May 13, 1947. L. I. MENDELSOHN 2,420,607

MAGNETIC REPULSION GENEVA MOVEMENT

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Fig. 1.

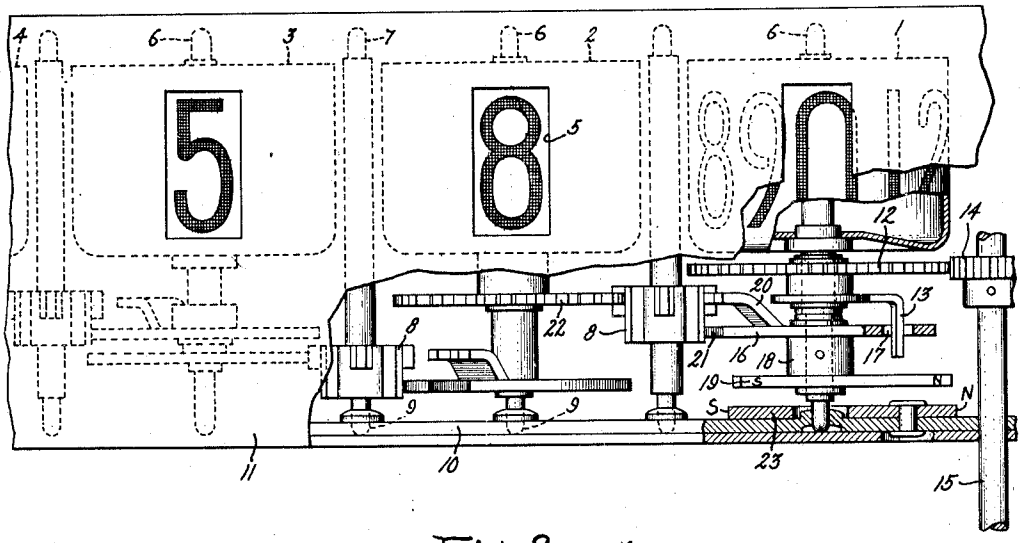


Fig. 2.

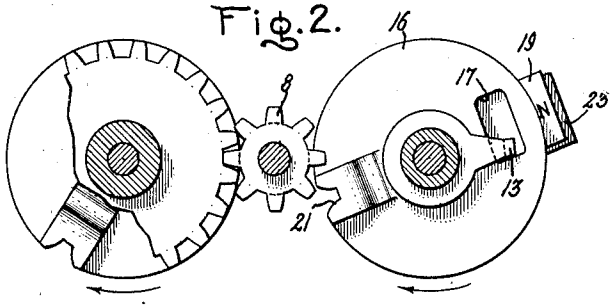
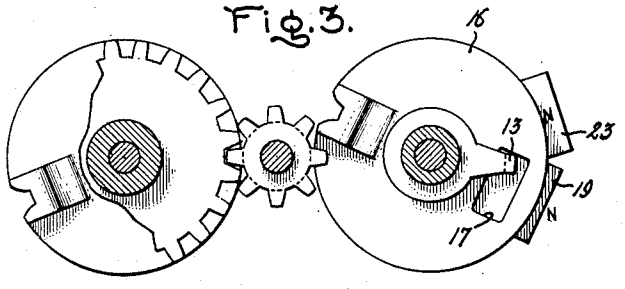


Fig. 3.



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Fig. 4.

