

3,164,698

3 Sheets-Sheet 1



INVENTOR.
WARREN L. PERRINE
BY
Beckler & Shamahan
ATTORNEYS

Jan. 5, 1965

W. L. PERRINE

3,164,698

MAGNETIC ROTARY PULSE SWITCH

Original Filed May 1, 1961

3 Sheets-Sheet 2

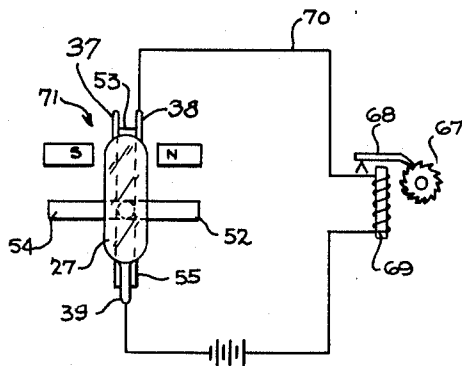


Fig. 4

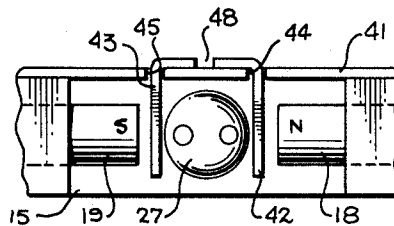


Fig. 5

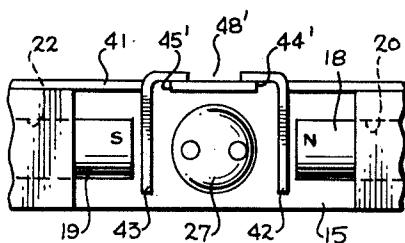


Fig. 6

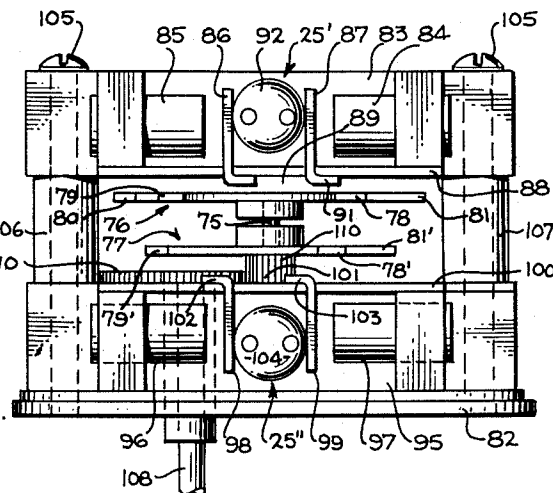


Fig. 7

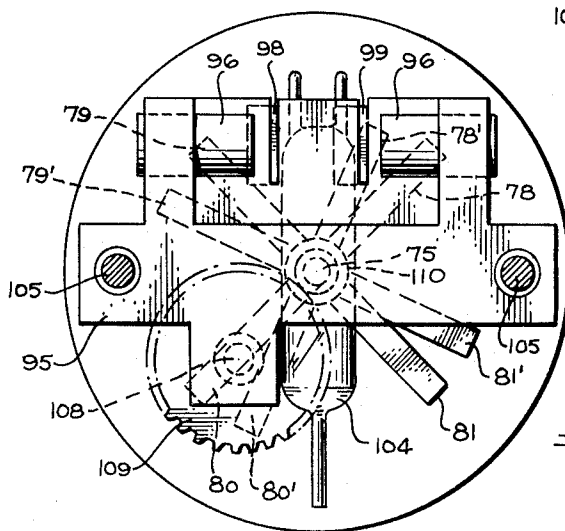


Fig. 8

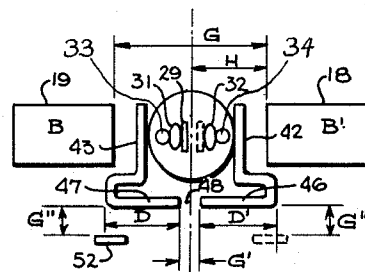


Fig. 30

INVENTOR.
WARREN L. PERRINE
BY
Beehler & Shamaham
ATTORNEYS

1

3,164,698

MAGNETIC ROTARY PULSE SWITCH

Warren L. Perrine, 12671 Bubbling Well Road,
Santa Ana, Calif.

Continuation of application Ser. No. 106,632, May 1, 1961. This application Apr. 19, 1962, Ser. No. 188,758
5 Claims. (Cl. 200-87)

This is a continuation of my co-pending patent application Serial No. 106,632, filed May 1, 1961, now abandoned, for Rotary Pulse Switch.

