept full of lubricant. The previously mentioned clearances communicate with the clearance between the core of the cam 4 and its outer shell 6. Thus end play in shaft 3 is not transmitted through cam 4 to the casing 5 or the cover 7. For the purpose of lubrication, the shaft 3 is provided with a pressure lubrication duct 3'', which communicates with a recess 13' in the bearing 13, for lubricating and for leakage balancing.

The housing 7 is provided with an inlet passage 15 and an inlet passage 51, for other substances or light oil at high pressures, or a lubricating oil of higher viscosity which is placed in a plunger fitted chamber inserted in a line connected either to inlet 15 or inlet 51, and to the bearing 13 depending to which inlet the connection is made.

Vanes 8 and 9 maintain contact with the sleeve 6 on the cam 4 by means of hinged followers 10 and 11. Springs 12 are inserted in a bore 12'

and inlet 15 respectively to engage the rear edge of the vanes 8 and 9 to urge the followers 10 and 11 into constant contact with the sleeve 6. The spring 12 in the bore 12' which engages the vane 9 is held in place by a plug 14, and the other spring 12 in the inlet 15 which engages the vane 8 is held in place by a stop and gage fitting 15'. The followers 10 and 11 are pivotally connected or hinged to the vanes 8 and 9 respectively and these connections are made so that the followers 10 and 11 pivot only through about 60 degrees and are in pivotal contact with the vanes, minimizing the slippage of fluid and placing little load on the hinge pins 8' and 9' respectively.

The sleeve 6 and vanes 8 and 9 divide the housing 5 into chambers 26 and 27 respectively. Ported rotary valves 17 and 18 are mounted in the housing 5 at the periphery of the chamber 26 and the ports in the valves 17 and 18 communicate with the chamber 26 as will be later described. Ported rotary valves 16 and 19 are mounted in the housing 5 at the periphery of the chamber 27 and the ports in the valves 16 and 19 communicate with the chamber 27 as will be later described. As the cam rotates and the valves are in communication with their respective chambers the flow will be reversed, as shown in Figs. 23 and 24 respectively.

When valves 16 and 18 are connected to opposite ends of a cylinder A of slightly smaller displacement travel than the pump, containing a piston P and connecting rod to a mechanical device, as shown in Figs. 23 and 24, the piston is made to reciprocate at the rate of speed at which the pump is driven. The difference in displacement is to allow for unavoidable slippage in both pump and cylinder.

Vanes 8 and 9 are shown set off from 180 degrees to compensate for the smaller displacement of the connecting rod end of such a cylinder and so drive said piston and mechanical device an equal distance in each direction.

"Set-off" shown in these figures is 6 degrees, but may be any angle the job requires, including no degrees. Thus a pump of this type may be used to rotate a mechanical device back and forth.

In Figs. 23 and 24, it will be seen that valves 16 and 17 are connected by a duct 29 which communicates with a pressure area 58. A poppet valve 57 being positioned between the pressure area 58 and a pressure area 52 to control the passage of fluid between the areas. Thus any excess fluid which does pass through the duct 29 is diverted through the pressure areas 52 and 58 respectively. Valve 16 may be ported through tubing 67' which is connected to one end of the cylinder A. Valve 18 may be ported through tubing 67 to the opposite end of the cylinder A.

With the system full of fluid the sequence of flow in connection with the vanes 8 and 9 and valves 16, 17, 18 and 19, as pointed out above, and with the cam 4 in the position as shown in Figs. 3 and 23 and the cycle of rotation being in a counter-clock direction is as shown in Figs. 23 and 24 wherein cam 4 will force the flow of fluid in chamber 26 against the cam 4 and vane 9 and outward through valve 18 and tubing 67 to cylinder A. Further movement of the cam 4 away from valve 18 causes the flow of fluid to be out of chamber 26 into chamber 27 ahead of vane 9 and the return flow from cylinder A being inwardly through tubing 67' to return to the chamber 27 through valve 16 behind cam 4. Therefore as cam 4 passes each follower, the flow behind the cam will increase until the pressure of the flow behind the cam builds up against each vane. Thus as the fluid enters the chamber 27 through valve 16, it will flow in back of cam 4 out of valve 19 into by-pass 20, thence through valve 17 into chamber 26 behind cam 4. As cam 4 passes vane 9, flow in chamber 27 is forced against vane 8 then the flow in chamber 27 will be ahead of cam 4 outwardly through valve 16 and tubing 67' into cylinder A. Then outwardly of cylinder A, through tubing 67 and inwardly through valve 18 and then through valve 17, by-pass 20 and valve 19 to be deposited behind cam 4 in chamber 27 as in Fig. 24. In Figs. 23 and 24 the valves 17 and 19 are shown connected by the by-pass 20 and in Fig. 3 and in Fig. 23 the flow is outwardly of valve 19 and inwardly of valve 17. In Fig. 24 the flow being reversed, the flow is outwardly of valve 17 and inwardly of valve 19. In other words, as the cam rotates and the pressure of the flow builds up behind the respective vanes the flow will change from inwardly through the valve to outwardly through the same valve.

