Feb. 5, 1935. E. BENEDEK 1,990,263

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Filed May 23, 1932 3 Sheets-Sheet 1

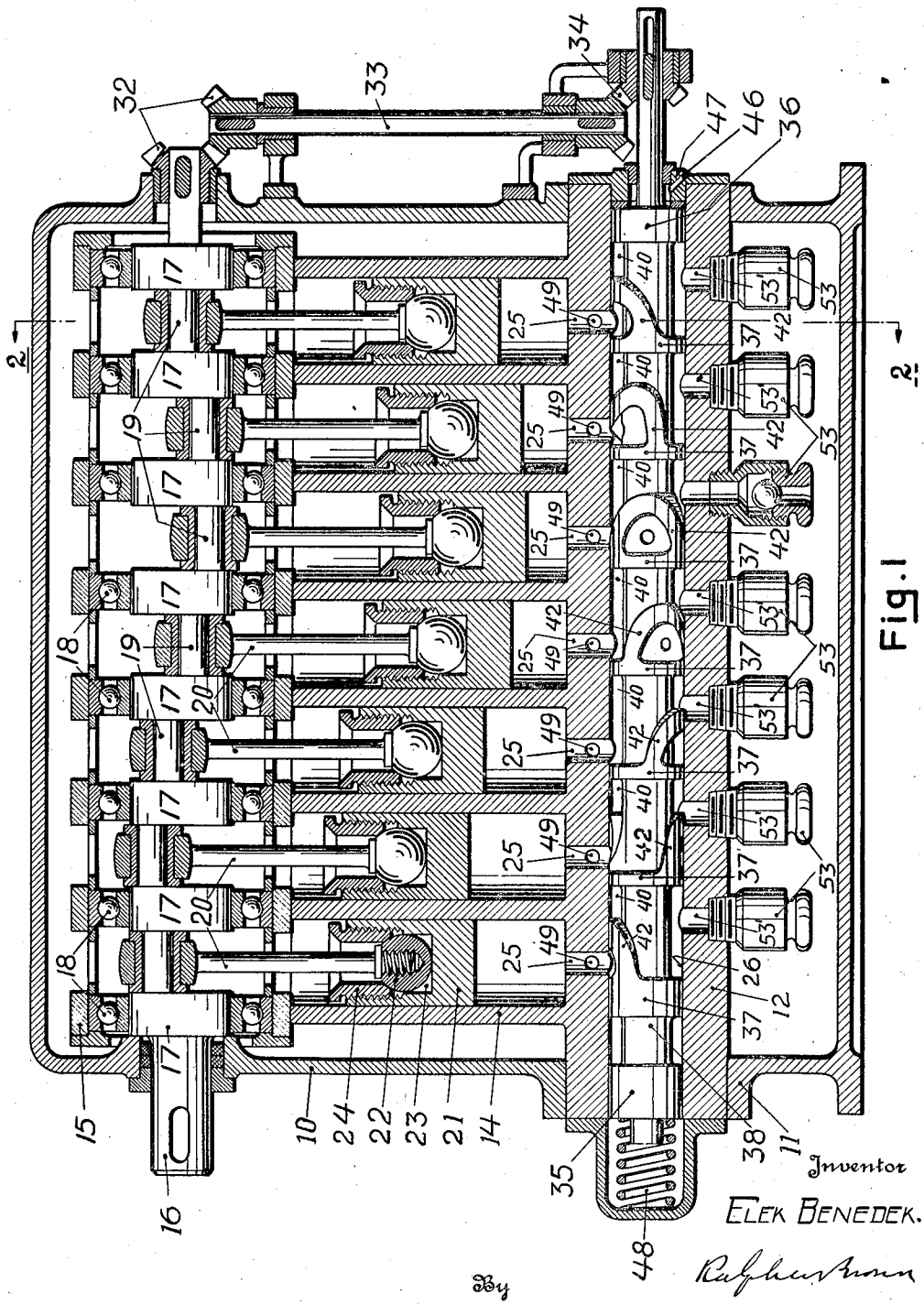

Fig. 1

Inventor

ELEK BENEDEK.