The invention relates to electric switches and has special reference to a type of switch commonly identified as a pulse switch of such form that it is capable of converting shaft rotation to an electrical pulse in order, for example, that the output can be transmitted to a device such as a counter or printer.

Recent advances in the electrical industry and in particular those portions of its directed to counters and computers have required switching devices of sundry types constructed in such fashion that rotary motion is converted to a pulsing switching operation in order to operate the various components where such rapid pulsing switch activity is in demand. Heretofore this has been accomplished primarily by use of electrical circuits which are capable of accomplishing the necessary switching but which have other drawbacks of a very serious character. Among these drawbacks are elements of high original cost, frequent and expensive maintenance, complexity of installation, and the incorporation of room and structure to accommodate the bulk and weight of the electrical system.

Among the objects of the invention, therefore, is to provide a new and improved rotary pulse switch or converter which provides a means for mechanically converting shaft rotation output of virtually any accessory part to an electric pulse so that the rotary output can be transmitted by virtue of a pulsing electric circuit to some other component such as a counter, printer, or comparable device operated by a pulsing current.

Another object of the invention is to provide a new and improved electromechanical pulsing switch device of a substantially rotary type which has a particularly low operating torque and is therefore adequate for use in delicate mechanisms despite the mechanical character of the conversion elements.

Another object of the invention is to provide a new and improved rotary pulse switch device which is positive in its action to the extent that no spurious pulses will be experienced, that is to say, which will operate without necessary pulses being missed and also without extra pulses being injected.

Still another object of the invention is to provide a new and improved rotary type pulse switch device which is capable of converting rotary motion to an electric pulse capable of operating devices such as a counter or a printer without the need for electrical amplification.

Further included among the objects of the invention is to provide a new and improved electromechanical rotary pulse switch which is relatively low in cost, which is small in size in proportion to the power capable of being handled, which is reliable and long in life, and which is of simple construction, thereby permitting rapid, accurate assembly and low maintenance, and providing a device wherein the parts are readily obtainable or easily constructed of common types of material.

Also included as an object is to provide a new and improved rotary pulse switch or converter which provides a means for mechanically converting shaft rotation output of virtually any accessory part to an electric pulse so that the rotary output can be transmitted by virtue of a pulsing electric current to some other component such

2

as a permanent magnet or reluctance type stepping motor which will impart to the motor a direction of rotation dependent upon the direction of the switch input shaft.

With these and other objects in view, the invention consists in the construction, arrangement and combination of the various parts of the device, whereby the objects contemplated are attained, as hereinafter set forth, pointed out in the appended claims and illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 is a front elevational view of the rotary pulsing switch device with the jacket or case cut away and partially broken away in the mid-area.

FIGURE 2 is a longitudinal sectional view taken on the line 2-2 of FIGURE 1.

FIGURE 3 is a plan view.

FIGURE 3a is a diagrammatic plan view showing the relative locations and relationship of air gaps.

FIGURE 4 is a schematic diagram showing the switch connected to a ratchet as it would be in performing work.

FIGURE 5 is a fragmentary plan view of the setting of the switching member for one sensitivity adjustment.

FIGURE 6 is a view similar to FIGURE 5 for a different sensitivity adjustment.

FIGURE 7 is a plan view of a modified version of the device.

FIGURE 8 is a front elevational view of the device of FIGURE 7.

FIGURE 9 is a longitudinal sectional view showing still another modified form of the device equipped with a differential.

FIGURE 10 is a cross sectional view on the line 10-10 of FIGURE 9.

FIGURE 11 is a schematic diagram of an electric circuit employing the device of FIGURES 9 and 10.

FIGURE 12 is a schematic diagram of a motor operatively coupled with the device.

FIGURE 13 is a diagrammatic drawing diagramming the principal switch parameters and constitutes an elevational view of the showing in FIGURE 3a.

FIGURE 14 is a diagrammatic showing of the relationship between vane rotation and switch action.

In an embodiment of the invention chosen for the purpose of illustration, there is shown a mounting plate 10, preferably of a ferrous material, to which the major portion of the mechanism is attached and which supports a jacket or cover 11 likewise of a ferrous material, thereby to provide a chamber 12. A mounting block 15 is secured to the mounting plate 10 by means of screws 13 threadably engaging the mounting block and extending through pags 14 of non-magnetic material and the mounting block 15. The mounting block extends substantially across the entire face of the mounting plate 10 and includes posts 16 and 17 spaced near the ends of the mounting block and forming with the mounting block a magnetic yoke. Mounted in the post 16 is a permanent magnet serving as a pole piece 18. On the opposite post 17 is a second permanent magnet serving as a pole piece 19. The inwardly facing ends of the pole pieces are of opposite polarity and by way of example it may be assumed that the inner end of the pole piece 18 is the north pole and the inner end of the pole piece 19 is the south pole. The pole piece 18 is arranged to slideably fit within an appropriate bore 20 of the post 16 to a position where it may be anchored or secured by means of a set screw 21. Similarly the pole piece 19 has a slideable position in a bore 22 and once in position may be secured therein by a similar set screw 23. Located as shown the pole pieces provide an air gap therebetween.

