W. H. Lindsay,

Piston Meter,

No. 9,060. Patented June 22, 1852.

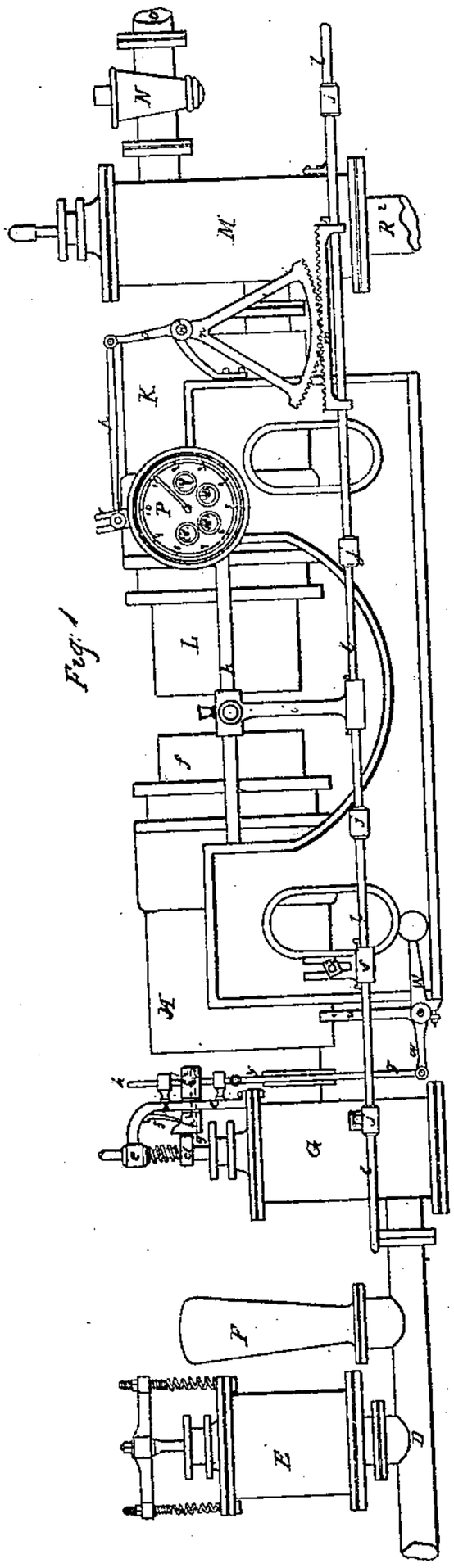

Fig. 1

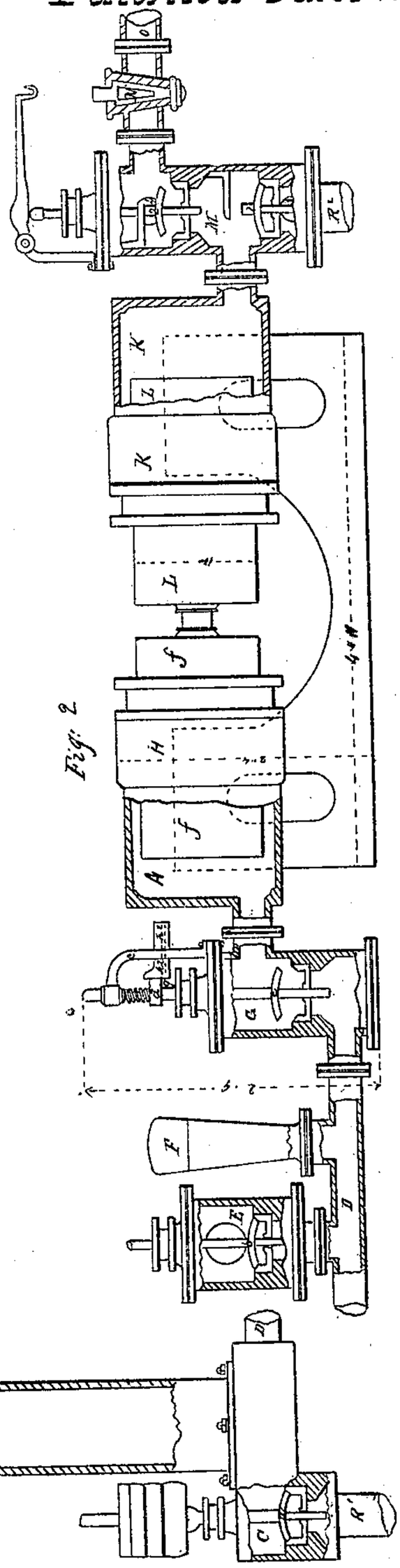

Fig. 2

UNITED STATES PATENT OFFICE.

WM. H. LINDSAY, OF NEW YORK, N. Y.

FLUID-METER, &c.

Specification of Letters Patent No. 9,060, dated June 22, 1852.

To all whom it may concern:

Be it known that I, WILLIAM HENRY LINDSAY, of the city, county, and State of New York, have invented certain Improvements in Fluid-Meters; and to enable those skilled in the art to make and use my invention I do hereby declare that the following is a full and exact description of the said invention, reference being had to the drawings annexed, forming part of this specification.

Figure 1 is an elevation; Fig. 2, the same partly in section, with the front frame removed.

A is a force or feed pump chamber; B, feed pump plunger; C, feed pump valve chest; D, connecting pipe between the pump chamber A and the drop or cut off valve chest G; E, loaded or overflow valve chest; F, air chamber; H, forcing cylinder; I, plunger working air and water tight in the same by means of suitable packing in the cylinder stuffing box, confined and regulated by a gland; K, meter cylinder; L, meter plunger working air and water tight, in the same manner as the plunger I; M, meter valve chest; N, regulating feed cock; O, delivery pipe connecting the meter valve chest M, with the boiler, tank, or other receptacle designed to receive the fluid displaced from the cylinder K; P, counter; R^1, R^2, supply or feed pipes from the hot well or tank to the feed pump A, and the meter cylinder K; *a*, foot or receiving valve in chest C, loaded by a weight, springs or other convenient