Sept. 22, 1931. S. P. CHRISTIE 1,824,074

INTERNAL COMBUSTION PUMP AND PRIME MOVER

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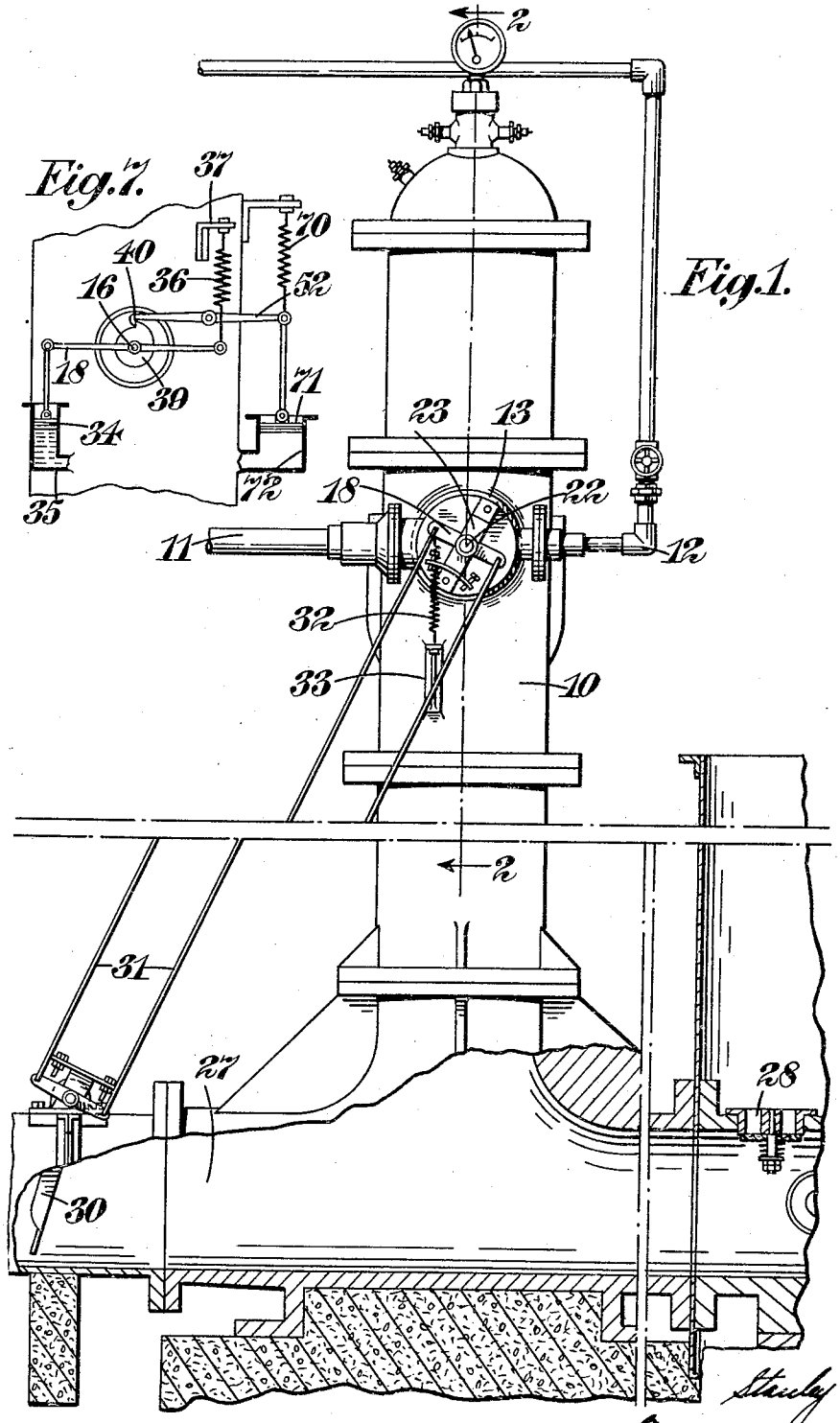


Fig. 1.

