Oct. 4, 1932. H. CHRISMAN 1,880,195

LIQUID METER

Filed Oct. 15, 1931 2 Sheets-Sheet 1

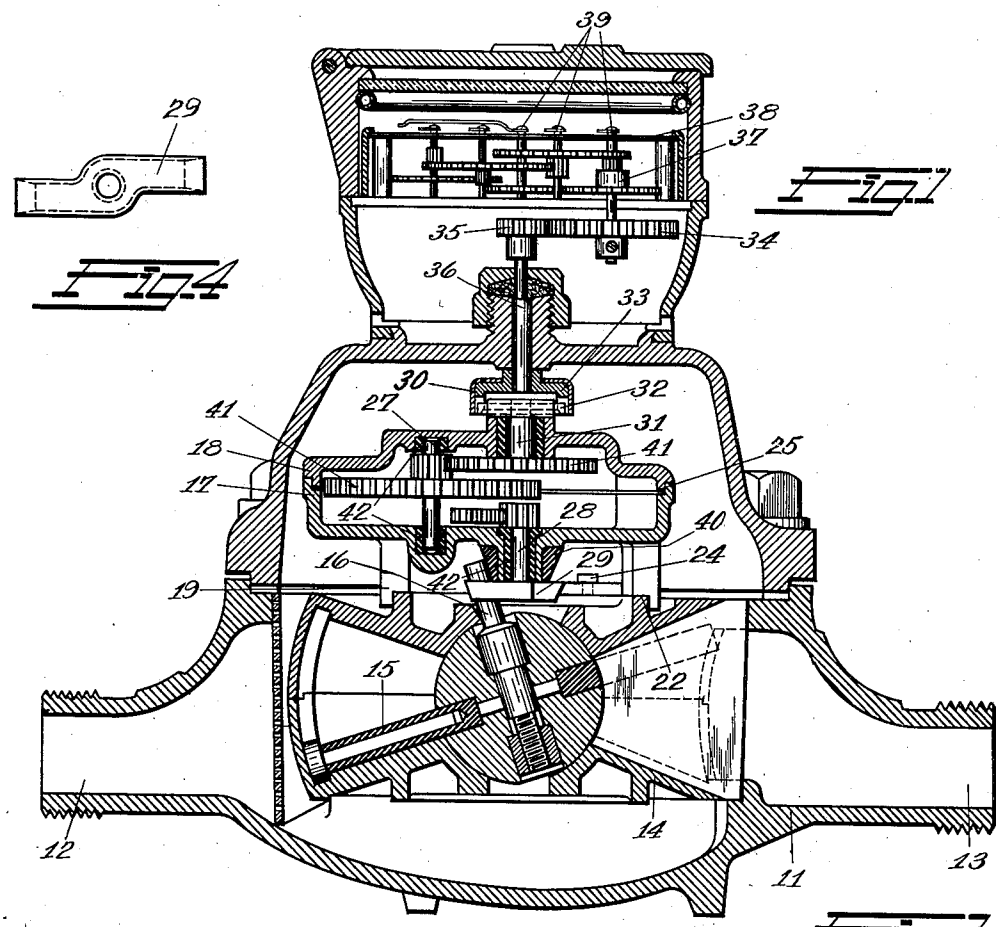


Fig. 1

Fig. 4

Fig. 2

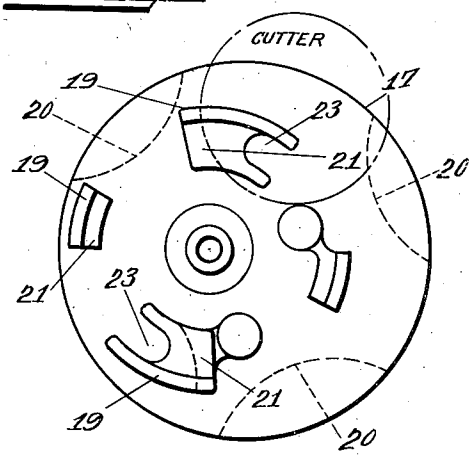
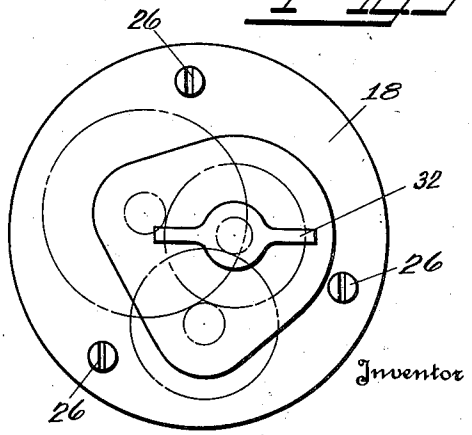


