June 19, 1951 D. J. FRANCKI 2,557,345

LIQUID LEVEL RESPONSIVE FLUID MOTOR SYSTEM

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Fig. 1.

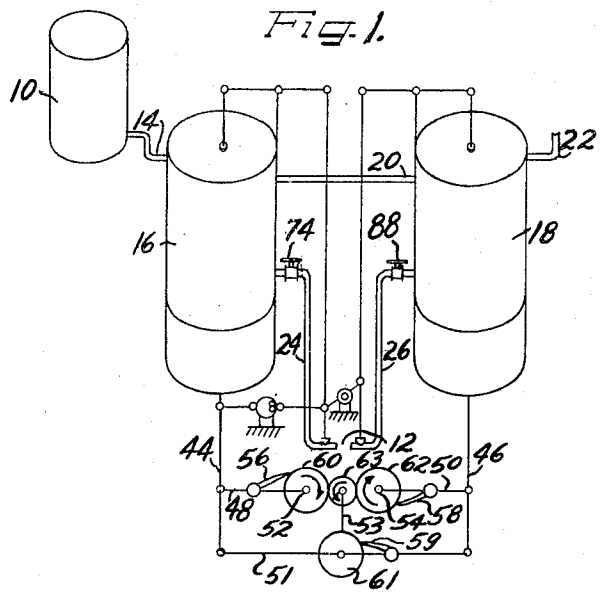
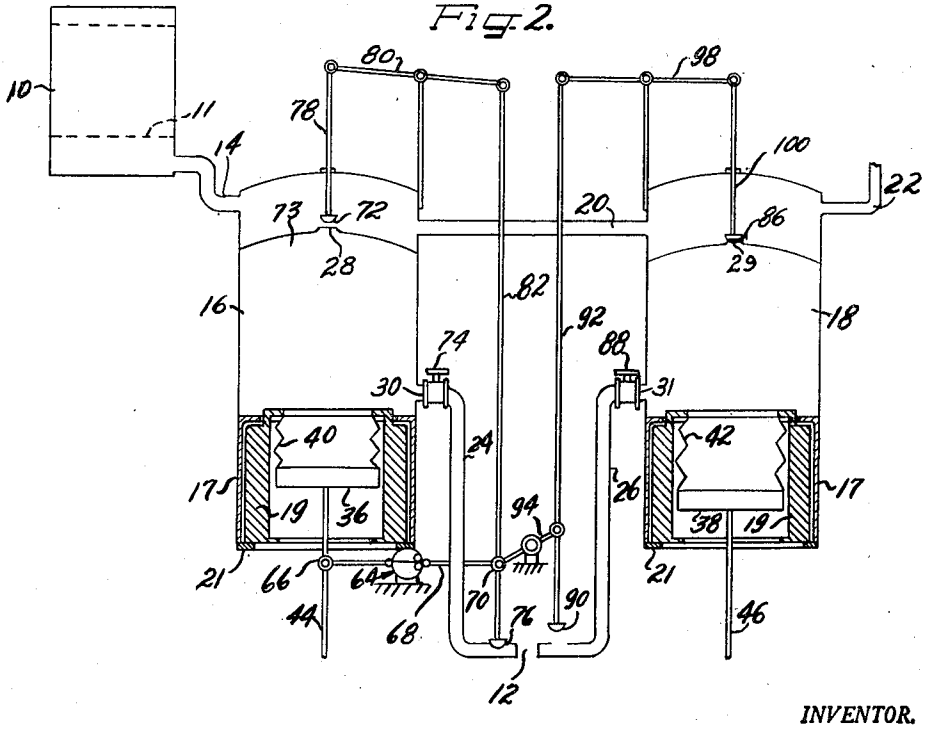


Fig. 2.



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Fig. 3.

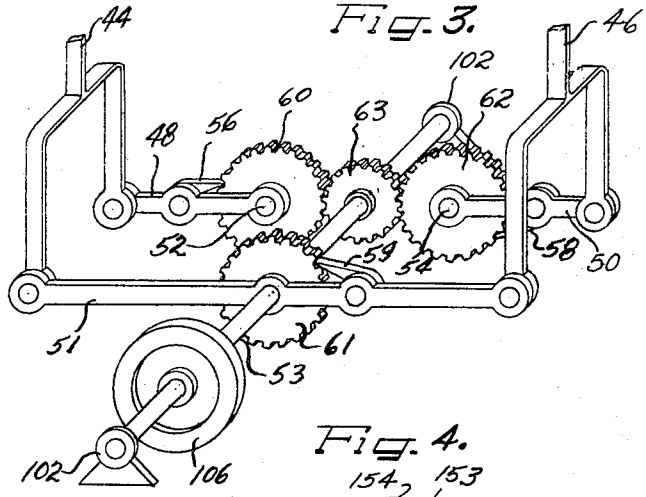


Fig. 4.

