G. C. PHARO.

PRESSURE OPERATED APPARATUS.

APPLICATION FILED JULY 13, 1915.

1,222,984.

Patented Apr. 17, 1917.

2 SHEETS—SHEET 1.

Fig. 1

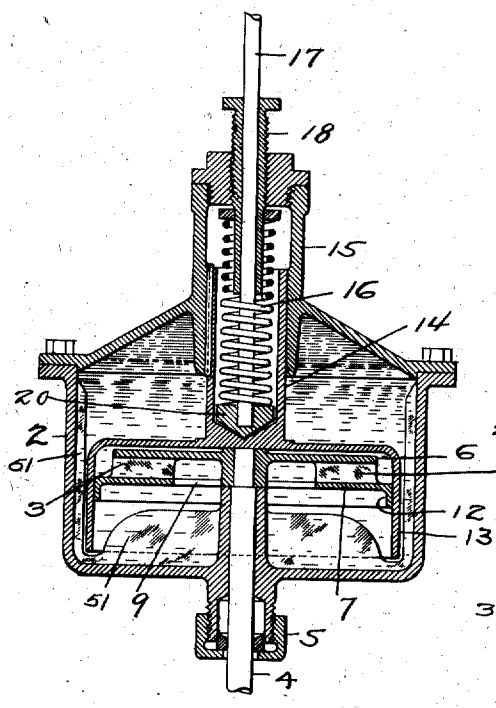
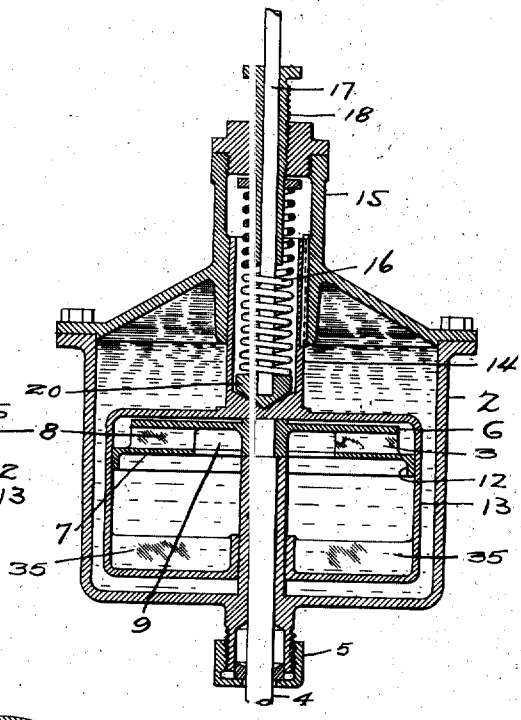


Fig. 2



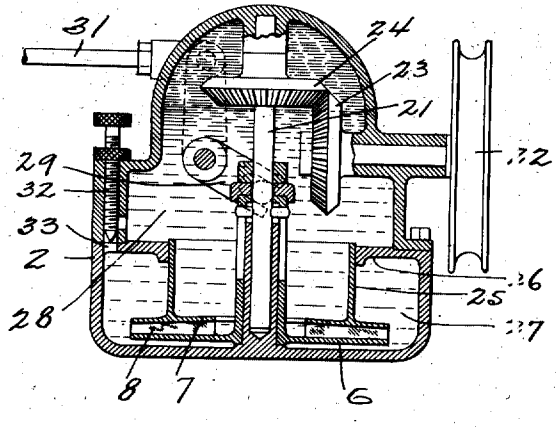


Fig. 3

WITNESS

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2 SHEETS—SHEET 2.