By

Attorney

Feb. 5, 1935. E. BENEDEK 1,990,263

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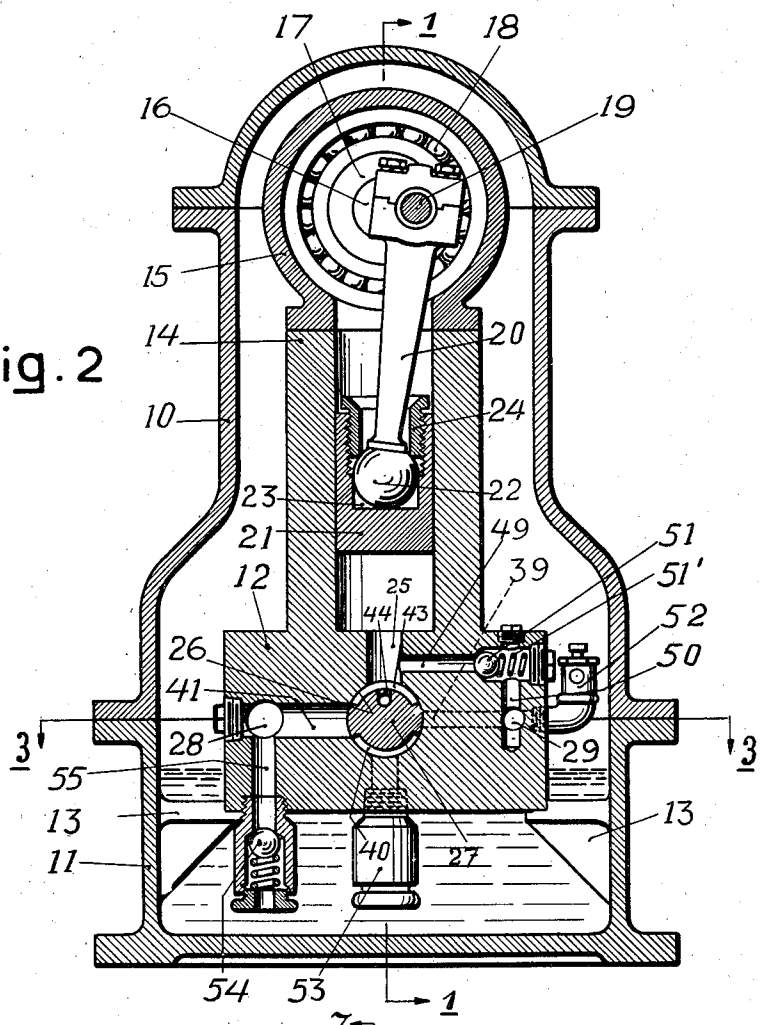
Fig. 2



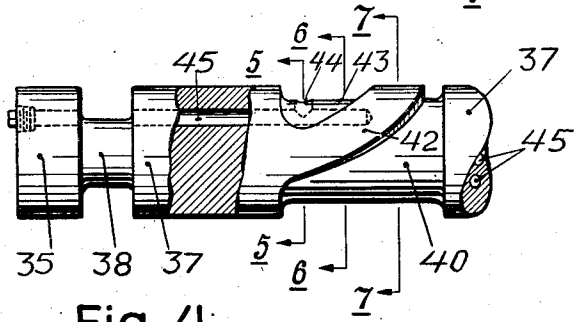


Fig. 4

Inventor

ELEK BENEDEK.

By Ralph Brown.