means; *b*, loaded valve in the waste chest E; *c*, drop or cut off valve in chest G; *d*, stud or projecting piece keyed on or otherwise attached to the spindle of valve *c*; *e*, frame or stand supporting the cut off movement, its lower end bolted on the cover of the chest G, the upper part being curved so as to embrace the drop valve spindle, forming a steadiment through which it can move freely.

The seat on which the drop valve slide *g*, works consists of projections on each side cast in a piece with the stand. There is an opening in the stand above the seat, admitting of the slide *g*, being about the same length as the seat (as shown by the dotted lines). Through the back or inner end of the seat, there is a slot or opening to admit of the inclined or disengaging slide *h*, working through it without touching. The slide *g*, is of the same width as the seat, the guide pieces h^2, h^2, pinned on each side forming a groove in which it works freely. On the outside or front end of the slide *g*, there is a pin or stud against which the lower end of the spring *f*, presses, its tendency being to constantly press or throw the slide *g* forward. On the inner or back end of the slide there is a slot, at such distance from its forward or outer end that when the wedge or inclined part of the slide *h* shall be raised just clear of it, its front end is sprung in under the stud *d*. Should it be in position to allow of it doing so by the valve *c*, being raised, and when the inclined part of the slide *h*, is drawn down through the slot in the slide *g*, it forces back or withdraws its end from under the stud *d*, "compressing the spring *f*," when the valve *c*, drops on its seat.

