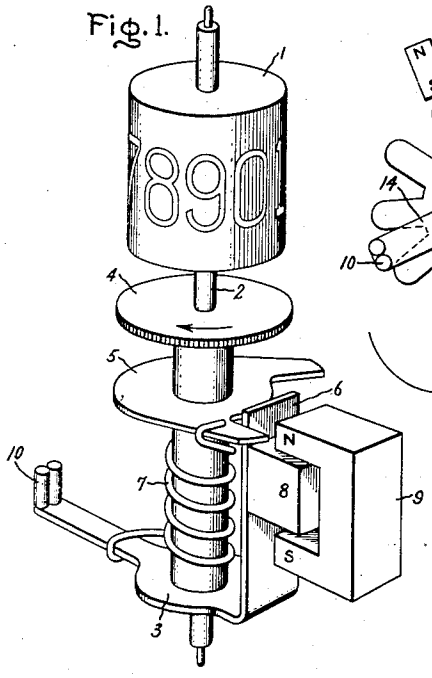
Feb. 18, 1947. H. A. BAKKE 2,416,081

MAGNETIC SNAP-OVER DRIVE FOR REGISTERS

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Fig. 1.



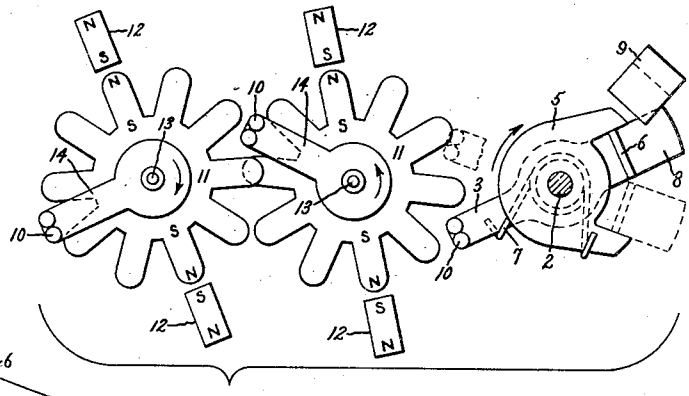


Fig. 2.

Fig. 3.

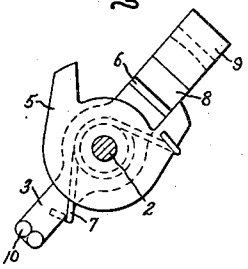
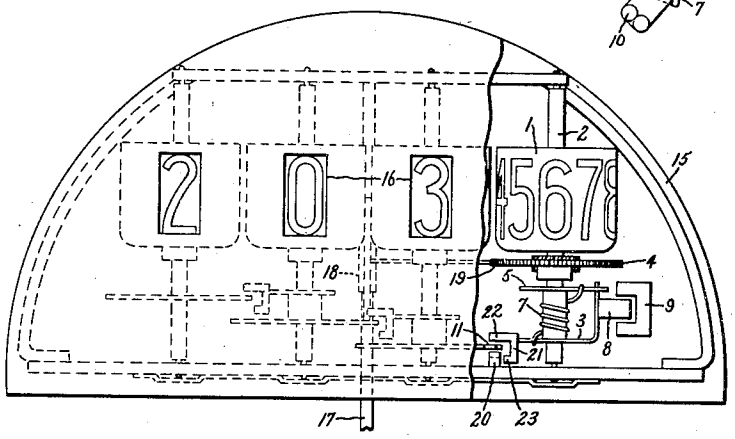


Fig. 4.



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Fig. 5.