Attorney

Feb. 5, 1935. E. BENEDEK 1,990,263

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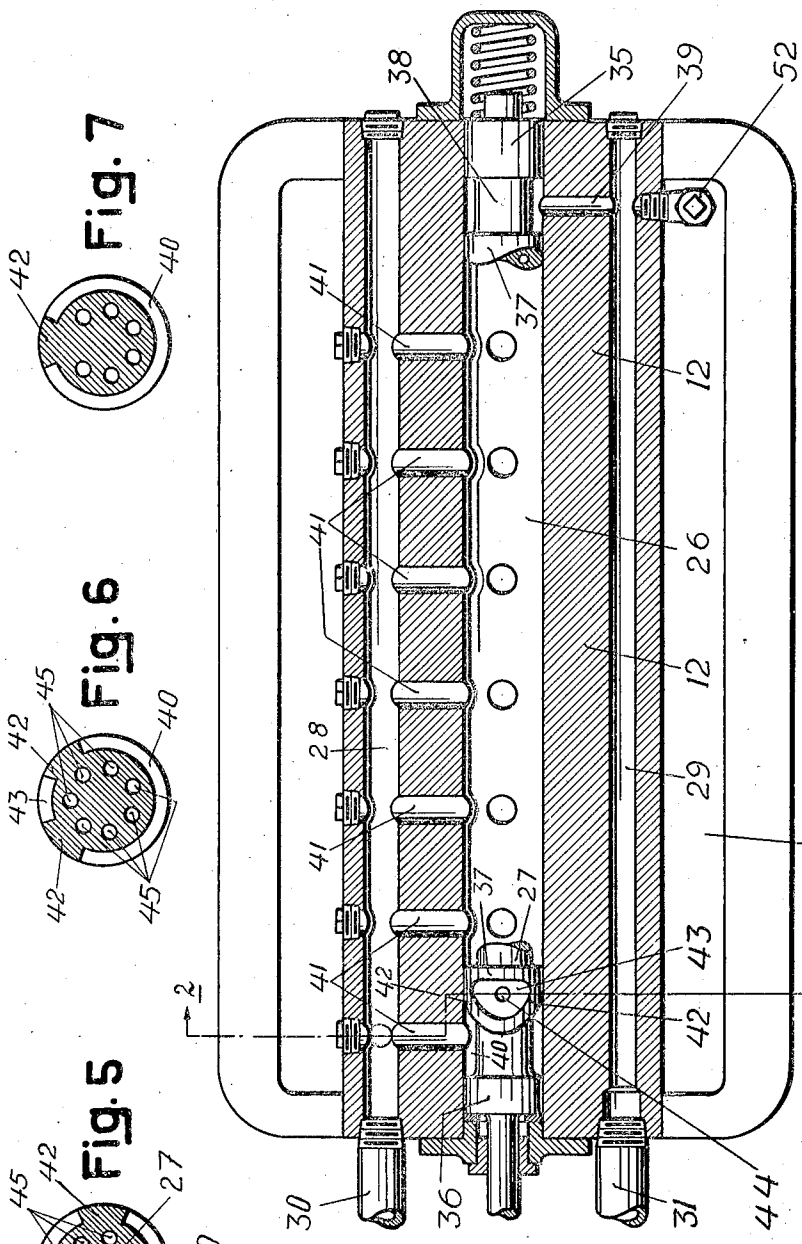

Fig. 3

Fig. 7

Fig. 6

Fig. 5

Inventor
ELEK BENEDEK.

By

Attorney

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UNITED STATES PATENT OFFICE

1,990,263

PUMP

Elek Benedek, Mount Gilead, Ohio, assignor to The Hydraulic Press Manufacturing Company, Mount Gilead, Ohio, a corporation of Ohio

Application May 23, 1932, Serial No. 613,011

11 Claims. (Cl. 103—37)

This invention relates to high pressure variable delivery pumps.

In my copending application Serial No. 522,895, filed March 16, 1932, I have disclosed a multiple cylinder pump having a plurality of crank driven constant stroke pistons and in which a variable portion of the discharge from each cylinder is utilized by adjustable valve mechanism controlling communication between the cylinders and the outlet port of the pump. In the pump therein disclosed the valve mechanism comprises an individual hydrostatically balanced valve for each cylinder.

