Jan. 5, 1954

B. S. BENSON

2,665,343

ROTARY SWITCH DEVICE

Filed Aug. 30, 1950

2 Sheets-Sheet 1

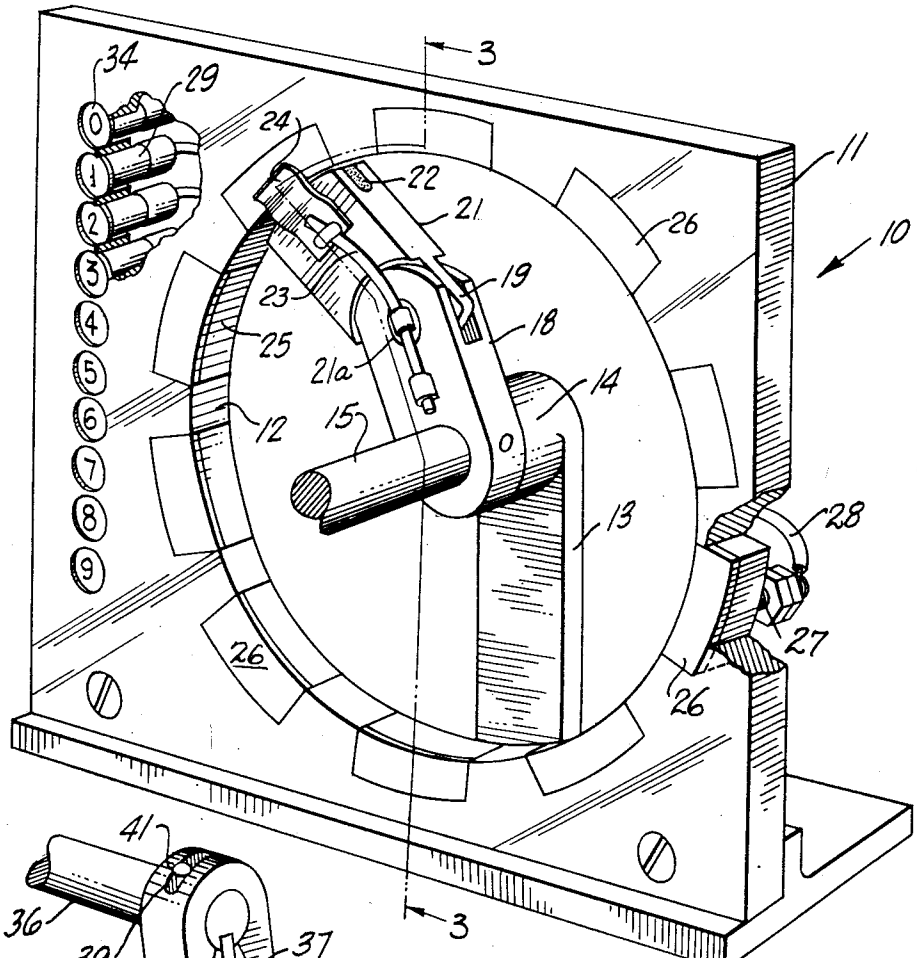


Fig. 1

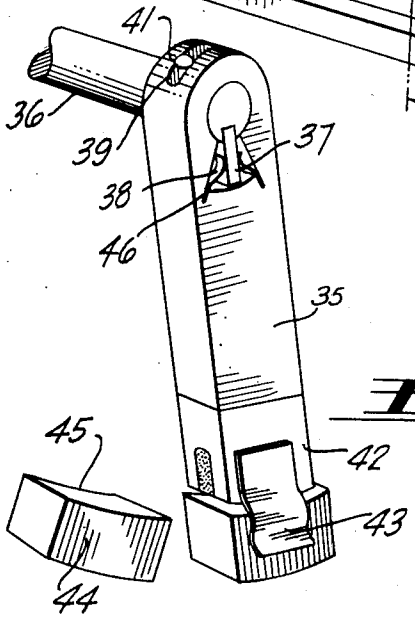


Fig. 4

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2 Sheets-Sheet 2

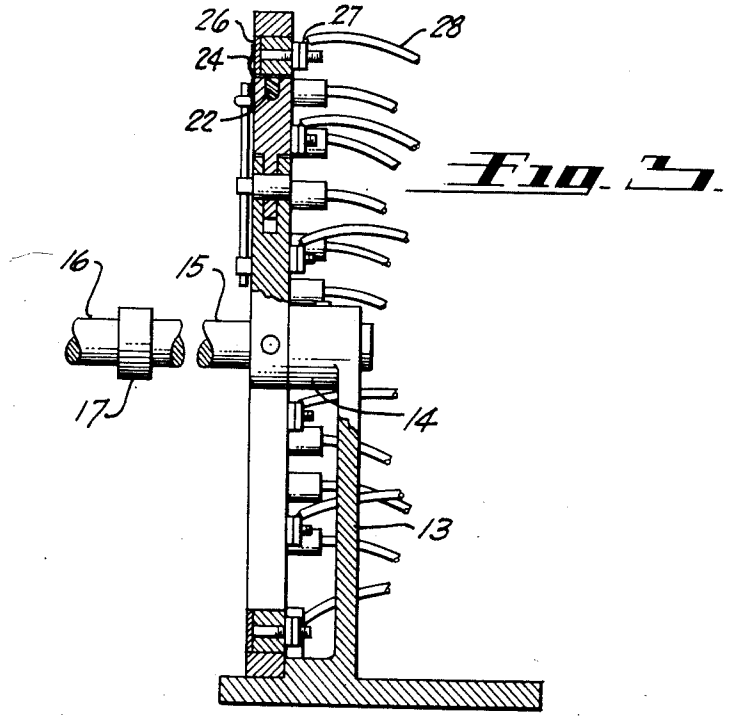


Fig. 3.

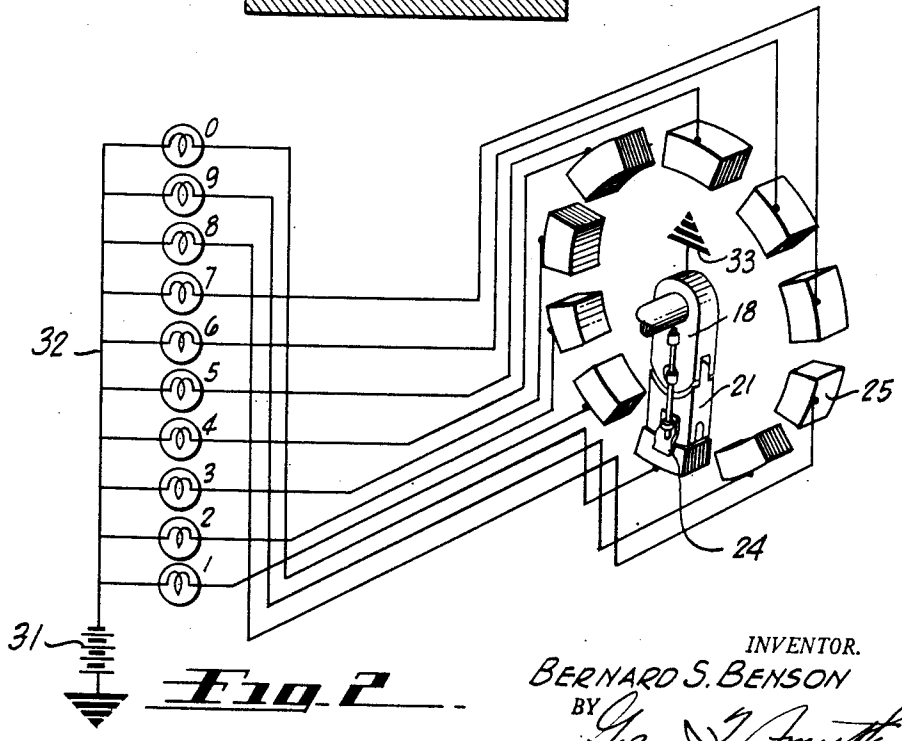


Fig. 2.

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UNITED STATES PATENT OFFICE

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ROTARY SWITCH DEVICE

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6 Claims. (Cl. 200—65)

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This invention relates to converting devices and more particularly to such a device for converting continuously varying values into discrete digital form.