Fig. 3



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LIQUID METER

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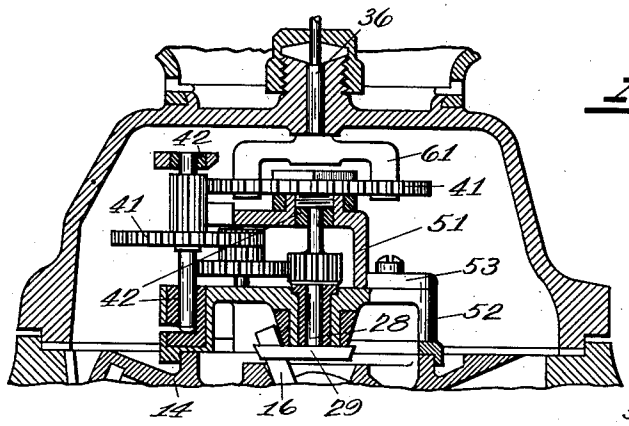
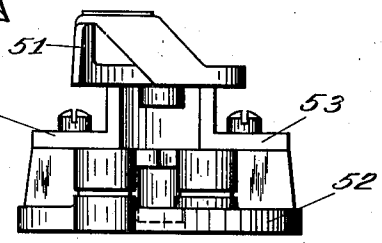


Fig. 5

Fig. 6



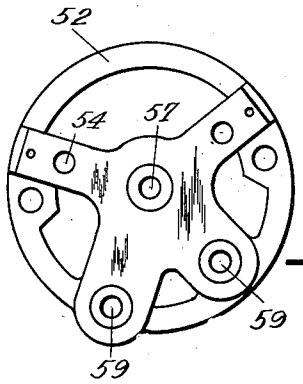


Fig. 7

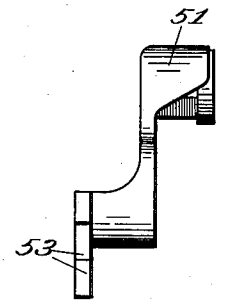


Fig. 9

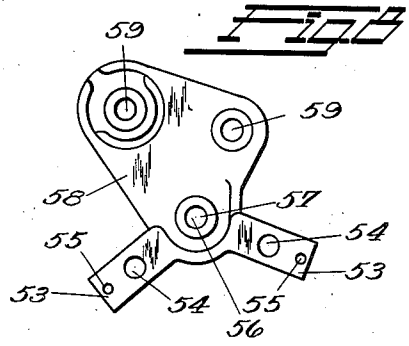


Fig. 8

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Patented Oct. 4, 1932 1,880,195

UNITED STATES PATENT OFFICE

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LIQUID METER

Application filed October 15, 1931. Serial No. 569,041.

This invention relates to liquid meters, and particularly to the gear trains interposed between the driven parts of the meters and the register mechanisms thereof.

One common form of liquid meter in use today comprises an outer casing in which is positioned a chamber having a nutating disc therein which oscillates due to flow of liquid through the chamber, the movement of the disc being transmitted to a register by way of a reduction gear train positioned within the casing. In some forms of meters, this reduction gear train is mounted in an open framework whereby the gears, pinions, shafts, bearings, and other parts are immersed in the liquid and are therefore subjected to the corrosive action of the liquid. In other forms of meters, this gear train is encased within a housing which is sealed against the entrance of liquid and contains a lubricant for the gears, pinions and shafts. In either of these types, some of the operating mechanism is always exposed to the liquid being passed through the meter.

The construction of liquid meters has been highly developed to reduce the friction of the moving parts to a minimum and the meters function accurately under tests and when initially installed. However, experience has shown that liquid meters deteriorates in use such that they become progressively less accurate. It has been found that this inaccuracy is due to a great extent to the corrosion of vital parts of the operating mechanism by the liquid, this corrosion taking place in water meters also even when relatively small percentages of acids or alkalies are in the water. Various expedients have been resorted to in an effort to check this corrosion, such as by the use of various metal alloys and more accurate machining of the parts, but these efforts have been only partially successful since the meters continue to deteriorate in service. It has been the usual practice to cast the supporting framework for the gear train in sand molds, whether said framework comprises an enclosing casing or an open frame, and then to machine this frame to size and drill the necessary openings to support the spindles and the gears in position.

