

Nov. 8, 1927.

J. E. McALLISTER

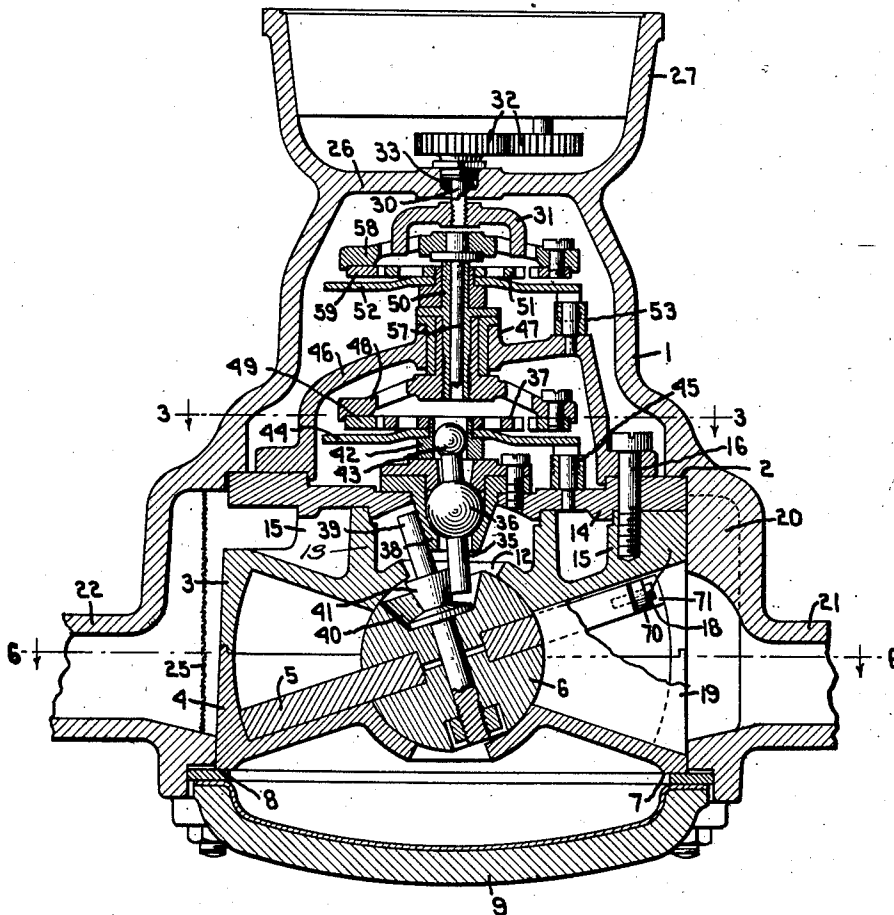
1,648,491

METER

Filed July 12, 1922

4 Sheets-Sheet 1

Fig. 1.



