(No Model.)

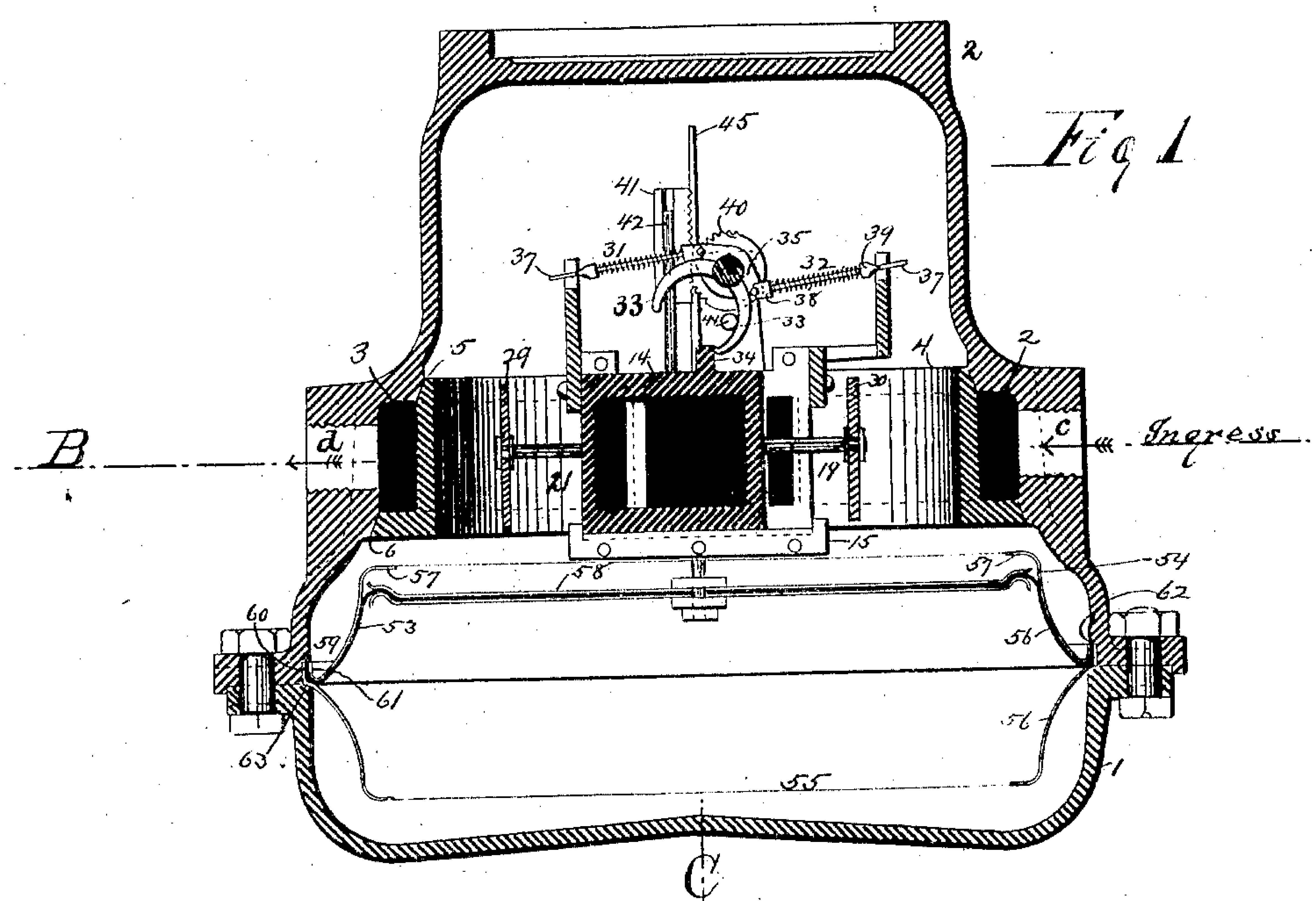
3 Sheets—Sheet 1

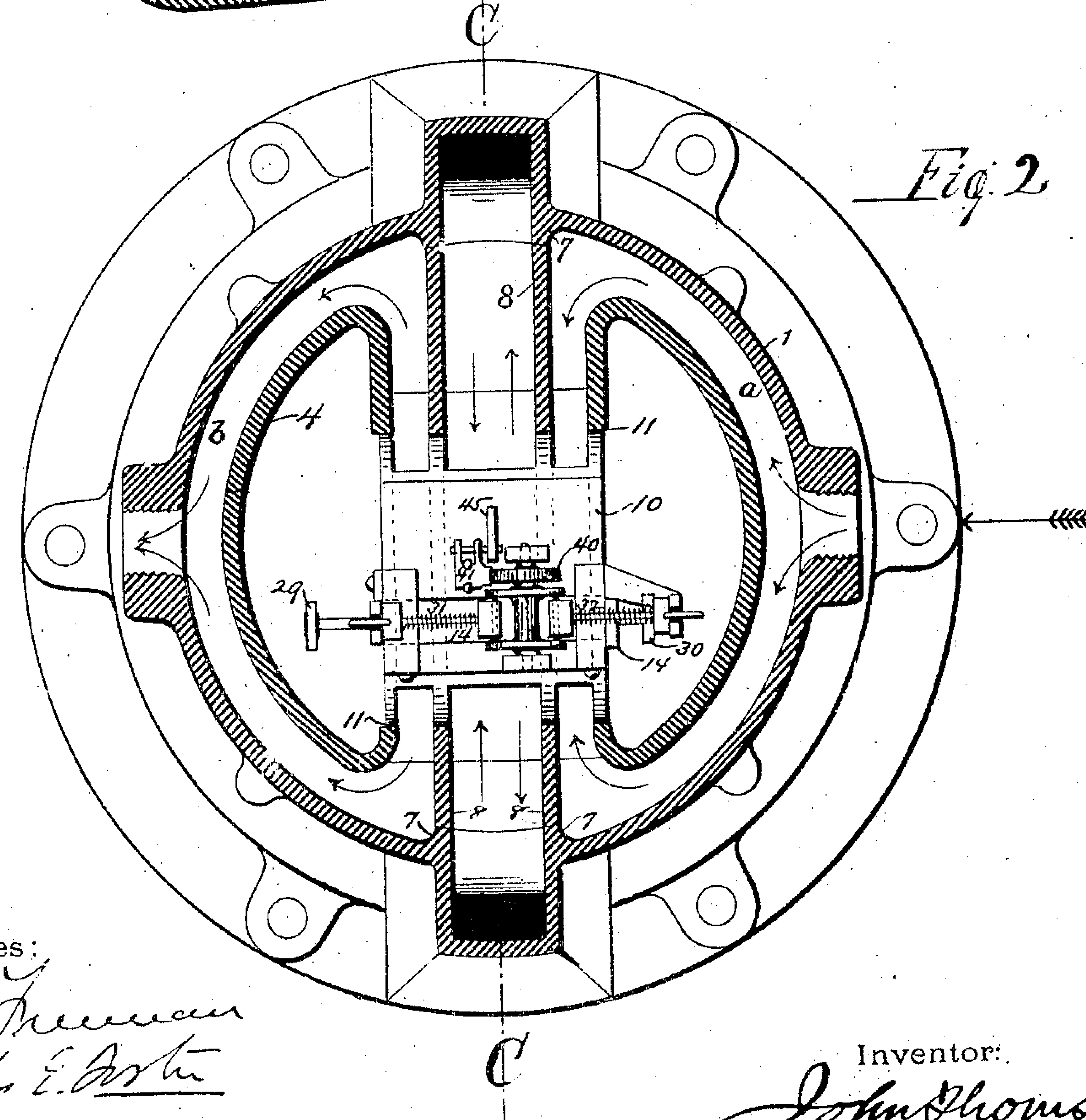
J. THOMSON.

DIAPHRAGM FLUID METER.