Midway between opposite ends of the mounting block 15 there is provided an aperture 26 within which is mounted a mercury wetted contact glass capsule switching

device of a type similar to that manufactured by C. P. Clare & Company, identified by their catalog No. 201, or other comparable switching device. The mercury wetted switch device herein described is one contained within a glass capsule or tube 27 secured by means of a rubber mount 28 in the aperture 26.

By way of example, it will be noted that the switching device is a glass envelope 27' which includes a multi-function nickel-iron alloy reed 29 welded at 30 to a tube sealed in the lower end of the capsule which serves as a combined armature and moving contact. In addition, microscopic grooves (not shown) in the surface of the reed provide the capillary paths required to feed mercury to the contact area. Two fixed contacts 31 and 32 are slightly flattened platinum alloy spheres mounted on identical supporting contact pole pieces 33 and 34 and are sealed in the upper end of the glass envelope; a small quantity of mercury 35 in a high pressure hydrogen atmosphere complete the capsule. In operation, as the reed or armature contact transfers, a filament of mercury is drawn between the reed and the contact. The filament may remain intact until the reed has made contact with the other contact at which time it ruptures at a speed estimated at 1500 G's creating an extremely rapid circuit breaking action. Under some conditions, however, the filament may rupture in advance of contact. It is important to note that the reed motion does not directly "make" and "break" contact but only serves to establish and break the mercury filament. Leads 37 and 38 are provided for electric contacts to a suitable circuit which also includes a lead 39.

The switching device requires for its operation a magnetic field of a direction and intensity necessary to establish a bistable condition for the reed or armature, stable against contact 31 or contact 32 and unstable in between.

In the interest of controlling and confining the maximum strength of magnetic flow in the magnetic path, there may be provided a positioning plate 41 (formed of suitable non-magnetizable material) attached by some convenient means to the posts 16 and 17 and extending in a direction parallel to the pole pieces 18 and 19 as well as being spaced laterally therefrom, as clearly appears in FIGURES 2 and 3. The positioning plate serves as a means for mounting and positioning auxiliary pole pieces herein identified as magnetic flux guide plates 42 and 43. These guide plates are preferably of a high-permeability low-retentivity magnetic material which extend transversely relative to the magnetic flow path between the pole pieces. By means of slots 44 and 45, respectively, guide plates are secured firmly in the chosen positions, as illustrated in FIGURES 1, 2 and 3. It should be noted further that an end piece 46 on the guide plate 42 is bent over at 90 degrees at the rear of the flow directing plate 41 in the direction of an end piece 47 on the guide plate 43. The end pieces facing each other as shown provide a secondary air gap 48 between them of a distance suggested in FIGURE 3. This gap may be wide or narrow, depending on the type of performance expected of the device as a whole.

In order to flex the armature 29 at the movable end 32 thereof, there is provided a pulsing member 50 in the form a wheel having a hub 51 from which extends in the chosen embodiment the four vanes 52, 53, 54 and 55. The hub is secured non-rotatably to an actuator shaft 56 rotatably supported upon a bearing plate 57 and upon the mounting plate 10. In this embodiment the pulsing member consisting of the vanes and the hub mounted as described on the actuator shaft is motivated an appropriate gear train having a ratio in this embodiment from rotation of the drive wheel to rotation of the actuator shaft of one to twenty-five. A drive shaft 59 has a large sprocket 60 thereon meshing with a pinion 61 on a shaft 62 upon which is another large sprocket 63 in turn meshing with a pinion 64 on the actuator shaft 56. The gear train described is merely one of convenience in providing precise bearing mounting for a gear train capable of step-

ping up input rotation to the drive wheel 58 a suitable amount depending upon the particular performance expected of the switching device.