The word flow is used because in this sequence the fluid does not actually circulate through the system. With the ratio shown between the displacement of the pump and the size of the inlet-outlet tubing the fluid actually moves only about one foot in each direction when the pump reverses automatically.

Secured to the housing 5 is an arcuate shaped rack 23 which is adapted to be engaged by the hour glass worm 21 which is journalled in the frame 22 fixed to the base 1, as shown in Fig. 5. The worm 21 is provided with a knurled nut 24 for the rotation thereof and a clamp nut in the frame 22 when turned will prevent the worm from turning once it has been manually rotated.

When it is desired to time the oscillation or reciprocation of the piston P with some other function of a machine such is accomplished by the rotation of the worm 21 and the subsequent rotation of the rack 23.

The manual control is more or less illustrative of the invention as any mechanical means now in general use may be used to rotate the worm 21. When the worm 21 is used, the tubing 67 and 67' must be flexible adjacent the pump.

The vane 8 on the lower edge is provided with a notch 8'' and the vane 9 on its lower edge is provided with a notch 9''. An interruptor 31 extends at right angles to the vane 8 and is mounted in housing 5 so that the notch 40 in the interruptor may engage the notch 8'' in the vane 8. An interruptor 32 similar in structure to the interruptor 31 extends at right angles to the vane 9 and is similarly provided with a notch therein that may engage the notch 9'' of the vane 9.

The valves are each provided with eccentric mounting pins 33 and the pins 33 engage in spaced slots 33' in each interruptor so that the pins 33 of valves 16 and 17 engage in the slots 33' in the interruptor 31 and the pins 33 of valves 18 and 19 engage in the slots 33' in the interruptor 32. The interruptors will stop a vane and rotate the pair of valves controlled by each in opposite directions. The stem of each interruptor is journalled in a hard packing and stop 35 and a cover plate 36 is provided for each interruptor to cover the recess in the housing 5 in which the interruptor is positioned. Screws 37 retain the plates on the housing. A soft packing gland 38 is provided for each interruptor and

a spring 34 for each interruptor retains the interruptor in released position.

A spring loaded key 39 is adapted to engage each interruptor by means of a notch in the interruptor and when the interruptor is thus engaged, its release will be delayed until the key 39 is struck by cam 4 during its revolution causing the release of pressure on the interruptor. This prevents the vane moving across the pump chamber. The vane 8 slides through the notch 40 in the interruptor when the interruptor has been released as in Fig. 9. In Fig. 14 the interruptor is shown in engaged position and the keys 39 are urged into position into the notch in the interruptors by means of small springs 39'.

Either interruptor 31 or interruptor 32 is simply pressed inwardly toward the pump when it is desired to interrupt automatic reversal, and the members are released in order to terminate this interruption. The valves do not cause reversal, but they interrupt it. The pump will reverse automatically with the valves removed.

The automatic reversal functions inherently as the rotating cam 4 passes vanes 8 and 9 in turn. As shown in Figure 3, the flow in chamber 26 is against vane 9 and outwardly through valve 18, continuing through tubing 67. The return flow is inwardly through valve 16 to chamber 27 behind cam 4. As cam 4 progresses, the vane 9 drops toward the center of the pump and a gradually increasing portion of return flow in chamber 27 exits through valve 19 to by-pass 20, then to valve 17 and into chamber 26 behind cam 4. As the cam 4 approaches a position opposite that shown in Figure 3, the flow in chamber 27 comes against vane 8 and outwardly through valve 19. The return flow comes inwardly through valve 18 to chamber 26 behind cam 4, and as cam 4 progresses past vane 9, a gradually increasing portion of return flow in chamber 26 exits through valve 17 to by-pass 20, then to valve 19 and into chamber 27 behind cam 4. The by-pass 20 serves to permit fluid to enter pump from the system behind the cam 4, regardless of its position. It is noted that valves 16 and 18 are closed to ducts 29 and 30 and open to pump chambers when the pump reverses automatically.

