

H. A. HUMPHREY & A. CERASOLI.
 APPARATUS FOR RAISING OR FORGING LIQUID.
 APPLICATION FILED NOV. 27, 1909.

1,057,060.

Patented Mar. 25, 1913.

2 SHEETS—SHEET 1.

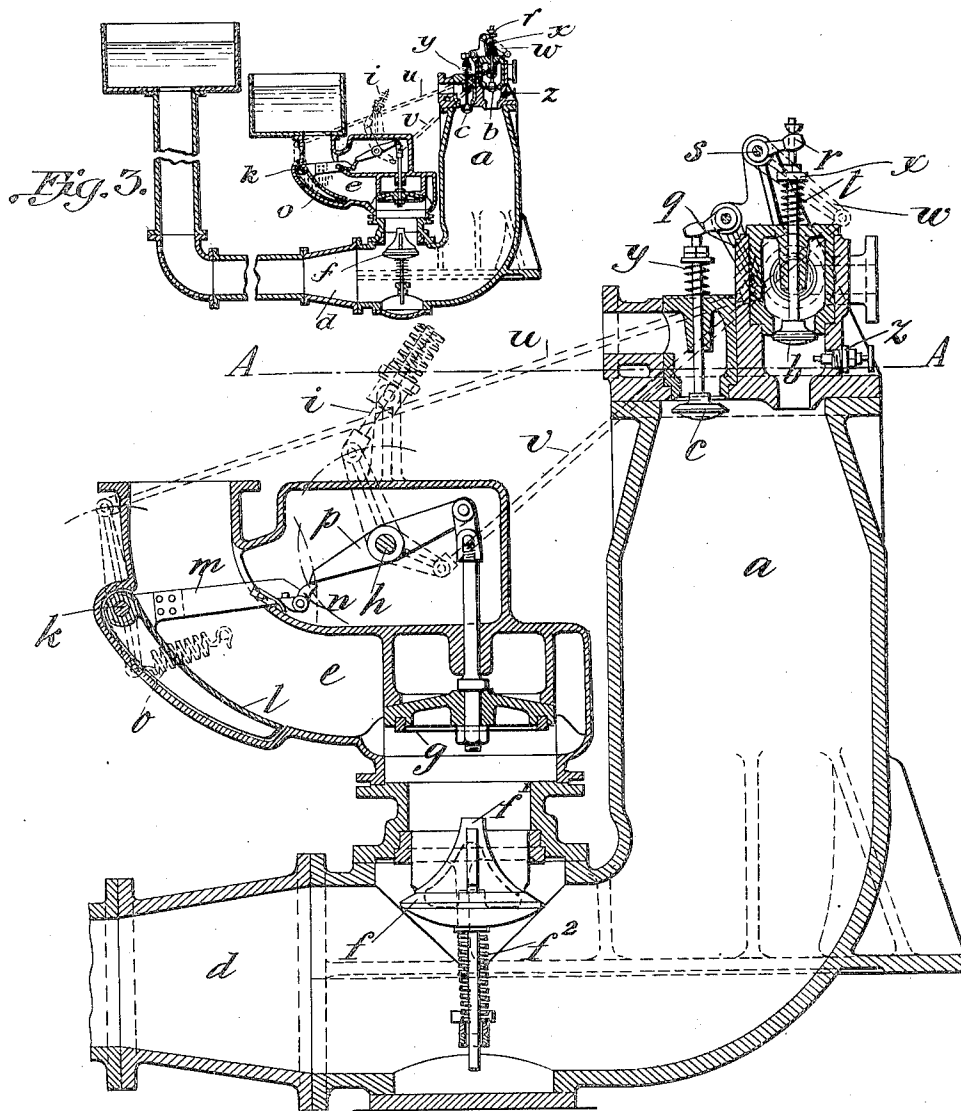


Fig. 1.