No. 318,327.

Patented May 19, 1885.





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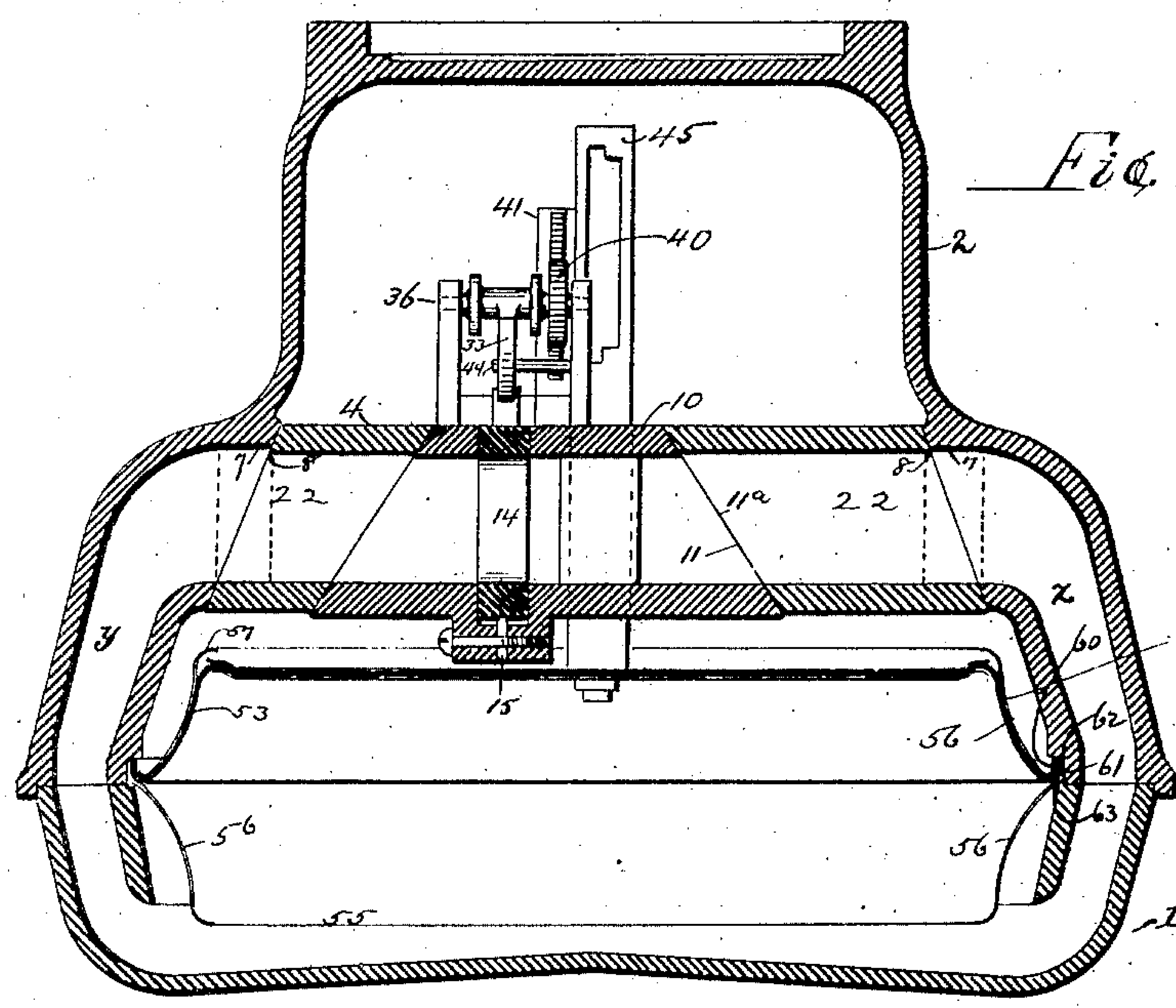

Fig. 3.

