June 22, 1948. H. L. LAMBERT 2,443,659

CENTRIFUGALLY OPERATED SWITCH

Filed Oct. 18, 1943

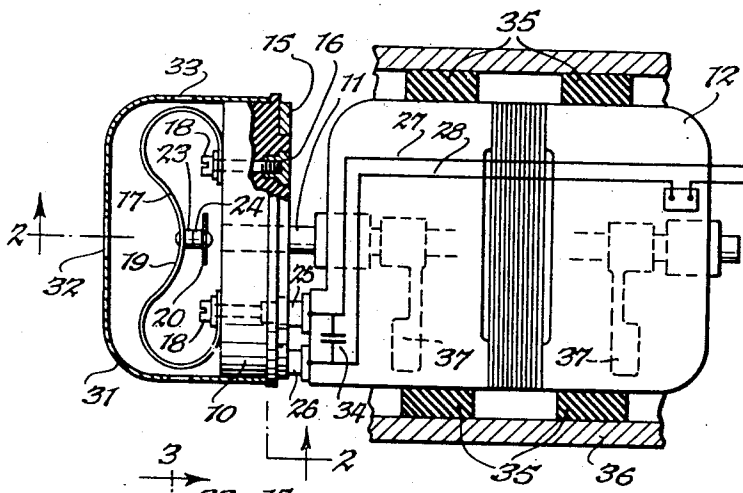


Fig. 1.

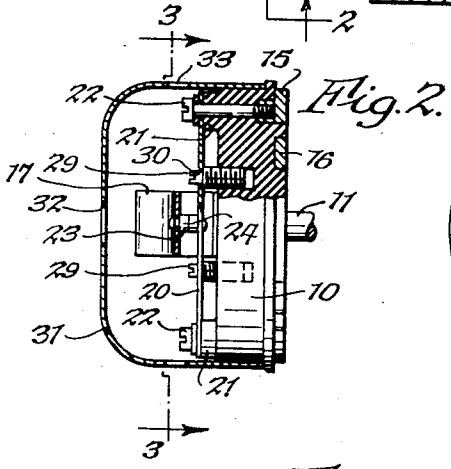


Fig. 2.

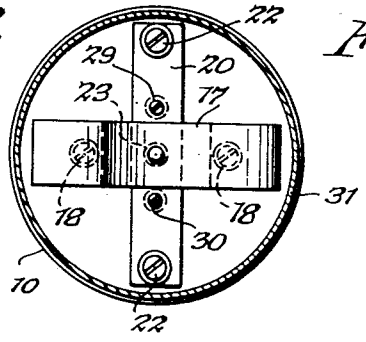


Fig. 3.

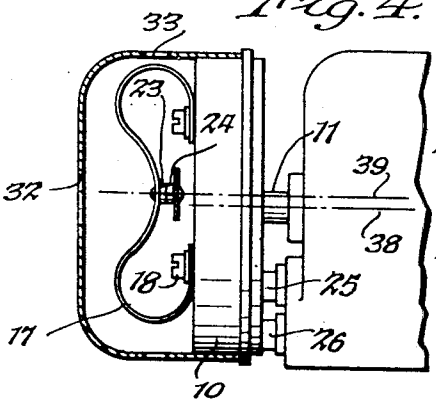


Fig. 4.

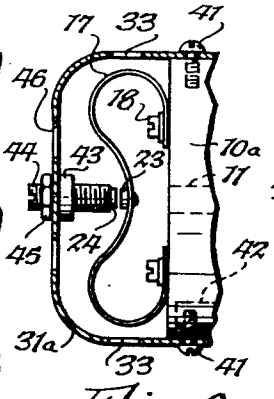


Fig. 6.

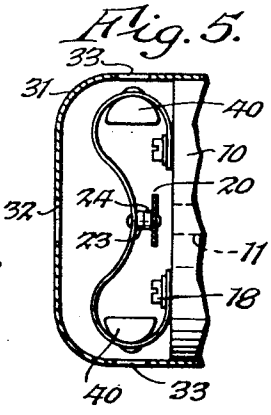


Fig. 5.

INVENTOR
Harry L Lambert
BY
Parker Prochnow & Farmer
ATTORNEYS

Patented June 22, 1948 2,443,659

UNITED STATES PATENT OFFICE

2,443,659

CENTRIFUGALLY OPERATED SWITCH

Harry L. Lambert, Enfield, N. Y., assignor, by mesne assignments, to The National Cash Register Company, Dayton, Ohio, a corporation of Maryland

Application October 18, 1943, Serial No. 506,646

1 Claim. (Cl. 200—80)

1

This invention relates to switches, and particularly to those which are centrifugally operated. Switches of this type have a variety of uses, such as to operate signals and various other electrical controls and devices, and to control the speed of motors, particularly a universal motor which operates on either A. C. or D. C. current.