Witnesses:

[Signature]

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Inventors
 Herbert A. Humphrey
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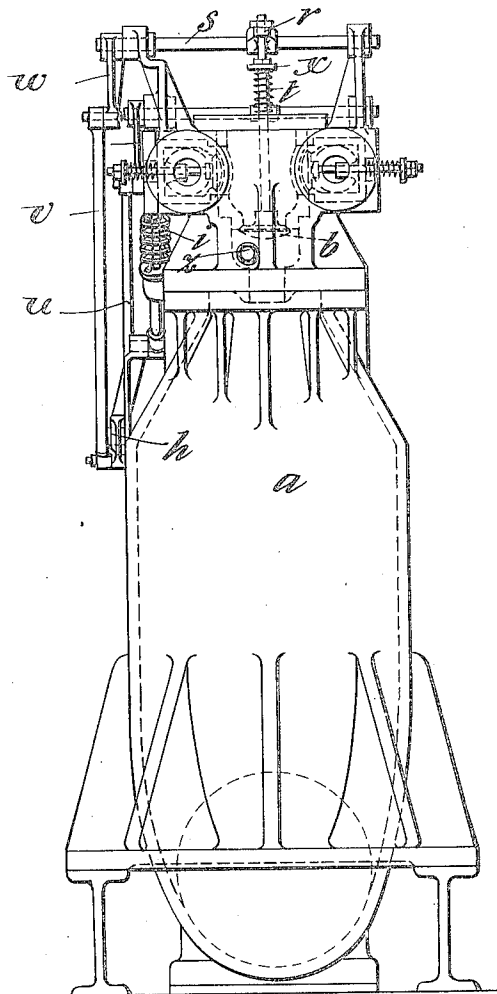
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2 SHEETS—SHEET 2.

Fig. 2.



Witnesses:

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UNITED STATES PATENT OFFICE.

HERBERT ALFRED HUMPHREY AND ALBERTO CERASOLI, OF LONDON, ENGLAND, ASSIGNORS TO HUMPHREY GAS PUMP COMPANY, A CORPORATION OF NEW YORK.

APPARATUS FOR RAISING OR FORCING LIQUID.

1,057,060.

Specification of Letters Patent.

Patented Mar. 25, 1913.

Original application filed August 16, 1907, Serial No. 388,902. Divided and this application filed November 27, 1909. Serial No. 530,232.

To all whom it may concern:

Be it known that we, HERBERT ALFRED HUMPHREY, consulting engineer, and ALBERTO CERASOLI, engineer, both subjects of the King of Great Britain, residing, respectively, at 38 Victoria street, Westminster, in the county of London, England, and 18 Avenue road, Regents Park, in the county of London, England, have invented a certain new and useful Apparatus for Raising or Forcing Liquid, of which the following is a specification.

Our invention relates to improved apparatus for raising or forcing liquid, in which the liquid acts as a freely reciprocating piston and performs the functions of a fly wheel and the momentum thereof is utilized.

It is known that advantage can be taken of the momentum of a moving mass of liquid to cause a pump to pass a larger volume of liquid than that calculated from the capacity and speed of the pump. The moving mass of liquid draws more liquid through the inlet valve than would be taken in by the mere operation of the pump.

The means for raising or forcing a liquid according to this invention consists in imparting a suitable momentum to a mass of the liquid by a propelling force, such as the combustion and consequent expansion of a compressed combustible mixture, and causing the kinetic energy, represented by this momentum, to introduce into the path of travel of the moving liquid, or to the rear of the liquid being propelled forward, more liquid, and into the combustion space a fresh supply of combustible mixture or the constituents of such a mixture. A portion of the liquid drawn is utilized in expelling the products of combustion from the combustion space, and, the momentum of the liquid returning toward the combustion space, under the pressure head to which it has been forced, may be utilized in compressing the combustible charge before it is ignited. The advantage of this means is that there need be no piston, other than the liquid piston, and that no valve is required between the combustion space and the column of liquid which is being forced.

Referring to the drawings which illustrate, merely by way of example, suitable means for effecting our invention, Figure 1 is a longitudinal section of the expansion

chamber end of such means. Fig. 2 is an end elevation of same. Fig. 3 is a longitudinal vertical section, on a reduced scale, showing the apparatus with high and low level reservoirs, the play pipe being broken for considerations of space.

Similar letters refer to similar parts throughout the several views.

A power chamber is provided in which is generated a propulsive force to be communicated to the liquid in the play pipe. In the present example this power chamber is the combustion or expansion chamber *a* provided with an inlet valve *b* for admission of combustible mixture, and an exhaust valve *c* for exit of burnt products. The lower part of the chamber communicates directly with the liquid conducting play pipe *d* leading, for example, to a reservoir at a higher level than that of the pump. It will be understood that this play pipe *d* must be of sufficient length to insure the acquisition by the liquid of the necessary momentum; the length will depend, of course, upon the dimensions of the apparatus, and speed of operation. It is assumed in this case, that the liquid level in the low level reservoir, from which the liquid is to be lifted, is approximately at A—A; it is then possible, as will presently be explained, to cause part of the liquid which enters the apparatus to expel the products of combustion from the chamber *a*.