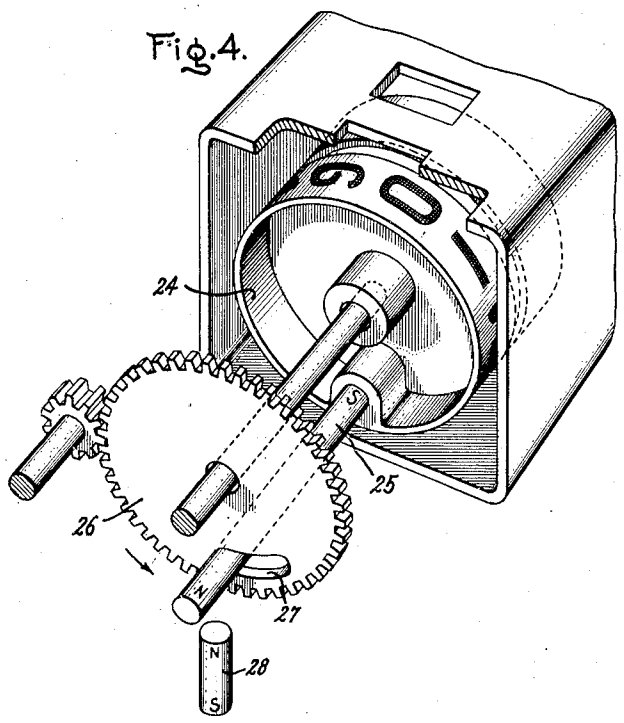
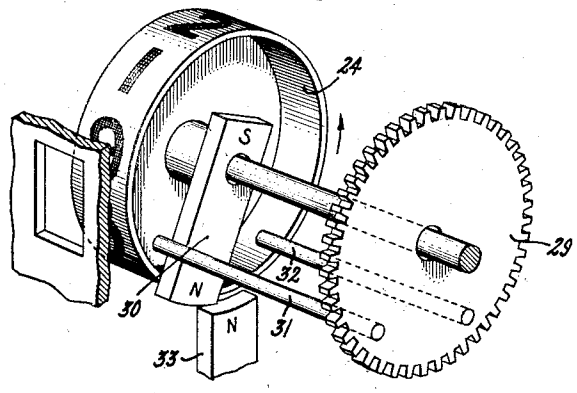


Fig. 5.



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UNITED STATES PATENT OFFICE

2,420,607

MAGNETIC REPULSION GENEVA MOVEMENT

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Application September 26, 1945, Serial No. 618,773

7 Claims. (Cl. 235—91)

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My invention relates to a Geneva movement gearing arrangement wherein the advance of the driven member of the movement is produced by repulsion of magnetic forces. The invention is particularly useful in meter driven registers where a step advancing operation of one or more cyclometer type counting drums or wheels is desirable with a minimum of frictional load on the meter, since the invention minimizes the friction of the conventional Geneva drive and requires no springs or weights for its operation.

The features of my invention which are believed to be novel and patentable will be pointed out in the claims appended hereto. For a better understanding of my invention, reference is made in the following description to the accompanying drawing in which Fig. 1 represents a sectional side view of a meter register equipped with my invention; Figs. 2 and 3 are fragmentary plan views of the drive of Fig. 1 which will be referred to in explaining the repulsion action; Figs. 4 and 5 show other possible driving arrangements embodying the invention.

In Fig. 1, I have represented a partial face view of a register mechanism having unit, tens, hundreds, and thousands counting drums 1, 2, 3, and 4. The drums are interconnected by driving means such that they all rotate in the same direction, right to left, as viewed in Fig. 1, and so that the tens drum 2 makes $\frac{1}{10}$ revolution for each complete revolution of the unit drum 1, the hundreds drum 3 makes $\frac{1}{10}$ revolution for each complete revolution of the tens drum 2, etc. Also, all drums except the unit drum are advanced in steps of $\frac{1}{10}$ revolution each, such that the numeral indications thereon are correctly positioned in the windows 5 as shown, except during the instant of advance from one numeral to the next. The present invention concerns permanent magnet means associated with the unit drum for accomplishing such step advancing operation. It is noted that the shafts 6 of the drums and the shafts 7 of the transfer gears 8 between the drums are vertical and have step bearings 9 in the lower wall 10 of the casing 11. This in itself reduces friction as compared to horizontal shafts and also allows for the use of large, easily read, upright numerals on the drums.

The unit drum 1 together with a gear 12 and driving dog 13 are secured to the unit drum shaft 6 and are driven through gear 12, a gear 14, and shaft 15 from a meter or other apparatus, not shown. The register may for instance be that of a watthour meter.