An object of the invention is to provide an improved dependable, centrifugally operated switch which will require a minimum of servicing, and which will be effective or ineffective within relatively close, accurate limits.

An object of this invention is to provide an improved, centrifugally operated switch which, when set to operate whenever a selected speed is reached, will always operate at that speed, even when also given bodily movements laterally of the axis of rotation while it is rotating; which will be self-cooling so as to operate without an increase in temperature; and which will be exceptionally compact, and simple and inexpensive in construction.

Another object of this invention is to provide an improved centrifugally operated switch in which the engagement and separation of the contacts is in a direction parallel to the axis of rotation; with which a wiping action of the contacts will be obtained so as to keep the contacts clean; with which the particular speed at which the contacts will be caused to engage or separate may be adjusted in a simple manner; which will operate in any position without change in the speed at which it is effective to open or close a circuit; which requires a minimum of metal; and which will be relatively light in weight and durable in use.

Other objects and advantages of the invention will be apparent from the following description of some embodiments of the invention and the novel features will be particularly pointed out hereinafter in connection with the appended claim.

In the accompanying drawing:

Fig. 1 is a longitudinal, sectional elevation through a motor mounting and rotating a switch constructed in accordance with this invention, and with the switch connected to control the speed of the motor, in a use where the rotating switch is subject to lateral bodily movements as well as rotary movements;

Fig. 2 is a sectional plan of the same, the section being taken approximately along the line 2—2 of Fig. 1, and with other portions partially broken away to show details of construction;

Fig. 3 is a transverse, sectional elevation

2

through the switch, with the section taken approximately along the line 3—3 of Fig. 2;

Fig. 4 is a sectional elevation similar to Fig. 1, and illustrating another embodiment of the invention, in which the motor and switch are not subject to transverse, bodily movement while rotating, but with the contacts somewhat off center to provide a wiping action between them;

Fig. 5 is a sectional elevation of the switch similar to Fig. 1 but illustrating a slight modification thereof; and

Fig. 6 is a sectional elevation similar to Fig. 1, of another modification of the switch.

In the embodiment of the invention illustrated in Figs. 1 to 3, the improved switch includes a block or element 10 of insulating material, somewhat cylindrical in shape and fixed on a rotatable shaft 11, for rotation therewith. In this particular example, the shaft 11 is the shaft of an electric motor 12 of the universal type; that is, a motor which operates on either A. C. or D. C. current as desired. One end of the shaft 11 is extended to support the block 10 of insulating material. Mounted on the face of the block or element 10 which is nearest the motor, are metal, annular collecting rings 15 and 16, concentric with one another and with the shaft 11.

A flexible, ribbon-like spring strip 17 of metal is disposed adjacent the opposite face of the block or element 10, and its ends are secured to that face of the block 10 by screws 18 which pass through apertures in the ends of the strip 17 and in the block or element 10, and are threaded into one of the annular collecting rings such as the ring 16. The screws 18 are disposed approximately on diametrically opposite sides of the axis of shaft 11, and the portion of the strip between its ends extends radially outwardly from the screws 18, then is bowed by large arcs so as to extend approximately across the axis of rotation of the shaft 11. The intermediate portion of this strip 17 which extends across the axis of the shaft 11 is not straight, but is additionally and arcuately bowed in a direction generally lengthwise of the shaft 11, and in the illustrated example this intermediate portion is reentrant towards the block 10.

Also secured to the same or outer end face of the block 10 is a flat, ribbon-like metal strip or member 20 which at its ends abuts against the end faces of bosses 21 on element 10, Fig. 2. Screws 22 have their shanks passing loosely through apertures in the ends of the member 20, then through apertures in the block or element 10, and threaded into the other annular ring

which in this instance is the ring 15. Since the member 20 and screws 22 are of metal, the ring 15 will be electrically connected to the member 20, and the ring 16 will be electrically connected to the strip 17. The screws 22 are also on diametrically opposite sides of the axis of the shaft 11, but the member 20 is disposed to extend at approximately right angles to the strip 17, as shown in Fig. 3. The intermediate portion or zone 19 of the strip 17 carries a contact 23 on the face toward the member 20, and another contact 24 similar to the contact 23 and aligned therewith endwise of the shaft 11 is carried on the adjacent face of the member 20. The contacts 23 and 24 in this example normally abut against each other and form an electrical connection between the member 20 and the strip 17, and thus between the annular rings 15 and 16.