At a part of the pipe *d* near the chamber *a* is an intake branch *e*, normally cut off from the pipe by an intake valve *f* above which is a second intake valve *g*. These valves may be opened and closed in any suitable manner, the devices shown in the drawings, and presently to be described, being only a specific example and not essential to the invention. Whatever mode of operation of the valve is adopted, however, it must be such as to allow the following working process:—Assuming the first intake valve *f* to be closed, and a charge of combustible mixture to be contained in chamber *a*, under the pressure produced by the pressure head and the momentum of the returning liquid, as aforesaid, this charge is ignited by any known ignition device, such as the spark plug *z*; explosion occurs, and the liquid is forced down the chamber *a* and along pipe *d*. When the liquid has attained a certain

velocity, and the combustion products have expanded to a certain volume, the pressure of the liquid from the low level reservoir on the intake valve *f* exceeds that of the water within the pipe *d* and the gases in chamber *a*. The intake valve now opens and liquid flows into the pipe *d* to pass along with the liquid moving therein, and also into the combustion chamber to expel the combustion products through the exhaust valve *c*, which is opened in any suitable manner for the purpose. The intake valve is shut again in any suitable manner, such as that presently to be described, while the liquid in pipe *d* still has sufficient momentum to cause some of the liquid, which has flowed into the combustion chamber, to follow it into the pipe *d*. The valve *b* at the same time opens and a fresh combustible charge is drawn into chamber *a*. When the liquid in the pipe *d* comes to rest, it returns under the pressure head, acquiring momentum, and compresses the fresh charge in the chamber *a*, whereupon ignition occurs again and the cycle is repeated.

The mechanism shown in the drawings for operating the valves may now be described.

There are two liquid-intake valves *f* and *g* in the intake, which are both shown, in the drawings, in the open position, this representing the position of the parts when liquid is flowing into the apparatus. The stem of valve *g* is linked to an arm on a rocking shaft *h* which can remain in only one of two positions, under influence of any known device such as a spring rod *i* operating on an arm on the shaft. A shaft *k* turns in suitably packed bearings in the walls of a recess in the intake *e*, and to that portion of this shaft which is within the intake, is keyed a curved plate *l* and an arm *m* carrying at its end a spring pawl *n*. The illustrated position of these parts is maintained by the velocity of the liquid flowing through the intake *e* and past the valve *f*, into pipe *d*. When this velocity falls below a certain value, consequent upon the fall of velocity of the liquid in pipe *d*, the pressure on the plate *l* becomes less than the tension of spring *o*, attached at one end to a fixed point and at the other to an arm on the portion of the shaft *k* which extends outside the intake casing. Plate *l* is therefore drawn inward and pawl *n* trips arm *p* on the shaft *h*, thus turning the latter sufficiently to allow the spring rod *i* to complete the movement and close valve *g*. Valve *f* remains open, because in that position, its stem *f'* is in contact with valve *g* and spring rod *i* is stronger than spring *f*². When the liquid returns in pipe *d* and the pressure in chamber *a* has risen above a certain value, valve *g* is opened by this pressure, thus allowing spring *f*² immediately

to close valve *f*. After expansion of the combustible charge, when the pressure in the pipe *d* has fallen below that in the intake, valve *f* is opened and the pressure of the inflowing water deflects the plate *l* until pawl *n* slips past the end of arm *p*, and engages therewith, ready for closing the valve *g*, in the manner already described. Since the exhaust valve *c* requires to be opened when liquid is flowing into pipe *d*, we have provided the lever *q*, linked by link rod *u* to an arm on the shaft *k*, so that the deflection of plate *l* by the flow of liquid through the intake causes the opening of the exhaust valve by depressing the valve stem against the tension of spring *y*. The return of the plate *l* to its spring-actuated position, due to the interruption of such flow, actuates lever *q* to permit the return of valve *c* to the closed position in response to the pressure of spring *y*. The admission valve *b* is prevented from opening when the valve *g* is open, by the engagement of a collar *r* with the head *x* of the valve stem. This collar *r* is carried by an arm on the shaft *s* which is rocked by a link rod *v* connecting the second arm *w* on shaft *s*, with an arm on shaft *h*. When the valve *g* is shut, collar *r* is lowered, and the suction in the chamber *a* has only to overcome the light spring *t*, in taking in a charge.

