June 1, 1965 C. R. SCHNEIDER 3,186,343

PUMPS AND COMPRESSORS

Filed March 25, 1963

FIG. 1

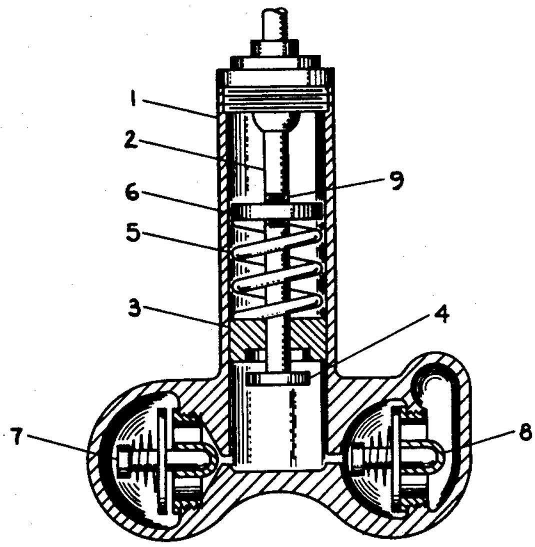
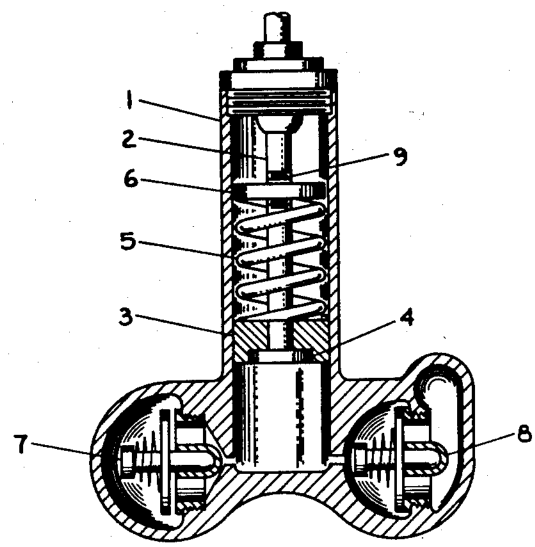


FIG. 2



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PUMPS AND COMPRESSORS

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1 Claim. (Cl. 103—38)

This invention relates to reciprocating piston or plunger machines, ordinarily called reciprocating compressors or pumps and particularly to means for varying the discharge of said machines while maintaining constant pressure. In the following these machines are called pumps although I desire it to be understood that everything noted hereafter will apply to compressors too.

In the conventional reciprocating pump the stroke of the pump is considered constant and thus the discharge of the pump is constant also. This condition is not always desirable as in the case when the discharge line of the pump is closed. In this instance the conventional pump would develop an excessive high discharge pressure while attempting to discharge a constant amount of fluid. As a consequence of the conventional pump operation, the discharge pressure of the pump is dependent on the rate of discharge from the pump. Thus a constant stroke and displacement pump has a constant discharge but a continuously varying discharge pressure. In some pump designs an external relief valve opens at the maximum permissible pressure to bypass the excessive fluid which is returned to the inlet of the pump whenever the system served by the pump does not require additional fluid. The power consumption at such a condition is high, because the pump displaces a constant amount of bypassed fluid against the maximum pressure. In order to avoid this waste of power an external shut-off switch is usually attached to the relief valve in these designs which interrupts the electric current to the motor and stops the operation of the pump. Whenever the system requires additional fluid the discharge pressure decreases, the relief valve closes, the switch connects the electric current to the motor and the pump operates again. In order to actuate the switch the relief valve must move through a considerable distance which in turn causes a disagreeable large drop of the maximum pressure in the system served by the pump. For large motor-pump aggregates frequent starting is undesirable or outright impossible. In order to avoid the high power consumption at idling or the numerous start and stop operations of the motor in some reciprocating pumps means have been incorporated to vary the length of the stroke of the piston. These means involve a great deal of linkage apparatus and usually a sensor element from the discharge line to the pump.

It is, therefore, desirable to provide an arrangement for varying the length of the stroke of the piston which eliminates the mechanical and hydraulical linkages including sensor elements of the present designs with their inherent slow response and inertia effects and which eliminates also the necessity of external relief valves and shut-off switches.

An object of this invention is, therefore, a pump which maintains a constant discharge pressure regardless of the variations in flow by incorporating a simple, highly sensitive and rapidly responding device.

Further objects and advantages of this invention will become apparent and the invention will be better understood by reference to the following description and the accompanying drawing, and the features of novelty which characterize this invention will be pointed out with particularity in the claim annexed to and forming a part of the specification.

In accordance with the broadest aspects of this invention, a piston of a pump is fastened to the piston rod by means of a spring which will allow a relative motion between the piston and the piston rod due to the compressibility of the spring.

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In the drawing:

FIG. 1 is a side elevational view, partly in section, illustrating the improved construction of a conventional pump.

FIG. 2 is also a side elevational view partly in section, further illustrating the improved construction of a conventional pump showing a different position of some of its parts.

Referring now to the drawing, there is shown a cylinder **1** having a piston rod **2** and a spring mounted piston **3** within. A discharge valve **7** and an intake valve **8** are included to complete the operational characteristics of the pump The piston **3** and the piston rod **2** are so assembled that the piston can move relative to the piston rod in an axial direction. The piston stop **4** is fastened securely to the piston rod **2** by offsetting, welding or by threads such that the piston rod **2** does not project past the lower side of the piston stop **4**. The piston **3** itself may be of any configuration, with reference to sealing rings, seals, gaskets and so forth between the piston **3** and the cylinder **1** and between the piston **3** and the piston rod **2** as long as said piston **3** can move relative to the piston rod **2** in an axial direction. In this particular drawing the seals between the sliding surfaces of the piston **3** against the inner wall of the cylinder **1** and of the piston **3** against the piston rod **2** are obtained by keeping the clearances between said surfaces very small.