The gear-train supporting frames heretofore used are generally cast from brass or bronze. One brass alloy which has been extensively used is composed of a large proportion of copper and small equal proportions of lead, zinc and tin. The composition of the alloys for these parts has been varied from time to time in an effort to secure castings that would not deteriorate in use and thus cause a substantial change in accuracy of the meter after use but such efforts have been unsuccessful.

I have discovered that the deterioration of the parts of the meter subjected to the liquid is largely due, not to the nature of the alloy used, but to the porous nature of the castings, whereby acid or alkaline liquids find minute openings to attack the members. The supporting framework for the gear train is frequently of relatively complex form and it has been generally assumed that casting the parts was essential, and that the corrosive effects of the liquid could only be eliminated by changing the alloys used.

The present invention is directed to the die-forging of the gear train parts exposed to the corrosive action of the liquid, thus eliminating defective castings caused by sand, faulty venting, and porous metal; thus providing parts which are far more uniform prior to the few necessary machining operations due to elimination of irregularities inherent in sand cast members. It is therefore unnecessary to rough-machine the supporting framework for the gears and the moving parts which are thus forged, and the necessity of chipping and filing the previous sand-cast members is also eliminated.

I have discovered that a suitable brass alloy can be die-forged to provide the frame, gears, driving arm, driven dog, and other parts of the gear train of a liquid meter, which will overcome the difficulties encountered in prior sand-cast parts. Parts of a liquid meter made in accordance with this invention by a die-forging operation have a surface hardness or density much greater than cast members, making them much less susceptible to corrosive action of liquids than cast members.

The die-forged members of a liquid meter made in accordance with the present invention therefore increase the life and maintain the accuracy of the meter far longer than the prior cast members. Furthermore, the die-forged supporting frame for the gear train is cheaper to manufacture in that many expensive machining operations may be eliminated and a much more attractive and saleable meter is produced due to the improved surface and regular appearance of the parts.

The principal object of this invention therefore, is to provide a gear train for liquid meters which give accurate service over a longer period of time than members previously used.

Another object of this invention is to provide a gear train for liquid meters wherein many expensive machining operations are eliminated and the discarding of many parts due to defective casting is eliminated by die-forging of the parts.

In prior practice it has been found that intermeshing gears and pinions of dissimilar metals wear longer in liquid meter gear trains and therefore give more accurate registration. Cast bronze gears in mesh with Monel metal pinions were tried in these gear trains but it was found that the cast bronze gears rapidly deteriorated due to the corrosive action of the liquid. Therefore in many meters today both gears and pinions are made of the same non-corrosive metal such as Monel metal.

Still another object of this invention therefore is to provide a liquid meter gear train in which the gears are die-forged from a brass alloy, each such gear intermeshing with a pinion of dissimilar metal such as Monel metal. By this combination the longer life of intermeshing gears of dissimilar metals is obtained and the die-forged gears do not corrode during use.

In order to combat the corrosive action of acid or alkaline liquids it has been customary to hot tin the cast parts after all machining operations to thereby impart a resistant coating. During to the inherent irregular surface of a cast member, this tinning has not been entirely successful in preventing corrosion since small air pockets are formed in the irregularities in the surface thus preventing the tin from coating many small areas, and corrosion begins at these points.

A further object of this invention therefore is to effectively prevent corrosion of all essential parts of the gear train whose change of shape would affect the accuracy of the meter and to avoid the prior hot tinning operation by die-forging the parts subject to corrosion thus forming smooth dense nonporous surfaces which are resistant to the action of acid or alkaline liquids.

Another object of this invention is to provide a gear train for use in liquid meters in which an open frame is provided for supporting the gears, pinions, and spindles, the frame, gears, and driving members interconnected to the register and movable meter member being made of die-forged brass and the pinions, spindles, and screws mounting the frame being of dissimilar metal, such as Monel metal.