Below dog 13 on shaft 6 of the unit drum is

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a driven disk member 16 having a slot 17 therein into which the turned-down end of dog 13 loosely extends. The slot is wide enough so that lost motion amounting to about $\frac{1}{10}$ of a revolution is permitted in the drive between the dog and disk member 16. Disk member 16 is mounted on a hub 18 with a permanent magnet 19 of bar shape and extending diametrically across the axis of rotation. Hub 18 is free to rotate on shaft 6 within the limits permitted by the lost motion connection 13—17. The disk member 18 has a driving tooth part 20 punched out of its rim and this tooth part is adapted to mesh with and drive the transfer gear 8 to the next or tens drum 2 when part 20 moves past transfer gear 8. The transfer gear has eight teeth but the lower ends of every other tooth are cut off. The lower four-toothed portion of the transfer gear 8 cooperates with the disk member 16 to lock the transfer gear from rotation except when tooth part 20 is in driving relation with the upper part of gear 8. At the time of such driving relation the adjacent lower tooth of gear 8 opposite disk member 16 enters the slot 21 formed in disk 16 by the punched-out part 20 and hence gear 8 is allowed to rotate ¼ revolution. At other times attempt to rotate gear 8 is prevented by the lower teeth coming against the full rim of disk member 16. Thus in Fig. 2 the tooth of gear 8 which overlies disk 16 is cut off opposite the disk, while the two adjacent teeth of gear 8 are locked from rotation by the disk 16. Disk 16 can, however, rotate clockwise driving gear 8 with a long tooth of the latter entering opening 21. The first transfer gear 8 meshes with a 20-tooth gear 22 secured to the shaft of the tens drum 2 so that when the toothed part 20 of disk 16 advances gear 8 ¼ revolution, drum 2 is advanced $\frac{1}{10}$ revolution. The drives for the following drums 3 and 4 are similar in operation to the transfer gear drive described. It now remains to be explained how when tooth part 20 drives gear 8, it does so in a quick advancing action even though drum 1 rotates slowly and conforms to the speed it is driven by the meter.

Secured to the floor of the casing and lying diametrically across the axis of rotation of the shaft 6 of the unit drum 1 just below permanent magnet 19 is a second permanent bar-shaped magnet 23. Magnet 23 is positioned so as to be parallel to magnet 19 when the toothed member 20 of disk 16 is about to contact and drive transfer gear 8 approximately as represented in Fig. 2. The two magnets are polarized so that their adjacent poles are of like polarity at this time and

hence set up a repelling magnetic force between them. This force resists forward rotation of disk member 16 as magnet 19 approaches the opposing position of magnet 23 until the magnets are exactly parallel at which time the rotative component of the force becomes unstable and as soon as magnet 19 passes very slightly beyond alinement with magnet 23, the opposing force drives magnet 19 and disk 16 in a clockwise direction in a quick forward step until dog 13 strikes against the upper edge of slot 17 about as shown in Fig. 3. During this quick repulsion force driving advance of disk 16 its tooth 20 drives the transfer gear 8 ¼ revolution, advancing the tens drum 2, $\frac{1}{10}$ revolution and bringing the next number on its drum into alinement with window 5. The force for driving drum 2 and subsequent drums is entirely repulsion force. It will also be noted that the magnets 19 and 23 extend both ways although not equally from the axis of rotation so that there is this repelling force at both ends. This is desirable as it tends to lift the shaft of drum 1 rather than shove it sideways and, as a consequence, the friction at its step bearing is reduced at the time energy is being stored and is released to advance the following drums 2, 3, etc. The advancing energy is made sufficient to advance all of the following drums 2, 3, etc., simultaneously, which action occurs when the register reading changes from 999 to 1000, for example.

The magnitude of this force can be nicely adjusted by the spacing of the magnets, their size, and length, or their strength.

