Sept. 16, 1924. 1,508,806

G. SILVESTRI

PUMP WITH VARIABLE OUTPUT AND CONSTANT NUMBER OF STROKES

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Fig. 1.

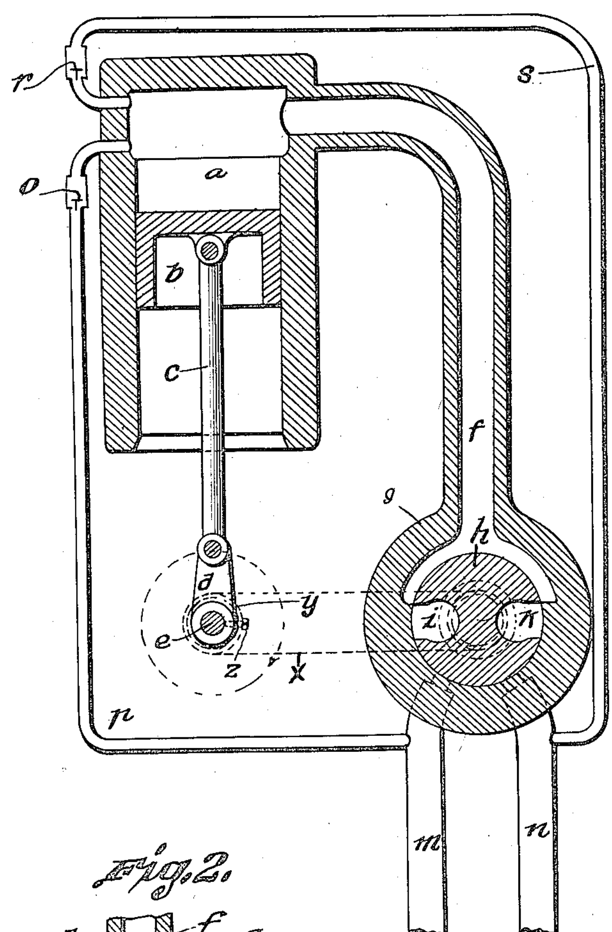
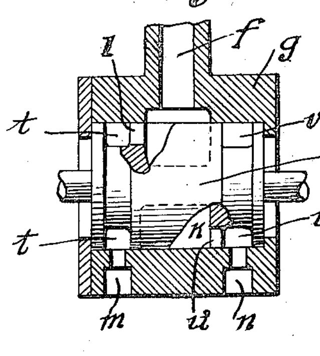


Fig. 2.



Inventor
Giulio Silvestri

By George Bayard Jones Atty.

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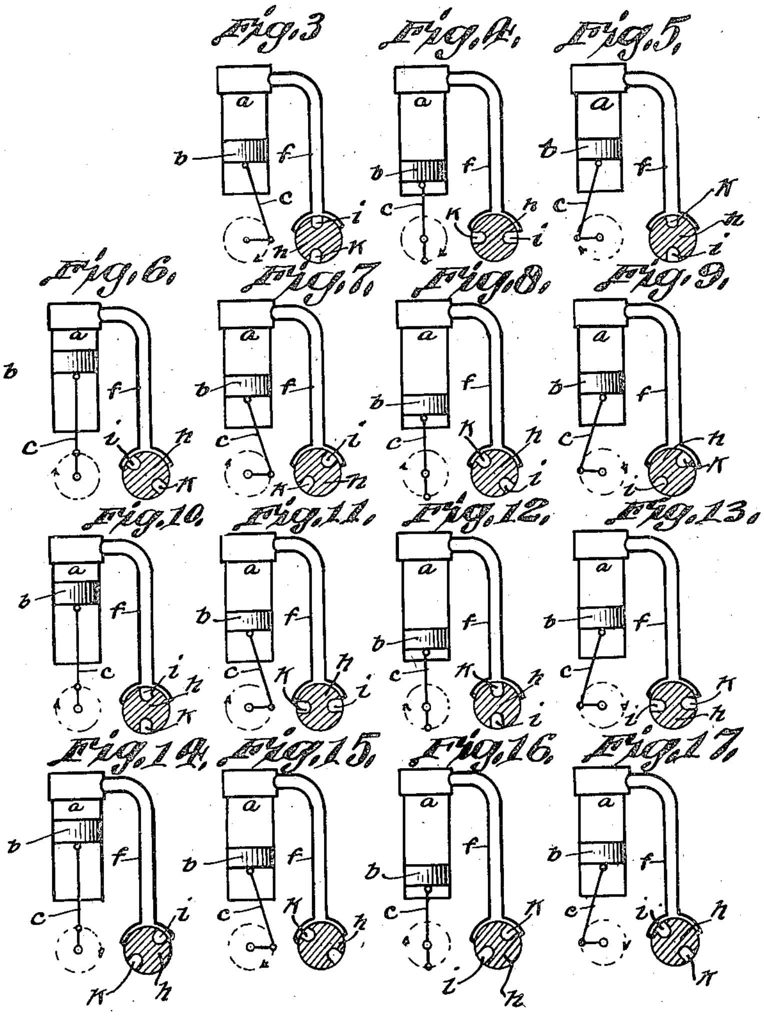