The piston **3** is also provided with a counterbore at its lower end which permits the retraction of the piston stop **4** into the piston **3** so that the lower surfaces of said piston **3** and said piston stop **4** are flush as shown in FIG. 2. The actuating spring **5** is essential to the pump's operation. The size and characteristic of said spring **5** would be selected by the operating conditions for which the pump is intended. The inner diameter of the spring **5** must be larger than the diameter of the piston rod **2**. Furthermore, the bottom face of the spring **5** must rest against the top face of the piston **3** and the top face of the spring against an axially adjustable plate, the output selector **6**. The inner surface of the output selector **6** is threaded and will mate with the threads of the threaded portion **9** of the piston rod. After adjusting the output selector **6** on the piston rod **2** to the desired spring force by rotating it around the thread **9** the said output selector **6** will be locked in place by any convenient means like lock-nuts, set screws or similar devices. In this drawing a self-locking friction thread **9** is used for this purpose. Like in conventional pumps the space above the piston **3** in the cylinder **1** is provided with a suitable drainhole (not shown) to permit any fluid which leaks from the lower part of the cylinder **1** past the piston **3** into the upper part of the cylinder **1** to escape to the outside.

It will be readily seen that the fluid pressure below the piston **3** forces said piston **3** against the spring **5**. As long as the initial spring force as adjusted and maintained by the output selector **6** is larger than the force exerted by the fluid pressure against the lower face of the piston **3**, the said piston **3** and the piston rod **2** with its piston stop **4** operate as a single unit like in any conventional pump. This condition is illustrated in FIG. 2. In FIG. 2 the piston **3** together with the spring **5**, the output selector **6**, the piston rod **2** and piston stop **4** move downward as a single unit. The fluid is forced out under pressure through the discharge valve **7**. The intake valve **8** is closed by the same pressure as in any conventional pump. After attaining the full stroke travel distance of the piston rod **2** the said single unit reverses its motion and moves upward (not shown). In this case the discharge valve 7 would be closed and the intake valve 8 would be opened by the entering new fluid as in any conventional pump.

However, if at a subsequent downward stroke the force exerted by the increasing pressure of the fluid against the lower surface of the piston 3 equals the preadjusted force of the spring 5 against the upper surface of the piston 3 the motion of the piston 3 will be stopped. This momentary condition is shown in FIG. 2. However, the piston rod 2 must complete its stroke. It travels with the piston stop 4 and the output selector 6 farther downward. This position is shown in FIG. 1. The piston 3 in FIG. 1 remains at the same height as shown in FIG. 2 while the piston stop 4 with the piston rod 2 moved lower into the fluid. Since the output selector 6 moves also lower the spring 5 in FIG. 1 is compressed. This will increase the pressure of the fluid slightly. This variation of maximum pressure can be held to a permissible minimum by designing properly the length of the spring between the piston 3 and the output selector 6 in the preadjusted position as shown in FIG. 2. The ratio between this length and the subsequent deflection due to compression as shown in FIG. 1 must be equal to the ratio between the maximum pressure and the permissible maximum pressure variation.

It will be readily seen that the piston 3 does not move anymore when the system served by the pump does not require additional fluid. In this case the pump can operate at full speed without transporting any fluid. The power used by the pump can be calculated by obtaining the product of the rate of volume of the fluid passed by the pump times the fluid pressure. Since the piston 3 is motionless and the volume passed is zero, the theoretical power consumption is zero also. Therefore, the said pump can idle at full pressure with idling power losses only, which consist mainly of friction losses. The frequent start and stop of pump motors is eliminated.

While a spring 5, an adjustable plate, called output selector 6 and a counterbore in the piston 3 for the retraction of the piston stop 4 have been shown, it will be readily apparent that this arrangement can be designed with rubber springs or other elastic devices. The arrangement can be designed also without the output selector 6 by connecting the upper end of the spring 5 or elastic device directly to the piston rod 3. In this case the arrangement would lack the possibility of varying the maximum pressure. It can also be designed without the counterbore in the piston 3 which would render the operation of the pump less efficient.

While I have shown and described a particular embodiment of this invention, further modifications and improvements will occur to those skilled in the art. I desire it to be understood, therefore, that this invention is not limited to the form shown, and I intend in the appended claim to cover all modifications which do not depart from the spirit and scope of this invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

An improved reciprocating pump comprising:
a cylinder,
a piston having an axial bore reciprocable in the cylinder between predetermined limits and in essentially fluid tight relationship with the cylinder,
a piston rod extending through the bore in the piston in sliding engagement therewith and in essentially fluid tight relationship therewith,
piston stop means on one end of said piston rod,
elastic compression means coupling the piston and piston rod for normally urging the piston against the piston stop means and for transmitting a predetermined force from the piston rod to the piston,
the end of said cylinder toward which said elastic compression means urges said piston including an inlet port and an outlet port, the cylinder wall being free of any other ports between said end of the cylinder and the reciprocating limit of the piston remote from said end of the cylinder,
an input line coupled to said input port,
a check valve between the input line and the input port,
an output line coupled to said output port,
a check valve between the output line and the output port,
drive means of sufficient power for reciprocating the piston rod even when there is no flow from the cylinder to the output line, the compression means maintaining the piston in engagement with the stop means during reciprocating of the piston rod except when the pressure between the piston and said end of the cylinder exceeds a predetermined level,
whereby when the pressure between the piston and said end of said cylinder exceeds said predetermined level said piston is slidable along the piston rod to maintain substantially constant pressure in said cylinder.

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