May 23, 1944. J. F. JOY 2,349,280

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Filed March 18, 1942 2 Sheets-Sheet 1

Fig. 2.

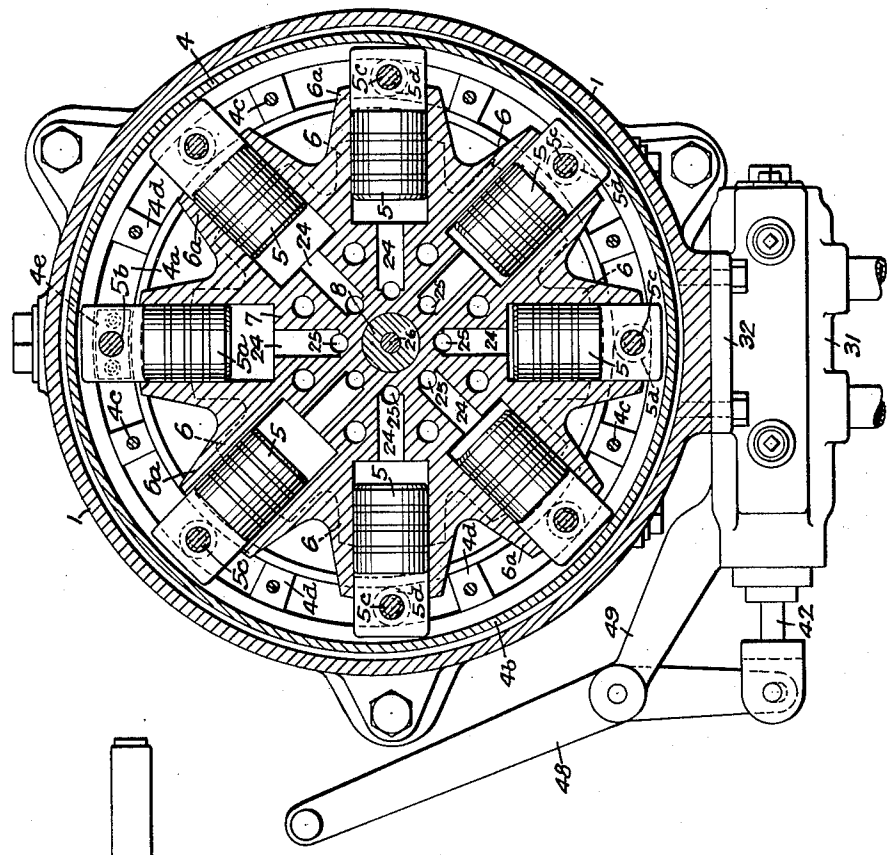
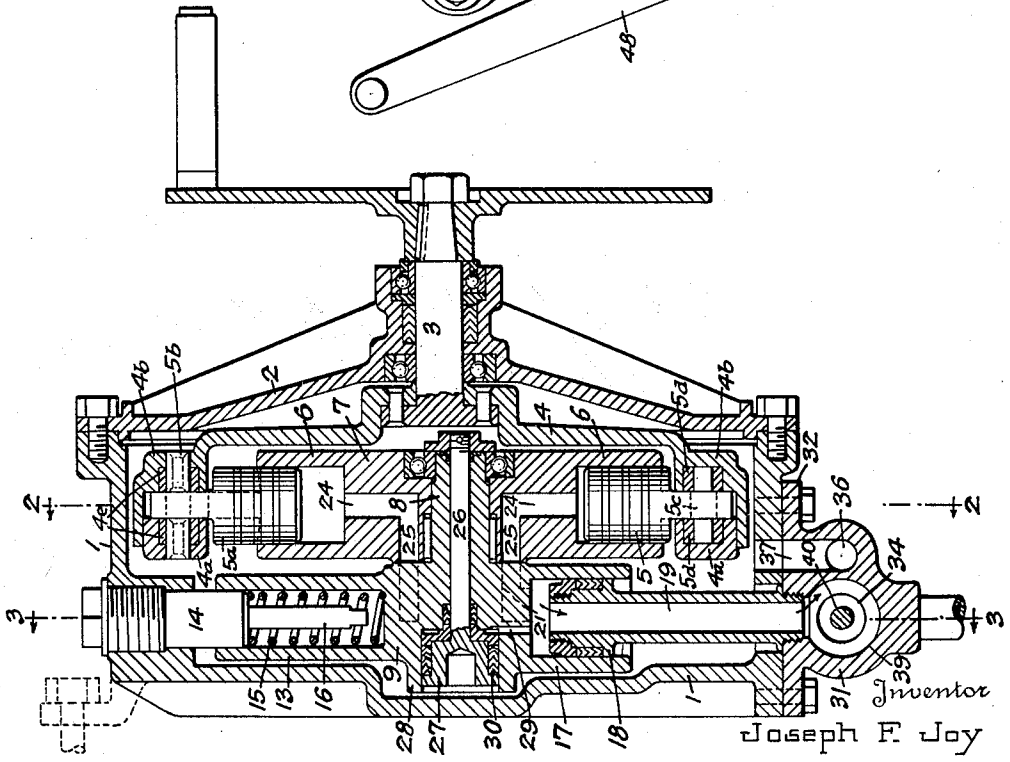