To establish the magnetic field necessary for the bi-stable condition of the armature, the glass capsule switching device is positioned within a magnetic air gap indicated as G in FIGURE 3a for example and G as shown in FIGURE 1. The gap is established by the permanent magnet pole pieces 18 and 19 and the magnetic yoke 15. Once the bi-stable condition of the switch has been established it is then necessary, for switch operation, to provide some means of making the bi-stable condition monostable. This is accomplished by decreasing the strength of the magnetic force holding the armature against one of the contacts thus causing the other contact to become the stronger and attracting the armature to it. This is done by means of three secondary air gaps. These are: a stationary air gap G' and two variable air gaps G'' and G''' which are created as each of the vanes 52, 53, 54, and 55 rotates past each of the flux guide plates.

The action of these air gaps can be described by FIGURE 13 as follows: The two permanent magnets are first set up with the structure as shown diagrammatically in FIGURE 3a and physically in FIGURES 1, 2, 3. The strengths of the magnets 19 and 18 indicated as B and B' must be selected and the magnets positioned to give the desired bi-stable condition. A vane, as it rotates clockwise will increase the effective area of the air gap between itself and an end 47 of a flux guide plate 43 until sufficient magnetic energy is conducted away from the contact 31 to cause the armature to "snap" to the contact 32. The point at which this "snap" takes place is shown as point (a) on FIGURE 13.

As the vane continues in its clockwise direction it arrives at some point (b) where the then established air gap between the vane and the flux guide plate is of a sufficient magnitude to cause the armature to snap from the contact 32 to the contact 31 and there remains until a vane again reaches point a. If the vane rotates in a counterclockwise direction, point a' may be the point of armature release from contact 32 and b' the point of release from contact 31. It will be noted that these are not the same points as in the clockwise direction nor are the angles subtended, c and c', by the vane rotation between these points necessarily the same. It is important that these angles be controlled during switch manufacture and adjustment in order to give the proper switch operating characteristics. It is to be noted that by means of this possible angular difference, clockwise to counterclockwise rotation, that a means of determining the direction of vane rotation becomes available.

FIGURE 14 has been selected as a means of showing, in detail, the relationship between vane rotation and switch action. It will be noted that there are four operating situations, clockwise and counterclockwise rotation and the use of contact 31 and/or contact 32. Where it is only necessary to use one direction of rotation and one set of contacts the relationship between these other situations is not important but if the switch is to be used in more than one of the four modes of operation it becomes necessary to construct and adjust the switch so that these modes of operation are consistent with the desired switch characteristics. The difficulty lies in the fact that any one adjustment to obtain the desired operating characteristics in one mode of operation affects the others so that it becomes important to control the switch construction, tolerances and adjustments such that control over other modes of operation may be achieved. Since the parameters of the switch are not independent but affect the other parameters, it is not possible to specifically attribute a change in the operating characteristics of the switch-vane relationship to any one parameter change. However, it is possible to determine the parameter that has the greatest effect on a switch characteristic. Reference to FIGURE 13 and FIGURE 14, will define angles c and c', and d and d' and angle e. The angle f is defined

as the angle through which the vane rotates during which a "make" before "break" of contact condition occurs. It is important in the switch design and adjustment that this condition be attained over the range of switch operation if consistency in the four modes of operation is to be achieved. However, it is possible to also achieve a "break" before "make" condition by a variation in the switch parameters over limited range of switch operations. It will be noted that f is also specified as f' , f'' , and f''' since this "make" before "break" angle may be different for each mode of operation.

The primary switch operating characteristics which can be controlled by varying the switch parameters can be listed as follows:

- (a) Range of vane speeds over which it is desired to operate switch in degrees per unit of time.
- (b) Degrees vane rotation during which contact is desired for each of the four modes operation.
- (c) The maximum force (F) required to move vane past the flux guide plates. For a switch designed and adjusted to meet certain characteristics it is desirable to reduce the force (F) to a minimum consistent with reliable operation.

These characteristics can be controlled. In relation to any particular characteristic it can be assumed that there is a primary affecting parameter, and that after the change has been made in this parameter that the other secondary parameters are also changed in order to bring the switch back into proper operation.

Permanent magnet strength.—Assuming B and B' to be the strength of the respective magnets, the relation between B and B' affects the relationship of c to c' . Strengthening B over B' tends to increase the value of c' over c . For c to equal c' it is necessary to have balanced magnets. Also, since it is not actually the strengths of the individual magnets 18 and 19 but the effect of the magnets at the armature, the gap G and the distance H also affect this characteristic. Increasing both B and B' primarily increases the value of (F). Decreasing B and B' decreases (F) until a level is reached when armature will not respond consistently over required operating range of switch.

Gap G'.—This gap is not essential for switch operation but does have the effect of reducing the force (F).