Fig. 7.

INVENTOR

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By Watson, Cole, Morse & Grindle

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Fig. 2.

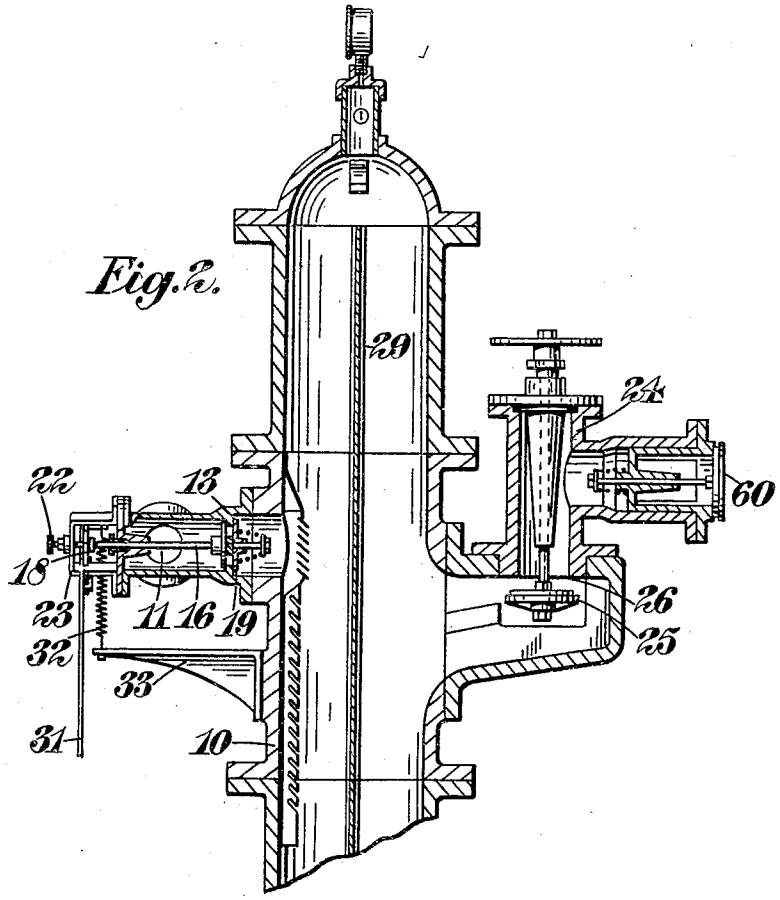
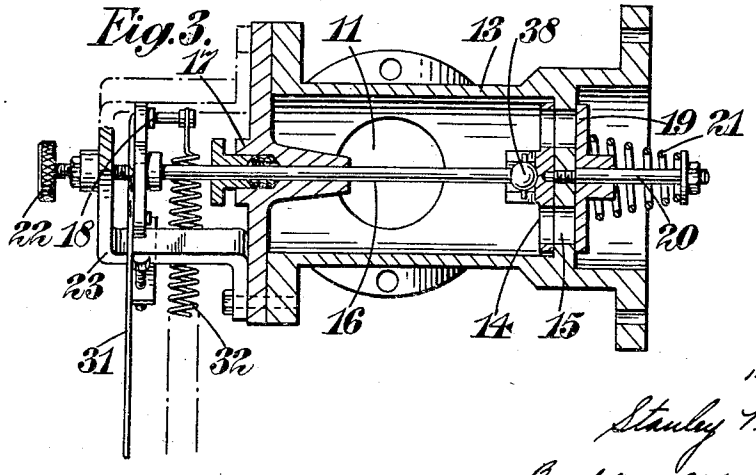


Fig. 3.



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Fig.4.