A conducting brush 25 is carried on the end face of the housing of motor 12 and bears against the exposed face of the ring 16, and a similar brush 26 also carried on the end of the housing of motor 12 bears against the other collecting ring 15, so that circuit connections may be made through the brushes 25 and 26 to the strip 17 and member 20 respectively, while the strip 17 and member 20 are rotating with the element 10. Circuit wires 27 and 28 are connected to the brushes 25 and 26 respectively, so that a circuit through those wires will normally be established by the engagement of the contacts 23 and 24. With this arrangement, and assuming that the shaft 11 is rotating, the element 10 and parts carried thereby will also rotate, and a closed circuit will exist between the conductors 27 and 28. As the speed or rotation of the shaft 11 increases, the centrifugal forces acting on the bowed strip will tend to move away from each other in a radial direction and thus take the bow out of the intermediate portion 19. This straightening out of portion 19, which will occur when a selected speed is reached or exceeded, is generally parallel to or endwise along the axis of rotation of shaft 11, and separates it from the contact 24, thus opening the circuit between the conductors 27 and 28.

The circuit will remain open until the speed falls below said selected speed, and then the resiliency of the strip 17 will overcome the centrifugal forces and return the strip 17 to its former position to place contact 23 in engagement with contact 24. While the circuit wires 27 and 28 may operate any desired signal device, the particular illustrated example of the use of the governor is to control the speed of the motor 12. For this purpose, the circuit wire 27 is connected to the line wire L^1 and the circuit wire 28 is connected to one terminal of the motor 12, the other motor terminal being connected to line wire L^2. When the speed of the motor reaches or exceeds a selected speed, the opening of the circuit at the switch will open the circuit to the motor, whereupon the speed of the motor will fall below said selected speed and the circuit will then be re-established. Thus, the switch will definitely prevent the speed of the motor from exceeding a selected speed.

In order to vary this selected speed at which the circuit is broken in this manner, means has been provided for shifting the intermediate portion of the member 20 carrying the contact 24 in a direction generally along the axis of rotation of the shaft 11 or toward and from the contact 23. This intermediate portion of the member 20 is spaced from the adjacent end face

of the element 10, and screws 29 are threaded into the element 10 on the face mounting the member 20, beneath the strip 20. Each of these screws 29 has a reduced head portion which extends loosely through an aperture 30 in the member 20, so that the shoulder between the reduced head portion and the body of the screw 29 will abut against the underface of the member 20.

These screws 29 are arranged at opposite sides of the axis of rotation of the shaft 11, and thus by turning the screws 29 in a direction to unscrew them from the element 10, the shoulders on the screws will force the intermediate portion of the member 20 outwardly or toward the contact 23, so that a much greater movement of the contact 23 with the strip 17 will be necessary in order to open the circuit between those contacts. Because of this, a much greater speed of rotation of the element 10 must then be reached or exceeded before the contact 23 will be separated from the contact 24. When the screws 29 are threaded in the opposite direction or into the element 10, the member 20 will return through its own resiliency to its normal position, in which the contact 24 is positioned to cause the opening of the circuit at the contacts at the minimum desired selected speed.

By reducing the height of the bosses 21, the member 20 may be shifted toward the face of the element 10 or in a direction away from the contact 23 in order to lower this selected minimum speed at which the circuit is opened. A cup-like shell or shield 31 may be telescoped over the periphery of the element 10 so as to prevent dust from settling on the contacts as much as possible, and to prevent accidental injury to the switch parts by accidental contact or bumping against the same. This shell 31 is provided with an aperture 32 approximately centrally of the end wall thereof which is approximately in alignment with the shaft 11, and also is provided with a plurality of apertures 33 arranged around the peripheral wall of the cup or shell 31 but spaced from the element 10. Thus air may circulate through the openings 32 and 33 and the interior of the shell 31 around the switch mechanism. This provides for dissipation of heat from the switch mechanism while the switch is operating, and the rotation of the switch parts tends to agitate the air within the shell 31 and cause movement of the air through the shell for this purpose.

It will be noted that the direction of rotation of the strip 17 and member 20 is edgewise of those members, whether the rotation is clockwise or counterclockwise, and this aids in causing a relative movement of air therepast to remove any heat which they receive by conduction from the contacts 23 and 24. There will be some minor arcing at the contacts 23 and 24, with some formation of heat, but any heat so formed will be dissipated by this rotation of the switch parts. As usual in make and break mechanism, a suitable condenser 34, Fig. 1, is connected across the circuit wires 27 and 28 to reduce arcing at the contacts 23 and 24 to a minimum.