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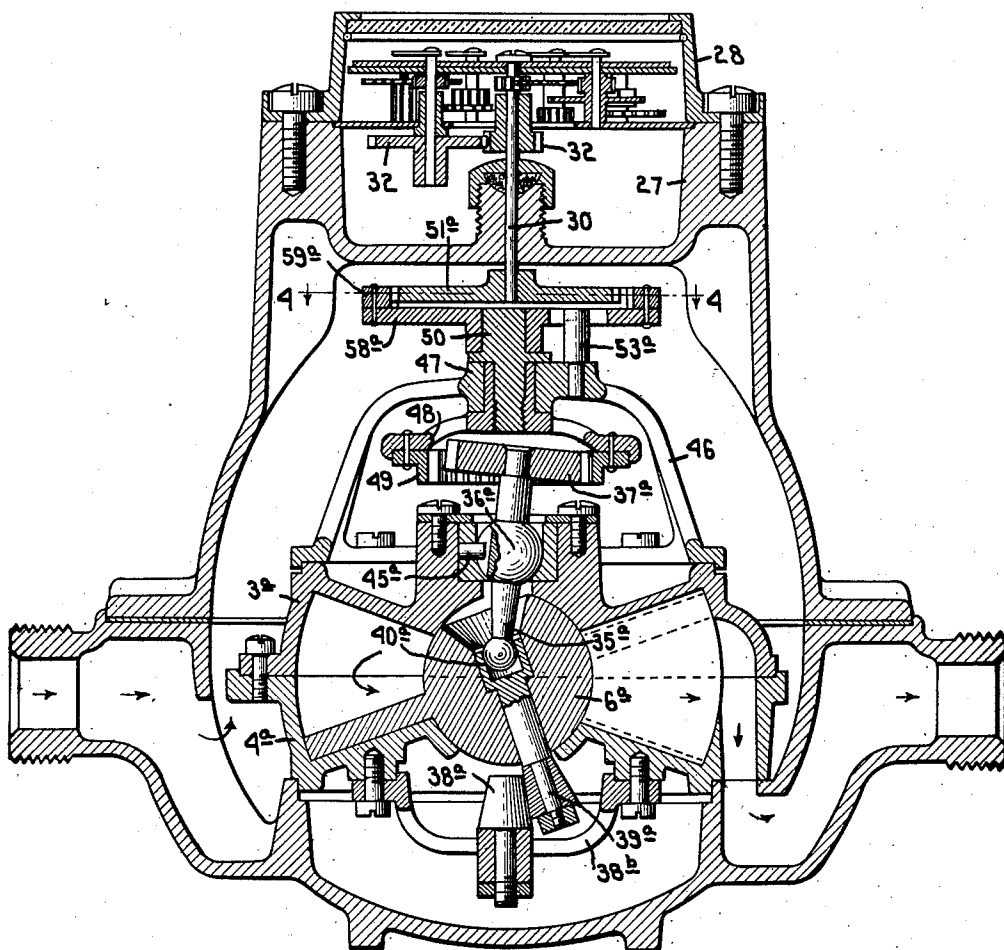
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Fig. 2.



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Fig. 3.

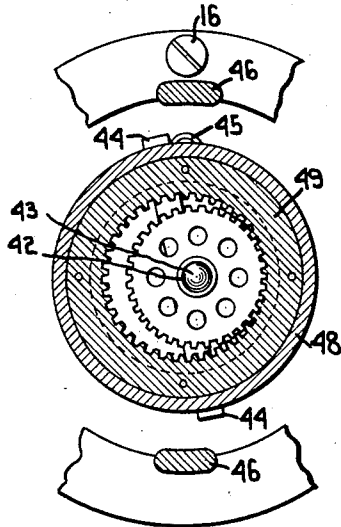


Fig. 4.

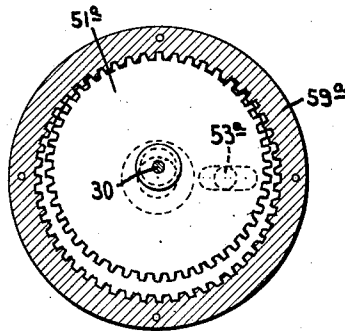
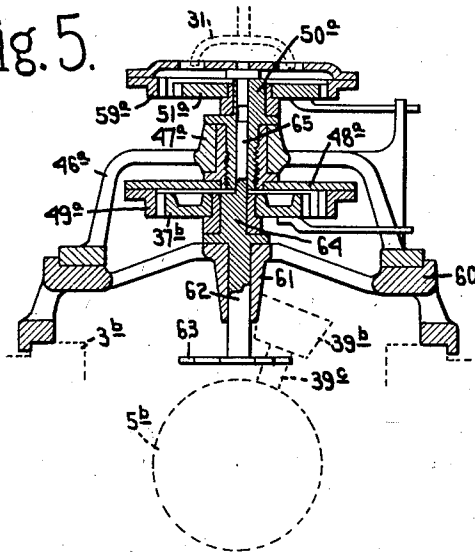


Fig. 5.



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4 Sheets-Sheet 4

Fig. 6.