Fig. 1.



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May 23, 1944. J. F. JOY 2,349,280

PUMP

Filed March 18, 1942 2 Sheets-Sheet 2

Fig. 4.

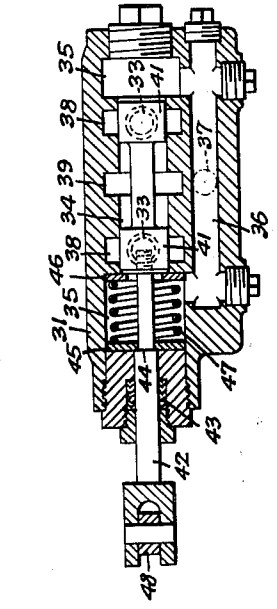
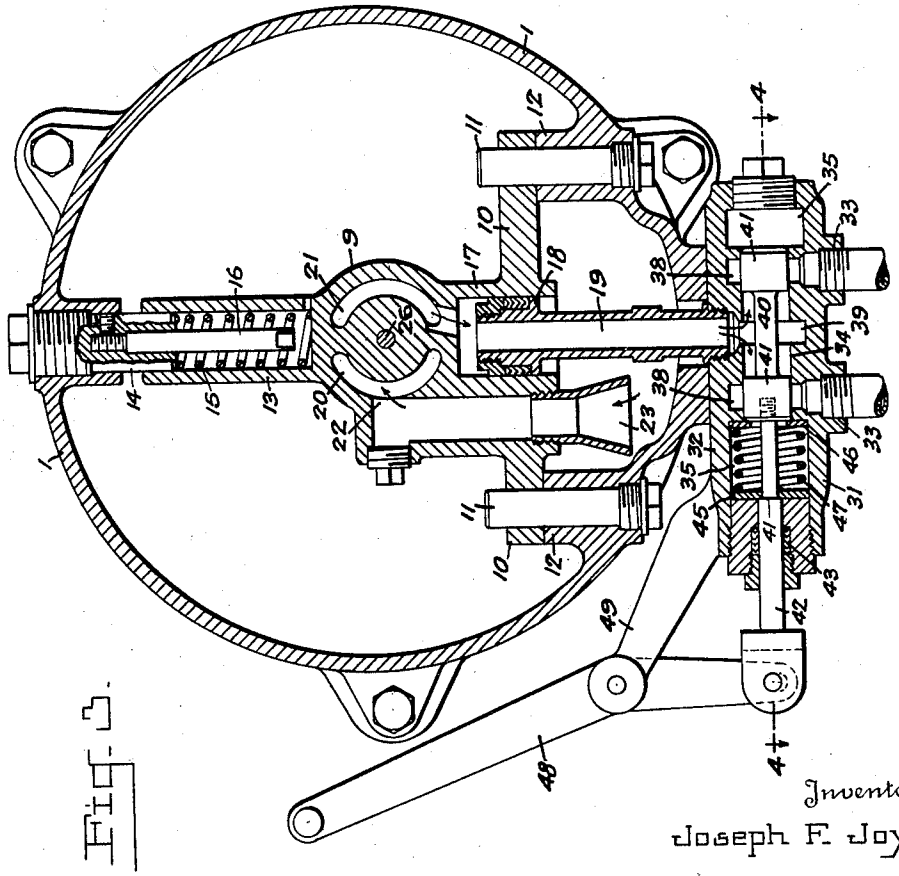


Fig. 5.



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Patented May 23, 1944 2,349,280

UNITED STATES PATENT OFFICE

2,349,280

PUMP

Joseph F. Joy, Claremont, N. H.

Application March 18, 1942, Serial No. 435,187

6 Claims. (Cl. 103—161)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to a pump for the fluid used in hydraulic mechanisms and more particularly to a variable displacement pump for a hydraulic elevating mechanism such as that shown in my copending application, Serial No. 435,186 filed herewith.