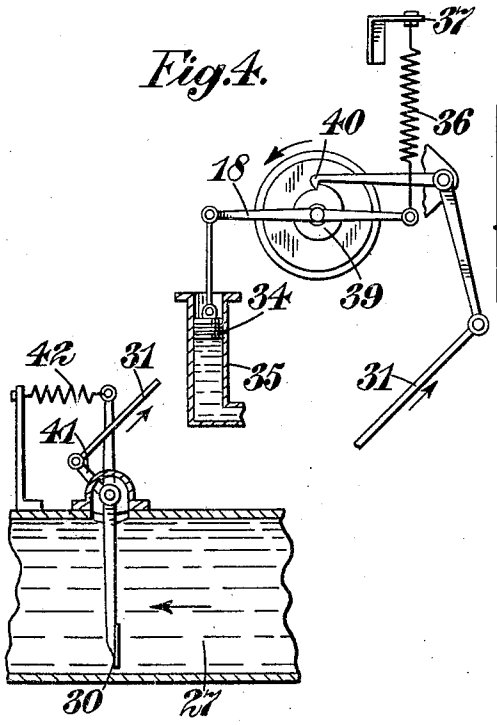


Fig.8.

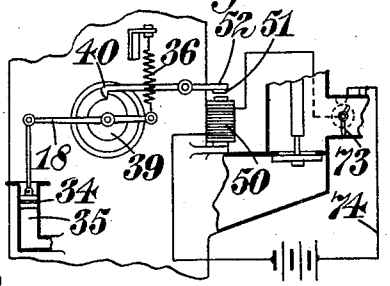


Fig.5.

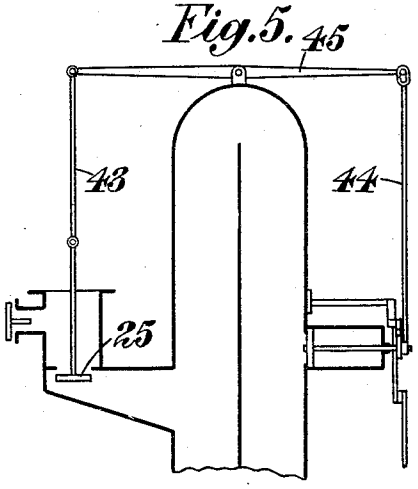
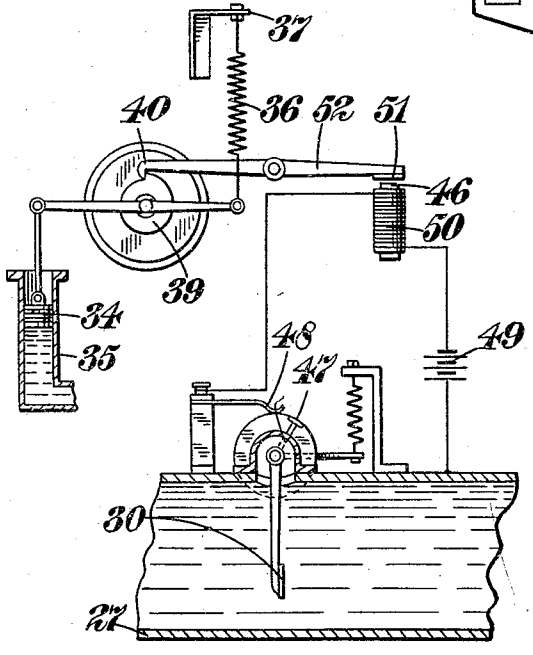


Fig.6.



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Patented Sept. 22, 1931

1,824,074

UNITED STATES PATENT OFFICE

STANLEY PERCY CHRISTIE, OF LONDON, ENGLAND

INTERNAL COMBUSTION PUMP AND PRIME MOVER

Application filed July 21, 1930, Serial No. 469,588, and in Great Britain August 14, 1929.