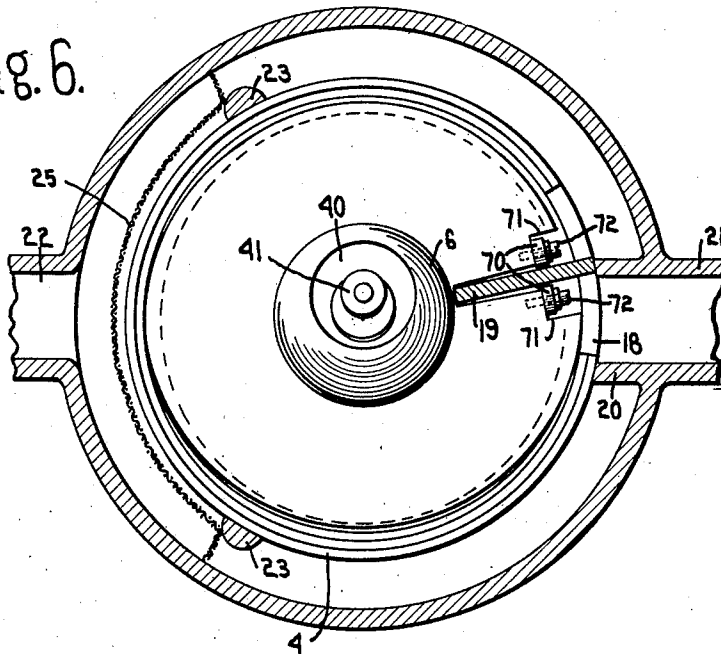
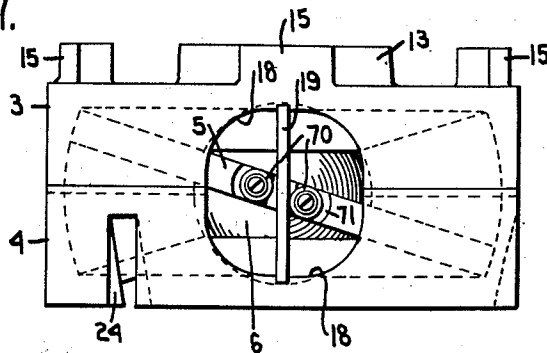


Fig. 7.



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UNITED STATES PATENT OFFICE.

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METER.

Application filed July 12, 1922. Serial No. 574,512.

This invention relates to meters of the type largely used for measuring water supplied to domestic users by municipal water works, although the same is not limited either to this liquid or to this type of use. The essentials of such a device are simplicity, cheapness, accuracy, long life, and sensitiveness to small flows. The usual type of such meter has become fixed by selection and custom to that having a nutating disk, connected by reducing gearing to an integrating train, said gearing being necessarily submerged in water in order to avoid the necessity of employing a high speed stuffing box, although the integrating train is generally separated from the water chamber by a stuffing box owing to the fact that the speed of the rotating member at this point has been so reduced by the gearing that the wear upon the stuffing box and the retarding effect of the friction are both negligible. However the submergence of the gear train in the water tends to produce a rapid wearing of both the teeth and bearings, especially by any sand suspended therein, this wear being particularly noticeable upon the rapidly moving members of the gear train. The objects of my invention are the provision of a gearing for meters which shall be less subject to wear than previous devices; shall consist of a much smaller number of moving parts, and these of a slower average rate of movement and a larger size of bearing surfaces; and the provision of a gearing for this purpose which shall be mounted with a maximum of simplicity so as to reduce the likelihood of disalignment. Further objects of the invention relate to improvements in the mode of connecting the nutating disk with the gear train so as to reduce the friction to the smallest possible degree and the provision of new, improved, and simplified means for holding the nutating disk against rotation; while further objects and advantages of my invention will become apparent as the description proceeds.

In the drawings accompanying and forming a part of this application I have shown certain physical forms in which my inventive idea can be embodied, although without intent to limit myself thereto since the same are intended to be merely illustrative and not limiting upon me. Fig. 1 is a vertical sectional view through a preferred form of meter embodying my improvements, Fig. 2 is a similar view showing a modification;

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 1 and looking in the direction of the arrows; Fig. 4 is a sectional view corresponding to the line 4—4 of Fig. 2, and looking in the direction of the arrows; Fig. 5 is a vertical sectional view through a gearing embodying my invention as designed for replacement purposes in existing types of meters; Fig. 6 is a sectional view of the meter shown in Fig. 1, the upper part of the metering chamber being removed to show my improved nutating disk; and Fig. 7 is a side elevation of the metering chamber shown in Fig. 1 with my improved disk therein.