When a vane is interrupted, such as vane 8, and valves 16 and 17 are closed to the pump, flow is diverted through duct 29 to by-pass 20. Basically, the purpose of the automatic reversal is to translate rotary motion for reciprocal motion or its variants rapidly and more precisely than is possible through the combination of conventional rotary gear pumps and reciprocating panels.

Here again manual control is shown, but the interruptors may be connected to movable mechanical devices and actuated by their movement in desired sequence by any number of devices now in general use: (Hydraulic or pneumatic columns, electric relays, trip rods, etc.).

It is noted that the advancement of the cam 4 into the chamber 27 while it is still expelling fluid from the chamber 26 does not oppose return flow in the chamber 27 because the by-pass 20 allows it to egress to the chamber 26 behind the cam 4; and the pump is so designed that there is no appreciable change in displacement, and volume changes in the fluid due to variations in temperature and/or pressure are both minimized and absorbed by pressure controls later to be described.

A removable barrel 41 is fitted into the cover 7 above the pressure space 52. A plunger 42 moves within the barrel 41 and the plunger is controlled by a spring 43 which is of sufficient strength to resist normal working loads, but provides for the expansion of fluid to slightly enlarge the displacement of the system or the contraction of the system to slightly diminish it when spring 43 has been slightly compressed in establishing pressure. Slip rods 44—44 connect plunger 42 to a threaded spring compressor 45, and the rods 44—44 are free to slide upward through the compressor 45 as the spring 43 compresses. The spring 43 is securely held between the plunger 42 and the spring compressor 45. Projections 46 on the spring compressor 45 engage grooves 47 in the barrel 41 for the length of travel of the compressor 45 only. They prevent the compressor 45 from rotating in the barrel 41 when a differential screw 48 is rotated in the spring compressor 45, advancing or retracting it, as shown in Fig. 6.

The differential screw 48 is inserted through a removable cover 49 and the threads in the cover 49 in which the screw 48 turns are of coarser pitch than those in the spring compressor 45, so that when a hand wheel 50 which is affixed to the upper end of a screw 48 is rotated, its leverage and its precision of adjustment are increased because the plunger 42 travels a distance equal only to the difference in pitch between the threads in the compressor 45 and those in the cover 49.

The advancement or retraction of the hand wheel 50 increases or decreases the pressure of the fluid in the pressure space 52. The differential screw 48 prevents the spring 43 from coming near enough to the cover 49 to interfere with the function of the slip rods 44—44; and the plunger 42 is domed as at 42' adjacent the screw 48 to permit the spring 43 to compress at the lower end of travel of the plunger 42. A gage attached to fitting 51 communicates with the pressure space 52 by which pressure in said space may be noted. Thus the valves 16 and 18 (moving ahead of the cam 4) are connected to the valves 17 and 19 (moving behind cam 4) via poppet valves 59, 60 and poppet valve 57, and with resistance in the tubing 67 leading to a mechanical device, such as cylinder A, Figs. 23 and 24, higher than the pressure in the space 52, fluid is looped from high to low side of the cam 4 without leaving pump.

When the hand wheel 50 has been advanced to establish compression, then the resistance of the driven mechanism forces the flow to be diverted into the space 52 through the valve 59 or 60, respectively, depending on which direction the flow is being routed by vanes 8 and 9. The regulation of valve 57 by means of an adjusting screw 53 controls the resistance on the fluid as it flows out of chamber 52 and therefore is a factor on the pressure required to maintain valve 59 or 60 open to flow. Up to that pressure, fluid flows to the driven mechanism. The flow through valve 57 becomes the difference between the capacity of the pump and the requirement to propel a driven mechanism at the speed desired. Thus fluid entering space 29 through space 58, creates a resistance to the return flow from the driven mechanism, subject to adjustment of the adjusting screw 53 which contacts spring 54. A plunger 55 is inserted between the spring 54 and a spring 56 and is affixed to valve 57. Thus the valve 57, located between pressure space 52 and pressure space 58 is maintained in

a closed position by the spring **56** plus any pressure on plunger **55**.

Due to the difference in area of the valve **57** and the plunger **55**, a lower unit pressure in the space **58** than in the space **52** maintains the valve **57** closed when pressure is static. The difference in unit pressure in the spaces **52** and **58** required to open or close valve **57** is variable by means of the adjusting screw **53** which uses the spring **54** to alter the relative tension of the springs **54** and **56** against the plunger **55**, see Fig. 6.