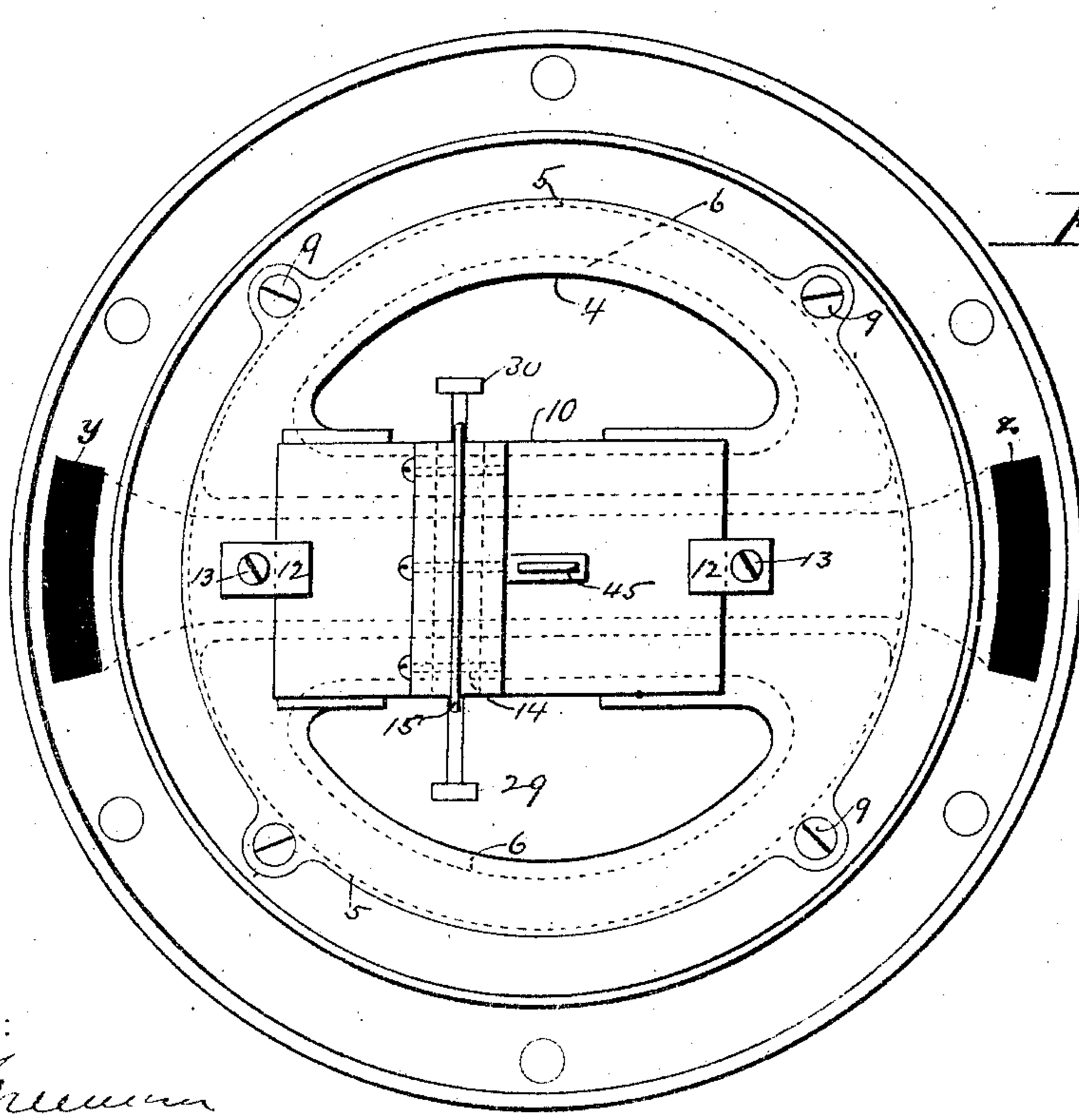

Fig. 4.

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(No Model.) 3 Sheets—Sheet 3.

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Fig. 6.