This application is a divisional application of our copending application, filed August 16, 1907, Serial No. 388,902, for a method which may be effected by the means described and claimed in the present application.

1. Means comprising a play pipe, an intake and a discharge, the play pipe providing an unobstructed path of travel whereby liquid, of sufficient bulk to acquire useful momentum, is freely reciprocated and the momentum, of the movements in each direction, is utilized to store energy.

2. Means comprising a play pipe, an intake and a discharge, the play pipe providing an unobstructed path of travel whereby liquid, of sufficient bulk to acquire useful momentum, is freely reciprocated between intake and discharge, and the momentum of the movements in each direction, is utilized to store energy.

3. Means comprising a play pipe, an intake and a discharge, the play pipe providing an unobstructed path of travel whereby liquid, of sufficient bulk to acquire useful momentum, is freely reciprocated, and means whereby the momentum of the movements in each direction, is utilized at required intervals in providing a propelling force for continuing the movements.

4. Means comprising a play pipe, an intake and a discharge, the play pipe providing an unobstructed path of travel whereby liquid, of sufficient bulk to acquire useful

momentum, is freely reciprocated, and means whereby the momentum of the movements in each direction, is utilized to deliver liquid to greater head or pressure, to introduce fresh liquid and a propelling force is made available for continuing the movements.

5. Means comprising a power chamber, a play pipe, an intake and a discharge, the play pipe providing an unobstructed path of travel, whereby liquid of sufficient bulk to acquire useful momentum is freely reciprocated, the outstroke caused by energy delivered in the power chamber and means whereby the momentum of the liquid in each direction of movement is utilized to make available fresh energy in the power chamber.

6. Means comprising an expansion chamber, a play pipe, an intake and a discharge, the play pipe providing an unobstructed path of travel, whereby liquid, of sufficient bulk to acquire useful momentum, is freely reciprocated, the outstroke caused by an expansible charge, and means whereby the momentum of the outstroke is utilized to renew the expansible charge.

7. Means comprising an expansion chamber, a play pipe, an intake and a discharge, the play pipe providing an unobstructed path of travel, whereby liquid, of sufficient bulk to acquire useful momentum, is freely reciprocated, the outstroke caused by an expansible charge, the momentum of the outstroke is utilized to renew the expansible charge, and the momentum of the instroke is utilized to compress the charge.

8. Means comprising an expansion chamber, a play pipe, an intake and a discharge, the play pipe providing an unobstructed path of travel, whereby liquid, of sufficient bulk to acquire useful momentum, is freely reciprocated, the outstroke caused by an expansible charge, and the momentum in each direction is utilized, so that at proper intervals fresh expansible charges are introduced and compressed.

9. Means comprising an expansion chamber, a play pipe, an intake and a discharge, the play pipe providing an unobstructed path of travel, whereby liquid, of sufficient bulk to acquire useful momentum, is freely reciprocated, the outstroke caused by an expansible charge, and the momentum in each direction is utilized, so that liquid is delivered to greater head or pressure, fresh liquid is introduced and at proper intervals fresh expansible charges are introduced and compressed.

10. Means comprising an expansion chamber, a play pipe, an intake and a discharge, the play pipe providing an unobstructed path of travel, whereby liquid, of sufficient bulk to acquire useful momentum, is freely reciprocated, the outstroke caused by an expansible charge, and means whereby the

momentum in each direction is utilized, so that liquid is delivered to greater head or pressure, fresh liquid is introduced, burnt products are discharged, and, at proper intervals fresh expansible charges are introduced and compressed.

11. Means comprising an expansion chamber, a play pipe, an intake and a discharge, the play pipe providing an unobstructed path of travel, whereby liquid, of sufficient bulk to acquire useful momentum, is freely reciprocated, the outstroke caused by an expansible charge, means whereby the momentum of the outstroke is utilized to renew the expansible charge, and means whereby the pressure in the combustion chamber controls the intake and the discharge.

12. Means comprising an expansion chamber, a play pipe, an intake and a discharge, the play pipe providing an unobstructed path of travel, whereby liquid, of sufficient bulk to acquire useful momentum, is freely reciprocated, the outstroke caused by an expansible charge, and means whereby the momentum of the outstroke is utilized to renew the expansible charge, and means whereby the flow of liquid controls the intake and the discharge.