When disk 16 and its magnet 19 have rotated 180 degrees from the position shown in Fig. 2, there is attraction between the magnets but little side thrust on the shaft. At this time the unit disk member 16 stops rotating until dog 13 has moved from the rear of slot 17 to its forward end after which the disk is again driven forward with the dog. There is no driving action with the following drums at the time, since the tooth 20 is approximately 180 degrees from the position shown in Fig. 2. It is to be noted that in this 180 degree attraction position just referred to the magnets 19 and 23 while parallel will be displaced endwise relative to each other, whereas in the repulsion position they are substantially superimposed. Hence the repulsion torque will have a higher maximum value than the attraction torque, which is a desirable condition. This is brought about by displacing the centers of the magnets slightly to one side of the axis of rotation. Thus the north poles of the magnets are farther from the axis of rotation than the south poles. When there is repulsion, the magnets are substantially superimposed and opposing poles are close together, whereas in the attraction position unlike poles are relatively farther apart. The magnetic forces in each case are inversely proportional to the square of the distance between the force producing magnetic poles. The material which I prefer to use for the permanent magnets is an alloy containing 50% copper, 20% nickel, 27.5% iron, and 2.5% cobalt prepared substantially as described in United States Patent No. 2,196,824.

Fig. 4 represents another embodiment of the invention where 24 represents a counting drum or other driven member and is driven in the direction of the arrow through a pin 25 and a driving gear 26. The pin enters a slot 27 in gear 26 and this connection permits lost motion between the two for the desired angular movement. The pin 25 is a permanent magnet polarized as indicated. At one point in its rotation the north pole of pin magnet 25 comes adjacent to the north pole of a stationary permanent magnet 28. If the rotation of gear 26 be counterclockwise as represented by the arrow, pin 25 will be driven to approximately the position shown by the gear. At this point a strong repulsion force exists between the like poles of the stationary and rotating magnets and as soon as pin 25 is moved very slightly past magnet 28, this magnetic force will suddenly drive magnet 25 to the forward end of the slot 27 and advancing drum 24 a like distance. Assuming that the axis of rotation be horizontal, the stationary permanent magnet 28 may preferably be located adjacent the path of magnet 27 at about the lowest point of its rotation. Thus the sidewise thrust on the rotating parts is in a lifting direction on the rotating parts. Also assuming that the weight of magnet 25 unbalances the rotating assembly, to the extent that this is so, the unbalanced weight assists in driving magnet 25 toward magnet 28 when 25 is moving downward, and 25 is assisted in moving upward by the repulsion forces.

The modification of Fig. 5 is much like Fig. 4 where 24 represents a counting drum and 29 a meter-driven advancing gear. Secured to the hub of drum 24 is a permanent magnet 30 disposed essentially as a spoke of the drum. The magnet 30 and drum 24 are driven counterclockwise by a lost motion driving connection comprising a pair of pins 31 and 32 extending from gear 29 on either side of magnet 30. Adjacent the lowest point of rotation of magnet 30 is a stationary permanent magnet 33 so polarized that it presents an opposing pole to the outer pole of magnet 30. The parts are shown in the position where magnet 30 is being driven toward magnet 33 by pin 31 against repulsion force. As soon as magnet 30 is slightly beyond magnet 33, the repulsion force will quickly advance magnet 30 and drum 24 until the magnet 30 strikes pin 32. Here again the magnet 33 is placed to best advantage to reduce the weight of rotating parts on bearings and utilizing the weight of magnet 33 to reduce the load on the driving meter when the repulsion force is being built up, and utilizing such magnetic forces as exist following a repulsion advance operation to assist the meter in lifting weight 30 from its lowest to highest position. While the magnetic force predominates over the unbalanced weight to control the quick advancing operation, there is no reason why we may not employ the best disposition of the magnets to minimize friction and reduce the load variations as explained. While Figs. 4 and 5 will ordinarily have additional counting drums driven at a lower ratio as in Fig. 1, such additional drums have not been completely shown, since they may be of conventional construction and a description thereof need not be repeated.

In accordance with the provisions of the patent statutes I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a mechanical drive, a rotary driving member and a rotary driven member, a lost motion driving connection between said members and means for producing a quick forward advance of

the driven member ahead of its driving member at a given point in the path of rotation of the driven member comprising a permanent magnet on the driven member, and a stationary permanent magnet positioned adjacent the path of movement of the driven magnet such that at one point in the path of rotation of the driven magnet a magnetic repulsion force is set up between said magnets sufficient to drive the driven member forward ahead of its driving member.