Fig. 4

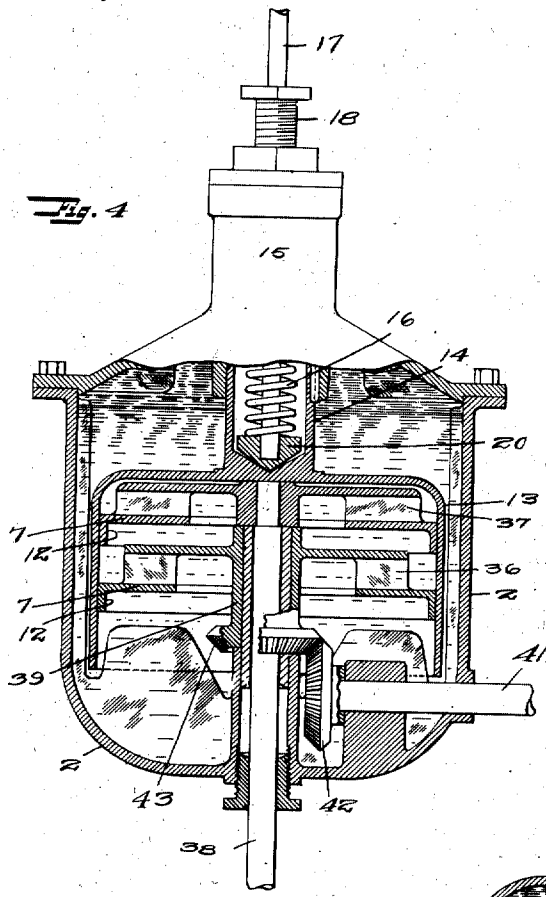
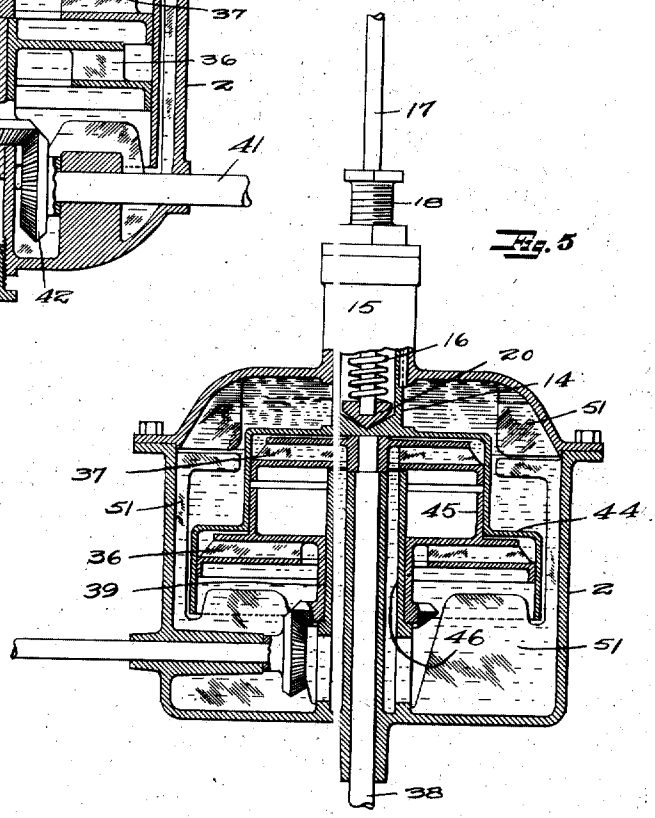


Fig. 5



WITNESS

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UNITED STATES PATENT OFFICE.

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PRESSURE-OPERATED APPARATUS.

1,222,984. Specification of Letters Patent. Patented Apr. 17, 1917.

Application filed July 13, 1915. Serial No. 39,605.

To all whom it may concern:

Be it known that I, GORDON C. PHARO, a citizen of the United States, and a resident of Marysville, Yuba county, State of California, have invented a certain new and useful Pressure-Operated Apparatus, of which the following is a specification.

The invention relates to pressure operated apparatus in which pressure is produced in a chamber by the rotation of an impeller or other device acting on a liquid. A rotating impeller is employed for forcing fluid outward into a chamber the pressure of the fluid in the chamber varying with the speed of the impeller. One of the walls of the impeller forms one of the walls of the chamber and the pressure produced therein causes a relative axial movement of the impeller and the casing which forms the other walls of the chamber.

