G. W. PIERCE.
Fluid-Meters.

No. 149,059. Patented March 31, 1874.

Fig. 1.

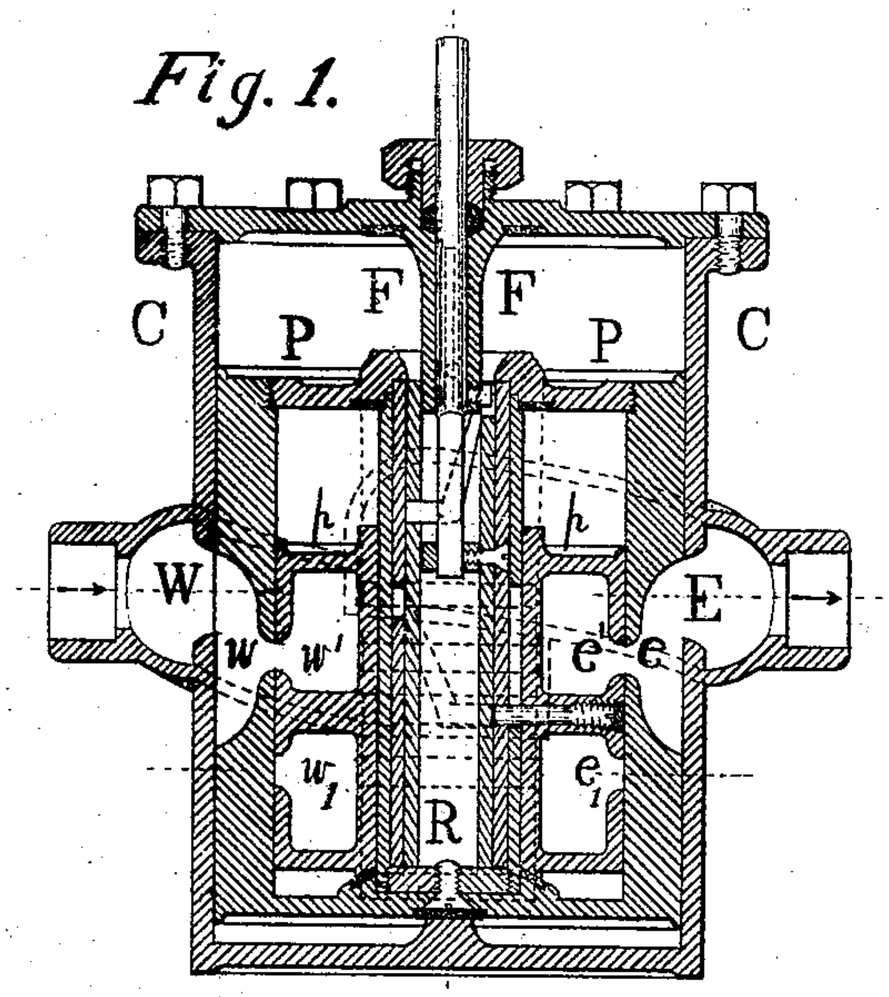


Fig. 4.