The above is the reverse of Sickell's well known cut off arrangement, in which the bracket keyed on the lifting rod forms the seat on which the drop valve slide works, the disengaging or inclined slide being stationary, whereas in the above described arrangement, the seat on which the drop valve slide works is stationary, and the inclined or disengaging slide performs its duty by means of the link *y*, attached to its lower end, which derives its motion at the proper time and for the proper distance from the plungers I and L, through the arm *i*, slide rod *l*, the bracket *s*, and the pin *t*, adjusted in the slot of which, coming in contact with the arm or bell crank *u*, keyed on the end of the motion rod *v*, gives the required motion to the link *y*, and the disengaging slide *h*, through the arm or lever *w*, keyed on the motion rod *v*. The cross arm of the bell crank *w*, has a weight, or a spring if preferred, attached to it, for the purpose of bringing back the arms *u*, and *w*, the link *y*, and disengaging slide *h*, to the position shown in Fig. 1, which will be the case when the plungers I and L, "and with them the arm *i*, slide rod *l*, bracket *s*, and pin *t*," have advanced sufficiently on their force stroke to admit of the bell crank regaining its position at rest which it will retain until the pin *t*, again comes in contact with it on the return or exhaust stroke of the plungers I and L.

The arm *i*, derives its motion by means of a bracket attached to the coupling bolt of the plungers I, and L, the outer end on which the arm *i*, is keyed, working in the guide rod *k*. The slide rod *l*, is keyed in

the boss on the lower end of the arm *i*, and is kept in position by working through eyes in the steadiments *j*, *j*, *j*, *j*. On one end of the rod *l*, the rack *m* is keyed, and the motion or travel of the plungers I and L, thereby communicated to the counter P, by means of the rack *m*, working into the sector or segment *n*, which is keyed on the motion rod n^2, transmitting its motion through the lever or arm *o*, to the counter arm *r*, by means of the link *p*. The duty of the rod *l*, is also to impart the proper motion to the disengaging slide *h*, by means of the bracket *s*, keyed on the opposite end from that which carries the rack *m*, which is done by the adjustable pin or stud *t*, being so set in the slot of the bracket, by means of a jam nut, that by its action on the arm of the bell crank *w*, the disengaging slide *h*, shall have just drawn back or cleared the drop valve slide *g*, from under the stud *d*, on the spindle of the drop valve *c*, when the plungers I and L, are within so short a distance from the termination of their required stroke, on the exhaust, that by the time the drop valve *c*, shall have closed on its seat, they will have reached the given point. This arrangement insures the capability of the plungers performing a full force stroke at any time, by their always returning to a given point on their exhaust. 1, foot or receiving valve in the meter valve chest M; 2, delivery valve in the same; 3, opening or nozzle in the chest M, under the foot valve 1, by which the blow off from the boiler can enter to the meter cylinder K, for the purpose of being measured; 4, opening or nozzle above the delivery valve 2, by which the blow off escapes overboard, after being measured.

Having given reference to the several parts shown in the drawings, I will now proceed to describe the operation of this machine, and wherein the improvements consist:

The drawings represent the feed pump plunger B, during its force stroke displacing the fluid from the pump chamber A, which in its passage through the pipe D, and chest G, to the forcing cylinder H, has raised the drop valve *c*, which is retained in that position by the slide *g*, springing in under the stud *d*, the fluid forced in the cylinder H, giving motion to the plungers I and L, whereby a quantity of fluid is displaced from the meter cylinder K, equal to the solid content of the entered plunger L, which it delivers to the boiler, tank, or other receptacle through the valve 2, and pipe O, supposing that the regulating feed cock N, was open during the above.

At the termination of the plungers force stroke as above the delivery valve 2, falls on its seat, thereby preventing the return of any fluid displaced from the meter cylinder K, during a pause or stop that takes place between the termination of the force, and the commencement of their exhaust strokes, by reason of the following causes. The air contained in the chamber F, during the force stroke is under the same pressure as that exerted on the forcing plunger I, which is greater than that on the meter plunger L, to an extent equal to the increased pressure per square inch on the area of surface of the plunger I, required to overcome the friction of the plungers I and L, their inertia, and the friction of the fluid in its passage from the cylinder K, through the pipe O, to the boiler, etc., which we will take to be 3 lbs. per square inch of area of surface.