An object of the invention is to provide a pressure operated apparatus of the class described, which is simple in construction and efficient and sensitive in operation.

Another object of the invention is to provide a pressure operated apparatus in which unbalanced pressures are produced on opposite sides of an impeller.

Another object of the invention is to provide an apparatus of the class described, in which diaphragms which are operated on and moved by the liquid under pressure are eliminated.

The invention possesses other advantageous features, some of which, with the foregoing, will be set forth at length in the following description, where I shall outline in full that form of the invention which I have selected for illustration in the drawings accompanying and forming part of the present specification. In the drawings I have shown several specific forms of my generic invention, but it is to be understood that I do not limit myself to such forms, because my invention may be embodied in a multiplicity of forms, each being a species of my said invention. It is also to be understood that by the claims succeeding the description of my invention, I desire to cover the invention in whatever form it may be embodied.

Referring to said drawings:

Figure 1 is a vertical section of one form of the apparatus of my invention.

Fig. 2 is a vertical section of a slightly modified form.

Fig. 3 is a vertical section of another specific form of the apparatus.

Fig. 4 is a vertical section of a two-stage pressure apparatus, which is particularly designed to control the speeds of two associated mechanisms.

Fig. 5 is a vertical section of a compound pressure apparatus which is to be operated from two sources.

The apparatus possesses a great variety of uses, several of which will be set forth herein. Since it includes an element, the position of which varies with the speed of the impeller or pressure producing element, the apparatus may be employed as a governor for steam engines, internal combustion engines, hydraulic apparatus and other devices. It may be employed to control the throttle valve or valve mechanism and in internal combustion engines it may be employed to vary the timing of the ignition spark. The apparatus is not deleteriously effected by jolts and is, therefore, particularly adaptable for governing the speed or spark of internal combustion engines which drive vehicles or the speed of the vehicle or the speeds of both the vehicle and the engine. In this instance it is particularly useful in connection with internal combustion engine driven tractors which usually operate over rough or broken ground. The device may also be employed as a speed indicator and in this connection is particularly useful on motor cars since it is not deleteriously affected by jolts nor by the electric currents which are now extensively employed for various purposes on motor cars. It may also be employed as an apparatus for producing pressure for doing work such as riveting, punching, etc.

In prior devices, in which a rotary impeller has been employed to produce pres-

sure, the fluid operated on has been caused to exert its pressure against pistons and diaphragms, which were connected to steam valves. The ordinary arrangement of a piston in a cylinder has not proved satisfactory on account of the leakage past the piston when pressures are employed and the results obtained from diaphragms have been unsatisfactory on account of the fact that the flexure of the diaphragm is proportional to the pressure only over a very short range of deflection. In the present invention I have employed the casing surrounding the impeller as the movable element and have employed the impeller as a piston. The piston impeller in the apparatus of my invention divides the interior of the casing into chambers and forms the wall of one of the chambers and the difference in pressure in the chambers produced by the rotating piston impeller causes the casing to move axially relative to the impeller. In the preferred form of construction the piston impeller is stationary axially and the casing movable, although this order may be reversed.

I shall first describe the apparatus shown in Figs. 1 and 2. This apparatus comprises a tight housing 2, preferably circular in form, in which is arranged a rotatable impeller 3 secured to the shaft 4, which projects from the housing through the stuffing box 5. The impeller comprises side plates 6 and 7 and a plurality of vanes 8. The side plate 6 is imperforate and the side plate 7 is provided with a central suction inlet 9 and is of slightly larger diameter than the side plate 6. On its periphery the plate 7 which is on the suction side of the impeller, is provided with a flange 12 or other enlarged bearing surface.