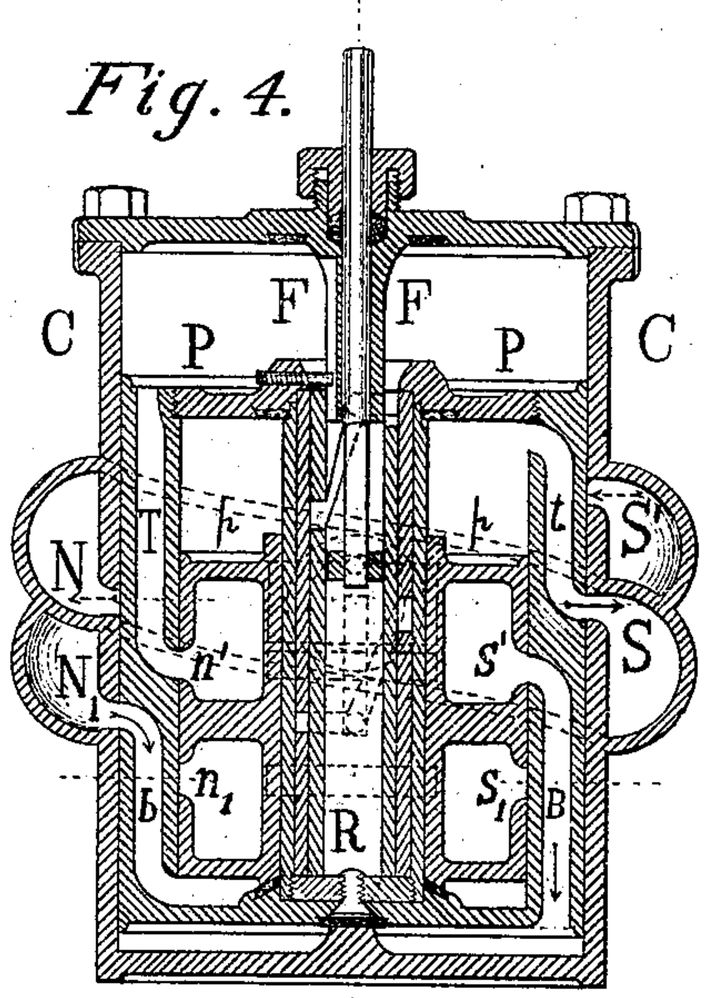


Fig. 2.

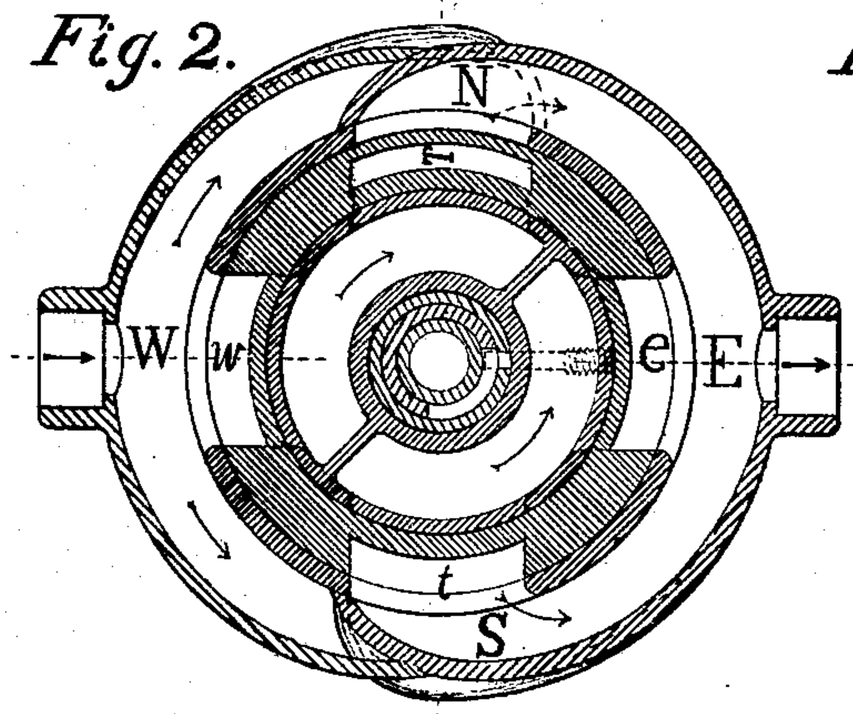


Fig. 5.