An object of the present invention is to simplify and otherwise improve the construction and operation of pumps of the type above referred to.

The present application discloses a similar type of variable delivery pump having a single rotary valve for controlling the discharge from the several cylinders.

Other more specific objects and advantages will appear from the following description of an illustrative embodiment of the present invention.

In the accompanying drawings:—

Figure 1 is a vertical longitudinal sectional view of a pump constructed in accordance with the present invention.

Fig. 2 is a vertical transverse sectional view on the line 2—2 of Fig. 1.

Fig. 3 is a horizontal sectional view on the line 3—3 of Fig. 2.

Fig. 4 is a fragmentary detail of the rotary valve shown particularly in Fig. 1.

Figs. 5, 6, and 7 are sectional views of the valve taken substantially along the lines 5—5, 6—6, and 7—7, respectively, of Fig. 4.

The pump shown is enclosed within an appropriate housing 10 whose base 11 forms a liquid reservoir. A block 12, rigidly mounted on appropriate brackets 13 within the base 11, supports a plurality of upright cylinders 14 which in turn support a head structure 15.

A crank shaft 16 in the upper part of the housing 10 is provided with a plurality of circular cheek plates 17 journalled in individual antifriction bearings 18 secured within the head structure 15. Crank pins 19 supported by and between successive cheek plates 17 are connected through appropriate crank arms 20 with pistons 21 reciprocable within the cylinders 14. In this instance each crank arm 20 is equipped with a ball 22 closely fitted for rocking action within a cylindrical pocket 23 formed in the associated piston 21, each ball being retained by a sleeve 24 screwed into the pocket. The successive crank pins 19 are equally spaced about the axis of the crank shaft.

A port 25 in the base of each cylinder 14 communicates with a longitudinal bore 26 formed in the block 12. A valve element 27, closely fitted for rotation within the bore 26, cooperates with the several ports 25 to control communication of each cylinder with a supply passage 28 and a discharge passage 29. The supply passage 28 is connected to a pipe 30 constituting the return side of a hydraulic circuit and the discharge passage 29 is connected to a pipe 31 constituting the high pressure or working side of the circuit. The valve element 27 is rotated synchronously with and by the crank shaft 16 through appropriate means such as mitre gears 32, shaft 33 and mitre gears 34.

In this instance the valve element 27 is provided with end heads 35 and 36 and with a plurality of integral collars 37. An annular space 38 between the end head 35 and adjacent collar 37 communicates at all times with a passage 39 which leads to the discharge passage 29. (See Fig. 3.) The spaces 40 between successive collars 37 communicate with the supply passage 28 through individual passages 41.

To oppositely spiraled ribs 42 extend laterally from diametrically opposite points on each collar 37 and merge at their extremities to completely enclose a substantially triangular depression or pocket 43. The successive pockets 43 are equally spaced about the axis of the valve element, and each has a port 44 in the bottom thereof which communicates with a longitudinal passage 45 leading to the annular space 38.

The arrangement is such that during rotation of the valve element 27, in the position of Fig. 1, each cylinder port 25 communicates alternately with an adjacent pocket 43 and space 40. The rotation of the valve is so timed with respect to the crank shaft that, during each upward or suction stroke of each piston, port 25 communicates with the supply passage 28 through port 41 and space 40, and during each pressure stroke the port 25 communicates with the discharge passage 29 through passage 39, space 38, passage 45 and pocket 43. That condition exists so long as the valve 27 is in the position shown with the port 25 adjacent the collar 37 where it coacts with the wide portion of the pocket 43.

If the valve element 27 be moved lengthwise toward the left (Fig. 1), so as to cause each cylinder port 25 to register with a narrow portion of its cooperating pocket 43, each cylinder then communicates with the space 38 and discharge

passage 29 through only a portion of each pressure stroke, and pump delivery is correspondingly reduced. Although various means may be provided for thus moving the valve element 27, I have in this instance provided hydraulic means for this purpose including a hydraulic connection 46 which leads to the right end 47 of the valve bore, and through which hydraulic pressure may be applied to the end head 36 to shift the valve element lengthwise against the resistance of a spring 48.