The device of the present invention, in the broadest aspects thereof, comprises means for translating variable values indicative of the position of a movable part into discontinuous discrete form. The continuously varying values are, in the illustrated embodiment of the invention, translated into rotational movement of a shaft which carries a contact element movable over a plurality of contact members fixed in a spaced apart relationship.

Each contact member forms a part of a normally open electric circuit and these normally open circuits are seriately energized as the contact element relatively moves into engagement with the members in accordance with the rotational movement indicative of the continuously varying value. The seriate energization of the circuits thus form discrete or discontinuous registrations of the progression of the movable part. Each circuit may include an electro-responsive element capable of furnishing the signal or indication desired, depending upon the field of use of the device. Where a decimal system of measurement is desired, the members are decadel, that is, ten in number although it will be obvious that the segments could be other than ten in number.

To eliminate the possibility of a contact element coming to rest intermediate an adjacent pair of members to thus produce an impositive signal, means are provided for rapidly moving the contact element relative to the members as the contact element moves toward disengagement with an engaged member to bring about substantially instantaneous movement of the contact element into engagement with the next adjacent member. Thus, even though the motion of the part producing relative movement between the contact element and the members over which the contact element relatively moves may cease, the device of the present invention is incapable of producing an impositive signal for the contact element is prevented from coming to rest intermediate an adjacent pair of members. Furthermore, the substantially instantaneous movement of the contact element from one member to the next adjacent member reduces to a minimum the time lag in the transit of the element from one member to the next.

The means used to produce the substantially instantaneous movement, in the illustrated embodiment of the present invention, comprises magnetic means carried by the contact element. Arranged adjacent each contact member is a mass of ferromagnetic material which, through magnetic attraction, tends to hold the contact element in engagement with a member. The contact element, in all embodiments of the invention illustrated, is mounted for independent movement relative to the rotated shaft but is held by resilient means in a "normal" position relative to said member.

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The contact element thus is held in engagement with a segment even though the rotated shaft continues to rotate as the part is moved. Once the force exerted by the resilient means is greater than the magnetic forces tending to hold the contact element in engagement with the member, the contact element is quickly swept into engagement with the next adjacent member. The magnetic means of the contact element again holds the latter in engagement with this member until the rotated shaft has again moved in its cycle to a position in which the magnetic forces are less than those created by the resilient means, whereupon the element is again quickly swept into engagement with the next member.

Other features and advantages of the present invention will be hereinafter apparent from the following description, particularly when taken in connection with the accompanying drawing, in which

Figure 1 is a perspective view of the device of the present invention with portions broken away to more clearly illustrate certain structural details;

Figure 2 is a schematic showing of the electrical circuits thereof;

Figure 3 is a section taken along line 3—3 of Figure 1; and

Figure 4 is a perspective view of a portion of a modified form of the present invention.

The device of the present invention, referring now to the drawing and more particularly to Figure 1, comprises a suitable casing-like member 10 including a wall element 11 having a circular opening formed therein presenting a cylindrical wall surface 12. The wall element 11 carries a bracket 13 including a suitable bearing member 14 for supporting a shaft 15 for rotation about an axis coincident with the axis of said cylindrical wall surface 12. The shaft 15, by some suitable means, is drivingly connected to a continuously moving element such as, for example, a rotatably driven shaft, the rotations of which are to be registered or indicated. It should be made clear

here that the device of the present invention is not limited to measuring or recording the revolutions of a rotatably driven member for, by conventional rack and pinion means, straight line motion of a moving member can be easily translated into rotational movement, which movement in turn can be used to rotatably drive the shaft 15.

To simplify the disclosure of the device of the present invention, however, the device will be described herein as one for translating the continuously varying values represented by a rotating shaft 16, referring now to Figure 3, and coupled to the outer end of the shaft 15 by some suitable coupling device, indicated at 17, into discrete, discontinuous form.