Describing the parts by reference numerals, 1 represents the meter casing which may be of any suitable or desired shape and size, that shown in Fig. 1 having intermediate of its height an annular internal seat 2 defining two chambers, one for the reception of the metering chamber and the other for the reducing gearing. The metering chamber is made of a pair of hollow, non-corrodible members 3, 4, fitted accurately together and preferably presenting a slightly tapered exterior surface adapted to fit snugly in the chamber prepared therefor. The interior of the metering chamber is formed in the usual manner for the reception of the nutating disk 5 and its central ball 6, and the member 4 is formed exteriorly with a seat 7 adapted to rest against the packing 8 of the frangible cap 9 which is secured in place by the bolts 10 in such wise as to yield or break upon freezing in the usual manner. The corresponding part of the other member, 3, is formed with a central opening 12 disclosing the ball and surrounded by an upstanding flange 13 on which is seated the circular plate 14, the top of the member 3 being also formed with spaced bosses 15, 15 to which this plate is fastened by screws 16.

The side walls of the members 3 and 4 are formed at one point with registering notches 18 traversed by the upright diaphragm plate 19 which is inset tightly so as both to fix the positions of the two parts relatively to each other and to define an inlet and outlet. The interior of the casing is formed with a hollow boss 20 adapted to communicate with the outlet so defined, said boss communicating with the outlet nipple 21. Some other part of the casing is formed with an inlet nipple 22, and the metering casing is held tightly against the boss 20 by suitable

ribs 23, which, however, permit the water to flow freely around all sides of the casing in order that its pressure may not deform the parts nor cause them to bind. Suitable notches or passageways 24 are also provided to permit the liquid to reach the end of the member 4. In accordance with the illustration of the drawings I shall hereafter denominate this the bottom of the casing, although I do not restrict myself to such use nor is the meter restricted to such position. In order to reach the inlet the liquid must flow over, around, and under the metering chamber, a screen 25 being preferably provided at some point in its course.

The top of the casing is formed with a web 26 surmounted by a hollow cup 27 upon which is a casing 28 having therein a suitable integrating train such as is shown in Fig. 2. Journalled in the center of this web is a rotatable spindle 30 having at its lower end a fork or other coupling element 31 and having its upper end connected to the integrating train by the gears 32, known as "change gears", leakage at this point being prevented by a stuffing box 33. The parts heretofore described are old and standard, and my improvements will now be described.

Mounted for universal movement above the metering casing and operatively connected with the ball 6 is a nutating staff 35 having intermediate its ends the ball 36, and operatively associated with the upper end of that staff is a gear wheel 37. Of the numerous possible modes of mounting and operating this staff, I prefer that shown in Fig. 1, though other modes, such as shown in Fig. 2 are entirely operative. In Fig. 1 the plate 14 carries a depending hollow cone 38 in which the ball 36 is mounted and through which the staff 35 extends. The angle of this cone is the same as the angle of nutation of the disk 5, and the ball 6 is provided with an axial pin 39 called the control bar which revolves around the cone. This pin may be caused to function as a bolt to hold the parts of the ball together as shown in Fig. 1 or the ball may be made solid as shown in Fig. 2. Preferably the ball is formed around the upper end of this pin with a recess 40 receiving the staff 35 which engages a roller or enlargement 41 on the pin. With this arrangement the staff 35 follows the nutation of the disk 5 and the effect of the staff is to hold the control bar away from the cone, thereby decreasing friction. Indeed under ordinary circumstances the control bar never comes into contact with the cone, but other arrangements can be employed as will hereafter be described.

In Fig. 1 the sun gear wheel 37 is shown as provided with a hub 42 which loosely receives the ball 43 formed on the upper end of the staff 35, rotation of the gear being prevented by a finger 44 engaging a

post 45 on the plate 14. I have shown the finger as symmetrical for balancing, though one post is enough. Secured to the plate 14 is a bracket 46 having a vertical bearing 47 directly in line with the axes of the balls 6 and 36, and journaled in said bearing is the hub of a spider 48 to which is secured an internal or planet gear 49 meshing with the gear 37. Above the bearing 47 and rotatable with the spider 48 is an eccentric 50 on which is sleeved a second gear 51 similar to the gear 37 and similarly restrained from rotation by the fingers 52 engaging the post 53 carried by the bracket 56.