This invention is for improvements in or relating to inlet valve operating gear for liquid piston internal combustion pumps and prime movers particularly of the type in which the fuel charge is introduced wholly or in part during the upward or return stroke of the liquid piston. In pumps of this type the fuel may be supplied by the reciprocation of a liquid column within a chamber separate from the combustion chamber (or stand pipe) which column is synchronized with the stand pipe column, as described in British Patent Specification No. 241,635, or, alternatively, the fuel may be supplied under pressure from an extraneous device such as a compressor or blower.

The present invention has for an object to provide a simple and reliable valve mechanism for internal combustion liquid piston pumps, and, therefore, provides in a liquid piston internal combustion pump, the combination with a fuel inlet valve of the "semi-rotary disc" type, of a device operable by the flow of the liquid, or by the flow of the exhaust gases, or by pressure variations within the combustion chamber, to effect or to time the movement of said fuel inlet valve. It is to be understood that a valve of the semi-rotary disc type comprises a ported disc which is revolvable (less than one revolution) in face contact with a complementarily ported seating. Preferably, a non-return valve is situated between the said inlet valve and the working cylinder.

In one construction according to this invention, the inlet valve is operatively connected to a paddle or similar device which is pivotally mounted within the play pipe for movement by the flow of the liquid. In an alternative construction, the inlet valve may be actuated by the movement of a piston within a cylinder which is in communication with the combustion chamber, and the timing of the valve may be controlled by a detent operated by a flow actuated device. Conveniently, the flow actuated device may operate to make-and-break an electric circuit through the windings of an electro-magnetic device associated with the detent. If desired, the inlet valve may be operatively connected with an exhaust valve, so that the closing of the exhaust valve effects the closing of the inlet valve.

Various constructions according to this invention will now be described in detail by way of example, with reference to the accompanying drawings, in which—

Figure 1 is an elevation of a liquid piston internal combustion pump showing one method of actuating the inlet valve;

Figure 2 is a section taken on the line 2—2 in Figure 1;

Figure 3 is a section on an enlarged scale through the inlet valve,

Figure 4 illustrates diagrammatically a modified construction in which the inlet valve is actuated by means of a piston movable within a cylinder which is in communication with the combustion chamber;

Figure 5 shows diagrammatically a modified construction in which the inlet valve is interlinked with the exhaust valve;

Figure 6 shows diagrammatically a further modified construction in which the timing of the valve opening is effected by an electro-magnetic device controlled by the flow of the liquid;

Figure 7 is a diagram illustrating an arrangement in which the opening of the inlet valve is timed by a vacuum device, and

Figure 8 is a diagram illustrating a still further method of timing the inlet valve.

Throughout this description like reference numerals indicate like parts.

The pump illustrated in Figures 1 and 2 operates on the two-stroke cycle and comprises a stand pipe 10 enclosing the combustion chamber, to which air is supplied by a pipe line 11, and gas by a pipe line 12, from external compressors which are not shown. The two pipe lines 11 and 12 both communicate with a valve chest 13 which houses the fuel inlet valve. The latter, which is shown in detail in Figure 3, comprises a semi-rotary perforated valve disc 14, the face of which is in contact with a stationary perforated disc 15 secured to the valve chest 13; the valve disc 14 is rotated by means of a shaft 16 which passes through a stuffing box 17 at the outer end of the valve chest and is there provided

with a crank 18. In order that the rotary disc shall accommodate itself to the face of the stationary disc a universal joint, which is shown diagrammatically at 38, is introduced between the disc 14 and the shaft 16. Between the stationary disc 15 and the interior of the combustion chamber is mounted a non-return valve comprising a valve head 19 slidably mounted upon a spindle 20 and held in contact with the face of the stationary disc 15 by means of a compression spring 21. Wear on the face of the semi-rotary disc 14 may be taken up by a screw 22 which is mounted in a bracket 23 bolted to the valve chest 13, the screw 22 being formed with a pin-point bearing which is in contact with the end of the shaft 16.