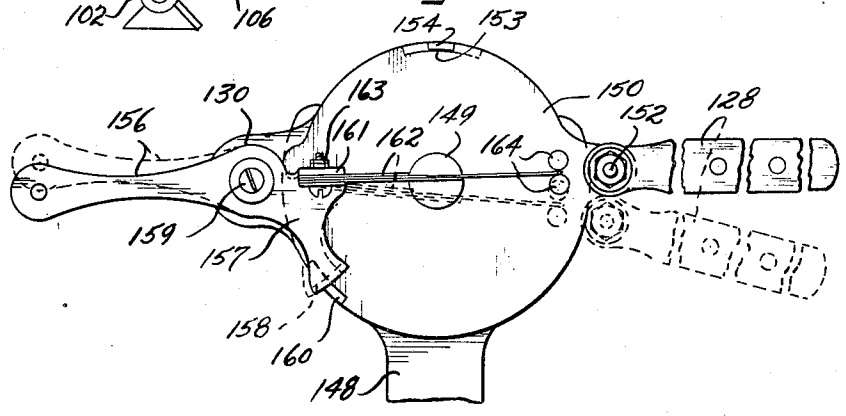
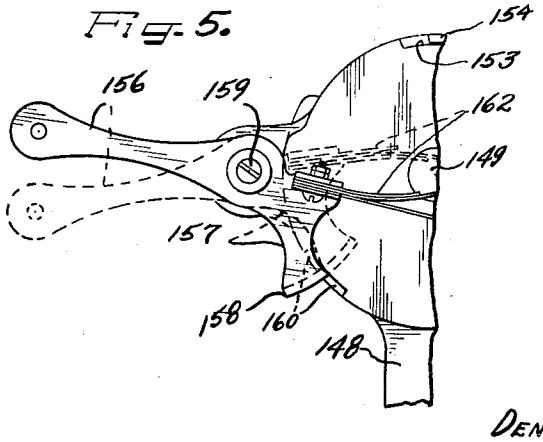


Fig. 5.



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LIQUID LEVEL RESPONSIVE FLUID MOTOR SYSTEM

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Application November 16, 1946, Serial No. 710,290

2 Claims. (Cl. 60—51)

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My invention relates to a fluid motor for conversion of the energy of a body of water to useful mechanical energy.

It is an object of my invention to provide an improved fluid motor.

It is a further object of my invention to provide an improved fluid motor capable of deriving useful work from a small flow of fluid.

Yet another object of my invention is to provide a fluid motor capable of deriving useful work from a small flow of fluid over a moderate distance.

Yet another object of my invention is to provide a fluid motor having features of construction, combination, and arrangement, wherein it is inexpensive in construction and reliable in operation to the end that it may be utilized for a maximum number of practical operations where a fluid, such as water, is available as a source of energy.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention, itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings.

On the drawings:

Figure 1 is a somewhat diagrammatic view showing the complete fluid motor embodying the features of my invention;

Figure 2 is a more detailed somewhat diagrammatic view of portions of my invention as illustrated in Figure 1;

Figure 3 shows in detail the mechanical movement for converting the up and down motion of the pistons of my invention to useful rotary motion; and

Figures 4 and 5 show the valve actuating mechanism utilized in the embodiment of my invention illustrated in Figure 1.

As shown on the drawings:

In Figure 1, the container of liquid from which energy is derived is designated at 10, liquid in this container having greater elevation, and hence greater static energy, than the liquid at the point of discharge 12. From source 10, the liquid flows through pipe 14 to inlets 28 and 29 of cylinders 16 and 18, the latter being connected to cylinder 16 by pipe 20. Overflow pipe 22 provides an outlet for fluid from pipe 20 and cylinders 16 and 18 when there is excessive pressure therein so as to prevent overloading the apparatus. From cylinders 16 and 18, fluid flows from outlets 30 and 31 through pipes 24 and 26 to be discharged at point 12.

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Cylinders 16 and 18 are terminated at their lower ends by pistons 36 and 38, Figure 2, respectively, each of these being connected to the corresponding cylinder by Sylphon bellows 40 and 42, respectively. Each piston is further connected to connecting rods 44 and 46 so that the downward or upward force on the pistons themselves is communicated to rods 48 and 50, Figure 1, which are pivotally mounted about shafts 52 and 54, respectively, and are pivotally connected to connecting rods 44 and 46, respectively. In addition, the forces on pistons 36 and 38 are communicated to connecting rod 51 which is pivotally mounted on shaft 53. The various connections could be of the lost-motion type to facilitate the respective movements of the rods.