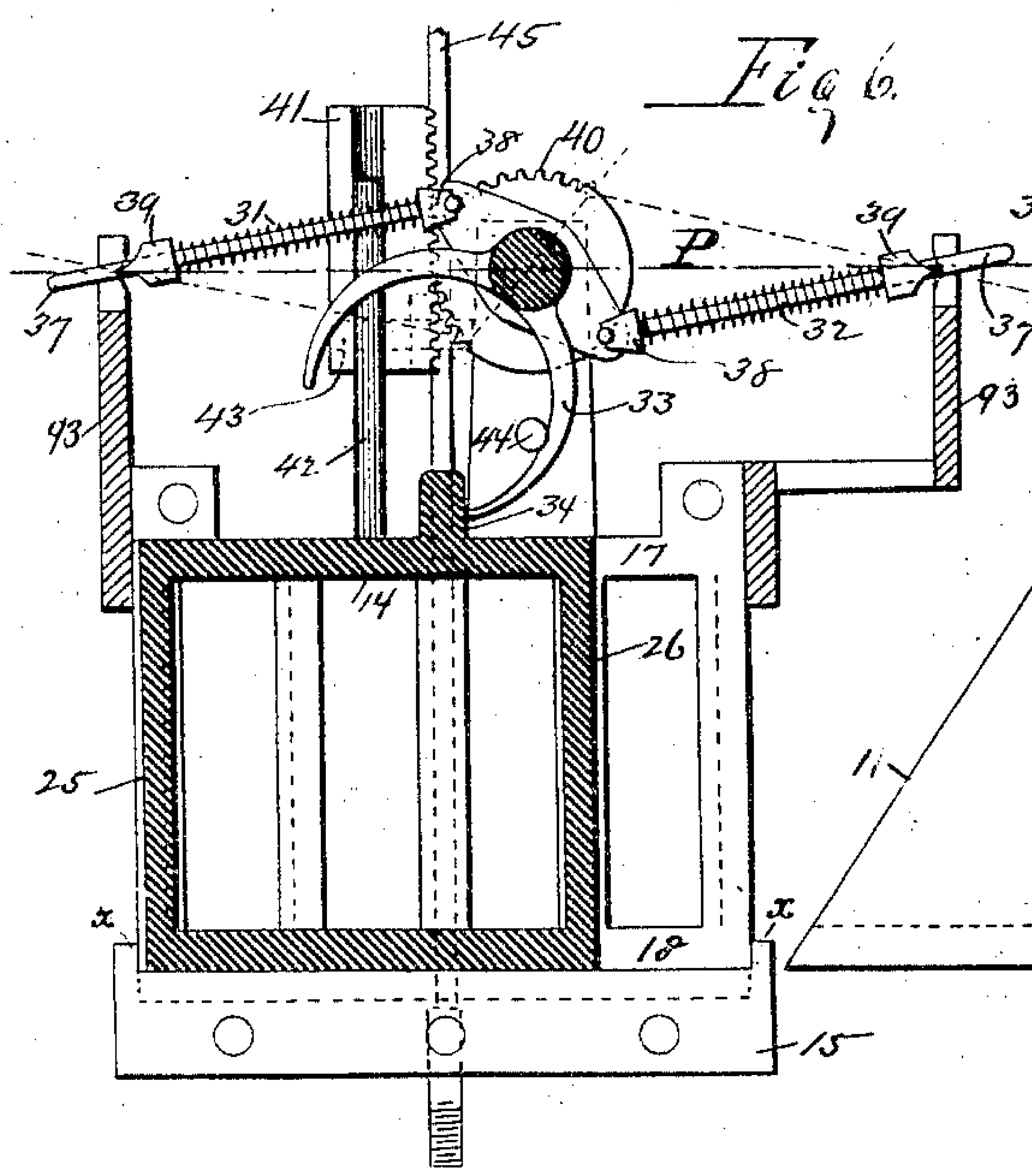


Fig. 5.