2. In a mechanical drive, a rotary driving member and a rotary driven member normally driven by the driving member through a lost motion driving connection, means for producing a quick forward advance of the driven member ahead of its driving member at a given point in the path of rotation of the driven member comprising a permanent magnet on the driven member and a stationary magnet adjacent the path of rotation of the driven magnet, said magnets being positioned and polarized such that at said given point in the path of rotation of the driven magnet a magnetic pole thereof is driven past and above a like magnetic pole of the stationary magnet producing a repulsion magnetic force sufficient to drive the driven member ahead of the driving member and also producing a friction-reducing lifting force on said driven member.

3. In a mechanical drive, a driving member, a driven member, a lost motion driving connection between said members, said members being mounted for rotation on vertical shafts, a permanent magnet on the driven member having its magnetic poles on opposite sides of the axis of rotation of said driven member, a stationary permanent magnet having its magnetic poles on opposite sides of said axis of rotation and located below and sufficiently close to the path of rotation of the driven magnet as to cause the driven member to be driven forward ahead of its driving member by the magnetic repelling force of said magnets as the driven magnet is rotated past the stationary magnet with their like poles adjacent each other.

4. In a mechanical drive, a driven member mounted for rotation on a vertical axis, means for driving said member in a given direction, a lost motion driving connection between said driven member and driving means, a bar-shaped permanent magnet driven with said member and having its magnetic axis extending across the axis of rotation of the driven member, a bar-shaped stationary permanent magnet with its magnetic axis extending across said axis of rotation and located below and sufficiently close to the driven magnet as to produce alternate forces of attraction and repulsion as the driven magnet is rotated about said axis as the magnets become parallel to each other, said magnets being of approximately the same length and extending further from the axis of rotation at one end than the other and polarized so that during rotation of the driven magnet the like poles of said magnets approach closer to each other than do their unlike poles, and whereby a magnetic repulsion force is produced which is greater than the attraction force and is sufficient to drive the driven member ahead of its driving means to the extent permitted by said lost motion driving connection.

5. In a mechanical drive, driving means, a rotary driven member, a lost motion driving connection through which the driven member is normally driven by said driving means, a permanent magnet driven with said driven member, a stationary permanent magnet having a magnetic pole located adjacent to the path of rotation of a like pole of the driven magnet whereby a force of repulsion is produced between the like poles of said magnets at a given point during each revolution of the driven member, said force being sufficient to drive the driven member ahead of its drive means to the extent permitted by said lost motion driving connection, and means driven by said driving member only when the latter is thus driven ahead by such repulsion force.

6. In a mechanical drive, a rotary shaft, a cyclometer type of register for registering the integrated rotary movement of said shaft, a drive between said shaft and register including a lost motion driving connection, a rotary magnetic part driven through such connection and a stationary magnetic part out of the path of movement of the rotary magnetic part but closely adjacent said path and past which the rotary magnetic part is driven, said magnetic parts having like magnetic poles such that a magnetic force of repulsion is set up between them when adjacent, causing a quick advance movement of the rotary magnetic part when slightly past the stationary magnetic part which advance is permitted because of the lost motion driving connection, and a counting wheel of said register driven ahead the distance between counting characters thereon with such quick advance movement of the rotary magnetic part and solely by said force of magnetic repulsion.

7. In a mechanical drive, a driven member mounted for rotation about a horizontal axis, means for driving said member, a lost motion driving connection between said means and driven member, said driven member having a permanent magnet thereon, the weight of said driven member being unbalanced about its axis of rotation, and a stationary permanent magnet positioned beneath and adjacent to the path of rotation of the driven magnet on said member, said magnets being polarized such that in the lowermost rotary position of the driven magnet like magnetic poles of said magnets are closely adjacent and produce a repelling magnetic force sufficient to drive the driven member forward ahead of its driving means to the extent permitted by the lost motion driving connection, the repelling force occasioned by said magnets also tending to compensate for the unbalanced weight of the driven member.

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