As will be evident from inspection of Figure 3, rods 48 and 50 are pivotally connected to pawls 56 and 58, respectively, so that motion of either of these rods in the pawl-engaging direction causes corresponding rotation of ratchet wheels 60 and 62. Similarly, rod 51 is pivotally connected to pawl 59 so as to rotate ratchet wheel 61 when rotated in the pawl-engaging direction. As will be described in further detail hereinafter, ratchet wheels 60 and 62 are provided with gear teeth so as to be mutually engaged with gear 63, to the end that the angular velocities of wheels 60, 61, and 62 are maintained constant relative to each other. Thus, as the pistons 36 and 38 execute reciprocating movement, the shaft 53 is rotated and useful mechanical work may be obtained therefrom.

Figure 2 is a cross section view showing in more detailed fashion the valve mechanism whereby pistons 36 and 38 are caused to execute reciprocating motion as a consequence of the flow of fluid through cylinders 16 and 18. As shown in this figure, the valve mechanism is arranged for the condition wherein piston 36 is executing downward motion and piston 38 is executing upward motion. As will be evident from inspection of Figure 2, the main control of the valve mechanism is achieved through the actuating device shown generally at 64, this device being pivotally connected to a connecting rod 44 at point 66 and having its operating arm 68 pivotally connected to point 70 to operate the valve mechanism. With respect to the flow of fluid to cylinder 16, it will be observed that actuating device 64 controls two separate valves 72 and 76. The former valve controls the inlet of water or other fluid

from source 10 to the lower portion of cylinder 16, and consists of rod 78 pivotally connected to operating arm 80, the latter being connected to pivot 70 by rod 82. Thus, as pivot 70 is depressed, valve 72 is opened and as pivot 70 is raised, valve 72 is closed. In the closed position, valve 72 forms a seal with member 73 to prevent fluid flow to the lower portion of cylinder 16. Valve 76 is also connected to operating arm 82 so as to be closed when pivot 70 is depressed. It is thus evident that, as pivot 70 is depressed, valve 76 is closed and valve 72 opened. On the other hand, if pivot 70 is raised by corresponding motion of connecting rod 44, valve 76 is opened and valve 72 closed.

The flow of fluid through cylinder 18 is controlled by valves 86 and 90. These valves are actuated by rod 92 which is caused by lever 94 to assume a position opposite to that of rod 82. Thus, when pivot point 70 is depressed so as to close valve 76 and open valve 72, lever 94 raises rod 92 to open valve 90 and close valve 86, valve 86 being closed by reason of its connection through rod 100 to operating arm 98 and hence rod 92. Thus, as pivot point 70 executes reciprocating motion in accordance with motion of connecting rod 44, the valves 86 and 90 execute motion opposed to that of valves 72 and 76, thereby causing periodic flow of fluid in operating cylinders 16 and 18, the flow in cylinder 16 being 180° out of phase with that in cylinder 18.

A strainer 11 is provided in container 10 to prevent entrance of foreign matter into the operating mechanism of the fluid motor.

Valves 72 and 86 in open position permit air trapped in the tanks 16 and 18, respectively, to be vented.

Downwardly extending skirts 17 are provided to protect bellows 40 and 42 and prevent damage thereto. Assembly of the unit is facilitated by supports 19 which are attached at their upper ends to bellows 40 or bellows 42 and may be attached at their lower ends to skirts 17, the latter attachment being achieved by support plates 21 attached to skirts 17 by wing nuts or similar devices (not shown).

Hand operated valves 74 and 88 are provided in pipes 24 and 26, respectively. It is the function of these valves to prevent leakage of fluid down these pipes when the fluid motor is not operating, thereby causing the motor to remain in operating condition at all times.

A tank (not shown) may be provided at the outlet valves 76 and 90 so that fluid is discharged therefrom into the fluid of the tank. This further reduces the tendency of pipes 24 and 26 to drain when the motor is not in use.