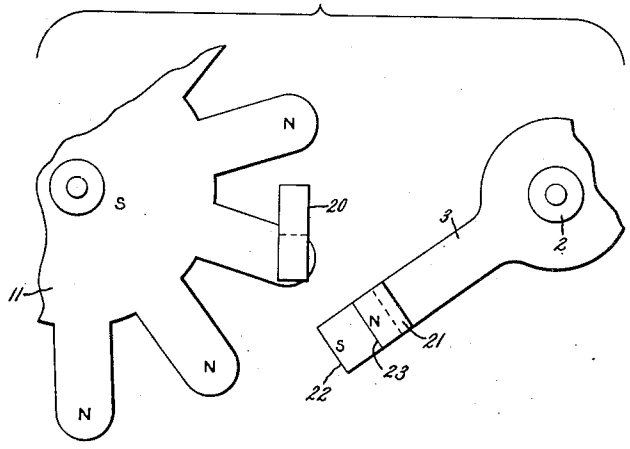


Fig. 6.

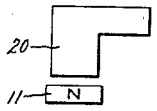


Fig. 7.

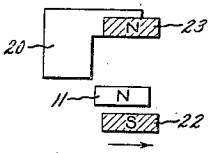


Fig. 8.

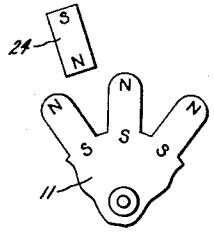
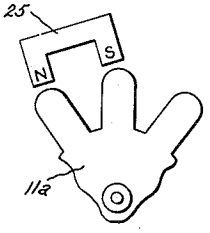


Fig. 9.



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UNITED STATES PATENT OFFICE

2,416,081

MAGNETIC SNAP-OVER DRIVE FOR REGISTERS

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Application February 24, 1945, Serial No. 579,626

6 Claims. (Cl. 235—91)

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My invention relates to cyclometer registers and the like, and its object is to provide a register of this type in which the different counting wheels are advanced and locked through the action of magnetic forces utilizing what might be termed a form of magnetic gearing and escapement. The invention provides a reliable, long-lived, quietly operating mechanism having small friction losses.

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 drawings in which Fig. 1 represents a perspective view of a driving mechanism in which continuous motion is modified to obtain a sudden stepping driving action during a selected portion of one revolution of the driven part. Fig. 2 shows a top end view of the mechanism of Fig. 1 together with additional counting wheel step-by-step driving mechanism which uses magnetic driving and locking action. Fig. 3 represents the relative position of certain parts of Fig. 1 when one part is magnetically locked and another part is beginning to store up energy to advance the locked part. Fig. 4 represents a face view of a register for a watthour meter equipped with my operating mechanism; Fig. 5 is a plan view of portions of a combined magnetic driving and locking embodiment of my invention so arranged that at the time of an advancing operation the magnetic locking force is nullified. Fig. 6 is an end view of one of the poles or teeth of a driving wheel and the magnetic locking tooth adjacent thereto corresponding to the form of the invention shown in Fig. 5. Fig. 7 is a view similar to that of Fig. 5 with the pole pieces of the driving magnet superimposed and with the parts positioned as during an advancing operation. Fig. 8 represents a repulsion form of magnetic locking, and Fig. 9 an attraction form of magnetic locking where the magnetic forces are arranged to assist in removing weight from the bearings.

In Fig. 1 it is assumed that the drum 1 is the unit or lowest digit drum of a cyclometer register. This drum is secured to a shaft 2 to which the double armed part 3 is also secured. Pivoted on shaft 2 is a gear wheel 4 assumed to be driven in the direction indicated by an integrating watthour meter or some other device, the integration operation of which is to be registered or counted. Gear wheel 4 is secured to an arm 5 having an outer fork into which a crank arm part 6 from arm 3 loosely extends in driving relation. Be-