Referring again to Figure 1, it will be seen that the shaft 15 adjacent the inner end thereof carries a radially extending arm 18 which will be moved about the opening as the shaft is rotatably driven. The arm 18 terminates at its free end in a longitudinally extending slot receiving a lug 19 projecting from the end face of a member 21. A pin 21*a* passed through aligned openings formed in the bifurcations of the arm 18 and the lug 19 pivotally mounts the member 21 to the outer end of the arm 18. The member 21, in the embodiment of the invention shown in Figure 1, is formed of magnetic material suitably magnetized to form a permanent magnet. The magnet may be of bar form in which the poles thereof are located at opposite ends thereof, although preferably the member 21 is formed as a U-shaped or horseshoe magnet in which both poles are located at the outer or free end of the member. The slot or passage between the legs of the magnet may be filled with some suitable non-magnetic material, as indicated at 22.

Fixed to the one face of the arm 18 is an elongate leaf spring 23, which spring extends longitudinally of the arm 18 beyond the outer end thereof and this projecting end of the spring is permanently fixed to the magnet 21. The spring is such that it normally holds the magnet 21 in a position in which the same forms a longitudinal extension of the arm 18. The spring, however, will permit the member 21 to pivotally move in either direction about the axis formed by the pin 21*a* so that the magnet may move independently of the arm 18.

A resilient contact element 24 is fixed to the one face of the magnet 21 and extends outwardly beyond the pole faces thereof. This contact element will be moved in a circular path as the shaft is rotated substantially coincident with that portion of the front face of the wall element 11 which forms the defining edge of the circular opening. Embedded within the material forming the wall element 11 are a plurality of segments 25, ten in number, and spaced apart an equal distance circumferentially of the cylindrical wall surface 12. The one face of each segment is substantially flush with the cylindrical wall surface 12 while the adjacent side face of each element is substantially flush with the front surface, that is, that surface of the wall element 11 over which the projecting portion of the contact element 24 moves. The outer end face of the magnet is preferably given a cylindrical contour substantially conforming to the cylindrical wall surface 12. Thus, as the magnet rotatably moves about the opening, the pole faces thereof are just slightly spaced from those faces of the segments 25 which are substantially flush with the wall surface 12.

Fixed by any means desired to that side face of each segment which is substantially flush with the front surface of the wall element 11 is a contact member 26. It will be seen that these contact members are seriately engaged by the resilient contact element 24 as the shaft 15 is rotatably driven from the shaft 16.

Each contact member 26 includes a terminal element 27 which extends rearwardly of the wall element 11. A conductor 28 is led from each terminal element 27 to an electro-responsive element 29, here shown as a small incandescent lamp or the like. The lamps 29, electrically connected to the contact members 26 are disposed in openings linearly arranged on the wall element 11, as best shown in Figure 1. Each lamp 29, referring now to Figure 2, is connected to a source of current, indicated at 31, through a common lead or conductor 32.

The arm 18 is grounded, as indicated at 33, and engagement of the contact element 24 with each contact member 26 completes the circuit of the lamp 29 electrically connected to the engaged contact member. It should be understood now that the energization of the lamps 29, as the contact element 24 seriately engages the contact members 26, will indicate or register the position of the element 24 relative to the circumferentially arranged contact members 26. As the contact element 24 is carried by the arm 18 which is moved in accordance with the continuously varying value represented by the rotating shaft 16, the energization of the lamps 29 will consequently indicate or register in discrete, discontinuous form the quantum of this varying value.

To simplify the signal or indication made by an energized lamp and to present the signal in digital form, the wall element 11 may carry small translucent discs 34 closing the openings in which the lamps 29 are disposed. These linearly arranged discs 34 will carry indicia in the form of the digits, as clearly shown in Figure 1. The contact members 26 are so connected by the leads 28 to the lamps 29 that energization of any lamp will indicate, in tenths, a partial revolution of the shaft 16. This is done merely serially connecting the segments to the lamps arranged adjacent the discs bearing digits. Thus, if the shaft is rotated nine-tenths of a revolution, the contact element 24 will be engaged with the "9th" segment electrically connected to the lamp 29 arranged adjacent the discs 34 bearing the digit "9."

To eliminate an impositive signal, such as would occur if the contact element 24 should come to rest intermediate any adjacent pairs of contact members 26, the segments 25 are formed of a ferromagnetic material so that the magnet 21, because of magnetic attraction, tends to remain in an arrested position substantially aligned with a segment 25 even though the arm 18 continues to move with the shaft 15.