The exhaust valve of the pump comprises a valve casing 24 and a poppet valve 25 which is normally held in contact with a seating 26 (formed on the casing 24) by the pressure existing within the combustion chamber. There is also a light non-return valve 60 controlling the outlet to atmosphere from the casing 26. Upon the charge being exploded the liquid column is impelled down the stand pipe 10 and flows to discharge along the play pipe 27. The momentum of the liquid column thus set in motion is sufficient not only to create a vacuum within the stand pipe, but also to draw in a fresh supply of liquid through inlet valves which are shown diagrammatically at 28 and at this period the exhaust valve 25 opens, the non-return valve 60, being closed, thus maintaining the partial vacuum. The return flow of liquid to effect the discharge of the exhaust gas and the compression of the charge may be brought about in any preferred manner. For example, the play pipe may deliver wholly or partially into an air or gas reservoir, the pressure built up therein during the explosion stoke being employed to effect the return flow of liquid, or the play pipe may deliver against a pressure head, so that when the momentum of discharge is exhausted a simple return flow of the liquid column under gravity takes place. Upon the return flow the exhaust gas is forced out through the exhaust valve and at or about the same time the inlet valve is opened and a fresh charge forced in under pressure. The fuel charge is prevented from flowing out through the exhaust valve by a partition 29 which divides the stand pipe vertically into two portions. The inlet valve is now closed by the rising liquid and the momentum of the returning liquid column is sufficient to compress the charge after first closing the exhaust valve by impact.

In the construction shown in Figure 1, the inlet valve is opened as follows. A paddle 30 is pivotally mounted within the play pipe 27 and this paddle is linked by tie-rods 31 with the crank 18 upon the end of the valve spindle 16. On the return of the liquid column the paddle 30 is moved towards the right, as viewed in Figure 1, thus bringing the ports or apertures in the semi-rotary disc 14 and the stationary disc 15 into register, when the pressure of the fuel supply forces the non-return valve 19 off its seat and permits the entry of the fuel to the combustion chamber. Upon the pressure (due to the momentum of the returning water) within the combustion chamber becoming greater than the pressure at which the fuel is supplied (for example by an external compressor) the non-return valve 19 returns to its seating and remains in that position during the commencement of the explosion stroke, but immediately the liquid column is impelled along the play pipe 27 the paddle 30 is moved to the left as viewed in Figure 1 and the apertures in the semi-rotary disc 14 move out of register with the apertures in the stationary disc 15, thus positively closing the inlet valve.

The inlet valve may be slightly biased towards the open position by an extension spring 32 which is attached to the crank 18 and to a bracket 33 on the exterior of the stand pipe 10.

In the arrangement which is illustrated diagrammatically in Figure 4, the crank 18 is at one end attached to a piston 34 working within a cylinder 35 which is open to the combustion chamber. An extension spring 36 extends between the opposite end of the crank 18 and a bracket 37 on the exterior of the standpipe and biases the semi-rotary inlet valve, whose details are as shown in Figure 3, towards the open position. Attached to the spindle 16 of the inlet valve is a cam 39 which is engaged by a detent 40 preventing the valve being opened. The latter is in the form of a bell-crank lever and is coupled by means of a tie-rod 31 to a crank 41 mounted on the shaft of a paddle 30 within the play pipe 27. This paddle 30 is biased to move towards the right by an extension spring 42.

At the end of the explosion stroke a partial vacuum is produced within the stand pipe 10. Immediately the return of the liquid column takes place the paddle 30 is moved towards the right, assisted by the extension spring 42. This movement releases the detent 40 from engagement with the cam 39 and the inlet valve is moved in an anti-clockwise direction (as indicated by the arrow) to open, this movement being first due to the extension spring 36, but also assisted by the partial vacuum which may still exist within the stand pipe, acting on the piston 34. In a similar manner the pressure of compression within the stand pipe forces up piston 34 and closes the inlet valve, and upon the explosion stroke the paddle 30 is moved towards the left and the detent 40 engaged with cam 39 to maintain the inlet valve in the closed position during the outward flow.