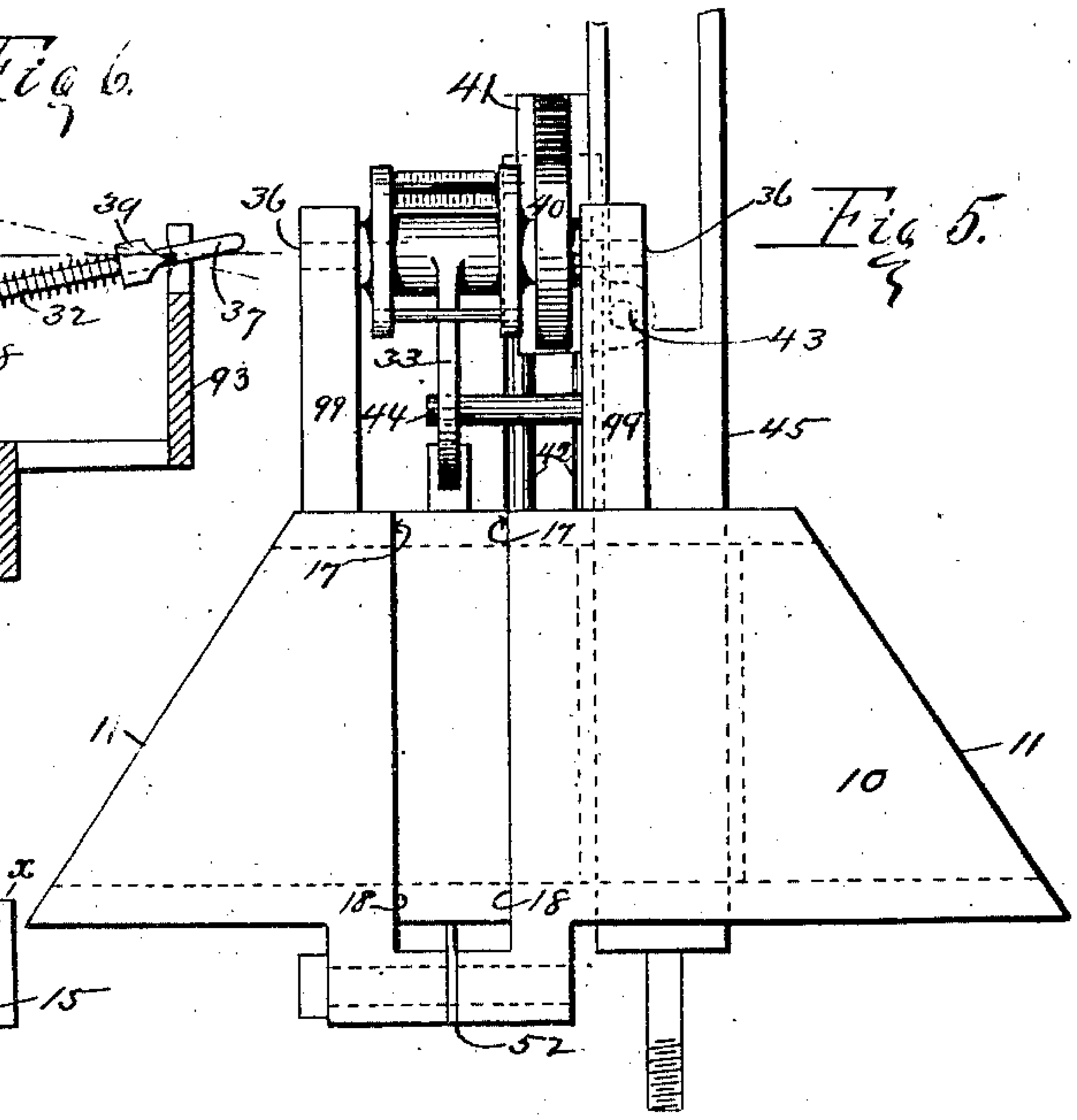
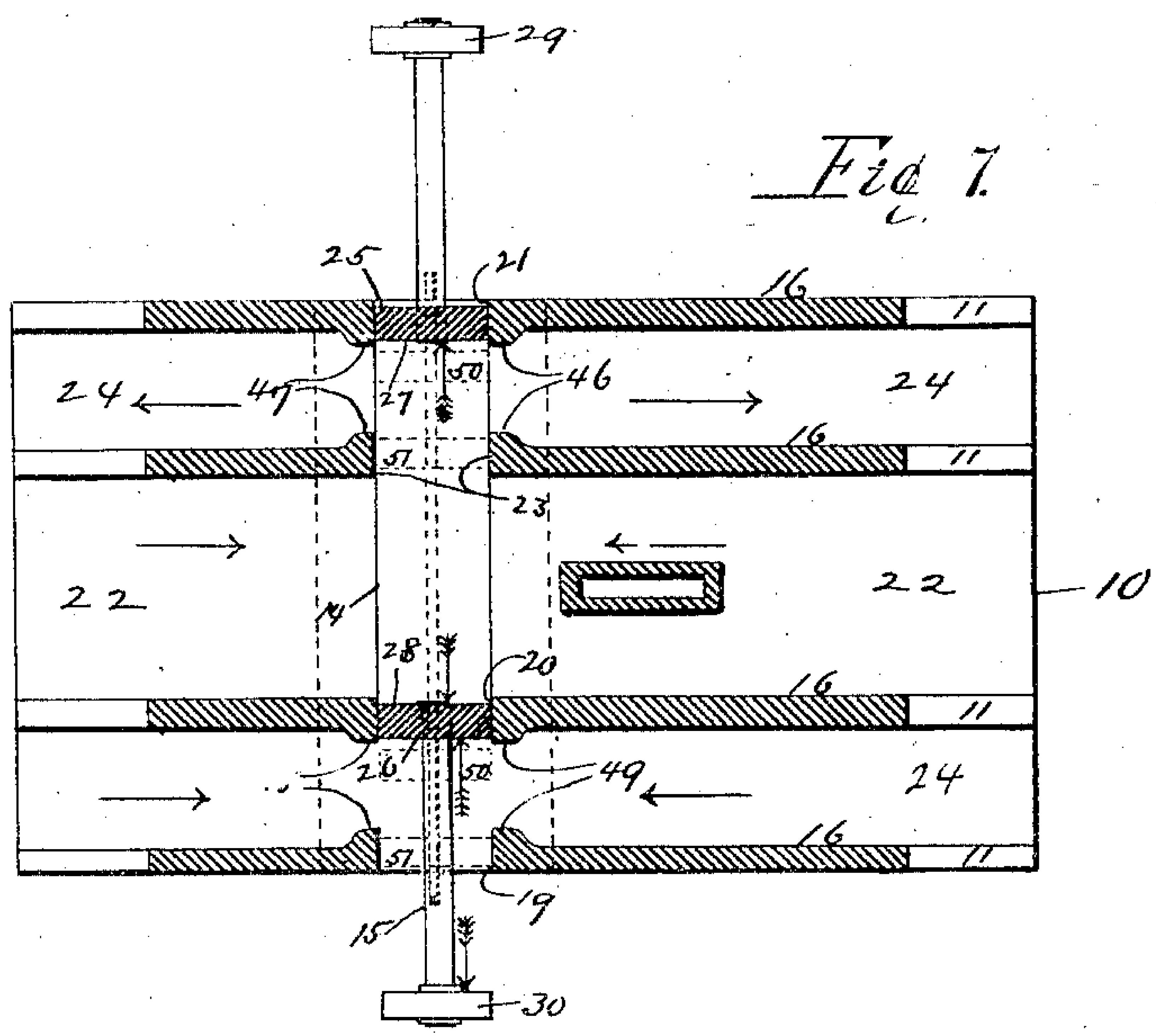


Fig. 7.



Witnesses:

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UNITED STATES PATENT OFFICE.

JOHN THOMSON, OF BROOKLYN, NEW YORK.

DIAPHRAGM FLUID-METER.

SPECIFICATION forming part of Letters Patent No. 318,327, dated May 19, 1885.

Application filed January 31, 1885. (No model.)

To all whom it may concern:

Be it known that I, JOHN THOMSON, a citizen of the United States, and a resident of the city of Brooklyn, county of Kings, and State of New York, have invented certain new and useful Improvements in Fluid-Meters, of which the following is a specification.