Figure 3 is an isometric view showing the connection of connecting rods 44 and 46 and wheels 60, 61 and 62 to convert the up and down reciprocating motion of pistons 36 and 38 to useful mechanical energy. As shown in this view, shaft 53 is supported by bearings 102, these bearings being positioned so that the gear teeth on wheels 60 and 62 engage corresponding teeth on wheel 63. As connecting rod 44 is forced in the downward direction by pressure exerted on piston 36, pawl 59 engages wheel 61 to cause motion of that wheel in the counterclockwise direction. Pawl 56 slips over gear 60 so no force is transferred thereto. On the upstroke of rod 44, pawl 56 engages gear 60 to cause rotation thereof in the clockwise direction and corresponding counterclockwise rotation of gear 63 and shaft 53. Pawl 59 slips under this condition. Similarly, as connecting rod 46 is forced in the downward direction by pressure from cylinder 38, pawl 58 engages wheel 62 and forces that wheel in the clockwise direction, thereby rotating shaft 53 through gear 63 in the counterclockwise direction. Pawl 59 slips under this condition. On the upstroke of piston 38, pawl 58 slips over wheel 62, but pawl 59 engages to rotate shaft 53 in the counterclockwise direction. If desired, the variations in angular velocity of shaft 53 associated with the periodic application of torque from pawls 56, 58 and 59 may be reduced in magnitude by a flywheel such as 106 attached to rotate with shaft 53. Of course, the device for which the mechanical energy is desired, such as a stamping machine, air pump, saw, etc., is likewise connected to shaft 53.

It will be observed that the effect of the mechanism shown in Figure 3 is positively to rotate shaft 53 in the counterclockwise direction regardless of whether rods 44 and 46 are ascending or descending.

The valve operating mechanism 64 is shown in Figure 4. It is the purpose of this mechanism to convert the continuous reciprocating motion of connecting rod 44 to actuate valves 72, 76, 86, and 90 in accordance with the position of the pistons and thus cause continuous operation of the motor. This mechanism comprises a support 148 which is adapted to be secured in any suitable manner to the point of support of the apparatus. Operatively mounted on a pivot pin 149 is a plate 150. Plate 150 carries the arm 128 which is adapted for connection to the valve operating rod 82, Figure 2, at pivot 70 and is connected to plate 150 by bolt 152. The bolt 152 enables the arm 128 to be angularly adjusted relative to the plate 150. The plate 150 is provided at one portion of its periphery with a recessed portion 153 into which there projects a detent 154 mounted on the support 148.

Extending oppositely from the arm 128, the other arm 130 is pivoted to the support 148 by screw 159. The outer end 156 of this arm is adapted for connection to the connecting rod 44 which oscillates the arm 130 in response to the motion of the piston 36. The inner end 157 of the arm 130 forms a shoulder 158 having a curved surface of constant radius relative to the pivot pin 159 of the arm 130. The shoulder 158 forms a latch against which a projection 160 of the plate 150 abuts.

The end 157 of the arm 130 is bent to form an outwardly extending right angle portion 161 to which a leaf spring 162 is connected by means of bolt 163. The free end of the spring 162 is disposed between a pair of spaced posts 164 which are located on plate 150 opposite the inner end of the arm 128.

It will be observed that when the arm 128 is in the raised position, as shown in full lines, the detent 154 is in engagement with the right end of the recessed portion 153 of the plate 150 and the projection 160 abuts the outer surface of the shoulder 158. In this position the spring 162 is inactive and not flexed in either direction. If the arm portion 156 is now moved upwardly, as shown in the full lines of Figure 5, the shoulder tends to move outwardly to such a position as to release the engagement of the projection 160 therewith. The spring 162 is now flexed downwardly so as to cause the plate 150 to rotate in a clockwise direction with a snap action as soon as the shoulder 158 moves out of engagement with the projection 160. The plate then rotates until

the detent 154 engages the left end of the recessed portion 153, thus moving arm 128 downwardly and operating the valves. The final position assumed is shown in the dotted lines of Figure 4. It will be noted that the spring is not flexed in this position. On the opposite stroke, the portion 156 of the arm 130 is moved downwardly until the position shown in the dotted lines of Figure 5 is reached. In this position, the projection 160 engages the inner surface of shoulder 158 and the spring 162 is flexed as shown in the dotted lines. Upon further movement of the arm 156, the end 157 moves as shown in the dotted lines of Figure 5, until the projection 160 is released by the shoulder 158. This inward movement causes the spring 162 to be straightened to the position shown in the solid lines in Figure 4, so that the moment the projection 160 is released the plate 150 is rotated in the counterclockwise direction until the detent 154 again engages the right end of the recessed portion 153, thereby returning the valves to their initial positions.

It will be apparent that with a valve operating mechanism as described above, the valves are opened and closed with a snap action, although the end 56 of arm 130 is oscillated with uniform motion.

Having described the construction of an illustrative embodiment of my invention and the various elements thereof, I will now outline its operation.