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tween arms 5 and 3 preferably there is a spring 7 so arranged that if 3 be held stationary and arm 5 be driven, the spring is tensioned. The crank arm 6 is made of or carries a piece of magnetic material 8 which acts as an armature with respect to a small stationary permanent magnet 9 at one point in the revolution of the armature part 8. The arrangement is such that for about $\frac{9}{10}$ of a revolution of gear 4 and arm 5, arm 3 together with shaft 2 and drum 1 is driven thereby by reason of the slight tension in spring 7 which, when the armature 8 is not held back by magnet 9, holds the crank arm 6 against the leading arm of the fork in arm 3 as represented in Figs. 1 and 3. It is to be observed here that in Figs. 2 and 3 the mechanism is viewed as from the upper side of Fig. 1. Upon reaching the position of the parts represented in Fig. 3, the crank arm 6 is resiliently held from rotation with forked arm 5 by reason of the magnetic forces of attraction between permanent magnet 9 and armature 8 which are now adjacent each other. As gear 4 continues to rotate, the tension in spring 7 is increased, while the trailing arm of the fork of arm 5 approaches and contacts the crank arm 6 and starts to drive it directly moving it forward away from the magnet 9 as represented in Fig. 2.

In approximately the position of the parts represented in Fig. 2, the increased tension of the spring 7 overcomes the decreasing holding action of magnet 9, and the crank arm 6 snaps forward against the leading fork prong in arm 5, which position it retains for approximately the next $\frac{9}{10}$ of a revolution of the parts until the crank arm 6 again comes opposite and in holding relation with respect to magnet 9, whereupon stepping snap action advance is repeated. When the crank arm 6 thus snaps forward, the numeral drum 1 is advanced $\frac{1}{10}$ revolution, changing the number or character thereon which is in viewing position from 9 to 0.

In the mechanism shown in Fig. 1 it is considered that the spring 7 may be omitted, in which case the crank arm 6 will normally rest against the trailing fork of the part 5, and the forward stepping advance action of the arm 3 will occur by attraction of the armature 8 toward magnet 9, the end, instead of the beginning, of such advance stepping action coinciding with the position of the parts shown in Fig. 1. In this case the position of magnet 9 should be changed to approximately the dotted line position of the armature 8 in Fig. 2, so that the stepping advance operation will coincide with the advance of the

next cyclometer counting wheel 11 as hereinafter explained; and so far as the broad aspects of my invention are concerned, I may utilize the magnetic forces set up between armature 8 and magnet 9 as armature 8 passes 9 in either of the ways described.

The other extension or arm of the double arm 3 is provided with magnetic material at 10, to provide a ten-to-one magnetic drive with respect to the next or "tens" counting wheel mechanism of the register. This mechanism comprises a wheel 11 having ten evenly spaced teeth or poles of magnetic material. The axis of rotation of wheel 11 does not necessarily need to be exactly parallel to that of the driving member. These teeth and the magnetic driving element 10 on arm 3 are polarized either directly or indirectly so as to provide a magnetic gear drive between them. The arm 3 with its driving pole tooth 10 may be visualized as a ten-toothed gear wheel with all but one tooth cut off, so as to provide a ten-to-one gear ratio. As illustrated in Fig. 2, wheel 11 is made of permanent magnet material and polarized radially so that its hub is a south pole and the teeth north poles. In this case the driving tooth 10 of arm 6 is made of magnetic material but is not necessarily a permanent magnet. The part 10 does not contact with the teeth in wheel 11 but passes sufficiently close thereto to form a magnetic drive during $\frac{1}{10}$ of a revolution of arm 3. This $\frac{1}{10}$ of a revolution of arm 3 and tooth 10 when wheel 11 is driven is that $\frac{1}{10}$ of a revolution of arm 3 when it snaps forward as previously explained. Thus 10 moves from the position shown in full lines in Fig. 2 to the position represented in dotted lines and in so doing advances wheel 11 one tooth or $\frac{1}{10}$ of a revolution.