The provision of a switch mechanism on a rotating member which is not only mounted for rotation, but is capable of at least some lateral, bodily movement during rotation, raises a particular problem. If the contacts of the switch open in a direction crosswise of the axis of rotation such lateral, bodily movement will produce unintended opening or closing of the switch

contacts, and thus render the switch mechanism useless and undependable on that type of device. Mercury switches on such elements are also unsatisfactory, because the jiggling of the mercury interferes with the accuracy of its operation. Inasmuch as the contacts 23 and 24 separate and approach each other only in a direction parallel to the axis of rotation, the lateral, bodily movement of the switch will not materially interfere with or affect the speed at which the switch mechanism is effective but this lateral or crosswise bodily movement of the switch mechanism will cause the strip 17 to jiggle or move sidewise to some extent and cause the contact 23 to wipe sidewise on the face of the contact 24 so as to keep the abutting faces between those contacts clean.

As one example of a mounting for the element 10 and switch mechanism which provides for some lateral, bodily movement, the motor 12 is mounted in annular rings or sleeves 35 of soft resilient rubber, of the nature of gum rubber tubing or sponge rubber, which in turn are mounted within the support or housing 36 which encircles the motor 12 and the bushings 35. The space between motor housing 12 and the outer housing 36 is less than the thickness of the rubber rings 35, so that when the parts are assembled as shown in Fig. 1, the rubber rings 35 will be under some radial compression, which not only aids in preventing endwise movement of the motor 12 but constitutes a floating support for the motor and the switch mechanism carried thereby. It will be understood that the motor 12 is entirely spaced from the enclosing support or housing 36, so that the entire support for the motor 12 will be solely through the floating support provided by the resilient rubber rings 35 which are preferably under some radial compression.

The shaft 11 is axially unbalanced to a substantial extent well in excess of any axial unbalance due to unintentional inaccuracy of manufacture, and this unbalance may be accomplished in any suitable manner such as by the use, for example, of weights 37 provided on and spaced along the shaft 11 in alignment with one another on the same side of the shaft. These weights 37 will rotate with the shaft 11, and the centrifugal forces acting on the weights 37 will tend to pull the shaft 11 with them outwardly and in a closed loop or circular path of small amplitude and having a frequency or period corresponding to the period of rotation of the shaft 11. Since the shaft 11 is carried by rigid bearings in the motor 12, this centrifugal force will also tend to drag the motor 12 with it in this circular path of small amplitude but high frequency, which movement is permitted by the resilient rings 35.

The rings, however, being under compression, will tend to transmit this closed-loop or gyratory movement to the enclosing support or housing 36, which movement may be utilized commercially for various purposes which are not a part of this invention, and therefore, will not be described. It will be noted, however, that this closed-loop or gyratory movement of the motor 12 with the shaft 11 will produce a similar movement of the element 10 and the switch mechanism carried thereby, which gyratory movement is laterally of the axis of rotation of the shaft, and therefore, causes a sidewise movement of the strip 17 and hence a wiping of the contacts 23 and 24, as above explained.

For this reason, the contacts 23 and 24 may be disposed concentrically with the axis of the shaft 11 and still have this wiping action. If the motor 12 is not provided with an axially unbalanced armature and shaft, and one desires to obtain the benefits of a wiping action between the contacts 23 and 24, this may still be accomplished by disposing the switch mechanism with the strip 17 and contacts 23 and 24 slightly eccentrically of the axis of rotation of the shaft 11, as shown in Fig. 4. Referring to Fig. 4, the parts have the same reference characters as in Figs. 1 to 3, but the strip 17, member 20 and the contacts 23 and 24 are disposed slightly to one side of the axis of rotation 38 of the shaft 11. The axis of the switch mechanism is designated by the reference 39, and it will be noted that there is a definite offset between these axes. In such an arrangement, if the speed of rotation of the element 10 and the switch mechanism carried thereby varies, the strip 17, which is now slightly off center, will tend to move sidewise to different extents with such changes in speed, and this will move the contact 23 sidewise with respect to the contact 24, and give this wiping action as the speed varies. Although the strip 17 is still balanced on opposite sides of its axis 39, nevertheless, it is unbalanced with respect to the axis of rotation 38, and therefore, the centrifugal forces acting on the strip 17 at different speeds will tend to move the strip 17 sidewise due to this unbalance in amounts proportional to the variations in the speed of rotation, which gives the wiping action between the contacts.