Provision is made for preventing the creation of excessive pressures within each cylinder that might otherwise result during each pressure stroke from a momentary trapping of the liquid therein as each rib 42 passes beneath each cylinder port 25 during rotation of the valve element. In this instance this is accomplished by the provision of a passage 49 which leads from each cylinder port 25 to a passage 50 communicating with the discharge passage 29. (See Figs. 1 and 2.) Each passage 49 is controlled by an outwardly opening check valve 51 which is held lightly against its seat by a spring 51'. It will thus be noted that whenever the pressure in any cylinder 25 tends to exceed the pressure in the delivery passage 29 the associated check valve 50 will immediately open to thereby permit the cylinder to discharge momentarily into the delivery passage 29.

A high pressure relief valve 52 connected to the delivery passage 29 limits the pressure therein.

Throughout the operation and irrespective of the longitudinal position of the valve element 27 all of the chambers 40 therein are open to the supply passage 28 through the passages 41, so that each cylinder 14 is always open to the supply passage 28 through each suction stroke. Under some conditions of operation, however, the liquid supplied to the supply passage 28 from the return side 30 of the circuit may be insufficient to satisfy the demands of the pump, causing cavitation in the liquid column and other objectionable conditions. Provision is therefore made for supplying liquid from the reservoir in the base 11 of the pump casing to thereby automatically compensate for such insufficiencies as and when they occur.

For this purpose the pump shown is provided with a plurality of inwardly opening check valves 53 immersed within the liquid reservoir 11 and each in constant communication with one of the chambers 40 in the valve element 27 through a passage 53', regardless of the rotative or longitudinal position of the valve.

A pressure relief valve 54, connected to the supply passage 28 through a passage 55, limits the pressure within the return side 30 of the circuit and permits the escape of liquid from the passage 28 in excess of that demanded by the pump.

In the pump shown each of the several pockets 43 in the valve element 27 is formed by ribs 42 which make equal angles with the connected collar 37, although the ribs 42 may be disposed at different angles, one of them for instance extending substantially parallel to the axis of the valve and the other disposed at an acute angle thereto. Various other changes may be made in the embodiment of the invention hereinabove specifically described without departing from or sacrificing the advantages of the invention as defined in the appended claims.

I claim:—

1. In a variable delivery hydraulic pump the combination of a plurality of cylinders and coacting pistons, a liquid supply passage, a liquid discharge passage, rotary valve means having longitudinally-tapered chambers for connecting each cylinder alternately with said supply and discharge passages, and means for shifting said valve means longitudinally to vary the quantity of liquid delivery.

2. In a variable delivery hydraulic pump the combination of a plurality of cylinders and coacting pistons, a liquid supply passage, a liquid discharge passage, and a rotary valve having means for connecting each cylinder with said supply and discharge passages alternately during rotation thereof, said valve being longitudinally adjustable, and said last named means being arranged to vary the quantity of liquid delivery between each cylinder and said discharge passage in response to longitudinal movement of said valve.

3. In a variable delivery hydraulic pump the combination of a plurality of cylinders and coacting pistons, a liquid supply passage, a liquid discharge passage, a rotary valve, said valve having means for maintaining communication between each cylinder and said supply passage throughout each suction stroke, said valve also having means for effecting communication between each cylinder and said discharge passage during each pressure stroke, said last named means comprising a plurality of longitudinally tapered chambers in said valve for communication with the respective cylinders, said valve and chambers being shiftable longitudinally to thereby vary the quantity of liquid delivery between each cylinder and said discharge passage.