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UNITED STATES PATENT OFFICE.

GIULIO SILVESTRI, OF RODAUN, NEAR VIENNA, AUSTRIA.

PUMP WITH VARIABLE OUTPUT AND CONSTANT NUMBER OF STROKES.

Application filed January 12, 1921. Serial No. 436,793.

To all whom it may concern:

Be it known that I, Giulio Silvestri, a citizen of Austria, residing at Rodaun, near Vienna, in Austria, have invented a new and useful Improvement in Pumps with Variable Output and Constant Number of Strokes (for which I have filed applications in Austria April 18, 1914, Patent No. 73854 of December 15, 1916; Sweden, February 24, 1917, Patent No. 46409; Norway, August 10, 1917, Patent No. 36096; Denmark, August 10, 1917, Patent No. 24543 of May 7, 1919; Spain, March 20, 1920, Patent No. 73028 of August 2, 1920; Czechoslovakia, April 10, 1920, Patent No. 2619; Poland, May 4, 1920, application No. 6407/1920; Switzerland, July 1, 1920, Patent No. 93654; France, July 7, 1920, Patent No. 519321; Belgium, July 8, 1920, Patent No. 288827; Italy, July 21, 1920, Patent No. 189593; Hungary, August 16, 1920, application No. 10587; Germany, May 1, 1914, No. 314380), of which the following is a specification.

The present invention relates to an arrangement for varying the output and the direction of flow of reciprocating pumps without changing the number of strokes or the length of the stroke of the piston. The said variation is attained in well-known manner by drawing a quantity of liquid from the delivery pipe into the pump cylinder during the suction stroke, and returning said quantity of liquid into the suction pipe during the delivery stroke. The invention consists broadly in this, that between the pump cylinder on the one hand and the suction and delivery pipes on the other hand there is provided a regulating member controlling the communication between the pump cylinder and the said pipes and rotating at a number of revolutions corresponding to the number of strokes of the piston, which member alternately puts the pump cylinder in communication with the suction pipe and the delivery pipe, and which, from the normal adjustment at which the pump cylinder communicates with the suction pipe during the entire suction stroke and with the delivery pipe during the entire delivery stroke, may be adjusted to rotate more or less in advance of or after the pump piston.

The advantage of this arrangement lies in the very considerable simplification of the pump which needs only a single rotating regulating member, which not only performs the regulation of the output but also takes over the function of the suction and pressure valves otherwise necessary, and, finally, which also determines the direction of flow of the delivered liquid, so that a special reversing device also becomes unnecessary. Moreover, the casing in which the regulating member rotates may be arranged separate from the pump itself, and the regulating member need only be driven at a number of revolutions corresponding to the number of strokes of the piston, so that the arrangement may easily be applied to any existing pumps.

The invention is illustrated in the accompanying drawings in which Fig. 1 shows a lift pump with a crank and a controlling or regulating member which operates according to the method described, Fig. 2 shows the corresponding regulating member in longitudinal section and Figs. 3 to 17 are diagrammatic illustrations of different working positions of the various parts with different deliveries of the pump.

For the sake of simplicity and easier understanding of the invention a single acting lift pump has been selected for illustration but the invention is in no way limited to such pumps.

In the drawings *a* denotes the pump cylinder, *b* the pump piston which is driven by the piston rod *c* and the crank *d* from the shaft *e*. From the pump a pipe or a passage *f* leads to a casing *g* in which the regulating member or valve *h* rotates. This member or valve possesses at opposite points chambers *i* and *k* running axially of which the one chamber *i* is continuously in communication through a port *l* and an annular chamber *t* in said valve *h* with the suction pipe *m*, the other *k* being continuously in communication through a port *u* and an annular chamber *v* in said valve *h* with the delivery pipe *n* of the pump. The outlet of the passage *f* into the casing *g* is made wide enough to enclose an angle which is equal to that enclosed by the radii to the adjacent edges of the chambers *i* and *k* of the regulating member.