The eccentric is formed with a vertical socket in line with the bearing 47 receiving a rotatable arbor 57 which supports and centers the spider 58, which in turn carries the internal or planet gear 59 meshing with the sun gear 51. The spider 58 is formed for engagement with the fork 31 whereby the spindle 30 is driven. The external and internal gears having unequal numbers of teeth, the result of their interaction is a slow, differential progression, and the two differential gears being arranged in series, the effect of the one is multiplied to that of the other. The speed reduction is so great that the movement of the parts is very slow, added to which the amount of tooth surface in contact at all times is very great. All the gearing is supported from the single bearing 47 and the number of parts is a minimum. Moreover these parts can be duplicates in case the ultimate ratio be a perfect square. Standard meters are now in use having ratios of 144 to 1, 168 to 1, and 256 to 1. The first named ratio can be secured by two 12 to 1 differential gears and the last by two 16 to 1 differential gears, while the second differs from a pair of 13 to 1 gears by an amount that is inside the accepted tolerance limits.

It should be noted, however, that both the ratio and the direction become changed depending whether it is the inner or the outer gear which is held against rotation. If the inner gear be held from turning, then it becomes the standard about which rotation is counted and the ratio is determined to the number of its teeth; however if the outer gear be held against rotation as shown at 59^a in Fig. 2, while the spur gear 51^a be connected to the spindle 30, then that spindle will be driven in the opposite direction and at a ratio determined by the number of teeth on the outer gear. Thus with gears of 36 and 39 teeth, the ratio will be 12 to 1 in one direction when the smaller gear is held and 13 to 1 in the opposite direction when the larger gear is held. Owing to the large number of teeth in contact, the gears can be made comparatively thin which enables them to be punched instead of milled.

The parts shown in Fig. 2 are essentially the same as in Fig. 1 so far as my improved

gearing is concerned, the parts 46 to 50 being identical and the only difference being that the post 53^a engages the spider 58^a of the internal gear 59^a instead of a finger carried by the external gear. Also the plate 14 is omitted, thus permitting the water to swirl freely through the gearing, whereas in Fig. 1, although the plate is not water tight and the gearing is submerged, the gear chamber defined thereby is so closed that sand-bearing currents are excluded.

In Fig. 2 I have shown the ball 6^a as formed on its upper side with an axial recess 40^a in which is received the spherical lower end of the nutating staff 35^a. The middle of this staff is provided with a ball 36^a mounted in a socket formed in the top wall of the member 3^a of the metering chamber, and the gear 37^a is fastened directly to this staff, rotation being prevented by a pin or post 45^a in the socket engaging a suitable slot in the ball 36^a.

With this arrangement the control cone 38^a is necessarily carried on a bracket 38^b fastened to the bottom of the part 4^a of the metering chamber, the control bar 39^a now projecting downwardly. This is a perfectly operative arrangement but is inferior to the first for two reasons: the effect of the staff is to oppose that of the cone, thereby increasing friction; and the nutating gear 37^a does not make as good contact as the sliding gear.

In Fig. 5 I have shown a gear assembly of my invention ready to substitute for the spur-gear train ordinarily employed. 5^b represents the nutating ball, 39^b the contact-bar-roller, and 3^b the top of the metering chamber. To this top I fasten a frame 60 having at its center a depending hollow stud 61 taking the place of the contact cone and carrying a rotating spindle 62 with a star wheel 63 at its lower end to engage the control bar 39^b. Carried by the upper end of the spindle is an eccentric 64 (in place of the usual 8 or 9 tooth pinion) operating the non-rotating gear 37^b which meshes with the internal gear 49^a journaled by the spider 48^a to the hub 47^a of the bracket 46^a. The hub of this spider carries in turn a second eccentric 50^a operating the nonrotating gear 51^a which meshes with a second gear 59^a which in turn engages the dogs 31. In case this assembly be substituted for an eight-gear train it will be made as shown, but if substituted for a six-gear train it is necessary to reverse one of the differentials as shown in Fig. 2 and 4. In this view I have shown the eccentric 64 as provided with an axial pilot 65 entering a bore in the next member for better centering.