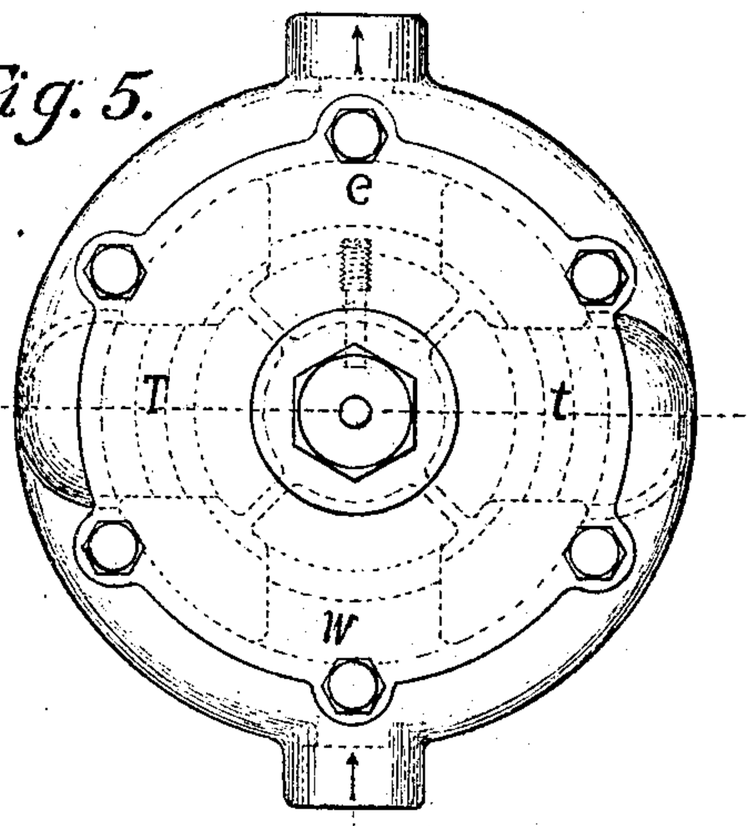


Fig. 3.

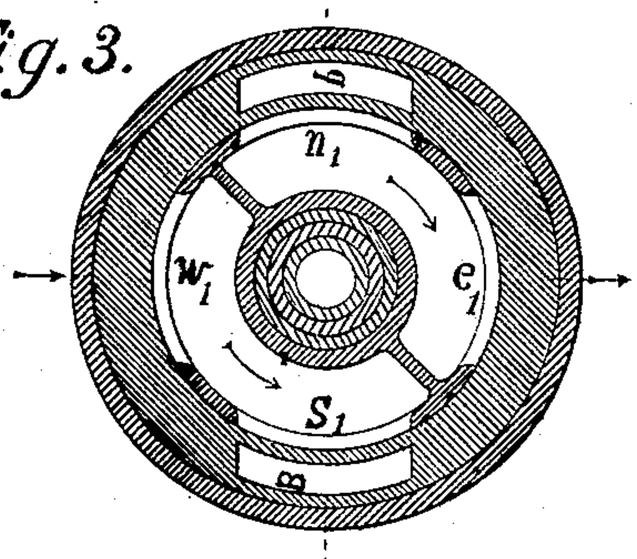
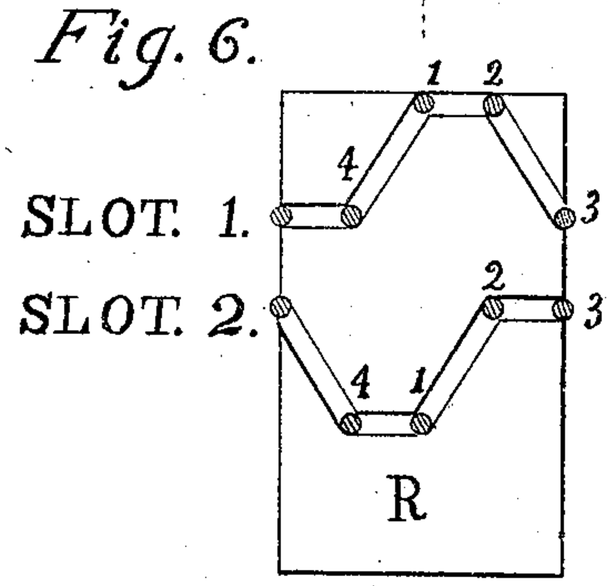


Fig. 6.



Witnesses
Henry H. Sprague
George G. Crocker

Inventor
George W. Pierce.

UNITED STATES PATENT OFFICE.

GEORGE W. PIERCE, OF BOSTON, MASSACHUSETTS.

IMPROVEMENT IN FLUID-METERS.

Specification forming part of Letters Patent No. **149,059**, dated March 31, 1874; application filed February 23, 1874.

To all whom it may concern:

Be it known that I, GEORGE W. PIERCE, of Boston, State of Massachusetts, have invented a Fluid Meter, Motor, or Clock, of which the following is a specification:

My machine is a system of hollow cylinders with all their axes in the same straight line.

Figures 1 and 4 are vertical sections intersecting in the axis at right angles to each other. Figs. 2 and 3 are horizontal sections through the points W E and *w e*, Fig. 1. Fig. 5 is the view from the top. The letters which stand for the points of the compass show the relative position of the figures. Fig. 6 is a view of two slots cut in two pieces of tubing, which are afterward pinned together, making the hollow cylinder R. Slot 1 is exhibited as it would appear if unrolled from the outside of the inner tube, slot 2 being unrolled from the inside of the outer tube at the same time, their positions corresponding as in the figure, which exhibits likewise the successive positions of two pegs, one in each slot, by corresponding numbers.