Another object of this invention is to provide a gear train for use in liquid meters wherein the driving crank operably driven by the movable member of the meter in response to liquid flow, and the rotating member or dog driven by the gear train to drive the register are made of die-forged brass whereby the accuracy of the meter will not be affected by corrosion of these parts in use. In prior practice it has been found that corrosion attacked the spindle and dog secured thereto which drive the register, causing this spindle to bind in its bearing and thus cause excessive friction and inaccurate registration. By die-forging this dog the corrosion at this point is prevented.

A further object of this invention is to improve the construction of the casing enclosing the gear train of a liquid meter whereby it may be easily and accurately assembled in fixed relation to the nutating disk chamber of the meter.

Various other objects of the invention will be apparent from the following description and the appended claims taken in connection with the accompanying drawings wherein

Figure 1 is a vertical section through a liquid meter of the nutating disc type having a gear train embodying this invention.

Figure 2 is a bottom plan of the gear train casing of Figure 1.

Figure 3 is a top plan thereof.

Figure 4 is a plan of the driving crank for the gear train.

Figure 5 is a partial section through a liquid meter including an open frame gear train.

Figure 6 is a side elevational view of the open frame with the gear train removed.

Figure 7 is a top plan view of the lower portion of the open frame.

Figure 8 is a bottom view of the top portion of the open frame.

Figure 9 is a side elevational view of the member shown in Figure 8.

Referring to the drawings wherein like reference characters indicate like parts, Figure 1 illustrates the casing member 11 having the inlet opening 12 and the outlet 13 and containing a nutating disc chamber 14, preferably of die-forged brass construction as disclosed in the co-pending application of Harry G. Weymouth and Horace Chrisman Serial No. 460,975, filed June 13th, 1930. This chamber contains a nutating disc 15 having a pin 16 projecting out of the upper portion of the casing and adapted to drive the gear train.

In this form of the invention, the reducing

gears of the gear train are encased within two mating cup-shaped members 17 and 18 shown also in Figures 1, 2 and 3, and lubricant such as oil or grease is sealed within these members. The member 17 is provided with four downwardly projecting integral lugs 19 which have undercut shoulders as illustrated for cooperative engagement with an upstanding annular flange 22 on the chamber 14. Two of the lugs 19 have arcuate slots 23 therein for receiving the heads of bolts 24 which are secured to the chamber 14. The shoulders of lugs 19 make an accurate fit with the nutating disc chamber 14 and the casing member 17 is given a partial rotation to engage the slots 23 under the heads of the bolts 24 to thus firmly and accurately secure the gear train in position.

In accordance with this invention the members 17 and 18 are die-forged under high pressure from a suitable alloy, preferably a brass alloy. One such alloy which has been found to give satisfactory results is composed of approximately 60% copper, 37½% zinc, and 2½% lead. This alloy is formed into billets or disks containing about the correct amount of metal, and the billets are then heated to about 1250° F. and are then placed in the die press between suitable dies and are subjected to high pressure of the order of 600 tons. The downwardly extending lugs 19 are die-forged integrally with the lower member 17 and the arcuate slots 23 are die-forged therein. These slots 23 are preferably made diverging with the larger portions thereof at their upper ends to facilitate the die-forging and prevent sticking of the dies.

It will be seen from Figures 1 and 2 that two of the lugs 19 have overhanging arcuate portions extending parallel to the under surface of member 17 and connected thereto by lugs 21. In a die-forging operation it is impossible to forge the parts as thus shown, and so the members 17 when they come from the die-forging press have the portions 21 extending the full length of the arcuate portions, that is, there are no separate overhanging portions spaced from and extending parallel to the lower surface of member 17. Then two of the lugs 19 are milled out with a milling cutter, as shown by the dotted line showing of such cutter in Figure 2, to provide the overhanging arcuate portions having the slots 23 therein. This milling operation is not necessary in cast metal chambers but with the cast chambers many other machining operations are necessary which are eliminated by die-forging, such as an initial rough cut machining.

The upper member 18 of the gear train casing is provided with an annular depending flange 25 which seats in a recess in the upper edge of member 17, and the members 17 and 18 are secured in liquid-tight engagement by bolts 26.

The members 17 and 18 are provided with openings which align when the members are assembled to support a plurality of spindles 27. Furthermore, the lower casing 17 has an opening for supporting an outwardly projecting spindle 28 which has secured thereto a driving crank 29 shown in detail in Figure 4. The pin 16 secured to the nutating disc oscillates about the spindle 28 as a center and engages the crank 29 to thereby drive spindle 28 and the gear train.