13. Means comprising an expansion chamber provided with inlet and discharge valves, a play pipe having a liquid intake, whereby a liquid piston is freely reciprocated in the play pipe and the momentum of its movements in each direction is utilized so that at each cycle of operation a fresh expansible charge is introduced and compressed, and a movable member affected by the pressure of the liquid for controlling the valves in the expansion chamber.

14. Means comprising an expansion chamber provided with inlet and discharge valves, a play pipe having a liquid intake connected therewith, whereby a liquid piston is freely reciprocated in the play pipe and the momentum of its movements in each direction is utilized so that at each cycle of operation a fresh expansible charge is introduced and compressed, and a movable member affected by the pressure of the liquid for controlling the liquid intake.

15. Means comprising an expansion chamber, a play pipe, an intake and a discharge, the play pipe providing an unobstructed path of travel, whereby liquid, of sufficient bulk to acquire useful momentum, is freely reciprocated, the outstroke caused by an expansible charge, and means whereby the momentum of the outstroke causes a diminution of pressure to the rear of the liquid body and the entry of fresh liquid into the play pipe, expelling burnt products, and, upon interruption of the liquid intake, the continuing momentum entrains a fresh charge.

16. Means comprising an expansion cham-

ber, admission and exhaust valves connected therewith, a play pipe, a valve controlled liquid inlet connected therewith, and a movable vane adapted to be affected by the movement of the liquid for controlling the valves.

17. Means comprising an expansion chamber, admission and exhaust valves connected therewith, a play pipe, a valve controlled liquid inlet connected therewith, a movable vane adapted to be affected by the movement of the liquid for controlling the valves, whereby liquid is reciprocated in the play pipe, the first outstroke due to expansion of a charge in the expansion chamber, and whereby the momentum of the outstroke causes a diminution of pressure to the rear of the liquid, an intake of fresh liquid and discharge of burnt products, and whereby a rise of pressure in the combustion chamber causes the interruption of liquid intake and the continuing momentum causes the introduction of a fresh charge.

18. Means comprising an expansion chamber, admission and exhaust valves connected therewith, a play pipe, a valve controlled liquid inlet connected therewith, a movable vane adapted to be affected by the movement of the liquid for controlling the valves, whereby liquid is reciprocated in the play pipe, the first outstroke due to expansion of a charge in the expansion chamber, and whereby the momentum of the outstroke causes a diminution of pressure to the rear of the liquid, an intake of fresh liquid and discharge of burnt products, and whereby a rise of pressure in the combustion chamber causes the interruption of liquid intake and the continuing momentum causes the introduction of a fresh charge, and whereby an instroke due to head or pressure, after the momentum of the outstroke is expended, gathers momentum and compresses the fresh charge.

19. Means for forcing liquid comprising a combustion chamber, a play pipe, an intake for liquid, a valve in the intake adapted to open when the pressure in the intake exceeds that in the chamber, a second valve in the intake, means depending on the flow

of liquid for positively closing the second valve, said second valve adapted to open and the first valve adapted to close when the pressure in the chamber exceeds that in the intake.

20. Means for forcing liquid comprising a combustion chamber, a play pipe, an intake for liquid, a valve in the intake adapted to open when the pressure in the intake exceeds that in the chamber, a second valve in the intake, means depending on the flow of liquid for positively closing the second valve, means for keeping the first mentioned valve open so long as the second valve is closed, said second valve adapted to open and the first valve adapted to close when the pressure in the chamber exceeds that in the intake, an admission valve and an exhaust valve in the combustion chamber, means for opening said admission valve when the second intake valve closes and means for opening the exhaust valve when the first intake valve opens.

21. Means for forcing liquid comprising a combustion chamber, a play pipe, an intake for liquid, a valve in the intake adapted to open when the pressure in the intake exceeds that in the chamber, a second valve in the intake, adapted to open when the pressure in the chamber exceeds that in the intake and as the first intake valve is closing, a spring controlled plate pivotally mounted so that the moving liquid exerts a pressure on said plate, means whereby the liquid actuated plate causes the closure of the second intake valve, a spring controlled admission valve in the combustion chamber adapted to open when the second intake valve closes, and an exhaust valve in the combustion chamber adapted to open when the first intake valve opens.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

HERBERT ALFRED HUMPHREY.
ALBERTO CERASOLI.

Witnesses:

JOSEPH MILLARD,
W. J. SKERTEN.