Gaps G'' and G'''.—Decreasing this value is a means of increasing the speed range of the switch in degrees vane travel per unit of time. Force (F) is also increased when G'' and G''' is decreased.

Width D and D' of flux guide plates.—Increasing the width D and D' tends to increase the value of c over d and c' over d' . The number of vanes also increases the value of c over d and c' over d' . Four vanes are shown in FIGURE 1; however, any number of vanes can be used provided the distances D and D' are adjusted for the best compromise relation between c and d and c' and d' up to the point when a succeeding and following vane interferes excessively with the working air gap of a vane passing by the guide plates.

In operation when rotary motion is fed into the drive shaft 59, which can even be rotary motion taken from a linearly moving element, if desired, by suitable conventional means, not shown, or by a rotary source depending on conditions, the rotary motion is conveyed through the gear train just described to the actuator shaft 56, thereby to rotate the pulsing member 50. Inasmuch as there are four vanes on the pulsing member in the chosen embodiment with a ratio of one to twenty-five, the input shaft will create one hundred cycles of the vane movement past the gap 48 for one rotation of the input drive shaft 59. Accordingly, should there be a rotation of the input shaft at the rate of twelve revolutions per minute, there will accordingly be a pulsing or cycling of the vanes productive of twelve hundred cycles per minute of switching effect.

The switching effect has previously been described as accomplished by passage of the vanes 52, 53, 54, 55 past the air gaps. The pulsing member and its vanes are made preferably of a high permeability-low retentivity material so that they in effect become temporary magnets when they are passed within the range of the magnetic flow paths between the pole pieces 18 and 19.

It is characteristic of the switching member herein described that by varying the magnetic field by the location of or strength of the magnets, it is possible to control the action of the armature so that the switch pattern can be controlled through the armature. The main criteria is to locate the magnets in such fashion that a slight variation or imbalance in the magnetic field cause the armature to move one pole to another followed by the characteristic "snap" action. Since the objective of the invention is to control the armature from a rotating shaft, a means related to the rotating shaft is provided to produce the imbalanced effect. Such means comprises the above described vanes 52-55.

The steel vanes are rotated in proximity to the biasing magnets, and are made to serve effectively even though not moved through the greatest concentration of magnetic lines of force. This is accomplished by modifying the magnetic field so that there will be sufficient field in the vicinity of the path of the vanes to achieve a desirable strong effect. Such modification of the field is accomplished by the magnetic flux guide plates 42 and 43. Operating characteristics which are achieved include: extremely low torque requirements to turn the vane, no discontinuity at low speeds, no miscounts at high speeds, and control of on and off time. In addition, the present device achieves the optimum arrangement of parts for compactness, convenience, etc.

In the form described the switch can be used with particular success to convert from a shaft rotation to a numerical indication by means, for example, of a Veeder-Root type electromechanical counter. It can also be used as an output to electronic counters and for pulsing some stepping motors and printers.

A diagrammatic set-up has been illustrated in FIGURE 4 by way of example only where there is shown a rotating ratchet 67 actuated by an arm 68 which is motivated by a solenoid 69. The solenoid is periodically energized by a closure of the circuit 70 through the rotary pulsing switch of the type herein described indicated generally by the reference character 71.

As a means of varying the breadth of the gap 48 suggested in FIGURE 5, the spacing of slots 44' and 45' as indicated in FIGURE 6, locating them at different positions upon a flow directing plate 41', will accomplish this purpose. As shown in FIGURE 6, the slots are spaced wider apart, although making use of the same guide plates 42 and 43. The new arrangement, however, provides a gap 48' which is very much wider than the gap 48 of FIGURE 5 and FIGURE 3. The narrow gap 48 of FIGURE 5, assuming vanes 52, 53, 54, and 55 constant breadth, serves to decrease the torque force F as a primary effect, whereas a wide gap such as the gap 48' of FIGURE 6 under comparable circumstances, serves to increase the torque force F as a primary effect.

In the modified form of the invention illustrated in FIGURES 7 and 8, a single actuator shaft 75 is employed on which are two pulsing members 76 and 77, each substantially of the same general character and possessed of an equal number of identical vanes indicated respectively by the reference characters 78, 79, 80, and 81 for the member 76 and 78', 79', 80' and 81' for the member 77. The vanes on the respective pulsing members are, however, offset with respect to each other so that the vanes of the pulsing member 76, for example, cause the armature of a switching device 25' to make contact at a different instant relative to the making of contact by the armature in the switching device 25". This in effect generates a "logic" which heretofore has been accom-

plished by transistor circuitry necessary to drive a permanent magnet or inductance type stepping motor but which is accomplished substantially mechanically in the form of the invention of FIGURES 7 and 8. The dual switch by virtue of this becomes bi-directional. Moreover, in this form of device, though it may be preferable as a convenience to establish two magnetic paths through the respective switching devices closely adjacent the pulsing members 76 and 77, it is understood that the primary purpose is the establishment of a suitable magnetic path which affects both the switching device and its respective pulsing member even though the magnetic path may be initiated by separate sets or by a common set of north and south pole pieces.