In the application of hydraulic elevating mechanism to heavy artillery weapons it has been found that the displacement of the driving pump has been limited by the amount of turning force which a man might be expected to exert under conditions of maximum pressure such as might be required in setting a heavy gun in motion against the forces of inertia and friction.

It is therefore an object of this invention to provide a pump the displacement of which, and consequently the rate of gun movement, can be varied automatically with the resistance to movement of the gun while the turning force exerted on the pump may remain substantially constant. With this type of pump the handwheel may be turned at a substantially constant rate and a substantially constant force may be exerted thereon. However, as the volume and pressure output of this pump varies with the load imposed thereon. this force if opposed by a stationary gun will cause the volumetric capacity of the pump to decrease while the pressure is increased and, as the resistance of the gun to movement decreases, the pressure will lower and the volumetric capacity will increase. The result will be that the gun may be gradually but quickly accelerated from a standing start to its maximum rate of movement.

It is a further object to produce a pump having pressure responsive means to maintain a tight seal in the running joint between the pump body and the valve means.

Another object is the provision of a variable displacement pump of comparatively high capacity which falls within the severe weight and space limitations imposed upon artillery equipment and may be manufactured with economy and convenience.

The exact nature of the invention as well as other objects and advantages thereof may be clearly seen from a description of a preferred embodiment as shown in the accompanying drawings in which:

Figure 1 is a vertical longitudinal sectional view of a pump embodying my invention.

Figure 2 is a vertical cross-sectional view on the line 2—2 of Fig. 1.

Figure 3 is a view similar to Fig. 2 on the line 3—3 of Fig. 1.

Figure 4 is a horizontal sectional view on the line 4—4 of Fig. 3.

Referring to the drawings by character of reference, the pump shown therein comprises the pump case 1 and a pump case cover 2. Power is transmitted to the pump through a ball-bearing mounted drive shaft 3 to a reactance ring or piston actuating member 4 carried by the inner end of the shaft 3. The piston actuating member 4 includes a pair of annular, grooved, rim members 4a and 4b secured together with the grooves in opposition to each other by machine screws 4c penetrating the rims 4a and 4b and engaging spacer blocks 4d therebetween. A piston 5a has been swingably secured to the actuating member 4 by means of a piston pin 5b engaging the piston 5a, spacer blocks 4e and the rims 4a and 4b. Each of the other pistons 5 has been provided with a piston pin 5c having reduced end portions engaging rollers 5d which are received within the annular groove between the rim members 4a and 4b. Each of the pistons is received in one of the cylinders 6 in the pump body 7 which is rotatable about an axis normally eccentric to that of the pump body. It will be seen that the piston 5a will transmit the circumferential driving force to the pump body and that each piston is reciprocable in its cylinder 6. Webs 6a formed on the cylinder body extend up each side of the pistons into the space between the rim members 4a and 4b of the member 4 serving as guide fingers to maintain the pump body and the member 4 in alignment. The pump body is journalled on a trunnion 8 on the pump base 9 which is slidably mounted in the pump case 1 with a capacity for vertical reciprocation therein. It will be obvious that when the trunnion 8 is eccentric with relation to the drive shaft 3 rotation of the drive shaft will result in rotation of the pump and in reciprocation of each of the cylinders with respect to the pistons therein. The amount of reciprocation will be directly proportional to the displacement of the trunnion axis with respect to the drive shaft axis. The pump base has the same general shape as an inverted T, and the arms 10 of the pump base are received over guides 11 secured to the pump case 1. Maximum stroke limiting stops 12 are provided to limit the downward movement of the pump base. The shank 13 of the pump base is cylindrical in form and slid-

able on the upper guide 14 which also serves as a support for a spring 15 tending to force the pump base to rest on the stops 12. An adjustable minimum stroke limiting stop 16 is also provided on the upper guide. A cylinder 17 is provided in the pump base and is slidable over a piston 18 secured to the pump case and having a cylindrical bore 19 in communication with the outlet port from the pump. It will be obvious that pressure developed in this cylinder will be in opposition to the forces of gravity and of the spring 15 tending to hold the pump base down. To the extent that this pressure is able to overcome the spring the pump base will be raised thus decreasing the eccentricity of the trunnion with respect to the drive shaft and consequently shortening the stroke and lessening the displacement.