The regulating member *h* is driven at a suitable ratio to the shaft *e*. The transmission ratio is dependent on the number of chambers *i* and *k* in the regulating member *h* and is in the proportion of 1:1 when as in the present illustration only two chambers are provided in the regulating member.

The regulating member can however be rotated independently of the rotation about its axis, as, for instance, by driving the valve or member *h* from the crank shaft *e* by means of a chain *x* and by adjusting the driving sprocket *y* on crank shaft *e* into different positions in which it may be secured by means of the set screw *z*, as illustrated diagrammatically in Fig. 1. By this displacement is determined whether the opening of the chambers *i* and *k* to the passage *f* coincides or not with the commencement of the suction or delivery stroke of the pump piston.

The pump operates at full output when the opening phases of the chambers exactly coincide with the phases of movement of the piston, i. e. when the chamber *i* communicating with the suction pipe *m* at the beginning of the suction stroke of the piston and the chamber *k* communicating with the delivery pipe *n* at the beginning of the pressure stroke open to the pump passage *f* and close at the end of these strokes. The modus operandi of the arrangement with this adjustment of the regulating member *h* is clear from Figs. 1 to 5. Fig. 1 shows the position of piston and regulating member at the beginning of the suction stroke; Fig. 3 shows them in the position in which the piston is moving at its greatest speed during the suction stroke; Fig. 4 shows them at the point of change of stroke, and Fig. 5 shows them in the position in which the piston is moving at maximum speed during the delivery stroke. If the regulating member is now so adjusted that the chamber *i* opens before the piston has commenced its suction stroke and the chamber *k* opens before the piston has commenced its delivery stroke a reduction of the output takes place. In Figs. 6 to 9 a lead of 45° is assumed.

It is to be observed that with this adjustment the pump is in communication with the suction pipe *m* only during that part of the suction stroke of the piston which corresponds to a movement of the regulating member through 135°. The pump piston has, however, still to complete the remaining portion of its suction stroke. During this interval the pump is already in communication with the delivery pipe *n* through the chamber *k*. The pump thus operates during this portion of the suction stroke as an engine, and it uses a portion of the fluid which it takes from the delivery pipe *n*, and transmits the corresponding work to the driving shaft *o*. On completion of the change of stroke the pump supplies to the delivery pipe until the chamber *k* closes the passage *f* which again corresponds to a rotation of the crank through 135°. In the last part of the delivery stroke the pump is again in communication with the suction pipe. The pump thus forces into the suction pipe a quantity of liquid which is equal to the quantity removed at the end of the suction stroke from the delivery pipe. The output of the pump is thus reduced by that amount which it receives at the conclusion of the suction stroke from the delivery pipe, and by that amount which at the end of the delivery stroke it delivers to the suction pipe. With a lead of the regulating member of 45° these two quantities amount to about 15%. The pump supplies only about 70% of its capacity although the number of strokes remains unaltered.

The output falls off rapidly with the increase in lead and is reduced to zero when the lead amounts to 90°, as will be clear from Figs. 10 to 13. In this case the pump takes liquid from the suction pipe only during the first half of the suction stroke. During the second half of the suction stroke it receives liquid from the delivery pipe. On the suction stroke the same operation takes place in the reverse direction. The pump during the first half of the delivery stroke now delivers to the delivery pipe and in the second half of the delivery stroke returns the liquid to the suction pipe. As, however, these four quantities of liquid are exactly alike the output of the pump is nil. If the regulating member is given a greater lead, say to 135°, Figs. 14–17, an increase in the output again takes place, but the direction of movement of the liquid set in movement by the pump is reversed.

As shown in Fig. 14, the pump actually takes liquid from the suction pipe *m* only during a crank rotation of 45°. During the further rotation of the crank through 135° the pump is under the influence of the liquid in the delivery pipe *n* and runs as an engine or removes liquid. On the succeeding delivery stroke the pump delivers liquid only during one crank rotation through 45° into the delivery pipe *n* and the remainder passes into the suction pipe *m*. As, thus, a larger quantity of liquid is removed from the delivery pipe and this is forced into the suction pipe reversal of the feeding device of the pump takes place.