The form of device in this embodiment follows substantially the principles of construction already disclosed in the initially described form except for its dual character. There is in essence a mounting plate 82 upon which the switching devices 25' and 25'' are mounted. For the switching device 25' there is a mounting block 83 forming part of a magnetic yoke in that it consists of a magnetic material upon which are mounted pole pieces 84 and 85 consisting of permanent magnets. Magnetic flux guide plates 86 and 87 are secured to a flow directing plate 88 so that a gap 89 exists between ends 90 and 91. The guide plates lie on opposite sides of a glass tube 92 within which the switch elements are located.

Similarly for the other switching device 25'' there is provided a mounting block 95 upon which are mounted pole pieces 96 and 97 likewise comprising permanent magnets which with the mounting block forms a magnetic yoke. Here again magnetic flux guide plates 98 and 99 are secured to a flow directing plate 100 to form a gap 101 located between ends 102 and 103 of the respective magnetic flux guide plates 98 and 99. The guide plates lie on opposite sides of a tube 104 within which the appropriate switch elements are located. Both of the mounting blocks are secured by bolts 105 to the mounting plate 82 and are spaced apart by spacers 106 and 107. In this instance an input shaft 108 acting through gears 109 and 110 serves to rotate the common shaft 75 thereby to actuate the pulsing members 76 and 77 in the manner already described.

In still another form of the device illustrated in FIGURES 9 and 10 there is shown a switching device 115 consisting of the usual tube 116 substantially like those heretofore described which is secured in a mounting block 117 anchored in a manner similar to that already described to a mounting plate 118. The mounting block forms in part a magnetic yoke in company with pole pieces like the pole piece 119 having the same relationship with respect to the tube as has already been described. Mounting flux guide plates 120 one of which is shown in FIGURE 9 are interposed on opposite sides of the tube 116 and are fastened to a flow directing plate 121 which in turn, by means not shown, is mounted upon the mounting plate 118, thereby to establish a gap similar to the gaps described in connection with the first two forms of the invention.

In this instance there are two input shafts 125 and 126. The shaft 126 may be assumed to carry the reference speed to the mechanism and the shaft 125 to carry the input speed. A differential 127 is driven in part by gears 128 and 129 from the shaft 126. Gears 130 and 131 are driven from the shaft 125, the gears 129 and 131 being considered the side gears of the differential. A spider gear 132 is driven by the gear 129 and in turn drives another spider gear 133. A spider gear housing 134 keyed to a shaft 135 by a set screw 136 drives a clutch face 137, likewise keyed to the shaft 135 by a set screw 138.

As the clutch face 137 is rotated in a counter-clockwise direction, as viewed in FIGURE 10, it will have no effect upon a ball 139. When, however, the clutch face 137 is rotated in a clockwise direction as viewed in FIGURE 10, the ball 139 will be caused to rotate also in a

clockwise direction but this rotation will impart to the outer race 140 of a bearing 141 rotation in a counter-clockwise direction. A vane 142 forms an integral portion of the outer race 140 and moves from its position of rest against a stop 143 to a position of engagement against a stop 144, namely, the broken line position 142' of FIGURE 10. Since the vane 142 can then rotate no further, counter-clockwise rotation of the race 140 will be arrested but inasmuch as the clutch face 137 continues to rotate, the ball 139 will be forced under the race since the entire bearing 141 is free to be lifted for a moment above its position of rest upon the shaft 135. This permits the ball 139 to be moved to the broken line position 139' after which by action of a spring 145 upon an arm 146, the bearing is moved promptly down again to a position on the shaft 135. It will be understood that the arm is pivoted at a point 147 to an appropriate portion of the structure to which a pin 148 also secures the lower end of the spring 145, these being mechanical expedients well known in the art. The arm 146 at its opposite end is attached to an inner race 149 of the bearing 141 whereby the force generated in the spring 145 serves normally to provide traction for the drive of the ball 139.