At the upper portion of the member 18 of the gear train housing, a spindle 31 projects upwardly and carries a cross pin 32 which engages in slots in the driving dog 33 of the register mechanism.

The driving dog 33 is die-forged as previously explained and has engaged thereover a sleeve member 30 preferably of Monel metal. The die-forged dog 33 has a pressed fit with and is soldered to a shaft 36 and cross pin 32 is made of Monel metal. By die-forging the dog 33 an accurate and permanent fit is obtained and corrosion is prevented around these parts.

As indicated in Figure 1, the register mechanism includes a gear 34 driven by a pinion 35 secured to shaft 36 which projects through a stuffing box into the meter casing and has secured on its inner end the dog 33. The registering mechanism includes the usual gears and pinions 37 and the dial 38 over which the hands 39 move to register the flow of liquid through the meter.

It will be seen that the nutations of discs 15 are transferred by a surface engagement between the pin 16 and crank arm 29, thence by the intermeshing gears to spindle 31 and from the surface engagement of pin 32 with the dog 33, through spindle 36 and thence to the register. The various parts of the gear train are compactly arranged in a definite relationship and if the parts slip or move out of this relationship excessive friction and drag on the meter may result, causing inaccurate registration. For example, if the supporting lugs 16 become corroded to such extent that the entire housing formed by members 17 and 18 moves slightly, the resultant misalignment of the parts may cause excessive friction at some points in the drive, resulting in inaccurate registration of the meter. According to this invention, both the crank arm 29 and the dog 33 are die-forged under high-pressure from a brass alloy, one such alloy which has been found to give satisfactory service being formed of approximately 60% copper, 37½% zinc, and 2½% lead. It will be understood however, that the composition of the alloy used for all of the die-forged parts may be varied without departing from the spirit of this invention, so long as the alloy may be readily forged into the parts making up the gear train with

the improved results attained by the corrosion resistant surfaces.

The crank arm 29 and dog 33 as well as the other die-forged parts of the gear train mechanism are forged as described in connection with casing members 17 and 18. The male and female dies are of course carefully machined to exact size and the metal of the alloy is caused to flow therein to assume the desired shape. When the parts are die-forged as explained, the enormous pressure to which they are subjected causes the metal to be much more dense than the metal of sand-cast members. Furthermore the surfaces of these members are much smoother and harder and have a much improved finish.

The crank arms 29 and the dog 33 may be die-cast to the exact shape desired and the only finishing machining operation necessary is to properly machine the holes to fit the same on spindles. In this machining operation however, no rough turning operation is necessary since the die-forged parts are smooth and the final machine cuts may be made at once.

A hard rubber or fiber thrust roller 40 is journalled on an integral downwardly extending sleeve surrounding shaft 28 and nutating disk pin 16 bears against this roller. Any wear or corrosion of this sleeve materially affects the meter accuracy and by providing a die-forged casing 17 having the sleeve die-forged therewith, there is no corrosion of the casing or sleeve against which this thrust roller bears. Therefore the roller is maintained in correct alignment and any wear on the roller itself is even, whereas, if sand cast chambers are used, corrosion of the sleeve allows the roller 40 to twist out of alignment and excessive friction results. In some cases this misalignment is sufficient to prevent the roller from turning and it becomes worn out of shape. By preventing corrosion of the casing and the sleeve adjacent this roller the continued accuracy of the meter is insured.

The machining operations necessary on housing members 17 and 18 are reduced to a minimum by the die-forging operation, it being merely necessary to ream out the hole to receive the bushings for the spindles, mill out two of the lugs 19 as previously explained and finish off the meeting edges of the two members to provide the shoulders 25 to make a fluid-tight joint.

Furthermore, in order to secure the desirable characteristics provided by gears and pinions of unlike metals, the gears 41 of the gear train are also die-forged and the pinions meshing therewith are machined from Monel metal. These die-forged gears are superior in many respects to the usual cast gears since the openings between spokes and hub and rim of the wheels will always come out uniform. Although meshing gears of unlike metals are not essential for the oil enclosed gears of Figures 1 to 3, the gears 41 are die-forged to standardize production and to provide uniform parts in which machining operations are reduced. The gears used for the oil enclosed train are thus interchangeable with those of the open train hereinafter described. In the embodiment of the invention illustrated in Figure 1, rubber bushings 42 are provided in each of the openings of the mating members 17 and 18 to provide bearings for the spindles.