Surrounding the impeller and forming a close running joint with the outer surface of the flange 12 is a cylinder or casing 13 which is provided with a cylindrical extension 14 which is guided in the hub 15 forming part of the housing. The cylinder or casing 13 in which the piston impeller rotates is movable axially and is preferably but not necessarily splined to the hub so that it may not rotate. Rotation of the liquid contained in the housing will, by its centrifugal force, produce pressures on the casing which are in opposition to the pressures created by the impeller. By preventing the rotation of the casing the tendency of the liquid to rotate is reduced. The rotation of the liquid in the housing, due to the effect of the impeller, when the casing is non-rotatable, or due to the effect of the impeller and casing when the casing is rotatable, is minimized or prevented by radially disposed vanes 51 arranged in the housing and disposed in close relation to the casing and extending into the open bottom of the casing. That part of the casing lying on the impeller side of the wall 7 of the impeller forms in conjunction with the piston impeller a closed chamber into which fluid is forced by the impeller. The casing is normally held depressed by an adjustable spring 16 which surrounds a rod 17 and bears against a shoe 20 to which the rod is attached and which bears against the casing. The rod 17 is slidable axially through the nipple 18 in time with the axial movement of the casing.

The housing is filled with oil or other liquid, the viscosity of which partly determines the sensitiveness of the apparatus. When the impeller is rotated the oil is drawn through the suction inlet of the impeller and discharge into the chamber formed by the casing and the wall 7 of the piston impeller. The oil exerts a pressure on the wall of the casing which opposes the pressure of the spring or the weight of the parts and produces an axial movement of the casing, the amount of movement varying with the speed of the impeller. The amount of movement for any given speed of the impeller may be varied by varying the compression of the spring 16 by screwing the nipple 18 into or out of the housing. The shaft 4 is the driving shaft and may be connected to a rotating part of the apparatus to be governed, to a rotating part of the vehicle or apparatus whose speed is to be determined or to any power driven means, depending upon the service to be rendered by the apparatus. The rod 17 is connected directly or by suitable mechanisms to the engine valve gear, the throttle, the ignition timer, speed indicator, etc., or it may be employed for exerting axial pressure. Normally, when the impeller is at rest, it lies adjacent the upper wall of the casing and the casing moves upward as the impeller rotates. It is apparent that the impeller may be arranged to lie normally adjacent the lower part of the casing and the impeller may be inverted, so that its rotation will produce a decrease of pressure in the closed chamber, which will produce an axial movement of the casing.

In the construction shown in Fig. 2 the difference in pressure on the casing is augmented by employing the suction or vacuum produced by the impeller in conjunction with the pressure produced thereby to produce the axial movement of the rod 17. In this construction the casing 13 is closed at its lower portion and the side plate 7 divides the casing into two chambers. The cylindrical extension 14 of the casing is splined to the hub 15, so that the casing does not rotate and the rotation of the oil in the lower chamber is prevented by radial ribs or vanes 35 formed in the lower part of the

casing. The casing is filled with oil and as the impeller rotates oil is drawn from the lower chamber and forced into the upper chamber, the vacuum and pressure acting in combination to cause an axial movement of the casing. This construction is more sensitive and more powerful than that shown in Fig. 1.

In the construction shown in Fig. 3 the impeller is movable axially due to variations in the speed thereof. In this instance the impeller is splined to the shaft 21 which is driven from the pulley 22 through the gears 23—24. The impeller is provided on its upper surface with an upstanding annular wall 25 which divides the upper surface into two parts. The wall 25 engages the partition wall 26 of the housing 2, dividing the housing into two chambers 27—28. The housing is partly filled with oil and rotation of the impeller forces the oil into chamber 27 where it exerts a pressure on the opposite sides of the impeller. The area of the lower face of the impeller in chamber 27 is greater than the area of the upper face lying in the same chamber, so that the pressures on opposite sides of the impeller are unbalanced, the greater pressure exerting its force upwardly and thereby producing an axial movement of the impeller. The axial movement of the impeller is transferred through the lever 29 to the rod 31 which serves the same function as the rod 17 in Fig. 1.

The sensitiveness of the apparatus is controlled by an adjusting screw 32 which controls a by-pass 33 between the chambers 27—28; opening the by-pass making the action more sluggish and closing it making it more responsive. When the apparatus is used as a governor, the screw 32 may be employed to adjust the position of the impeller with relation to the speed thereof.