When cam **4** is in motion, its tendency is to lower the pressure of the return flow entering the pump. Since valves **17** and **19** are connected by the pressure spaces **29** and **30** and the by-pass **20** to the pressure space **58**, the lowering of the pressure is reflected through the valve **57** which opens to meet this deficiency, in turn lowering the pressure in the space **52**. This allows the valve **59** or **60** to open to reestablish pressure in the space **52**, thus maintaining preadjusted differences in pressure between the spaces **52** and **58**.

This sequence actually occurs more rapidly than the movement of the plunger **55** can open and close the valve **57** as the plunger works between the springs **54** and **56**. Thus the valve **57** fluctuates providing varying degrees of flow when the spaces **52** and **58** are out of equilibrium.

Springs **63** adjusted by adjusting screws **61** and **62** permit inertia loads in a driven device to be overcome rapidly or gradually upon reversal. The valve **60** is connected to the valve **13** by a pressure space **65** via a pipe **66**. The valve **59** is connected directly to the valve **16** via a pressure space **64**. The valves **16** and **18** are open to the pressure spaces **64** and **65** when they are open to the pump chamber, closed to them when they are closed to the pump chamber. The adjusting screws and spring cases **61** and **62** have removable ends to permit assembly of valves, and have breather holes. There is a removable plug immediately above the valve **57** to permit insertion and removal of the valve and its seat. The adjusting screw **53** has a breather as has the cover **49**.

With the pump affixed to a power source as in Figure 2, and with the system full of fluid and the rotation in the same direction; but with valves **16** and **17** closed to pump and vane **9** interrupted as shown in Figure 22, and the pump connected to opposite ends of a cylinder whose displacement is X times that of the pump, or to a rotor to be driven indefinitely in one direction, the sequence of flow is as follows: With the flow ahead of the cam **4**, the flow is forced against vane **9** and outward through valve **18** to a cylinder or rotor, then returns through valve **16** which is now open to duct **29** whence flow passes to valve **17**, by-pass **20** and valve **19** to be deposited behind cam **4** as previously described, except that with only vane **9** following cam **4**, as in Fig. 22 the pump now has only one chamber.

The flow will continue in this direction as long as fluid can be fed into the pump from the system, or until interrupted by interrupting vane **9**, when the fluid neither enters nor leaves pump as when both vanes are interrupted, all valve ports are closed to the pump. To reverse release vane **9**, when valves **16** and **17** are open to the pump, valve **16** closes to duct **29**, valve **18** opened

to duct **30** when vane **9** was interrupted, making valve **16** the outlet and valve **18** the inlet-flow reversing through by-pass **20**. Valve **17** is open to duct **29** and valve **19** is open to duct **30** at all times. Valves **17** and **19** are alike and valves **16** and **18** are alike.

There has thus been provided a pump and a regular which, using a piston having slidable vanes, will, in operation, increase the initial pressure from multiple sources and, by reducing this increased pressure to a greater extent than the pre-adjusted pressure reduction ratio, to maintain a preadjusted difference in pressure.

Thus this system of flow of fluid by providing a relatively constant actual impelling pressure and not permitting the fluid to expand to atmospheric pressure, minimizes heat generation by alternate compression and expansion of the fluid. Also by maintaining the fluid in the system under a predetermined minimum pressure, the system uses or consumes less power in its operation.

Although the invention was primarily designed to be used with my co-pending applications before noted, it may also be used for other purposes. It may be used with gaseous propellants at high speeds by maintaining closer tolerances in manufacture, or for heat exchanging or straight transfer work.

It is believed that from the foregoing description, the manner of operation and the construction of the pump will be apparent to those skilled in the art, and it is to be understood that changes in the minor details of construction, arrangement and combination of parts may be resorted to, provided they fall within the spirit of the invention and the scope of the appended claim.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

A rotary pump comprising a casing having a fluid therein, a base on said casing for mounting said casing to a power take off housing, a shaft in said casing, a cam on said shaft, an outer shell loosely mounted on said cam, vanes slidably mounted in said casing and said vanes engaging said shell at an end thereof and extending in opposite directions from said shell, said vanes providing a plurality of chambers in said casing, a plurality of inlet-outlet valves communicating with said chambers and providing an inlet and outlet for each chamber and the casing, said valves being rotatable and positioned on opposite sides of said vanes for permitting the free flow of fluid into and out of said chambers to change the pump from a reversal flow type to a steady output type, eccentric pins secured to the bottom edge of said valves, means for engaging said pins for rotating said valves and said last means is adapted to engage and stop said vanes during the operation of said valves.

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