In executing reciprocating movement, the pistons 36 and 38 each pass through two conditions of operation: one corresponding to the downstroke of connecting rod 44 and upstroke of connecting rod 46, and the other corresponding to the reverse strokes of these rods. Referring to cylinder 16, when the downstroke is executed, valve 72 is open and valve 76 is closed. In this condition the liquid in source 10 is in communication with the liquid acting against the surface of piston 36. Thus the downward pressure on piston 36 is equal to the head of liquid corresponding to the difference in elevation between piston 36 and the liquid level in source 10 plus the difference in the air pressure on the upper surface of the fluid in source 10 and the lower surface of the piston 36. This pressure is, of course, somewhat reduced by the friction losses incident to passage of fluid into the lower portion of cylinder 16. This force, which is, of course, in the downward direction, acts through connecting rod 44 to produce torque on shaft 53. On the upstroke, valve 72 is closed and valve 76 is open. In this case the fluid in cylinder 16 is in communication with the air pressure at point 12. The effective pressure exerted on piston 36 then becomes the difference between the upward pressure exerted by air pressure at the bottom of this piston and the downward pressure due to the liquid above it. This pressure may be made to have a net upward direction by causing the level of the discharge at point 12 to be below the level of the piston. The pipe 24 then forms a syphon for the removal of water displaced by the upward movement of the piston through outlet 30. The upward force acting on the piston due to atmospheric pressure is equivalent to the pressure head of approximately 32 feet of water. As nearly this same atmospheric pressure acts at the discharge point 12, the force causing the syphon to operate is that attributable to the weight of water standing in pipe 24 between the level of the piston and the point 12. Thus, the lower the point 12, the stronger will be the syphon

action and the more rapid the upward movement of the piston.

If, however, the height of water standing in the cylinder above the piston exceeds 32 feet, the piston will not rise until the excess is discharged through the outlet 30. To prevent this delay, and to restrain the piston's upward movement as little as possible, the cylinder should be made very shallow. Then, with the sealing valve 72 only a short distance above the level of outlet 30, the piston will rise quickly against a very small head of water. Moreover, the outlet should be at as low a level with respect to the cylinder as is feasible, taking full advantage of the pressure head of water in the cylinder to effect a rapid discharge.

An added advantage of a shallow cylinder is that only the water displaced by the piston will be discharged in each cycle. When valve 72 is periodically opened, this amount will be replenished by the water under pressure from the elevated source 10 and the atmospheric pressure thereupon, which will displace the piston downwardly. If the outlet point 12 is not so low as to draw a vacuum, the cylinder may thus always be kept filled with water.

The operation of cylinder 18 and piston 38 is identical with that above described for cylinder 16 and piston 36.

My invention is susceptible of various modifications and alternative constructions. In particular, the device may comprise only a single cylinder which is caused to execute reciprocatory motion as described above. In this case the successive applications of torque to a single ratchet wheel will maintain that wheel in continuous rotation because of the inertia of the moving parts.

While I have shown a particular embodiment of my invention, it will, of course, be understood that I do not wish to be limited thereto since many modifications, both in the elements employed and their cooperative structure may be made without departing from the spirit and scope of my invention. I, of course, contemplate by the appended claims to cover all such modifications and alternative constructions that fall within the true spirit and scope of my invention.

I claim as my invention:

1. In combination in a fluid motor system, a fluid-tight chamber having a movable wall, an inlet and an outlet, the external face of said wall being in communication with atmospheric pressure, a container for a body of liquid at a greater elevation than said chamber and in communication with said inlet, a first valve means for closing said inlet, a pipe connection for said outlet and an orifice for the discharge thereof in elevation below the lowermost position of said movable wall, a second valve means for closing said orifice, and means actuated by movement of said movable wall to operate said first valve means to close said inlet and to operate said second valve means to open said orifice when said chamber becomes distended by static pressure of said liquid, said system including means for venting said chamber, so that said pipe connection will syphon said liquid from said chamber to reciprocate said movable wall.

2. In combination in a fluid motor system, a pair of fluid-tight chambers each having an inlet and an outlet, a container for a body of liquid at a greater elevation than said chambers and in communication with each said inlet, first valve means for closing each said inlet, a pipe connection for each said outlet and each discharg-

ing through an orifice, a second valve means for closing said orifice, said chambers having a movable wall such that each chamber may be distended by static pressure of said liquid, and means actuated by said movable wall to operate said first and second valve means respectively to close the inlet and to open the orifice of the distended one of said chambers and contemporaneously to open the inlet and close the orifice of the contracted one of said chambers, the face of said wall external to the distended one of said chambers being in communication with atmospheric pressure to alternately contract said chambers, each said orifice being lower in elevation than said movable wall, said system including means for venting said chambers, whereby liquid

is syphoned from the distended one of said chambers through its associated pipe connection.

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