My invention relates to that class of water-meters in which a vibrating diaphragm or piston shifts a valve to direct the in-current first to one side and then to the other of the piston; and my invention consists in certain improvements in the constructions of the parts intended to secure greater simplicity of construction and certainty of operation.

In the drawings, Figure 1 is a central vertical section through the ingress and egress openings of the cylinder, the sluice-ring, valve-chamber, and valve. Fig. 2 is a horizontal section on line B of Fig. 1 as viewed from above. Fig. 3 is a central vertical section on line C, exposing the intermediate water-ways in cylinder, sluice-ring, and valve-chamber. Fig. 4 is a plan of the upper cylinder as viewed from below, with the sluice-ring and valve-chamber in position. Fig. 5 is a side elevation of valve-chamber and valve. Fig. 6 is a front elevation of valve-actuating apparatus with valve in longitudinal section and one side of valve-chamber removed. Fig. 7 is a central horizontal section of valve and valve-chamber.

The valve-casing consists of the body or cap piece 2, the bottom piece, 1, and a removable chamber or sluice-ring 4.

The cap or body 2 is constructed to form with the sluice-ring a curved inlet-channel, *a*, communicating centrally with an inlet-port, *c*, and a curved outlet-channel communicating centrally with an outlet-port, *d*, and with vertical channels *y z* at the opposite sides, with their upper ends between short partitions 7 7.

The sluice-ring 4 is constructed to form said channels *a b* with the body portion, and has partitions 8 8, constituting prolongations of the partitions 7 7, and between the inner ends of the partitions 8 8, on opposite sides, fits a valve-casing, 10.

Below the sluice-ring is a flexible diaphragm or piston, 58, which is connected with devices, as fully described hereinafter, to shift the valve to direct the inflow to one side or the other of the piston and cause its rise and fall.

To avoid complicated core-work and nice machine-work within the cap-piece 2, the main ingress and egress sluices *a b* are formed equally by the cylinder and by the sluice-ring 4, the closure of the sluices being effected by the contact of the tapered faces 5 6 at an angle. This angle of contact is made as obtuse as possible, as shown, which permits the use of and the more convenient insertion of thin pieces of packing between the surfaces of the sluice-ring and cylinder, when, by forcing the sluice-ring down snugly by means of the retaining-screws 9, Fig. 4, first, the required degree of closure is obtained, and, second, in view of the said obtuse angles, the packing is not materially shifted by the sliding action of the surfaces forced to contact. Thus any inaccuracy in the metal surfaces will not materially affect the perfection of the joint. In the same manner a close joint between the valve-case 10 and sluice-ring is secured; but in this instance the contiguous faces 11 11ª are simply formed like a wedge, the angles of both being equal and even more obtuse than those of the sluice-ring and cylinder. A piece of packing cut to the shape of the faces around the ports is secured or simply laid in position, and the valve-casing is secured by the clamps 12 and screws 13. In this wise the joint can be perfectly made with but little fitting, and the parts can be readily separated, and be placed accurately in position, and can be adjusted endwise or laterally, as will be apprehended, across the ports by varying the thickness of the packing on either end. It will be apprehended that the said joints are not required to withstand the total pressure of the fluid like the cylinder, but the difference of pressure only between the ingress and egress chambers within the meter.

The valve 14 embodies the principles of a slide-valve and piston-valve, and is so formed and arranged that in action it will be in perfect equilibrium, under constant or different static pressures, and under direct and reactionary effects of currents of either low or high velocity. The movements of the valve are effected from those of the diaphragm 58, as will be hereinafter fully described.

As shown in the figures, the valve proper is simply a square or oblong frame of uniform thickness placed transversely across the valve-casing and within the valve-chamber.

The operation and construction of the valve will be best understood by referring to Figs. 5 and 6. The valve is supported on a narrow longitudinal bearing, 15, at the lower portion of the valve-chamber, and is fitted to move freely within its recess, but sufficiently close to remain packed under any excess of pressure within the meter at any point. When the valve is in the position shown, the ingress current passes through the channel 24 and the port 19 into the chamber above the diaphragm, the port 20 being closed by the forward end or section 28 of the valve, port 21 being also closed by the back end or extension, 25. The egress current meantime is being forced through the intermediate sluice or channel, 22, through port 23, and thence out through sluice 24, as shown by the arrows. Both the outer surfaces of the ends of the valve are exposed to the ingress pressure, and both the inner surfaces of the ends are exposed to the egress pressure. Whatever the difference of pressure may be, it will clearly be without effect upon the valve if the latter is strong enough to bear it—that is, there will be no effect from any difference of pressure tending either to hold the valve or to shift it. It is also clear that as the faces or edges of the valve which close the ports are under the equal effect of the direct currents through the valve-chamber, the valve will operate without friction or abrasion upon the portions of the channels between which it slides and which it is intended to close. It has been found that when the difference of pressure is but slight the valve may be fitted very loosely and the meter yet operate with satisfactory results, the film of fluid surrounding the valve being maintained by the capillary attraction of the contiguous surfaces, the valve being thus frictionless and water-packed, and without metal contact, except on its bearing at the bottom. It will furthermore be observed that the pressure on the inner faces of the valve ends will also be in balance with respect to the direct and reactionary effect due to the change of direction of the current from the intermediate to the egress sluice, or vice versa, as its direct action and reaction is upon equal areas of and borne by and between the ports of the valve itself. Upon the outer faces of the valve ends, however, the reactionary effect due to the changed direction of the ingress and egress currents is different. In Fig. 6 I have purposely omitted to illustrate one of the more important features of my improved valve the better to demonstrate the principle involved in the portion to be now described.