At the commencement of the feed pump plungers exhaust stroke, the compressed air in the chamber F, exerts its pressure on the fluid contained between the feed pump and the forcing cylinder H, assisting the return of the feed pump plunger, but retaining the plungers I and L, in the position they were carried to during the force stroke, "during which time the delivery valve 2, closes" until such time, as the feed pump plunger having returned so far as to allow of the expansion of the air to so great a degree that the pressure of the fluid from the hot well or tank on the plunger L, combined with the vacuity produced in the feed pump chamber by the continued travel of the feed pump plunger on its exhaust stroke, causes the plungers I and L, to return on their exhaust stroke, closely following up the feed pump plunger, by returning to the feed pump chamber, the fluid received during the previous stroke by the forcing cylinder H, the meter cylinder K, at the termination of their exhaust being fully charged with fluid or the plungers I and L, could not have returned.

Having shown the manner and the cause of the pause or stoppage taking place between the termination of the force, and the commencement of the exhaust strokes of the plungers I and L, by which the important object is attained of the closing of the meter delivery valve, while the plungers are at rest thereby insuring against the possibility of any of the fluid displaced from the meter cylinder returning, I will now describe the manner and the cause of a similar pause taking place between the termination of their exhaust and the commencement of their force strokes by which the equally important object is obtained of the closing of the feed valve 1, while the plungers are at rest, thereby insuring that the meter cylinder K is entirely full of fluid, and the entrance valve closed previous to the plungers I and L commencing their force stroke.

It will be readily understood from what has been previously stated in relation to the greater pressure per sq. in. of area surface

required on the plunger I than that on the meter plunger L, that on the termination of the exhaust stroke of the plungers I and L before sufficient pressure can be brought to act on them to cause their return force stroke, the air in the chamber F, will have to be compressed to that extent, and before the fluid displaced from the feed pump by the plunger on its force stroke, can exert the required pressure on the plunger I, it must first perform that duty, giving ample time for the foot valve 1 to close during the time taken up by the air being compressed.

The foot valve *a*, in the feed pump valve chest C, is loaded for the purpose of preventing its rise, and admitting the fluid from the hot well, or tank, etc., to the pump chamber, during the exhaust stroke of the feed pump plunger, so long as the forcing cylinder K, has any fluid to return to it, by the travel of the plungers I and L, on their exhaust stroke, and it requires to be loaded to the following extent. Suppose the feed pump B, and the meter cylinder K, are supplied from the same hot well, etc., or, that they are the same, or different fluids, of the same specific gravity, under the same head. Then I load the valve *a*, per square inch of surface, slightly in excess, say 1 lb. of pressure per sq. in. on the area of surface required on the plunger I, to overcome the friction, and inerta, attendant on the travel of the plungers I and L, which would make the required load on the valve, 4 lbs. per sq. in. and if its area of surface was 14 inches, the required load would be 56 or say 60 pounds.

It will be evident that if the same pressure per square inch is acting on the valve *a*, to raise it during the exhaust stroke of the feed pump plunger B, less the amount it is loaded, and the same pressure per square inch is acting on the meter plunger L, to force the plungers I and L, back on their exhaust, less the amount required per sq. in. to overcome their friction, and inerta, that the valve *a*, cannot raise as long as the plungers I and L, by their return on the exhaust, have any fluid to give back from the cylinder H, to the feed pump chamber A. If however at the termination of their exhaust stroke, when the drop valve *c*, has closed "preventing any further return of fluid to the pump chamber A, from the cylinder H," the feed pump chamber A, should require a charge from the hot well or tank, to fill it, the valve *a* being relieved of the pressure on it during the return of the fluid from the cylinder H, by the closing of the valve *c*, immediately raises, and supplies the deficiency. So that if the regulating feed cock N, should be wholly closed, the fluid displaced from the feed pump B, as it cannot force the plungers I and L, forward, cannot gain admission to the cylinder H, but escapes by raising the loaded valve *b*, and into the waste or overflow pipe, when the feed pump is supplied by the valve *a*, rising, admitting of a supply from the hot well during the feed pump plungers exhaust stroke, and in case of the feed cock N, being partly open a portion of the fluid displaced from the feed pump enters the cylinder H giving a proportional travel to the plungers I and L, the balance escapes by the loaded valve *b*, and on the feed pump plunger commencing its exhaust stroke, the plungers I and L, return the same as if they had made an entire stroke, the cylinder H, returning to the feed pump all it received, on doing which the drop valve closes, and the deficiency to the pump chamber is supplied from the hot well by the rising of the valve *a*.