It is characteristic of this class of devices that the disk 5 itself does not rotate, being formed at one point with a slot 69 to straddle the diaphragm 19. Many of the most careful meter makers seek to keep the

sides of this slot from rubbing against this diaphragm and expensive expedients have been employed to this end. I have discovered that the portion of the disk adjacent to this diaphragm need not be continuous and that a roller 70 located in a notch 71 at this point and pivoted on a radial or nearly radial stud 72 serves every purpose, and runs satisfactorily against the diaphragm notwithstanding any accidental bending or leaning thereof, as well as having no adverse effect upon the accuracy of metering, inasmuch as close fit between the disk and diaphragm is not essential. I have shown two rollers, one on each side of the diaphragm, and this is the best construction, but in practice the wear occurs practically all at one side, namely at the outlet opening, and a single roller located at this point is sufficient.

While I have described my invention in detail, I do not limit myself to such details but claim as my own, not only the various alternatives here illustrated and described, but all others falling within the terms of my claims.

Having thus described my invention what I claim is:

1. In a meter, the combination, with a nutating member, of a bracket having a bearing in line therewith, a hub journaled in said bracket and having an eccentric at one end and an internal gear at the other end, an external gear operatively connected to said nutating member and meshing with said internal gear, a spindle in line with said hub, and a second internal and external gear interposed between said eccentric and spindle, one of said last gears being connected to the eccentric and the other to the spindle, and means for holding one gear of each pair against rotation.

2. In a meter, in combination, a nutating element, a spindle, a stuffing box therefor, a single bearing in the common axis of said element and spindle, means to support said bearing, two gears partially carried by said bearing, one having a rotary motion and the other a planetary motion, a gear paired with each of the first gears, one connected to the nutating element and the other to the spindle, one gear of each pair being internal and the other being external.

3. In a meter, the combination with a metering disk having a ball at its center and a hollow control cone having its axis directed towards the center of the ball, of a control bar carried by the ball and projecting adjacent to the exterior of the cone, the ball being recessed adjacent to said bar, and a nutating staff projecting through said cone into said recess.

4. In a meter, the combination with a metering disk having a ball at its center and a hollow control cone having its axis directed towards the center of the ball, of a

control bar carried by the ball and projecting adjacent to the exterior of the cone, the ball being recessed adjacent to said bar, a nutating staff projecting through said cone
5 into said recess, a non-rotatable spur gear operatively connected to said staff, and an internal gear meshing with said spur gear.

5. In a meter, the combination with a nutating disk having a central ball and a
10 hollow control cone having its axis directed towards the center of the ball, of a control bar carried by said ball and movable about said cone, an operating staff projecting through said cone and engaging said bar,
15 and a planetary gear operatively connected to said staff.

6. In a meter, the combination with a nutating disk of an axial spindle rigid therewith and projecting therefrom, a second
20 nutating spindle engaging with and adapted to be driven by said first spindle, and a differential gearing of the planetary type having one of its members operatively connected to said second spindle.

25 7. In a meter, the combination with a nutating disk, and a rotatory-spindle, of a pair of internal and external gears, one of the same being mounted for rotation about an axis concentric with the disk and the
30 other operatively connected to said disk for eccentric movement in time therewith, a second pair of internal and external gears, operative connections between one of said
35 last gears and the spindle, means operative upon the operation of said first gears to afford an eccentric movement to the other of said last gears, and means for holding one gear of each pair against rotation.

40 8. A gear train for water meters comprising a support, a rotary member mounted therein and having an eccentric at one end and an internal gear at the other end, a planetary gear adapted for actuation by a
45 nutating disk, a second pair of internal and external gears, one connected to said eccentric and the other adapted to drive an integrating train, and means for holding one gear of each pair against rotation.

50 9. As an article of manufacture and sale, a self-contained gearing unit for existing meters comprising a yoke having a vertical aperture, a hub journaled in said aperture and having a vertical axial socket in its
55 upper end, an internal gear carried by the lower end of said hub, and an eccentric carried by the upper end of said hub, a spur-gear meshing with said internal gear and adapted to be gyrated by a nutating disk, a pair of intermeshing internal and external
60 gears located above said yoke, one of the same being journaled in said axial socket and the other being journaled on said eccentric, and means for holding one of each pair of gears against rotation.