The front face of the pump base has formed therein, in an annular zone surrounding the trunnion, a pair of spaced apart valve ports 20 and 21, respectively in communication with the cylinder 17 and with a passage 22 leading to an inlet pipe 23 adjacent the bottom of the pump case. A passage 24 from each of the cylinders 6 leads through the pump body to a separate opening 25 on the rear face thereof, the opening 25 being equally spaced from each other and located in opposition to the ports 20 and 21 in the pump base.

The trunnion 8 in the pump base is bored axially and a retainer bolt 26 is received therein to secure the pump body on the trunnion with the rear face of the pump body in liquid tight engagement with the front face of the pump base. The inner end of the retainer bolt 26 is further provided with a piston head 27 received within a cylinder 28 formed in the pump base. A passage 29 leads from the cylinder 28 to the cylinder 17 so that the outlet pressure of the pump will be duplicated in the cylinder 28. Suitable packing 30 is provided on the piston and about the shank of the retainer bolt to prevent leakage. It will be seen that the outlet pressure of the pump is thus utilized to maintain the liquid tight running contact between pump body and pump base.

It is intended that the pump case function as the oil reservoir for the hydraulic system and that the cavity therein be kept approximately two-thirds full of oil, the remainder of the space being filled with air under moderate pressure.

To summarize the operation of the pump proper it will be seen that rotation of the driving shaft by means of the handwheel results in reciprocation of the cylinders with respect to the piston. This pump is designed for clockwise rotation and when so rotated all of the cylinders to the left of the vertical bisector of Fig. 2 will be increasing in volume and will draw fluid from the pump case through the intake tube. Momentarily, as each piston passes the top position that cylinder will be shut off and will immediately thereafter be connected to the exhaust port. During the balance of the stroke the cylinder volume is decreasing and the oil will be expelled through the exhaust line passing through the stroke regulating cylinder and piston. Following up the pressure in the external hydraulic circuit the pressure in the stroke regulating cylinder will operate to shorten the stroke of the pistons as the external pressure is increased. This results in an approximately uniform rate of work per revolution or a substantially constant torque. However, under certain conditions, such as low temperature or prolonged disuse, the parts of the gun may become stiffened to an extent requiring the development of abnormally high pressure to initiate gun movement. It was to meet this condition that the adjustable minimum stroke regulating stop was provided in the top guide member thus preventing the ultimate reduction of the pump displacement to zero under abnormally heavy loads. Under lighter load conditions the spring will be able to overcome the pressure in the stroke regulating cylinder and will increase the stroke to provide a greatly increased rate of fluid flow and of gun movement.

In order to direct the flow of fluid to make it useful for either elevating or depressing the gun a reversing valve has been provided on the lower part of the pump case. The construction of this valve is best shown in Figs. 1, 3, and 4. Referring thereto by characters of reference it is seen that the valve comprises a valve casing 31 adapted to be secured to the bottom of the pump case or to be formed integrally therewith. The valve casing shown is provided with a flanged upper portion 32 to be secured to the pump casing and with a pair of tapped outlets 33 for connection to an external fluid circuit. Internally the valve casing is formed with a bore 34 having spaced sections of enlarged diameter. The enlarged portions 35 at opposite ends of the bore 34 are connected through a by-pass conduit 36 and an opening 37 is provided from the conduit 36 into the pump casing 1. The diametrically enlarged portions 38 are spaced slightly inward from the end portions 35 and are each in communication with one of the tapped outlets 33. The central portion 39 of the bore 34 is placed in communication with the bore 19 leading from the stroke regulating cylinder 17 on the outlet side of the pump. Slidable in the bore 34 is a valve 40 of the balanced piston type having portions 41 snugly fitting the bore and spaced so as to each span one of the enlarged portions 38. A valve operating rod 42 is extended outside the valve casing through packing 43 and is provided with a shoulder 44 engaging a washer 45 which is slidable in the enlarged portion 35 of the bore. A somewhat similar washer 46 has an internal diameter such that it will engage the end of the valve 40 without greatly obstructing the passage through the bore 34 and engaged between the washers is a valve centering spring 47 which will obviously tend to return the valve to centered position when displaced in either direction. An operating lever 48 is mounted on a bracket 49 on the valve body to form a convenient means of operation.