4. In a variable delivery hydraulic pump the combination of a plurality of cylinders and coacting pistons, a liquid supply passage, a liquid discharge passage, a valve bore having communication with said passages, each of said cylinders having a port communicating with said bore, and a valve rotatable in said bore and also longitudinally movable therein, said valve having means coacting with said ports during rotation thereof to connect each of said cylinders with said supply and discharge passages alternately and responsive to longitudinal movement thereof to vary the quantity of liquid delivery between each cylinder and said discharge passage.

5. In a variable delivery hydraulic pump the combination of a plurality of cylinders and coacting pistons, a liquid supply passage, a liquid discharge passage, a valve bore, a longitudinally-adjustable valve rotatable in said bore and coacting therewith to form an annular chamber, said discharge passage communicating with said chamber, said valve having a plurality of longitudinally tapered chambers each arranged to intermittently communicate with one of said cylinders during rotation of said valve, a passage in said valve connecting each of said last named chambers with said annular chamber, said valve also having means for effecting intermittent communication between each cylinder and said supply passage, and means for shifting said valve longitudinally to vary the quantity of liquid delivery between said cylinders and said discharge passage.

6. In a variable delivery hydraulic pump the combination of a housing having a liquid reservoir, a plurality of cylinders and coacting pistons in said housing, a supply passage, a discharge passage, a valve bore, a longitudinally adjustable valve having longitudinally-tapered chambers

and rotatable in said bore to effect communication between each cylinder and said supply and discharge passages alternately, means for adjusting said valve longitudinally to vary the quantity of liquid delivery between said cylinders and passages, and means for admitting liquid from said reservoir to said rotatable valve bore and cylinders to automatically compensate for any under supply of liquid that may occur in said supply passage.

7. In a variable delivery hydraulic pump, the combination of a housing having a liquid reservoir, a plurality of cylinders and co-acting pistons in said housing, a supply passage, a discharge passage, a valve bore, a longitudinally-adjustable valve having longitudinally-tapered chambers and rotatable in said bore to effect communication between each cylinder and said supply and discharge passages alternately, means for adjusting said valve longitudinally to vary the quantity of liquid delivery between said cylinders and passages and means comprising a unidirectional valve communicating with said reservoir whereby said pump draws liquid into said bore and cylinders from said reservoir to automatically compensate for any under-supply of liquid that may occur in said supply passage.

8. In a variable delivery hydraulic pump, the combination of a plurality of cylinders and co-acting pistons, a liquid supply passage, a liquid discharge passage, rotary valve means having longitudinally-tapered chambers for connecting each cylinder alternately with said supply and discharge passages, and pressure responsive means for shifting said valve means longitudinally to vary the quantity of liquid delivery.

9. In a variable delivery hydraulic pump, the combination of a plurality of cylinders and co-acting pistons, a liquid supply passage, a liquid discharge passage, rotary valve means having longitudinally-tapered chambers for connecting each cylinder alternately with said supply and discharge passages, and pressure responsive means for shifting said valve means longitudinally to vary the quantity of liquid delivery, said pressure responsive means comprising a piston head associated with said valve means to urge said valve means in one direction and yielding means for urging said valve means in the opposite direction.

10. In a variable delivery hydraulic pump, the combination of a plurality of cylinders and co-acting pistons, a liquid supply passage, a liquid discharge passage, rotary valve means having longitudinally-tapered chambers associated in pairs for connecting each cylinder alternately with said supply and discharge passages, and means for shifting said valve means longitudinally to vary the quantity of liquid delivery, said valve means being disposed in a longitudinal horizontal direction in said pump.

11. In a variable delivery hydraulic pump, the combination of a plurality of cylinders and co-acting pistons, a liquid supply passage, a liquid discharge passage, rotary valve means having longitudinally-tapered chambers associated in pairs for connecting each cylinder alternately with said supply and discharge passages, the chambers of each pair being separated by a diagonally-disposed ridge on said valve means and means for shifting said valve means longitudinally to vary the quantity of liquid delivery, said valve means being disposed in a longitudinal horizontal direction in said pump and passing continuously therethrough.

ELEK BENEDEK.