It will be remembered that the magnet 21 is pivotally mounted to the outer end of the arm 18 and can pivotally move against the action of the spring 23 relative to the arm 18 as the latter sweeps onward past the segment 25 substantially aligned with the magnet 21. Once the arm 18 has moved to some position intermediate this segment and the next adjacent segment in which the resilient forces created by the now flexed spring 23 are greater than the holding force created by the magnetic field, the magnet 21 will be quickly swept toward the next adjacent segment. This movement of the magnet carries the contact element 24 quickly from the engaged contact

member 26 toward engagement with the next adjacent contact member 26.

As the contact element 24 is swept toward engagement with the next adjacent contact member 26, the magnetic attraction between the magnet 21 and the segment 25, to which the next adjacent contact member is fixed, will augment the forces moving the contact element and, in effect, draw the magnet into substantial alignment therewith. As the magnet moves into a position substantially aligned with this segment, the magnetic forces again will hold the contact member 24 in engagement with the contact member until the arm 18 is again moved to a position in which the holding force created by the magnetic field is less than the force created by the again flexed spring 23. At this time, as should now be clearly understood, the magnet and the contact member 24 will be substantially instantaneously again pivotally moved by the spring 23 relative to the arm 18 to carry the contact element 24 into engagement with the next adjacent contact member 26.

Thus, as the contact element 24 is successively moved substantially instantaneously by the flexed spring 23 from one contact member to the next, there is no danger of the device supplying an impositive signal for there is little likelihood, even upon cessation of movement of the shaft 16, that the contact element 24 would come to rest in a position intermediate any adjacent pair of contact members 26. The successive engagement of the contact element with the contact members 26 resulting in successive energization of the lamps 29 will, as should now be understood, result in a positive registration at discrete intervals of the varying value indicative of the angular displacement of the shaft 16.

In the embodiment of the device of the present invention shown in Figure 4, an arm 35, similar in function to the arm 18, is connected to the one end of a shaft 36 substantially identical to the shaft 15, for limited arcuate movement relative to the shaft 36. In the now preferred form of mounting the arm 35 to the shaft 36, the latter is fitted with a key 37 longitudinally extending at the inner end of the shaft. The one end of the arm 35 is formed with a cylindrical passageway for receiving the inner end of the shaft 36 and opening into this cylindrical passageway is a coextensive keyway 38, the opposed walls of which diverge outwardly from the cylindrical passageway. The keyway 38 is substantially larger than the key 37 to permit the arm 35 to arcuately move a limited distance relative to the axis of the shaft 36.

Any means desired may be used to hold the arm 35 against movement longitudinally of the shaft 36 and one such means may comprise an elongate slot 39 formed in the end face of the arm 35 for passing a threaded stud or bolt 41 received in a tapped opening formed in the inner end of the shaft 36. The slot 39 should be of such a length that the stud 41 will move from one end to the other as the key 37 moves from a position engaging one of the diverging walls of the keyway 38 to a position in which it is engaging the opposed diverging wall.

The arm 35, in the embodiment of the invention now being described, carries at its outer end a permanent horseshoe magnet 42 to which is fixed a contact element 43 identical in all respects to the contact element 24. The contact element 43 is adapted to be successively engaged with contact members 44 carried by segments 45 formed of some ferromagnetic mateial carried about a cylindrical wall surface concentric with

the shaft 36. The contact members 44, like contact members 26, are electrically connected to some electro-responsve means, such as lamps similar to the lamps 29 of the earlier described embodiment of the invention. Such lamps would be successively energized as the contact element 43 successively moves into engagement with the contact members 44 to register in discrete form the progression of the shaft 36.

In this embodiment of the invention, a pair of resilient elements fixed to the arm, such as leaf springs 46 projecting into the keyway and terminating adjacent the opposed diverging walls thereof, tend to hold the arm 35 in a "normal" position relative to the shaft 36 but yet allow the arm 35 to arcuately move relative to the shaft 36. In the operation of the embodiment of the invention now being described, the attraction between the magnet 42 and a segment 45 will tend to hold the arm 35 against movement and substantially aligned with a segment 45 as the shaft 36 continues to rotate until such time as the resilient force created by the compression of one of the springs 46 is greater than the holding force of the magnet.