In Figs. 4 and 5 I have shown devices which are operated from two different sources of motion, this type of apparatus being particularly adapted for use as a speed governor, although it has other uses. In the construction shown in Fig. 4, the casing 13 is provided with straight side walls as in Fig. 1, and in the casing I arrange a plurality of piston impellers 36—37 preferably arranged in superposed relation. The walls 7 on the suction sides of the impellers are provided on their periphery with flanges 12 which form running joints with the casing wall. The impeller 36 draws oil from within the housing 2 and delivers it under pressure into the chamber between the two impellers and the impeller 37 draws oil from this chamber and forces it into the closed chamber at the top of the casing. When both impellers are rotating they operate as a double stage pump, producing a higher pressure in the closed chamber than either one individually could produce when rotating at the same speed. When impeller 36 alone is rotated, it operates to force oil through impeller 37 into the closed chamber and when impeller 37 alone is rotated, it draws oil through impeller 36 and forces it into the closed chamber. The impeller 37 is secured to the shaft 38 which projects from the housing and impeller 36 is secured to the hollow concentric shaft 39 which is rotated by the projecting shaft 41 through the gears 42—43.

In the construction shown in Fig. 5, the casing 13 is provided with a shoulder 44, forming two cylindrical portions of different diameter. The piston impeller 37 is arranged in the upper portion, is driven independently by the shaft 38 and produces a pressure, when rotated, against the top wall of the casing. The piston impeller 36 is arranged in the larger lower portion and is provided with a neck 45 which forms a running joint with the wall of the upper portion, forming two independent pressure chambers within the casing. Rotation of the impeller 36 produces an upward pressure on the shoulder 44. The impellers are arranged so that the suction side of each impeller is independently connected with the supply of oil in the housing. This is accomplished by increasing the diameter of the hollow shaft 39 to allow the oil conduit 46 to extend therethrough. In this construction each impeller produces an independent pressure and the pressures are additive in moving the casing axially against the opposition of the spring 16. In the constructions shown in Figs. 4, and 5 in which open bottom casings are employed, vanes 51 which prevent rotation of the oil in the housing are employed for the same purpose as in Fig. 1, and the casings may be rotatable or not, as desired.

The devices illustrated in Figs. 4 and 5 are particularly useful as governors to control the speed of vehicles and engines driving the same. As an example, the shaft 38 may be connected to a rotating part of the engine, the shaft 41 to a rotating part of the vehicle propelling mechanism or axle and the shaft 17 to the engine throttle. The impeller 37 is designed so that its rotation when operating alone moves the casing to prevent racing the engine when idling and the impeller 36 is designed so that the combined pressures produced by the two impellers moves the casing to control the speed of the engine when the vehicle is being driven in high gear. That is, the impeller 37 may operate alone to prevent a speed in excess of 1500 R. P. M. of the engine, and the two impellers in combination may operate to prevent a vehicle speed in excess of

20 miles per hour, at which speed the engine, when connected in high gear, will have a speed of 800 R. P. M. Therefore, when starting or when operating on low gear, a high engine speed may be obtained, but as the speed of the vehicle increases, the maximum possible speed of the engine is lowered.

I claim:

1. In combination, a rotatable centrifugally acting impeller having a radially extended side plate, a casing surrounding the impeller and movable axially with relation thereto, and forming a substantially fluid tight joint with the said side plate, and a body of liquid in said casing.

2. In combination, a rotatable centrifugally acting impeller having a side plate, a casing surrounding the impeller and movable axially relative thereto and forming a substantially fluid tight joint with the side plate, said plate dividing the casing into two chambers and a body of liquid in the casing adapted to be centrifugally forced into the impeller containing chamber by rotation of the impeller.

3. In combination, a casing containing a body of liquid and a rotatable centrifugally acting impeller arranged within the casing and forming on its suction side a substantially fluid tight joint with the casing, said casing and impeller being axially movable with respect to each other.