This relationship will continue as long as the clutch face 137 rotates in a clockwise direction as shown in FIGURE 10. Thereafter, however, by virtue of a change in the effect of the reference speed of the shaft 126, the clutch face 137 is rotated in an opposite direction, namely, a counter-clockwise direction as viewed in FIGURE 10. It will rotate the ball in position 139' in a counter-clockwise direction but this will generate clockwise direction of rotation in the counter race 140, whereupon the vane 142 will move from the position 142' against the stop 144 to its former position against the stop 143. At this point as rotation of the ball continues, the bearing will be again lifted from the shaft 135 and the ball will pass beneath it to the original solid line position 139 in which position upon continued counter-clockwise rotation of the bearing face 137 the vane will persist in its position against the stop 143 until reverse rotation again takes place.

It will be clear from the previous explanation that as the vane passes from a position against one stop to a position against the other stop, irrespective of which direction it may be, the vane will travel past the magnetic flux guide plates 120 and this will cause a shift in position of the switching device 115 with each passage.

As suggested by the schematic diagram in FIGURE 11, where a two pole switch device 115' is shown, operation in one direction will serve to energize a coil 150 thereby to actuate an armature 151. Contrarily, rotation in the opposite direction will effect energization of a coil 152 which will operate an armature 153 while at the same time the coil 150 will be de-energized thereby to release the armature 151. The schematic diagram is, however, merely representative of the effect which can be produced by the form of the invention of FIGURES 9 and 10. For example, in one recommended arrangement of the device a motor 154 drives the shaft 126 at a reference speed to the differential and the input speed may be fed to the differential 127 by the shaft 125. This relationship is suggested in FIGURE 12. The output of the differential serves to actuate the vane 142 in one direction or the other as already explained in response to changes in the relationship between the reference speed and the input speed and the changes in relationship may be used to actuate one or another of the armatures 151, 153 either to preserve an initial relationship in speeds or for some other appropriate purpose.

In practice the configuration of the vane 142 may be varied with respect to breadth for varied effects as it is rotated in opposite directions through the magnetic path, thereby to affect the magnetic field in a desired fashion.

Because it is the effect of a moving vane upon a magnetic field which is depended upon for the reliability and

performance of the snap acting switch herein described, it becomes important to protect the magnetic field thus carefully balanced from stray magnetic effects and from the influence of magnetic material which might be in the vicinity. Hence, the cover 11 is provided for the mounting plates 10, 82 and 118 and being of magnetic material the parts are capable of absorbing and deflecting any magnetic effect from the immediate vicinity of the critical magnetic balance of the device therein. Inasmuch as the magnetic flux guide plates can be made use of effectively in focusing and directing the magnetic flux existing between the pole pieces, it greatly conveniences the location and ease of mounting and movement of the pulsing member permitting the design of a very flexibly arranged and effectively operating moving mechanism spaced conveniently from the location of the switching device thereby making an operative assembly which is easy to construct and assemble in addition to being easy to operate and also one which can be readily be disassembled for servicing and repair as well as for readjustment to suit individual needs.

Various embodiments of the present invention, in addition to what has been illustrated and described in detail, may be employed without departing from the scope of the accompanying claims.

I claim:

1. A rotary pulse switch device comprising a mounting plate, a mounting block on the plate and a switching member on the block comprising a stationary contact and a reciprocating armature mounted in said member with a free end movable into and out of engagement with said stationary contact, a permanent magnet comprising magnetic pole pieces on said block, said pole pieces being of opposite polarity and mounted respectively on opposite sides of the free end of said armature and forming a magnetic path across said free end of said armature, said pole pieces being in balanced relationship on said mounting block, magnetic flux guide elements extending transversely across said magnetic path on respective opposite sides of said switching member, said guide elements having ends thereof forming a gap therebetween at a location on one side of said path, a rotary switch actuator shaft on the plate, a pulsing member mounted for rotation on said actuator shaft, a rotary input means operatively connected to said actuator shaft, said pulsing member comprising a plurality of vane means of high permeability-low retentivity magnetic material extending radially outwardly in balanced relationship on said actuator shaft, said vane means having a path of rotation parallel to said magnetic path and on one side of said pole pieces and said armature and adjacent said gap, said vane means upon rotation having a periodic modifying effect on said magnetic path whereby to effect reciprocation of said armature into and out of engagement with said contact point.