In order that such advance of wheel 11 shall be exactly $\frac{1}{10}$ revolution and in order that it shall be locked from rotation when not driven, there is provided near its periphery one or more stationary magnetic locking poles or teeth 12. Where, as here, the wheel 11 is polarized, these stationary locking teeth may be of magnetic material but not necessarily polarized except indirectly from wheel 11. Two polarized locking teeth are shown in the present instance and arranged on opposite diameters of the wheel 11 so that the side pull on the wheel due to magnetic attraction will be equalized and no increase in friction will result. The shaft 13 to which wheel 11 is secured will have a drum secured thereto with spaced numbers thereon from 0 to 9 and oriented on the shaft such that the numbers are consecutively positioned at the viewing position as the wheel is advanced. The magnetic locking teeth 12 are positioned to position correctly such numbers when in viewing position. The shaft 13 is also provided with an arm 14 with a magnetic driving tooth 10 cooperating with the next driving wheel of the register. The subsequent registering driving wheels, locking teeth, and driving arms may be similar to the one described. Alternate wheels will rotate in opposite directions. A mechanism for a three-drum register is represented in Fig. 2. The final wheel is shown provided with a driving arm 14 and tooth 10 to drive an additional wheel, but will ordinarily be omitted from the final drum shaft of the register mechanism.

It is evident that where, as here, there is a magnetic drive instead of a mechanical connection between the unit, tens, thousands, etc. shafts, the friction incident to the use of intermeshed mechanical gearing formerly used for such driving connections is eliminated. The force necessary to drive the register is correspondingly reduced. Wear and noise incident to such mechanical drive gearing is also eliminated. The alignment of the shafts and of driving parts is not so exacting. These advantages of the magnetic drive are even more pronounced when comparison is made with the Geneva and other forms of mechanical drive which have been used heretofore to obtain the desirable intermittent stepping drive and rotary positioning action characteristic of my invention.

While described as applied to a meter register, the magnetic drive and locking features of my invention are suitable for general application.

It is to be noted that the ten-to-one magnetic driving arrangement is reversible as to the direction of rotation, although only one direction of rotation is required in the use described. The magnetic locking means assists in limiting the step-by-step forward rotation of the driven member to its tooth pitch distance and in positioning it in favorable rotary driving positions with respect to the driving member.

In Fig. 4 there is shown a face view, a cyclometer type drum register for a watthour meter. The mechanism is supported in a suitable framework casing 15 arranged to be secured on a watthour meter. The casing has windows 16 in its front through which the number drums may be seen. The windows are dimensioned and positioned to show selected numbers printed on the drums in order that the kilowatt-hour reading of the meter may be observed. As represented, the meter registers 2036 kilowatt-hours, the drums being arranged to register units, tens, hundreds, and thousands from right to left. The unit drum 1 is driven through a mechanism similar to that described in connection with Fig. 1, the gear wheel 4 of such mechanism being driven from the watthour meter shaft indicated at 17 through worm gears indicated at 18 and at 19.

The driving and locking arrangement of the tens, hundreds, and thousands drums preferably differs somewhat from that previously explained and is shown in more detail in Figs. 5, 6 and 7. In the arrangement now to be explained, the magnetic locking action of the positioning magnet is arranged to be nullified at the time the wheel positioned thereby is advanced by reason of a redistribution of the magnetic flux in the magnetic parts involved. In this way the energy taken from the watthour meter for performing an advancing operation is considerably reduced.

The polarized magnetic toothed wheels are similar to wheel 11 of Fig. 2 and are designated by like reference characters. These wheels are positioned and held in their desired positions by a magnetic tooth 20 positioned at one side of the wheels opposite the tooth which is acted upon by the magnetic advancing device. The magnetic advancing arm is provided with a small permanent magnet 21 of the general shape shown in Fig. 4 having one longer pole piece 22 positioned to approach closely adjacent the other side of polarized tooth of wheel 11 opposite locking part 20 and the other shorter pole piece 23 positioned to approach closely adjacent a rear end portion of the locking tooth 20. Where, as represented, the outer ends of the teeth of the wheel 11 are polarized as a north pole, the pole 22 of magnet 21 will be polarized as a south pole and hence will attract and pull along with it the north pole of wheel 11 as it comes adjacent thereto. At the same time the north pole 23 of the