This possibility of reversal which always must succeed a zero output of the pump is of great value when the liquid supplied by the pump is used for driving an engine since such an arangement permits the engine to run in both directions with any suitable velocity without effecting any alterations to the pump or its drive.

If the regulating member is adjusted to a zero output of the pump the phase change in the regulating member takes place when the pump piston is at the middle of its stroke, that is, has its highest speed. As now on phase change of the regulating member a short interval elapses in which the pump is not in communication with the passages *m* and *n* during this time on the suction stroke in the pump cylinder a partial vacuum and on the delivery stroke an increase of pressure must take place.

The partial vacuum can be neglected. In order, however, to obtain more uniform loading of the driving machine for the pump and also to avoid the slight losses of liquid caused thereby there is provided on the pump a suction valve *o* Fig. 1, which is interposed in a branch pipe *p* connecting the suction pipe with the pump. The increase in pressure in the pump cylinder during the delivery stroke might lead to excessive demands. Therefore, the pump is provided with an outlet valve *r* to which a branch *s* leading to the delivery pipe *n* connects.

These two valves act thus as safety valves in order that the quantity of liquid supplied by the pump actually passes wholly into the delivery pipe of the pump and undesired effects are thus actually avoided.

I claim:

1. A pump, a delivery and a suction pipe associated therewith, means for withdrawing a quantity of liquid from said delivery pipe upon the suction stroke of said pump and forcing an equal quantity of liquid into said suction pipe upon the succeeding delivery stroke, and means for adjusting said other means whereby the output of said pump may be varied during the uniform operation thereof.

2. A pump of the kind described having a suction and a delivery pipe associated therewith, and a controlling device adapted to run at a suitable ratio to the number of strokes of said pump, said device being adapted to serve both said suction pipe and said delivery pipe and being adjustable so that the phases of opening of said suction and delivery pipes coincide with the suction and pressure phases of said pump or are in advance of or behind the same.

3. A pump of the kind described having a suction pipe and a delivery pipe, a piston operable in said pump, and a controlling device associated therewith and operable at a suitable ratio to the number of strokes of said piston, said device being adapted to serve both said suction pipe and said delivery pipe and being adjustable so that the phases of opening of said suction and delivery pipes coincide with the suction and pressure phases of said pump piston or are in advance of or behind the same, the pump chamber of said pump being connected with said suction and delivery pipes by branch pipes, one of said branch pipes having an overflow non-return valve opening to the pump chamber, said other branch pipe having a valve opening to said delivery pipe, said valves affording an auxiliary path free from resistance to the liquid.

4. In an arrangement for varying the output and the direction of flow of reciprocating pumps without changing the number of strokes or the length of the stroke of the piston, the combination of a pump cylinder, a reciprocating piston in said cylinder, a suction pipe, a delivery pipe, a movable regulating member interposed between said pump cylinder on the one hand and said suction and delivery pipes on the other hand, said regulating member controlling the communication between the pump cylinder and said pipes and being adapted to put the pump cylinder in communication alternately with the suction pipe and with the delivery pipe, means for operating said regulating member at a number of strokes corresponding to the number of strokes of said piston, and means for adjusting said regulating member to operate more or less in advance of or after said piston in relation to its normal adjustment at which said pump cylinder communicates with said suction pipe during the entire suction stroke of said piston and with said delivery pipe during the entire delivery stroke.

5. In an arrangement for varying the output and the direction of flow of reciprocating pumps without changing the number of strokes or the length of the stroke of the piston, the combination of a pump cylinder, a reciprocating piston in said cylinder, a suction pipe, a delivery pipe, a movable regulating member interposed between said pump cylinder on the one hand and said suction and delivery pipes on the other hand, said regulating member controlling the communication between the pump cylinder and said pipes and being adapted to put the pump cylinder in communication alternately with the suction pipe and with the delivery pipe, means for operating said regulating member at a number of strokes corresponding to the number of strokes of said piston, means for adjusting said regulating member to operate more or less in advance of or after said piston in relation to its normal adjustment at which said pump cylinder communicates with said suction pipe during the entire suction stroke of said piston and with said delivery pipe during the entire delivery stroke, an auxiliary pipe connecting said pump cylinder with said suction pipe, a back valve in said auxiliary pipe opening towards the pump cylinder, a second auxiliary pipe connecting the pump cylinder with the delivery pipe, and a back valve in said second auxiliary pipe opening towards said delivery pipe.

GIULIO SILVESTRI.