C is the case, containing N, E, and S, exit-ports, opening into a passage on the outside; and S′, W, and N,, entrance-ports, opening into an opposite passage, S′ being vertically over S, and N, under N, the passages, symmetrical outside, being coupled at their centers to the service-pipes. The piston P, made of two hollow cylinders or shells, inclosing a chamber in the form of a ring, has an intermittent stroke within the case. The piston *p*, in the form of a hollow cylinder, has a stroke equal to P's, alternating with it, within the ring-shaped chamber. P has six passages in its outer shell, *w* and *e*, opposite W and E, Fig. 1, and *t*, *b*, T, and B, Fig. 4, putting the top and bottom of the ring-shaped chamber and the interior of the case into communication, the first with N, and S, or N and S′, at the ends of the stroke of P; the second with the north and south ports of the middle horizontal section of the ring-shaped chamber. *p* has four chambers, separated by one horizontal and two vertical partitions not intersecting, with eight ports in two horizontal sections, two ports for each chamber, by means of which, with a rectilinear instead of a rotary motion, it performs the office of a four-way cock.

The automatic motion is as follows: Both pistons being at the lower end of their stroke, in the position shown in the drawing, Figs. 1 and 4, the water enters through the port N, in the case, from the left-hand outside passage coupled to the service-pipe, Fig. 1, and, passing through the passage *b*, in the outer shell of piston P, Fig. 4, into the ring-shaped chamber beneath the piston *p*, forces this piston up, the water in the chamber above it escaping through the passage *t* and port S, Fig. 4, into the right-hand outside passage coupled to the service-pipe, Fig. 1. At the end of the upstroke of *p*, the water enters through ports W *w w*, *s*, and passage B into the main chamber beneath the piston P, forcing this piston up, the water in the chamber above it escaping through the passage T and ports *n*,, *e*,, *e*, and E, Figs. 1 and 4. At the end of the upstroke of P, the piston *p* is compelled to take a down-stroke by water entering through the port S′ and passage *t* into the chamber above it, and escaping from below it through the passage *b* and port N, Fig. 4, the direction of the water in its passage through the case being indicated by the dotted arrows. At the end of the down-stroke of *p*, the water entering above the piston P through ports W *w w′ n′* and passage T, and escaping from below it by passage B and ports *s′*, *e′*, *e*, and E, Figs. 1 and 4, compels P to take a down-stroke, at the end of which both pistons have returned to the starting position, and the automatic motion is repeated.

p is not a mere valve, but a working piston. Its motion is measured, and its power is used. It may be made to take a stroke equal to P's, as in the drawing, and if desirable to have the same working area, by a simple contrivance, which I withhold at present, not to overcrowd the specification. It is not inside of P any more than it is outside, being inside the outer shell and outside the inner, with reference to the axis. Both pistons, in fact, are outside and inside of each other at the same time. P has in its core not a valve, but a revolving cylinder, which measures, adds, and regulates the motion of the pistons. How this is done is shown, Fig. 6: The peg in slot 2, after passing through a vertical slot in the inner shell of P, to prevent the pistons from relative rota-

tion, being fixed to *p*, causing R to revolve during the whole of its stroke, when the peg in slot 1 on the hollow cylinder F, fitting R and fixed to the head, traverses the slant of its slot during the stroke of P, which is prevented from rotating by pegs in its collar working in vertical slots in the upper part of F.