It will be obvious from inspection of Fig. 3 for example that if the valve operating rod is displaced inwardly the left hand fluid conduit will be connected to the left hand enlarged portion of the valve and hence to the return to the pump casing. Simultaneously the right hand fluid conduit will be connected to the high pressure outlet from the pump proper. If the valve is moved in the other direction the flow in the external circuit will be reversed. As the valve is balanced there will be no tendency for pressure against the valve faces to vary the adjustment of the valve and the valve may be conveniently used to limit movement under target spotting conditions by the employment of a throttling effect which may be achieved by only

partially opening the valve. When the equilibrators of the gun are properly balanced the breech end of the gun is heaviest when the gun is loaded and the muzzle end is heaviest after firing. These unbalanced loads must be borne by the hydraulic elevating cylinder and either circumstance may result in the gun having a tendency to overhaul and drive the pump. The arrangement here is such as to permit such overhauling and when convenient to utilize it to expedite elevation or depression of the gun. By reason of the throttling effect which may be secured in the reverse valve such movement will always be under complete control and may be stopped at will by the operator allowing the valve to return to neutral position.

While this pump was intended primarily for hand operation its application is obviously not limited thereto. The pump may conveniently be coupled to any source of driving power and will produce a smooth pulsationless flow at a rate which is substantially inversely proportional to the working pressure.

I claim:

1. In a fluid pump, a pump base having a trunnion thereon, valve means on said base having a flat face normal to the axis of said trunnion, a pump body rotatable on said trunnion, valve means on said pump body having a flat face opposed to the face of the valve means on said base, and pressure responsive means to maintain a liquid tight running fit between said valve faces.

2. In a fluid pump, the apparatus described in claim 1, said pressure responsive means comprising a cylinder axially aligned with said trunnion, a piston in said cylinder, a bolt integral with and extending from said piston along the axis of said trunnion, means on the outer end of said bolt to engage the outer face of said body, and means to apply fluid pressure to the piston in said cylinder whereby the valve faces will be constrained to closer engagement with each other.

3. On a fluid pump, centering means for a reversing valve comprising a valve bore, a balanced piston slidable in said bore, a diametrically enlarged portion of said bore near one end thereof, an annular member slidable in the enlarged portion of said bore and having an inner diameter less than that of the exterior of said piston, a closure for the enlarged end of said bore, a valve operating rod secured to said valve piston and extending axially therefrom through said closure, a shoulder on said rod spaced from and facing said valve piston, a second annular member engaging said shoulder and slidable in the enlarged portion of said bore, and a spring engaged between said annular members.

4. A fluid pump comprising a pump casing, a shaft journalled in an end of said casing, an annular member coaxial with said shaft and carried by the inner end thereof, a pump base in said casing, a trunnion on said pump base movable between positions of varying eccentricity with relation to said shaft axis but parallel thereto, a pump body rotatable about the axis of said trunnion, cylinders in said pump body, pistons reciprocable in said cylinders connected to said annular member, and discharge pressure responsive means adapted to decrease the eccentricity of said trunnion axis as the discharge pressure is increased, said casing forming a closed fluid reservoir, intake means for said pump adapted to draw fluid from said reservoir, a discharge conduit leading through said pressure responsive means from said pump body to the exterior of said casing, and a return conduit adapted to return fluid to said casing.

5. A fluid pump comprising a pump casing, a shaft journaled in an end of said casing, an annular member coaxial with said shaft and carried by the inner end thereof, a pump base in said casing, a trunnion on said pump base movable between positions of varying eccentricity with relation to said shaft axis but parallel thereto, a pump body rotatable about the axis of said trunnion, cylinders in said pump body, pistons reciprocable in said cylinders connected to said annular member, discharge pressure responsive means adapted to decrease the eccentricity of said trunnion axis as the discharge pressure is increased, said casing forming a closed reservoir adapted to contain a supply of fluid under pressure, intake means on said pump body adapted to draw fluid from said reservoir, discharge means leading from said pump body to a fluid circuit outside of said casing, and a return conduit adapted to return fluid from said exterior circuit to said casing.

6. A fluid pump comprising a pump casing, a shaft journalled in an end of said casing, an annular member coaxial with said shaft and carried by the inner end thereof, a pump base in said casing, a trunnion on said pump base movable between positions of varying eccentricity with relation to said shaft axis but parallel thereto, a pump body rotatable about the axis of said trunnion, cylinders in said pump body, pistons reciprocable in said cylinders connected to said annular member, discharge pressure responsive means adapted to decrease the eccentricity of said trunnion axis as the discharge pressure is increased, said pump base being slidable in said case from a position in which the trunnion has a maximum eccentricity with relation to the shaft to a position of less eccentricity; a regulating cylinder in said pump body axially parallel to the line on which said base is slidable, a piston in said cylinder connected to said pump casing, means to apply discharge pressure to said regulating cylinder, and spring means opposing sliding movement of said base.

JOSEPH F. JOY.