4. In combination, a casing containing a body of liquid, a plate forming a substantially fluid tight joint with the casing and dividing the casing into two chambers, one of which is closed, and means arranged in the closed chamber and axially movable with respect to the casing for forcing liquid into said closed chamber.

5. In combination, a casing containing a body of liquid, a rotatable centrifugally acting impeller arranged in said casing, a wall on the suction side of the impeller forming a substantially fluid tight joint with the casing and dividing it into two chambers, the chamber on the discharge side of the impeller being closed so that rotation of the impeller produces a difference in pressure in the two chambers, said casing and impeller being movable axially with respect to each other, and means opposing said relative movement.

6. In combination, an axially movable casing containing a body of liquid, a rotatable centrifugally acting impeller in said casing having a side plate forming a substantially fluid tight joint with the casing and dividing it into two chambers, the chamber in which the impeller is disposed being closed, and means connected to said casing arranged to be moved by the axial movement thereof.

7. In combination, a casing containing a body of liquid and a rotatable centrifugally acting impeller arranged in and forming a substantially fluid tight joint with said casing and dividing the casing into two chambers, the impeller and casing being relatively movable axially.

8. In combination, a casing containing a body of liquid, a rotatable centrifugally acting impeller arranged in said casing and forming on its suction side a substantially fluid tight joint with the casing whereby the casing is divided into two chambers, the impeller and casing being axially movable relatively, and a spring opposing said axial movement.

9. In combination, a housing containing a body of liquid, a casing arranged in said housing, a rotatable centrifugal impeller arranged in said casing and forming a substantially fluid tight joint therewith whereby the casing is divided into two chambers, rotation of the impeller serving to cause an axial movement of the casing with respect to the impeller, and means opposing said axial movement.

10. In combination, a housing containing a body of liquid, a casing having a closed end arranged in said housing, a rotatable centrifugal impeller forming a substantially fluid tight joint with said casing and dividing the casing into two chambers, rotation of the impeller serving to produce a difference in pressure in said chambers, said casing and impeller being axially movable relatively due to such difference in pressure and a spring opposing such axial movement.

11. In combination, a casing containing a body of liquid, a plurality of rotatable impellers in said casing dividing the casing into a plurality of chambers and means for independently rotating said impellers.

12. In combination, a casing containing a body of liquid, a plurality of rotatable impellers in said casing dividing the casing into a plurality of chambers, said casing being movable axially with respect to said impellers, means for independently rotating said impellers, and means opposing the axial movement of said casing.

13. In combination, a housing containing a body of liquid, an axially movable casing arranged in said housing, a plurality of independently driven impellers in said casing, rotation of the impellers serving to vary the pressure within the casing and produce an axial movement thereof, and means opposing said axial movement.

14. In combination, a housing containing a body of liquid, a casing arranged in said housing, a rotatable impeller arranged in said casing and forming a sliding joint therewith, whereby the casing is divided into two chambers, said casing and impeller being axially movable respectively, means

for rotating said impeller and means for preventing rotation of the liquid in the housing.

15. In combination, a housing containing a body of liquid, vanes in said housing to prevent rotation of said liquid, a casing in said housing and a rotatable impeller in said casing and forming a sliding joint therewith, said casing and impeller being axially movable relatively.

16. In an apparatus as described, a casing, a centrifugal impeller piston in said casing and a wall on the suction side of the piston forming a running joint with said casing, said casing and said impeller piston being axially relatively movable.

17. In combination, a cylindrical casing containing a body of liquid, a rotatable centrifugally acting impeller in said casing and having a wall on its suction side forming a substantially fluid tight joint with the interior of said casing and dividing it into two chambers, and means movable in response to the fluid pressure in said casing due to the rotation of said impeller.

In testimony whereof, I have hereunto set my hand at Marysville, California, this 6th day of July 1915.

GORDON C. PHARO.

In presence of—
ADA L. HEDGER.