By the construction of the gear train as thus described, a relatively cheap and accurate gear train mechanism is provided in which the die-forged parts have imparted thereto a surface which is dense and therefore non-corrosive by ordinary acid and alkaline liquids. Furthermore, the parts are more uniform and require less machining. The casing provided by the members 17 and 18 may be used indefinitely without corrosion and the gear train will accurately transmit the motions to register after long periods of use.

In some meters it is desirable to make the gear train of Figures 1 to 3 of the open type instead of oil enclosed. For this purpose it is only necessary to cut out portions of the housing member 17 as indicated by dotted lines 20 of Figure 2. The mountings for spindles 27, lugs 19, and screws 26 are of course not cut away and cover 18 and the gears, pinions and spindles are used as in Figures 1 to 3. Thus these parts are readily convertible from an open to a closed gear train and vice versa, and the die-forged gears may be used with either form.

In the open frame gear train shown in Figures 5 to 9 the supporting frame is composed of an upper member 51 and a lower member 52 which are bolted together to provide supports for the spindles of the gear train. The upper member 51 as illustrated in Figures 6 to 8, has two arms 53 extending therefrom with holes 54 for receiving bolts to clamp the frame members in position, and pins 55 for engagement in correspondingly spaced openings in lower frame member 52 for accurately positioning the two frame members. The central boss 56 also has an opening 57 for supporting one of the spindles, and the triangular-shaped arm 58 has openings 59 for the same purpose.

The lower member 52 shown in Figure 7 is an open framework having openings 57 and 59 aligning with the corresponding openings of member 51 for supporting spindles of the gear train and openings 54 for the bolts securing the two members. It will be noted that in this form of the invention, the gears, spindles, and pinions are all exposed to the liquid being metered. In the form shown in Figures 1 to 4, the gear train is enclosed

within the closed casing members which are adapted to receive a lubricant to prevent excessive friction. In the open frame gear train of Figures 5 to 9, it will be seen that any corrosive action of an acid or alkaline liquid may attack the gears and pinions as well as the framework. In this form of invention as well as in the closed casing form, the main gears 41 are die-forged whereas the pinions are made of Monel metal. Furthermore in this form both the frame members, and the driving crank are also of die-forged brass and the pinions, spindles and screws are made of Monel metal to thus give the advantages accruing from intermeshing gears of unlike metals. With this form of invention it will be clear that the corrosive action of acid or alkaline liquids is prevented due to the die-forging under high pressure of all parts whose corrosion would affect te accuracy of the meter during use. Also, the parts give exceptionally long and accurate service under severe conditions of usage with liquids which would seriously corrode and interfere with the accurate operation of cast parts. With open frames wherein the gear train is exposed to the liquid, gears machined from cast brass or bronze become seriously corroded after use, and the accurate operation of the meter is seriously affected.

In both forms of gearing shown, the dog which operates the register mechanism is die-forged and the spindle upon which it is mounted is made of German silver. This combination of metals both of which are resistant to corrosive action, prevents the corrosion where the spindle passes through the casing. This point has caused difficulties in the past since corrosion around the spindle or at the dog has caused the spindle to get out of alignment and to then bind in its bearings, causing excessive friction and inaccurate registration.

In the open frame gear train shown in Figures 5 to 9 the dog for driving the register engages directly through holes in the cast-driven gear of the train. As seen in Figure 5, this dog comprises a member 61 having downwardly projecting arms which engage through openings in the gear. This dog 61 is also die-forged under high pressure to prevent corrosion of the same.

The gear train mechanism for meters constructed in accordance with this invention by die-forging the parts may be operated over long periods of use without deterioration and corrosion, and the meters give accurate registrations at all times. The brass alloy herein given has been found to give excellent results, but this alloy may be varied, it being essential that an alloy be used which may be readily die-forged and which will have a surface of dense texture which is smooth and not readily attacked by acids or alkalines.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:—

1. In a liquid meter having a casing with a liquid inlet and outlet; a measuring chamber mounted in said casing; a register; a gear train in said casing and having parts exposed to the liquid being metered, said gear train being characterized by the fact that said exposed parts are die-forged of brass to provide dense texture surfaces which are substantially non-corrodible by acid and alkaline liquids; means operably connecting said gear train to said register, and means operated by the flow of liquid through said measuring chamber and operably coupled to said gear train.