Extra pegs and vertical slots may be used to diminish the wear of the essential parts, and the motive pegs increased in number by repeating the slots, Fig. 6, before they become continuous. Each piston is thus compelled to complete every stroke, and a continual rotation of R in the same direction is produced, which may be made uniform by proportioning the amount of revolution represented by the slant of the slots to the working area of the corresponding pistons. If the corners of the slots are rounded in a certain parabolic arc, each piston will be gradually started and brought to rest with a velocity proportionate at every instant to the width of the passages which are opening or closing upon it, both pistons moving together at the turn. An approximate effect is produced by any rounding to a distance each way not exceeding the altitude of a port. R locks each piston alternately, having a motion at right angles to theirs, and may be used in other double-piston meters. Given two pegs, the slots may be both in the outer or both in the inner surface of R, or a single slot may answer the purpose. This form may be used: A slanting or elliptic slot for one pin, discontinuous, which the pin traverses from one end to the other and back, and a continuous slot, returning into itself, for the other pin, with two straight portions parallel to the axis, united at the ends by two curved portions whose edges are arcs of circles, embracing the cylinder R, which gives R an intermittent rotary motion in opposite directions. The piston may carry the slot and R the peg. R may be carried by one of the pistons, as in the drawing, or prevented from rectilinear motion, and the number of additional pegs is immaterial. The slot in the exterior surface of R, Fig. 6, answers for two pistons external to each other, working side by side in their respective cylinders, R being placed between, prevented from rectilinear motion, and one peg fixed to each piston. The first pegs put in might be diminished at the point to fit the slot, and larger pegs used as the slot wears. The wear in the slants is self-compensating—in the horizontal parts may shorten the stroke; in the vertical slots alone threatens the action of the meter. The first set of slots may be otherwise described as elliptic, the second as circular, and the third as straight. R has a cross-piece, from which its rotation is taken off upon a central rod squared at the end, and communicated to a register at the top of the meter by a single gear, or a double mutilated one, to compensate a double rate of rotation. Free communication is left between the bottom of R and the top interior of the case. Spaces at the ends of stroke and slanting stops prevent sediment from clogging the meter, and, if the machine is supported upon a removable prop, to admit of rotation upon the couplings, it may be washed out without taking apart.

Two meters, one inverted, with their central rods coupled together, and their pistons in corresponding positions, are in a state of indifferent equilibrium, equal weights always moving in opposite directions, with cumulative effect or not, according to the arrangement of the pipes; and, the friction resulting from gravity having been removed by giving the axis a vertical direction, the loss of head becomes a minimum, uniform throughout the stroke. One machine with a constant head, or other clock, being made to carry a circular card, a meter inverted over it, or otherwise reversed in position, carrying a pencil or metallic point along a diameter of the card fixed to a rack gearing with horizontal wheels, or wheels parallel to the card, one of which is run by the register, records upon the card the rate at every instant and the amount discharged in every interval of time, and might be useful to detect the leakage from city mains, or the combined leakage and waste during those hours of the night when no water is used.

Properly packed, the machine is a motor, with an advantage over a crank. Two machines of the same or different sizes being coupled together by their central rods, if one of them, used for an engine, is run by water or steam, the other, having its operation reversed, becomes a pump. A combination of couples, with a common belt, might turn a mill, having an advantage in the way of portability and convenience of repair, one of them being easily uncoupled, and an extra one being substituted or not, without stopping the rest.

The arrangement of ports and passages herein described combines the utmost compactness and economy of stock with the greatest uniformity of distribution of the distances of shortest separation which are depended upon to prevent leakage, the ports in general being of equal width and equal altitude, and the shortest vertical separating distances in the drawing being equal, and the horizontal likewise, to half the width of a port and half the outer radius of *p*.

Other systems of ports being practicable, though less convenient, I have thought it necessary to claim—

1. The piston P, made of two hollow cylinders or shells, inclosing a chamber in the form of a ring, substantially as herein described, for the purposes set forth.

2. The piston P, having its ports and passages constructed and arranged substantially as herein described, for the purposes set forth.

3. The piston *p*, made in the form of a hollow cylinder, fitting the ring-shaped chamber, substantially as herein described, for the purposes set forth.

4. The piston *p*, having its ports and cham-

bers constructed and arranged substantially as herein described, for the purposes set forth.

5. The combination of C, P, and *p*, constructed and arranged, with their ports, passages, and chambers, substantially as herein described, to produce automatic motion.

6. The combination of P and *p*, or any two pistons, with a cylinder having a rotary motion upon its axis, and operating by means of one or more slots, in which work two or more pegs in any one of the methods herein described, or any equivalent method, to compel each piston to take a full stroke.

7. The cylinder R, having the slots of the form shown, whereby a continual revolution of R in the same direction is produced by the alternate stroke of the pistons, constructed and arranged substantially as within described, for the purposes set forth.

8. The combination of all the hollow cylinders C, P, *p*, R, and F, constructed and arranged, with their ports, passages, chambers, slots, pegs, and central rod, substantially as herein described, for the purposes set forth.

GEORGE W. PIERCE.

Witnesses:

HENRY H. SPRAGUE,

GEORGE G. CROCKER.