2. A rotary pulsing switch device comprising a mounting plate, a mounting block of magnetic material on the plate and a switching member on the block comprising opposite contact points and a reciprocating vane type armature mounted in said member with a free end movable in a path of flexure between said points, a permanent magnet comprising magnetic pole pieces having adjustable mountings on said block, said pole pieces being of opposite polarity and mounted respectively on opposite sides of the free end of said armature and of said points and forming a magnetic path across said armature in said path of flexure and said points, said pole pieces being initially movable to balanced position in said mounting, magnetic flux guide plates extending transversely across said magnetic path on respective opposite sides of said switching member, said guide plates having ends thereof extending toward each other and forming a gap therebetween at a location on one side of said path, a rotary switch actuator shaft on the plate, a pulsing member mounted for rotation on said actuator shaft, and a rotary input shaft operatively connected to said actuator shaft, said pulsing member com-

prising a plurality of vanes of predetermined breadth and of high permeability-low retentivity magnetic material extending radially outwardly in balanced relationship on said actuator shaft, said vanes having a path of rotation parallel to said magnetic path and on one side of said pole pieces and said armature and adjacent said gap, said vanes upon rotation having a periodic modifying effect on said magnetic path whereby to effect reciprocation of said armature in response to the movement of said vanes.

3. A rotary pulse switch device comprising a mounting plate, a mounting block of magnetic material on the plate and a switching member on the block comprising opposite contact points and a reciprocating vane type armature mounted in said member with a free end movable in a path of flexure between said points, a permanent magnet comprising magnetic pole pieces having adjustable mountings on said block, said pole pieces being of opposite polarity and mounted respectively on opposite sides of the free end of said armature and of said points and forming a magnetic path across said armature in said path of flexure and said points, said pole pieces being initially movable to fixed balanced positions in said mounting, magnetic flux guide plates of high permeability-low retentivity magnetic material extending transversely across said magnetic path on respective opposite sides of said switching member, said guide plates having ends thereof extending toward each other and forming a gap therebetween at a location on one side of said path, a rotary switch actuator shaft on the plate, a pulsing member mounted for rotation on said actuator shaft, and a rotary input shaft operatively connected to said actuator shaft, said pulsing member comprising a plurality of vanes of predetermined breadth and of high permeability-low retentivity magnetic material extending radially outwardly in balanced relationship on said actuator shaft, said vanes having a path of rotation parallel to said magnetic path and on one side of said pole pieces and said armature and adjacent said gap, said vanes upon rotation having a periodic modifying effect on said magnetic path whereby to effect reciprocation of said armature in proportion to the speed of movement of said vanes, said vanes being removable for replacement by vanes of different width whereby to vary the performance of said armature, and a shield of magnetic material entirely surrounding said pole pieces, said switch member and said vanes.

4. A differential pulse switch comprising a mount, a switching member on the mount comprising a contact element and an armature having a contact means thereon, a magnetic yoke on said mount having an air gap therein forming a magnetic path across said armature, and a pulsing assembly mounted on said mount comprising a reference speed shaft, an input speed shaft, a differential operably connected respectively to said shafts and an output element responsive to operation by said differential in forward or reverse directions, a slip clutch having an input clutch element on said output element, an output clutch element and a vane of high permeability-low retentivity magnetic material on said output clutch element, said vane having a path of travel along said magnetic path, stops located in spaced relation engageable with said vane at opposite limits of movement in said path of travel, said vane being movable in alternate opposite directions against said stops in response to operation of said differential and said vane having a modifying effect on said magnetic path whereby to shift the operative position of said armature upon movement of said vane along the path of travel.

5. A differential pulse switch comprising a mount, a switching member on the mount comprising opposite stationary contact elements and an armature having a contact means thereon reciprocatably mounted between said contact elements, a magnetic yoke on said mount having an air gap therein forming a magnetic path across said

11

armature, and a pulsing assembly mounted on said mount comprising a reference speed shaft, an input speed shaft, a differential having gears at opposite points operably connected respectively to said shafts and an output shaft responsive to operation jointly by said first two shafts in forward or reverse directions, a slip clutch having an input clutch element on said output shaft, an output clutch element and a vane of high permeability-low retentivity magnetic material on said output clutch element, said vane having a path of travel along said magnetic path, stops located in spaced relation engageable with said vane at opposite limits of movement in said path of travel, said vane being movable in alternate opposite directions against said stops in response to operation of said differential and said vane having a modifying effect on said magnetic path whereby to shift the operative position of

5

10

15

said armature upon movement of said vane along the path of travel.

References Cited by the Examiner

UNITED STATES PATENTS

2,872,597	2/59	Ormond	200—87
2,945,931	7/60	Reese	200—19
2,962,567	11/60	Rock	200—19
2,999,914	9/61	Stanaway	200—19
3,013,137	12/61	Vanden Broeck	200—19
3,086,095	4/63	Reese	200—87

FOREIGN PATENTS

538,409 8/41 Great Britain.

BERNARD A. GILHEANY, *Primary Examiner*.

ROBERT K. SCHAEFER, *Examiner*.

12