When the resilient force is greater than the holding force of the magnet, the arm 35 and consequently the contact element 43 will be quickly swept arcuately to a position in which the contact element 43 is engaged with the next adjacent contact member 44. In this movement of the arm 35, the particular means used to mount the arm 35 to the shaft 36 will permit the arm 35 to accelerate and move relative to the shaft 36 to a position in which the arm 35 is actually ahead of the shaft 36. As the shaft 36 continues to rotate, the key 37 will move into engagement with one or the other of the springs 46, depending upon the direction of rotation of the shaft 36 to again initiate compression of one of the springs 46. This is so, for the holding force of the magnet 42 will tend to hold the arm 35 against movement with the shaft 36. At the point where the force created by the compressed spring is again greater than the holding force of the magnet, the arm 35 will again be quickly swept forwardly to again bring the contact element 43 into engagement with the next adjacent contact member 44.

It will thus be seen that, in both embodiments of the invention herein illustrated, means are provided for translating variable values indicative of the position of a movable part into discontinuous, discrete form. There is no possibility of the contact element coming to rest intermediate adjacent pairs of contact members for in all embodiments illustrated, means are provided for rapidly moving the contact element relative to the contact members as the contact element moves toward disengagement with an engaged contact member to bring about substantially instantaneous movement of the contact element into engagement with the next adjacent contact member.

Although the now preferred embodiments of the present invention have been shown and described herein, it is to be understood that the invention is not to be limited thereto, for it is susceptible to changes in form and detail within the scope of the appended claims. For example, electro-magnets could obviously be substituted for the permanent magnet shown.

I claim:

1. A device of the type described, comprising: a master member adapted to be rotatably driven from a moving part; magnetic means; means for

mounting said magnetic means to said master member for limited movement with respect to said master member and movable therewith in a circular path of travel as said master member is rotatably driven; resilient means normally resisting retrograde and progressive movement of said magnetic means in said path relative to said master member as the latter is rotatably driven, said magnetic means including a contact element movable therewith; and a plurality of equally spaced apart ferro-magnetic segments, including contact portions, carried by a wall surface concentrically circumscribing said master member and arranged substantially coincident with the path of travel of said contact element; the magnetic forces created by movement of said magnetic means into a position juxtaposed with one of said segments holding said contact element in engagement with the contact portion of said juxtaposed segment as said master member continues to rotate until said magnetic forces are less than the movement resisting forces of said resilient means, whereupon said resilient means substantially instantaneously moves said magnetic means into juxtaposed relationship with the next adjacent segment to thus move said contact element substantially instantaneously into engagement with the contact portion of said next adjacent segment.

2. A device of the type described, comprising: a shaft adapted to be rotatably driven from a moving part; an arm radially extending from said shaft; a magnet carried at the outer end of said arm; resilient means normally holding said magnet in a predetermined position relative to said shaft whereby the magnet normally moves in a circular path of travel with said shaft as the latter is rotated, said resilient means normally resisting retrograde and progressive movement of said magnet in said path relative to said shaft as the latter is rotated; a contact element carried by said magnet and movable therewith in a circular path of travel as the shaft is rotatably driven; a plurality of equally spaced apart ferro-magnetic segments carried by a wall surface concentrically circumscribing said shaft and substantially coincident with the path of travel of said contact element; and a contact member carried by each segment; the magnetic forces created by movement of said magnet into position juxtaposed with one of said segments holding said contact element in engagement with the contact member carried by said juxtaposed segment as said shaft continues to rotate until said magnetic forces are less than the movement resisting forces of said resilient means whereupon said resilient means substantially instantaneously moves said magnet to said normal position relative to said shaft to thus move said contact element substantially instantaneously out of engagement with the contact member carried by said juxtaposed segment.