65 10. As an article of manufacture and sale

a replacement gear train for existing meters consisting of a supporting plate having a spindle adapted for rotation by a metering disk, and a pair of differential gear mechanisms of the planetary type arranged in
70 series, the initial member of one pair being operatively connected to said spindle.

11. In a meter, a nutating disc, a stem carried thereby and movable therewith, a first planet gear, a first sun gear, a second planet
75 gear, a second sun gear, an operated device, a non-rotatable lever having one end lying in the path of movement of said stem and the other end in engagement with one of said first gears whereby movement of said stem in
80 response to the nutations of said disc will swing the one end of said lever in a circular path to thereby swing the other end of said lever in a circular path and thus impart to the gear engaged thereby a non-rotating circular
85 translatory movement, means whereby the other of said first gears imparts to one of said second gears a non-rotating circular translatory movement, and means whereby the other of said second gears operates said
90 operated device.

12. In a meter, an operating device, a first planet gear, a first sun gear, a second planet gear, a second sun gear, an operated device, means whereby said operating device imparts
95 to said first planet gear a non-rotating circular translatory movement, means whereby said first sun gear imparts to said second sun gear a non-rotating circular translatory movement, and means whereby said second
100 planet gear operates said operated device.

13. In a meter, a nutating disc, a stem carried thereby and movable therewith, a planet gear, a sun gear, and a lever having one end
105 lying in the path of movement of said stem and the other end in engagement with one of said gears and mounted independently of said gear, whereby movement of said stem in response to the nutations of said disc will
110 swing the one end of said lever in a circular path to thereby swing the other end of said lever in a circular path and thus impart to the gear engaged thereby a non-rotating circular translatory movement.

14. In a meter, a nutating disc, a stem carried thereby and movable therewith, a first
115 planet gear, a first sun gear, a second planet gear, a second sun gear, an operated device, a lever having one end lying in the path of movement of said stem and the other end in
120 engagement with one of said first gears whereby movement of said stem in response to the nutations of said disc will swing the one end of said lever in a circular path to thereby swing the other end of said lever in
125 a circular path and thus impart to the gear engaged thereby a non-rotating circular translatory movement, means whereby the other of said first gears imparts to one of said second gears a non-rotating circular
130

translatory movement, and means whereby the other of said second gears operates said operated device.

15. In a meter, an operating device, a first planet gear, a first sun gear, a second planet gear, a second sun gear, an operated device, means whereby said operating device imparts to one of said first gears a non-rotating circular translatory movement, an eccentric operated by the other of said first gears to impart to one of said second gears a non-rotating circular translatory movement, and means whereby the other of said second gears operates said operated device.

16. In a meter, a nutating disc, a stem carried thereby and movable therewith, a planet gear, a sun gear, and a lever pivoted coaxially with said disc and having one end lying in the path of movement of said stem on the opposite side of said axis from said stem and the other end in engagement with one of said gears whereby movement of said stem in response to the nutations of said disc will swing the one end of said lever in a circular path to thereby swing the other end of said lever in a circular path and thus impart to the gear engaged thereby a non-rotating circular translatory movement.

17. In a meter, a nutating disc, a stem carried thereby and movable therewith, a planet gear, a sun gear, and a non-rotatable lever having one end lying in the path of movement of said stem and the other end in engagement with one of said gears whereby

movement of said stem in response to the nutations of said disc will swing the one end of said lever in a circular path to thereby swing the other end of said lever in a circular path and thus impart to the gear engaged thereby a non-rotating circular translatory movement.

18. In a meter, a nutating disc, a stem carried thereby and movable therewith, a planet gear, a sun gear, and a lever having one end lying in the path of movement of said stem and the other end in engagement with one of said gears whereby movement of said stem in response to the nutations of said disc will swing the one end of said lever in a circular path to thereby swing the other end of said lever in a circular path and thus impart to the gear engaged thereby a non-rotating circular translatory movement.

19. In a meter, an operating device, a first planet gear, a first sun gear, a second planet gear, a second sun gear, an operated device, means whereby said operating device imparts to one of said first gears a non-rotating circular translatory movement, means whereby the other of said first gears imparts to one of said second gears a non-rotating circular translatory movement, and means whereby the other of said second gears operates said operated device.

In testimony whereof, I hereunto affix my signature.

JOHN E. McALLISTER.