Figure 5 shows diagrammatically the interconnection of the inlet valve with the exhaust valve 25 by means of connecting rods 43 and 44, and a pivoted lever 45. It is intended that the closing of the exhaust valve 25 by the impact of the rising column of water shall operate to close the inlet valve. Similarly, the opening of the exhaust valve upon the expansion to atmospheric of the explosion pressure within the stand pipe operates to permit the opening of the inlet valve. The latter is provided with a detent which is operable by means of a paddle in the play pipe as described with reference to Figure 4, or, alternatively, the detent may be operated as described below with reference to Figure 6.

In the construction shown diagrammatically in Figure 6, the inlet valve is opened by means of a spring 36 and closed by means of a piston 34. The detent 40, however, is under the control of an electro-magnet 46 as follows. The paddle 30 within the play pipe 27 carries a contact arm 47 which on movement of the paddle to the right makes contact with a spring arm 48, and thus establishes a circuit from a battery 49 through the windings 50 of the electro-magnet 46. The latter attracts an armature 51 carried upon a lever 52 and moves the detent 40 out of engagement with the cam 39. On the explosion stroke the paddle 30 moves towards the left, thus breaking the circuit through the magnet windings and permitting the detent 40 to move into engagement with the cam 39 either by its own weight or by means of a spring, not shown.

In the arrangement shown in Figure 7 the shaft of the inlet valve spindle 16 carries a cam disc 39 which in the closed position of the inlet valve is engaged by a detent 40 formed on one end of a lever 52 which is constrained towards the engaging position of the detent by means of a spring 70. That end of the lever 52 remote from the detent is also connected to a plunger 71 movable in a chamber 72 which is in open communication with the stand pipe. The inlet valve spindle 16 also carries a crank arm 18 connected to a piston 34 working in a cylinder 35 which opens into the combustion chamber. An extension of the crank arm 18 has attached to it one end of a spring 36, and the other end of the spring is connected to a fixed bracket 37. With this arrangement the detent 40 is released by the downward pull of the plunger 71 on diminishing pressure within the combustion chamber, i. e. at or about the end of the outward stroke of the liquid piston. When the detent 40 is released the inlet valve is swung into the open position by the spring 36. When the liquid column rises in the combustion chamber the inlet valve is reset by the action of the piston 34, and the spring 70 again brings the detent 40 into engagement.

In the arrangement shown in Figurt 8 the resetting of the inlet valve is as before under the control of a lever 18, a piston 34 and a spring 36. In the closed position of the valve the latter is held by a cam disc 39 engaged by a detent 40, and the release of the detent is controlled by an electro-magnetic device which in turn is operated through the medium of the exhaust gases expelled through the exhaust valve. In the exhaust valve passage a vane 70, 73 is mounted in such manner that under the influence of the outflowing gases it will be swung into a position in which it closes a circuit 74 which is the energizing circuit for a magnet coil 50. When this coil is energized an armature 51 carried on a lever 52 (on the opposite end of which the detent 40 is formed) is attracted and the detent 40 is released.

I claim:

1. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, means to partially rotate said valve disc to bring the ports into and out of register, and means operable by the cyclic flow of the working fluid to control said partial rotation of the valve disc.

2. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, a pivoted paddle movable by the ebb and flow of the liquid piston, and linkage inter-connecting said paddle with the valve disc.

3. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet including a play pipe, the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, a paddle pivotally mounted within the play-pipe, and linkage interconnecting said paddle with the valve disc.

4. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, means to partially rotate said disc to bring the ports into and

out of register, and positive means for timing said partial rotation.

5. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, means to partially rotate said disc to bring the ports into and out of register, a catch associated with the disc, a detent for the catch, and means to move said detent into and out of engagement with the catch.

6. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc, means to rotate said disc in face contact with the valve seating less than one revolution at a time to bring the ports into and out of register, a catch associated with the disc, a detent for the catch, and means operable by the flow and recoil of the liquid column for moving the detent into and out of engagement with the catch.

7. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc, in face contact therewith, means to rotate said disc less than one revolution at a time to bring the ports into and out of register, a catch associated with the disc, a detent for the catch and means which are operable by the flow and recoil of the liquid column for moving the detent into and out of engagement with the catch and which comprises a paddle pivoted within the pump for oscillation by the liquid column and linkage interconnecting said paddle with the detent.

8. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, a cylinder open to the combustion chamber of the pump, a piston movable within the said cylinder and crank and connecting rod mechanism for converting the linear movement of the piston into partial rotation of the valve disc, and means operable by the flow and recoil of the liquid column for timing said partial rotation.

9. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and oulet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, a cylinder open to the combustion chamber of the pump, a piston movable within the said cylinder and crank, and connecting rod mechanism for converting the linear movement of the piston into partial rotation of the valve disc, and means operable by the flow and recoil of the liquid column for timing said partial rotation, comprising a paddle mounted for oscillation by said flow and recoil, a catch associated with the valve disc, a detent engageable in the catch and linkage interconnecting the paddle with the detent.

10. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, a cylinder open to the combustion chamber of the pump, a piston movable within the said cylinder, crank and connecting rod mechanism for converting the linear movement of the piston into partial rotation of the valve disc, and means operable by the flow and recoil of the liquid column for timing said partial rotation, comprising a paddle mounted for oscillation by said flow and recoil, a catch associated with the valve disc, a detent engageable in the catch and linkage interconnecting the paddle with the detent, an electrical circuit including an electro-magnet and switch operable by the movement of the paddle aforesaid, and an armature on the detent for attraction by the electro-magnet.

11. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, a cylinder open to the combustion chamber of the pump, a piston movable within the said cylinder, crank and connecting rod mechanism for converting the linear movement of the piston into partial rotation of the valve disc and means operable by the flow and recoil of the liquid column for timing said partial rotation, comprising a paddle mounted for oscillation by said flow and recoil, a catch associated with the valve disc, a detent engageable in the catch, an electrical circuit including an electro-magnet, an armature on the detent for attraction by the electro-magnet, a stationary contact in said circuit and movable contact associated with

the paddle and movable thereby to complete the circuit.

12. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, means to partially rotate said valve disc to bring the ports into and out of register and means operable by the flow of the exhaust gas for timing the said partial rotation.

13. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, a cylinder open to the combustion chamber of the pump, a piston movable within the said cylinder, crank and connecting rod mechanism for converting the linear movement of the piston into partial rotation of the valve disc and means operable by the flow and recoil of the liquid column for timing said partial rotation, comprising a catch associated with the valve disc, a detent engageable in the catch, a pivoted paddle exposed to the flow of the exhaust gas and and an electro-magnetic relay interconnecting the paddle and the detent.

14. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, a catch associated with the valve disc, a detent engageable in the catch and holding the valve shut, a spring arranged to bias the valve disc towards the open position, means operable by the cyclic flow of the working fluid to release the detent, and means for rotating the valve disc back against the spring into the closed position.

15. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith and means operable by the flow and recoil of the liquid column for rotating said valve disc.

16. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, an exhaust valve which is opened by the decrease in pressure within the pump, linkage interconnecting the exhaust valve with the inlet valve for opening the latter simultaneously therewith, and means, including a flow-actuated paddle, for timing said opening.

17. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, means to partially rotate said valve disc to bring the ports into and out of register, and means influenced by the cyclic flow of the working fluid to control said partial rotation of the valve disc.

18. In an internal combustion liquid piston pump having a combustion chamber provided with a fuel inlet, a valve control fuel outlet, and a liquid inlet and outlet the combination of a valve associated with said fuel inlet comprising a ported valve seating and a complementarily ported valve disc rotatable in face contact therewith, and means operable by cyclic changes in the working fluid to rotate the valve disc, less than one revolution at a time to bring the parts into and out of register.

In testimony whereof I affix my signature.

STANLEY PERCY CHRISTIE.