magnet 21 will approach a rear portion of locking tooth 20, effectively partially or completely neutralizing its magnetic holding action on the north pole tooth of wheel 11 which is adjacent thereto. Fig. 5 represents a side view of these parts with the driving arm 3 in position to advance wheel 11 in the next forward stepping action of arm 3. Fig. 6 represents an end view of the tooth of wheel 11 which is positioned adjacent the holding pole piece 20; and Fig. 7 represents a similar view with the position of the pole pieces of magnet 21 indicated during an advancing operation, the direction of which is indicated by an arrow. As shown in Figs. 6 and 7, the locking tooth 20 is preferably L-shaped with an extension along the path of movement of pole piece 23, so that the neutralizing action on tooth 20 continues until the tooth of wheel 11 has been moved well away from the holding position. As a matter of fact, there may be a beneficial magnetic repulsive action between tooth 20 and the receding tooth of wheel 11 while the parts are at and near the positions represented in Fig. 7. However, by the time the active tooth of wheel 11 has been advanced a full tooth space and the following tooth has been brought into locking position, holding tooth 20 being of soft iron is no longer effectively polarized by magnet 21, and tooth 20 regains its magnetic locking action by reason of the attraction between it and the following polarized tooth of wheel 11 which is now adjacent thereto. By careful design and positioning of the parts, I may thus retain the benefit of the locking positioning action but effectively neutralize it at the time of the advancing operation. By so doing, the load on the watthour meter for driving the register is kept low and more uniform, and the magnetic forces required for the positive operation of the register are likewise reduced. This arrangement operates satisfactory for either direction of rotation of the driving arm 3. Other arrangements for accomplishing this result will no doubt occur to those skilled in the art.

In Fig. 8, I have represented a holding and positioning magnet which functions on the repulsion principle. Here is a holding magnet 24 with the end which is nearest the polarized wheel 11 of the same polarity as the outer ends of the teeth of the wheel. This produces a repulsion force between these parts so that the wheel 11 is biased to a rotary position where its two adjacent teeth are farthest from magnet 24 as represented. Where the device is of such a character that the shaft of 11 would be horizontal, placing the repulsive holding magnet 24 beneath the wheel helps to support the weight of the wheel and reduces bearing friction.

In Fig. 9, I have represented a positioning and holding permanent magnet 25 for a wheel 11*a* like wheel 11 except made of soft iron and not polarized. Here, where there is attraction between the parts, the holding magnet should be above the wheel to support part of its weight. Even where the wheels 11 and 11*a* have vertical shafts, the holding magnets such as represented in Fig. 2 may be positioned on the upper or lower peripheral sides thereof, depending upon whether the holding force is attraction or repulsion, and obtain the benefit of reducing the weight supported by the necessary bearings.

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

1. Apparatus for converting continuous rotary motion into an intermediate stepping rotary motion comprising driving and driven rotary members having the same axis of rotation, a lost motion mechanical driving connection and a resilient driving connection between said members, said lost motion driving connection limiting relative rotation between said members to a fraction of a revolution, said resilient driving connection serving normally to advance the driven member relative to the driving member to the limit allowed by said lost motion mechanical driving connection when the driven member is unrestrained, and means for magnetically restraining the driven member from rotation in a certain rotary position thereof until positively driven directly by the driving member, said magnetic restraining means having a restraining force on the driven member in excess of the driving force in the resilient driving connection which restraining force is overcome when the driven member is driven directly by said driving member.

2. Apparatus for converting continuous rotary motion into intermittent step-by-step rotary motion comprising driving and driven rotary members having the same axis of rotation, a lost motion mechanical driving connection between said members which limits relative rotation of said members to less than one revolution, a spring connected between said members tending at all times to advance the driven member to the limit allowed by said lost motion driving connection, permanent magnet means for magnetically restraining the driven member from rotation only when in a certain rotary position until it is positively driven directly by the driving member, said magnetic restraining means then having a restraining force on the driven member in excess of the advancing force thereon due to said spring, said restraining force being overcome when the driven member is driven directly by said driving member.