Presuming that the valve-chamber and valve were suspended and operated in a vessel of infinite extent, the direct effect of the egress current would be entirely expended upon the greater volume of fluid in which it was being forced, and would therefore retransmit its effect equally in all directions upon the mass of fluid; hence its reaction upon the face 26, Fig. 6, would be practically counteracted by the indirect action through the fluid upon the face 25. In actual practice, however, it is required that the mechanism of the instrument be placed in the minimum of space, in consequence of which the effluent current will only partially expend the force due to its velocity upon the greater volume of fluid in which it is projected, and will pass through the said volume of fluid and expend the residual of its force upon the confining-walls of the meter. Consequently the direct action of the current being only partially expended upon the fluid in which the valve is suspended, it can only return to the face 25 that portion which will have been taken up by the main body of fluid, while the reaction of that portion of the force expended upon the rigid wall will be entirely returned to the face 26 of the valve. To this extent, then, the valve, and any valve under like conditions, whether in liquid or gas, will be out of balance, and will require a varying expenditure of power to shift its position, or in a ratio directly as the velocity of the current. I obviate this difficulty by attaching to or forming as a part of the valve the counter-pressure plates 29 30, Figs. 4 and 7, by which it will be seen that the currents which pass the outer faces, 25 26, are caused to act and react within the limits of the valve itself, and hence, regardless of their velocity, will produce no effect upon the valve that in any way can assist or retard its movement. The importance of thus eliminating each and all causes which can produce under any condition of flow or pressure, singly or in combination, a deterrent or accelerative effect upon the movement of the valve is that I am thereby enabled to perfectly balance the valve against variations of pressure or flow, and to use a diaphragm of very thin or elastic material, and yet obtain practically-uniform displacement of volume under all rates and conditions of flow and operation.

The valve is also of the most simple character, easily made and fitted.

The counter-pressure plates 29 30 need not necessarily be planed or ground on their sides. Therefore these surfaces are preferably formed slightly beneath the main surfaces of the valve, which act to close the ports.

A rock-shaft, 36, turns in bearings in standards 99 99, and carries a cross-arm, 35, to the ends of which are journaled the inner ends of rods 37, the outer ends of the latter sliding in openings in brackets 93.

The valve is actuated by toggle-springs 31 32, which are coiled on the rods 37, and upon being drawn to either side slightly beyond their dead-center line P act through the arms 33, carried by the rock-shaft 36, directly upon a tooth or extension, 34, on the valve. The action of the arms and springs is so timed relatively that the valve is put into motion by the direct action of the piston slightly in advance of the movement of the springs. Thus the springs are not required to overcome the entire inertia of the valve, but take it at the speed at which the piston is moving. This also prevents stoppage by obstruction of foreign matter. When both springs are operative, their thrust upon the journal is balanced; but even in the event of one spring becoming partially or totally inoperative the other would still act to properly operate the valve. The action of the springs arranged in this way is also very prompt as soon as the dead-center is passed, as it will be seen that each acts in the arc of a circle instead of at a tangent thereto, as in other devices.

Upon the end of each rod 37 is a connecting-block, 38, and also a sliding and bearing block, 39, between which is the spiral spring 32. This form of spring is capable of being very thoroughly tested before use, and it is durable, and will remain for a long time in an operative condition.

The compression of the springs and start of the valve are effected from the diaphragm through the segment-gear 40, fast to the shaft 36, which meshes with a rack, 41, sliding on the guide-rods 42. From the rack projects a pin, 43, and which enters a slot in the piston-rod 45, which is directly connected to the piston or diaphragm 58. The advantage of this arrangement over an ordinary lever-connection is that the connection with the piston is direct, and that the actuating-springs may be elevated without correspondingly increasing the piston-rod and height of the cylinder, the connection with the rack being low down, while a lever would require to be central and higher.

A further advantage of this form of valve and arrangement of actuating mechanism is the avoidance of "water-hammer" or pulsation in the pipe during the flow or at the reversal of the current through the meter.

The combined area of the sluices or ports 46 47, and also of 48 49, slightly exceeds the area of the ingress-pipe. In the illustration, Fig. 7, the thickness of the valve is shown as a little less than half of the width of the ports past which it travels. It will be seen that immediately the valve is started both the ingress and egress currents are being cut off in like and equal extent, and that when the valve will have reached the position indicated by dotted outlines 50 the current through the intermediate sluice and the cylinder of the meter will have been correspondingly reduced in velocity. The valve, continuing its transit, opens the ports previously closed; but the full velocity of the current will not be resumed until the valve will have reached its reverse position (indicated by dotted lines 51) in consequence of the valve closing a portion of the area required for passing a full volume of fluid. Therefore, although the described action of the valve is performed with great rapidity, its action is yet a cumulative one, and a certain extent of time is allowed in which to smoothly effect the expenditure of enegry required to reverse the current through the intermediate sluices, water-ways, and cylinder.

The movement of the valve is limited by the stops x x on the bearing-piece 15, and the action of the arms 33 and springs is limited by the stop-pin 44, as shown.

It will be apprehended that by forming the valve-sections to equal in thickness the breadth of the sluices a complete stoppage of the flow would be effected at each reversal of the valve, and that the meter would thus be mathematically exact in the sum of its displacements; but this has not been found necessary in practice, and as the form described requires less movement to effect a full reversal, and as it reduces pulsations, it is preferable. This form also presents another advantage, in that an obstruction which would prevent the valve from fully reaching its proper position would not thereby render the instrument totally inoperative, as the ports being open on the proper side the piston would operate at a less rate of speed until the valve was again shifted and the obstruction liberated.