3. A device of the type described, comprising: a master member adapted to be rotatably driven from a moving part; a permanent magnet; means for mounting said magnet to said master member for limited movement with respect to said master member and movable therewith in a circular path of travel as said master member is rotatably driven; resilient means normally resisting retrograde and progressive movement of said magnetic means in said path relative to said master member as the latter is rotatably driven, said magnetic means including a contact element movable

therewith; a plurality of equally spaced apart ferro-magnetic segments, including contact portions, carried by a wall surface concentrically circumscribing said master member and arranged substantially coincident with the path of travel of at least one pole face of said permanent magnet; the magnetic forces created by movement of said permanent magnet into a position in which at least one pole face thereof is juxtaposed with one of said segments holding said contact element in engagement with the contact portion of said juxtaposed segment as said master member continues to rotate until said magnetic forces are less than the movement resisting forces of said resilient means, whereupon said resilient means substantially instantaneously moves said permanent magnet into a position in which at least the one pole face thereof is in juxtaposed relationship with the next adjacent segment to thus move said contact element substantially instantaneously into engagement with the contact portion of said next adjacent segment.

4. A device of the type described, comprising: a shaft adapted to be rotatably driven from a moving part; an arm radially extending from said shaft; a magnet pivotally carried at the outer end of said arm; resilient means normally holding said magnet in a predetermined position relative to said arm whereby the magnet normally moves in a circular path of travel with said arm as the shaft is rotated, said resilient means normally resisting pivotal movement of said magnet relative to said arm as the shaft is rotated; a contact element carried by said magnet and movable therewith in a circular path of travel as the shaft is rotatably driven; a plurality of equally spaced apart ferro-magnetic segments carried by a wall surface concentrically circumscribing said shaft and substantially coincident with the path of travel of said contact element; a contact member carried by each segment; the magnetic forces created by movement of said magnet into position juxtaposed with one of said segments holding said contact element in engagement with the contact member carried by said juxtaposed segment as said magnet pivotally moves relative to said arm as said shaft continues to rotate until said magnetic forces are less than the movement resisting forces of said resilient means whereupon said resilient means substantially instantaneously moves said magnet to said normal position relative to said arm to thus move said contact substantially instantaneously out of engagement with the contact member carried by said juxtaposed segment.

5. A device of the type described comprising: a shaft adapted to be rotatably driven from a moving part; means presenting an inner cylindrical wall surface concentrically circumscribing said shaft; a plurality of equally spaced apart ferromagnetic segments carried by said means and each having a face substantially flush with said wall surface; a contact member carried by each segment; an arm; means for mounting said arm to said shaft for limited pivotal movement relative thereto; a magnet carried at the outer end of said arm, at least one pole face of said magnet moving in a circular path, as said shaft is rotated, substantially coincident with said cylindrical wall surface; a contact element carried by said magnet; and resilient means normally holding said arm in a preselected position relative to said shaft and resisting pivotal movement of said arm relative to said shaft as the latter is rotatably driven to thereby cause said contact

element to seriately move into engagement with said contact members, the magnetic forces created by movement of said magnet into a position juxtaposed with one of said segments arresting movement of said arm to hold said contact element in engagement with the contact member carried by said juxtaposed segment as said shaft continues to rotate until said magnetic forces are less than the movement resisting forces of said resilient means, whereupon said resilient means substantially instantaneously pivotally moves said arm relative to said shaft to thereby move said magnet into juxtaposed relationship with the next adjacent segment to thus move said contact element substantially instantaneously into engagement with the contact member carried by said next adjacent segment.

6. A device of the type described comprising: a shaft adapted to be rotatably driven from a moving part; means presenting an inner cylindrical wall surface concentrically circumscribing said shaft; a plurality of equally spaced apart ferromagnetic segments carried by said wall surface; a contact member carried by each segment; an arm radially extending from said shaft; a permanent magnet carried at the outer end of said arm, at least one pole face of said magnet moving in a circular path, as said shaft is rotated, substantially coincident with said cylindrical wall surface; a contact element carried by said magnet and seriately movable into engagement with said members as said shaft is rotatably driven; and resilient means normally holding said contact element in a preselected spatial position relative to said shaft and yieldably resisting displacement of said contact element from said position, the magnetic forces created by movement of said magnet into a position juxtaposed with one of said segments holding said contact element in engagement with the contact member carried by said juxtaposed segment as said shaft continues to move to thereby displace said contact element from said preselected position relative to said shaft until said magnetic forces are less than the displacement resisting forces of said resilient means, whereupon said resilient means substantially instantaneously moves said magnet relative to said shaft into juxtaposed relationship with the next adjacent segment to thus move said contact element substantially instantaneously into engagement with the contact member carried by said next adjacent segment.

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