3. In a drive, a rotary driven member having a plurality of evenly spaced magnetic driving teeth, a rotary driving member having one magnetic driving tooth, said members having different adjacent axes of rotation such that once during each revolution of the driving member its driving tooth approaches closely adjacent to the tooth of the driven member nearest thereto but without mechanical contact between them, the teeth of said members both being polarized to produce attractive magnetic driving action between them during such close approach causing the rotation of the driven member the distance of its tooth pitch, stationary nonpolarized magnetic locking means cooperating with the teeth of said driven member to prevent rotation except as above described and to assist in positioning the driven member in favorable rotary driving positions with respect to the driving member, said stationary magnetic locking means being positioned to attract that tooth of the driven member which is in driving position whereby its magnetic locking action on the driven member is reduced by reason of the arrival of the tooth of the driving member in driving position and a resulting redistribution of the magnetic flux between the magnetic parts mentioned.

4. In a drive, a rotary driven member having a plurality of evenly spaced magnetic teeth having their outer ends similarly magnetically polarized, a driving member having an axis of rotation adjacent to that of the driven member, said driving member having a driving arm and a permanent magnet located thereon adapted to

pass closely adjacent to the nearest tooth of the driven member at one point in the revolution of the driving arm but without mechanical contact between the driving and driven members, said permanent magnet magnetically cooperating with such nearest tooth to advance the driven member the distance of its tooth pitch during such passage, and a stationary non-permanent magnetic member located adjacent both the driven tooth of the driven member and the permanent magnet when in its rotary driving position but without mechanical contact with either for locking the driven member from rotation at other times, said permanent magnet having one pole of the same polarity as the outer ends of the teeth of the driven member, which pole approaches closest to the stationary locking member and a pole of the opposite polarity which approaches closest to the tooth of the driven member, whereby the magnetic locking action of the stationary member is substantially nullified during such rotary advance of the driven member.

5. A drive comprising a drive shaft subject to continuous rotation, a member having a driving arm rotatable about the same axis of rotation as said shaft, a lost motion mechanical driving connection and a resilient driving connection between said shaft and arm, said lost motion driving connection limiting rotation between said shaft and arm to a fraction of a revolution and said resilient driving connection serving normally to advance the arm relative to the shaft to the limit of said lost motion connection when the arm is unrestrained, means for magnetically restraining the arm from rotation in a certain rotary position thereof, said restraining means producing a restraining force on the arm in excess of the driving force in the resilient driving connection which restraining force is overcome when the arm is driven through the lost motion driving connection, whereby the arm is stopped and is followed by a sudden forward movement for a fraction of a revolution, a magnetic driving tooth carried by said arm, and a wheel having a plurality of evenly spaced magnetic teeth with which said driving tooth magnetically cooperates only during the sudden forward movement of said arm to advance the wheel in rotative steps corresponding to its tooth pitch one step for each complete revolution of said arm.

6. In combination with a rotary shaft, a cyclometer type of register driven thereby and on which the integrated rotary movement of the shaft is registered, 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 past which the movable magnetic part is driven, at least one of said magnetic parts being permanently magnetized such that magnetic forces are set up between them when adjacent, said magnetic forces producing a forward driving force on the rotary magnetic part when on one side of the stationary magnetic part and a backward restraining force on the rotary magnetic part when on the other side of the stationary magnetic part when the rotary magnetic part is in a region adjacent to and passing by the stationary magnetic part, said rotary magnetic part being positively and directly driven forward by said shaft when in the region of maximum restraint, the movement of said rotary magnetic part past said stationary magnetic part being accompanied by a stepping action advance movement of the rotary magnetic part which is permitted by reason of the lost motion driving connection, and a counting wheel of said register advanced the distance between counting characters thereon with the stepping action advance of said rotary magnetic part.

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