It is evident that the counter-pressure plates may be advantageously applied to any or all of the various valve systems, and that the present form of valve might be considerably modified without departing from the principle of its action, as it might be wedge-shaped, circular, as a piston, vibrating, or rotary valve.

The advantage of forming the valve-casing in two portions is that each half may thus be cast without coring to form the sluices, and as each face is a counterpart of the others they are made by a like means. The fitting of the valve is effected by extension or reduction of the joint between the flanges at 52.

It will be observed that the disposition of the entire valve-actuating apparatus (as also the register-connections, which are not shown in the figures) is above the valve and the ports of the chamber; hence they are in "dead-water," and not so liable to disarrangement as when otherwise disposed.

In constructing the diaphragm 53, it is formed as a frustum of a cone. By forming the pressure-cones 54 55 slightly curved inward in cross-section, as shown at points 56, the diaphragm is caused to roll upon them and operate with much greater perfection than when caused to bear on a straight or oppositely curved section. I also extend the cones above and over the piston, as at 57, thus completely enveloping the diaphragm, so that any deposit of foreign matter will be sustained upon the metal portion of the piston 58, or around the annular space 59 between the cone and the cylinder.

To secure the outer edge of the diaphragm, I form the cones 54 55 with parallel vertical flanges 60 61, turned outwardly, with sufficient space between them to take and clamp the diaphragm snugly. An annular recess, 62, is formed in the upper cylinder of such depth as to bring the outer surface, as 63, flush with or slightly below the face of the flange. The breadth of the flange of the lower cylinder is such that it laps the flange of the cones. Therefore by inserting any suitable plastic or yielding packing material between the flanges of the cylinders, and wide enough to lap the flange of the cones, the diaphragm and cones will be securely held in position without an injurious degree of compression upon the diaphragm, and this also insures a water-tight joint between the two cylinders.

I claim—

1. The casing with beveled faces and intermediate depressions, and the sluice-ring with corresponding faces and intermediate depressions, the said depressions, when the ring is in position, equally and jointly constituting a series of water sluices or channels, substantially as described.

2. The casing having inlet and outlet ports, and partitions 7, and channels *y z*, in combination with a detachable sluice-ring carrying partitions 8, and a detachable valve-casing provided with a valve and channels, and fitting between the partitions 8, substantially as described.

3. The cap-piece 2, having upper and lower bearing surfaces and faces or partitions, 5 6, at an obtuse angle connecting the said surfaces, and thereby forming intermediate depressions, and the sluice-ring having corresponding bearing-surfaces and partitions at a like obtuse angle, and intermediate depressions, substantially as described.

4. The sluice-ring having faces at an obtuse angle, and detachable valve-casing fitting between said faces, and with bearings corresponding thereto, substantially as described.

5. The combination of the casing having opposite inlet and outlet passages, *a b*, and channels *y z*, and partitions 8 8, substantially as described, and a detachable valve-casing carrying a valve, and provided with a central channel, 22, and side channels, 24, substantially as specified.

6. The valve sliding across a casing having a central and side channels and consisting of a rectangular frame, substantially as described.

7. The valve-casing provided with central and side channels and with side ports, 19 21, and transverse valve-seat, in combination with a frame-valve and valve-actuating piston-rod, substantially as described.

8. The valve-casing having central and side channels and lateral ports, in combination with a frame-valve the ends of which are less in thickness than the width of the side channels, for the purpose specified.

9. The combination, with the valve of a water-meter, of plates supported thereby, arranged to counterbalance the effect of water-currents upon the ends of the valve, substantially as described.

10. The combination of the casing, ports, channels, piston, and valve crossing and controlling the ports and provided with arms carrying plates 29 30, for the purpose set forth.

11. The valve supported by a narrow longitudinal bearing, substantially as described.

12. The valve-casing in two parts, with an intermediate valve supported by a narrow strip clamped between said parts, substantially as described.

13. The combination, with a sliding valve, of a rock-shaft provided with arms operating on the valve, and with arms connected to rods on opposite sides, extended through vibrating bearings, and with springs arranged on the said rods to be compressed as the connecting-points of the rods approach a line drawn through the axis of the shaft and said vibrating bearings, the said springs acting against each other, and thereby balancing their thrust upon the rock-shaft, substantially as described.

14. The combination of the sliding valve, rock-shaft 36, its arm 35, rods connected to said arm on opposite sides and sliding in bearings of vibrating brackets 93, and springs interposed between the brackets and bearings on the rods, substantially as described, the arrangement and construction being such that the valve is positively started by the direct action of the piston before the springs are carried beyond their dead-center, substantially as described.

15. The combination of the sliding valve, diaphragm, rock-shaft carrying arms arranged to make contact with said valve, an arm on the rock-shaft connected to rods sliding in stationary bearings at the outer ends, springs around said rods, and connections between the piston and rock-shaft, substantially as described.

16. The combination of the piston, piston-rod, guided rack connected with the rod, rock-shaft, and toothed pinion thereon gearing with the rack, and the spring or springs directly connected to the said toothed pinion, substantially as described.

17. The diaphragm and piston, combined with pressure-cones detachable from the case, arranged above and below the same and curved inward, substantially as and for the purpose set forth.

18. The cones combined with the flexible diaphragm and provided with upturned flanges adapted to a recess in the casing, substantially as described.

19. The cones with inturned flanges at their inner edges and combined with the flexible diaphragm, as and for the purpose set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN THOMSON.

Witnesses:
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JAS. G. COOPER.