The same action may be produced in other ways, as for instance, if the fluid supplied to the meter cylinder K, were of greater specific gravity than that supplying the feed pump, or that the head under which the meter cylinder and the feed pump are supplied should not be the same, then the valve *a*, requires to be loaded or not, according to circumstances.

The fluid in its passage from the feed pump chamber A, to the forcing cylinder H, raises the drop or cut off valve and on the arm or stud *d*, passing the slide *g*, it is sprung in under it by the spring *f*, the valve *c* remains open by this means during the force and exhaust strokes of the plungers I and L, until they have nearly reached their set starting point, when the slide *g*, is drawn back, or slid from under the stud *d*, by means of the disengaging slide *h*, operating on it in the manner as heretofore described.

The counter P, so far as its interior arrangement is concerned, is of the same construction as that described by me in the specification for patent, granted to me for a "fluid meter" dated 20th February, 1849, but to obtain more accurate indications, instead of recording the travel of the plungers by communicating their travel to the counter arm, by means of the link or connecting rod to the same, direct from the cross head, I employ the slide rod *l*, and the rack *m*, working into the sector or segment *n*, whereby a true proportional motion to the counter arm *r*, is obtained according to the distance the plungers travel.

I also secure more accurate measurement by giving motion to the hands on the dial plate of the counter, during the exhaust stroke of the plungers I and L, or in other words, I register, not the quantity that is assumed to have been displaced from the meter cylinder K, during the force or inward travel of the plunger L, by multiplying its area of surface by the travel as registered by the counter, but the quantity that

has entered the cylinder K, during the withdrawal of the plunger L, therefrom, during its exhaust stroke, is estimated by its recorded travel in that direction multiplied by its area of surface, for the following reasons.

The pressure under which the fluid is displaced from the cylinder K, by the plunger L, during its force stroke must be slightly in excess of that opposing its entrance into the boiler, etc., which we will say is 20 pounds on the inch, while the pressure exerted on the plunger L, to return it and the plunger I, on their exhaust stroke is that only which is required to overcome their friction and inertia, which in the case of the supply being received from a hot well or tank, under a 10 or 12 feet head, will give a pressure of say 5 or 6 pounds on the inch, exclusive of the atmospheric pressure.