2. In a liquid meter having a casing with a liquid inlet and outlet, a chamber in said casing having a nutating disk therein, a pin carried by said disk and oscillated by movement thereof; a register; a gear train in said casing operated by said pin and having parts thereof exposed to the liquid being metered, said gear train being characterized by the fact that said exposed parts are die-forged of brass to provide dense texture surfaces that are substantially non-corrodible by acid and alkaline liquids; and means operably connecting said gear train to said register.

3. A liquid meter comprising a casing; a nutating disk chamber disposed in said casing; a nutating disk mounted in said chamber and having a pin associated therewith; a register; means having a driving arm for operating said register; a gear train interposed between said disk and said arm, comprising a series of spindles and gears; two mating members, which when assembled support said spindles and gears; two shafts projecting from said gear train; one shaft having an arm driven by said pin, the other shaft having a member engaging said driving arm, said mating members and said two arms being formed of brass die-forged under high pressure to provide surfaces of dense texture substantially non-corrodible by acid and alkaline liquids.

4. In a liquid meter having a casing, a nutating disk chamber mounted in said casing with a nutating disk therein; said disk having a pin thereon; a register; a gear train interposed between said nutating disk and said register, said gear train including an arm driven by said pin to drive said gear train and being exposed to the liquid being metered,

said arm being formed of brass die-forged under high pressure to cause the surface thereof to be smooth, non-porous and of dense texture substantially non-corrodible by acid and alkaline liquids, and means operably coupling said gear train to said register.

5. In a liquid meter having a casing, a nutating disk chamber mounted in said casing with a nutating disk therein; a register; a gear train interposed between said nutating disk and register; means operably coupling said nutating disk and gear train; means operably coupling said gear train and register, said last named means including an arm which is normally exposed to the liquid being metered, said arm being formed of brass, die-forged under high pressure to cause the surface thereof to be smooth, non-porous, and of dense texture substantially non-corrodible by acid and alkaline liquids.

6. A liquid meter comprising a casing having an inlet and outlet; a nutating disk chamber and a nutating disk therein mounted in said casing; said nutating disk having a rotary pin associated therewith; a gear train, a register; means operably coupling said register to said gear train including an arm; means operably coupling said gear train and said pin including an arm; said gear train comprising two mating frame members having aligned bearings therein, spindles supported in said bearings carrying gears and pinions, said frame members being of skeleton form whereby the gears, the pinions and spindles are exposed to the liquid being metered; said frame members and arms being formed of brass, die-forged under high pressure to provide surfaces which are smooth, non-porous and of dense texture substantially non-corrodible by acid and alkaline liquids.

7. The invention as defined in claim 6 wherein said frame members and arms are die-forged of brass alloy in substantially the proportions of 60% copper, 37½% zinc and 2½% lead.

8. An enclosing housing for the gear train of a liquid meter comprising two mating substantially cup-shaped members both of which are die-forged of brass under high pressure to impart a smooth dense texture to the surfaces of said members substantially resistant to corrosion of acid and alkaline liquids, one of said members having a plurality of downwardly extending integral lugs for supporting said housing in position in the meter, said lugs being cut away to provide overhanging arcuate portions having slots therein for the reception of headed fastening members.

9. In a liquid meter, a casing having a nutating disk chamber therein; an arcuate upwardly extending flange on said chamber; a gear train housing comprising two mating substantially cup-shaped members die-forged from brass under high pressure to impart a smooth dense texture to the surfaces thereof substantially resistant to corrosion of acid and alkaline liquids, the lower of said members having a plurality of downwardly extending integral lugs having slots therein for engagement with the upwardly extending flange on said nutating disk chamber, some of said lugs being cut back to provide overhanging arcuate portions having arcuate slots therein; and headed bolts secured to said nutating disk chamber and engaged in the arcuate slots in the overhanging portions of said lugs.

10. In a liquid meter having a casing, a nutating disk chamber in said casing, a nutating disk mounted in said chamber and having a pin mounted thereon; a gear train supporting frame, a shaft carried by said frame and having an arm engaged and rotated by said pin; and a thrust roller freely journalled on said frame and frictionally rotating in engagement therewith; said frame being die-forged under high pressure to provide a smooth dense non-porous surface substantially non-corrodible by acid and alkaline liquids, whereby the surface against which said roller engages will not corrode and thereby cause excessive friction.

In testimony whereof I affix my signature.

HORACE CHRISMAN.