If air enters the cylinder K, during the plungers exhaust, "which is improbable as it has been shown that the plungers I and L, cannot return on their exhaust stroke, without the plunger L, being acted on by the pressure due to the head under which the cylinder K, is supplied, which must be at least equal to that required to overcome their friction and inertia. Should it remain in the cylinder when the foot valve 1, closed, which is still more improbable its properties being to rise where there is least pressure it is to be presumed that it will return to the hot well, etc., prior to the valve 1 closing, from the fact, that the fluid does not rush into the cylinder K, to fill a vacuum, occasioned by the withdrawal of the plunger L, as in the case of supplying a feed pump where the piston or plunger is drawn up, and the fluid rushes in to supply its place, but on the contrary the plungers cannot return without the required pressure acting on the plunger L, which is derived not from the vacuum alone, but from both combined," and is shut up in the cylinder by the closing of the foot valve 1, prior to the plungers force stroke, it will be seen that the plungers will spend a portion of their stroke, in compressing this air from 4 or 5 pounds up to 20 pounds on the inch, before the plunger L, will displace any fluid from it, which will render the estimate formed from the recorded travel of the plungers inaccurate. Now I have invariably found the following to take place: If there was any air confined in the cylinder K, when the plunger L, commenced its force stroke, it was entirely displaced from it during the plungers force stroke, as the valve 1, could be heard to strike the guard by rising, the instant the valve 2, had closed on its seat, proving two things conclusively, first, that the air being lighter than the fluid, although both must have been under the same pressure, previous to the valve 2 rising, had escaped or been driven from the cylinder first on the rise of the valve; secondly, that if any air was contained in the cylinder K, when the valve 2, closed, it did not exert a pressure equal to that due to the head of fluid supplying the cylinder, or it could not raise the valve 1, the instant valve 2 closed from which it will be seen that while there is a possibility of error occuring by estimating the quantity displaced from the meter cylinder during the force stroke, the liability is materially diminished by estimating from the travel of the plungers on the exhaust stroke, or in other words, measuring the quantity received instead of that displaced from the meter cylinder K.

When this meter is used in connection with a steam boiler, it will be necessary to provide a safety feed, in the manner set forth in a previous application.

In the use of the meter in connection with the boilers on board a steam ship, for the purpose of ascertaining the quantity of water evaporated by them during a given time or a voyage, it is necessary that the quantity blown off should be known, which deducted from the quantity shown by the counter to have been delivered by the pipe O, to them, will give the quantity evaporated. There are various methods by which the quantity blown off may be estimated, but in this meter provision is made for measuring it with the same accuracy as that of the feed.

To the meter valve chest M, two pipes 3, and 4, are attached, each provided with a stop cock. The pipe 3, below the foot valve 1, leads to the water space in the boiler, and the pipe 4, above the delivery valve 2, leads overboard, in the supply pipe R^2, is also provided with a stop cock. When it is desired to blow off, the stop cock N, on the delivery pipe O, and the stop cock on the supply pipe R^2, are closed, and the cocks on the pipes 3 and 4 opened, previous to doing which it is necessary to load the delivery valve 2, by means of a weight and lever on the valve spindle, to keep the valve closed, otherwise it would blow through.

On opening the cocks on the pipes 3 and 4, the feed pump being at work, the blow off water from the boiler enters the meter cylinder K, through the pipe 3, and foot valve 1, during the exhaust stroke of the feed pump plunger, and is discharged overboard, through the delivery valve 2, and the pipe 4, on the feed pump plungers force stroke.

If preferred a separate counter may be used to register the amount of blow off, worked the same as that for registering the feed, by transferring the motion of the arm *o*, by means of the link *p*, from the counter arm *r*, to that of the blow off counter arm. The blow off counter may be dispensed with, if it is made the duty of the engineer or other

attendant to register in a book for that purpose, the indications given by the counter during the time or times the blow off was in operation, which amount taken from the entire quantity indicated will give the evaporation.

What I claim as my invention and desire to secure by Letters Patent is:

1. In combination with a force pump and a piston or plunger actuated by water or other fluid forced from the same, the air vessel and the drop valve arranged and actuated substantially as described, whereby the measuring piston or plunger is caused to pause at the end of each stroke in either direction, substantially in the manner and for the purposes described.

2. I also claim supplying the pump chamber A, and the meter chamber K, through valves arranged and operating as described and loaded in proper relative proportion, or supplied from heads of proper proportional height, for the purpose herein described, height of head of supply or amount of load on the valves being equivalents producing the same results.

3. I also claim actuating the counter through the agency of a rack and a segment cog, arranged substantially as described whereby any movement of the meter piston or plunger less than a whole stroke is counted up in proper proportion by the counter.

WILLIAM HENRY LINDSAY.

Witnesses:

WILLIAM LINDSAY,

HENRY P. MCGOWN.