In Fig. 5, the construction is the same as shown in Figs. 1 to 3 except that additional weights 40 may be secured to the strip 17 at the bowed portions farthest from the axis of rotation, which increase the centrifugal forces on the strip 17 tending to separate the contacts 23 and 24. These weights 40 are preferably placed on the inside of the loops in the strips 17 to which they are secured, and the curvatures of the faces of the weights 40 which are nearest the abutting wall or face of the strip 17 have shorter radii of curvature than the bowed ends of the strip, so that the strip may change its shape under centrifugal action without being objectionably affected by contact of the strip 17 with the weight 40. By placing the weights 40 within the loops, the necessary overall dimensions of the switch mechanism may be kept to a minimum.

In Fig. 6 another modification of the invention is illustrated in which a circuit between the contacts 23 and 24 is established when a selected speed has been reached or exceeded. The construction is similar to that shown in Figs. 1 to 3, except that in place of the member 20 for mounting the contact 24, the shell 31*a* is made of metal and carries the contact 24. Those parts in Fig. 6 which correspond to similar parts in Figs. 1 to 5 have similar reference characters. The element 10*a*, which is similar to the element 10, is mounted on the shaft 11 and the metal shell 31*a* which telescopes over the periphery of element 10*a* is secured thereon in any suitable manner, such as by screws 41 which pass through the shell 31*a* and are threaded into the body of the element 10*a*. One of these screws 41 is threaded into a lug 42 which is cast integrally with, or attached to, the collecting ring 15, so that the ring 15 will be electrically connected to the metal shell 31*a*. The shell 31*a* has a boss 43 centrally of its bottom or closed end wall, through which a screw 44 is threaded, and secured in adjusted positions by a lock nut 45. The inner end of the screw 44 carries the contact 24, and the central aperture

32 of Figs. 1 to 3 is replaced by a plurality of apertures 46 arranged on opposite sides of or around the boss 43.

With this construction, the circuit between the wires 27 and 28 will normally be broken at the contacts 23 and 24, and when the speed of rotation has reached or exceeded a predetermined or selected speed, the centrifugal forces acting on the bowed strip 17 will tend to straighten out the central portion sufficiently to carry the contact 23 into engagement with the contact 24 and thus establish a circuit between the conductors 27 and 28. In such case, however, the conductors 27 and 28 will not be connected in series with the motors, but will be used to control some electrical signal or other device, or they may through a relay, control the circuit of the motor so that when the contacts 23 and 24 engage, they will complete a circuit through a relay which opens the main line circuit to the motor. Such controls are old and well known and for that reason, have not been illustrated, but they are mentioned here merely to convey the idea that devices of this type do have usefulness in connection with such controlling circuits. By adjusting the screw 44 endwise, the speed at which the contacts 23 and 24 will be caused to engage may be varied within a considerable range.

Electrical switches of this centrifugally operated type are particularly useful in controlling the speed of universal motors which operate successfully on both A. C. and D. C. current. Such motors tend to race, and if a resistance is connected in series with them in order to control their speed, this cuts down the power available in the motor, especially when starting. Such motors also tend to run hot, and the dissipation of heat from them may be difficult because of the fact that such motors are often placed within casings or enclosures where the cooling of the same by air circulation is difficult.

It has been found that when motors are controlled by centrigugally operated switches in this manner, the motors may be operated at all times with maximum power and torque, yet the speed is controlled within definite, close limits, and such motors run cold, even when operated for long periods. Apparently the interruptions of the circuit to the motor prevent overheating of the motor, and the switch mechanism itself is self-cooling so that this combination of a centrifugally operated switch controlling the speed of a motor is advantageous.

It is believed that the operation of the various embodiments of the invention which have been herein described and illustrated will be clear from the foregoing description, and they will only be briefly referred to by way of summation.

When a switch constructed in accordance with this invention is rotated, the bowed strip 17 will tend to straighten out and move its intermediate portion in a direction parallel to the axis of rotation, and a contact carried on that intermediate portion either separates from or engages another contact when such straightening out has reached a selected extent so as to make or break a circuit as desired when a selected speed has been reached or exceeded. While this intermediate portion may bow in either direction along the shaft, centrifugal forces will always tend to straighten out bows in the strip 17 and thus cause an endwise movement of the contact 23. The circuit wires 27 and 28 may be used to control any signal device or indicator, or any other electrical device, or they may be used to control the speed of the motor directly as shown in Fig. 1, or through the use of a relay. The engagement and separation of the contacts 23 and 24 in response to speed of rotation is not affected by lateral movements of the motor while it is operating, and in the example shown in Figs. 1 to 3, such lateral movement may actually be utilized to cause a wiping action of the contacts. In any case, the contacts 23 and 24 need not be aligned with the axis of rotation of the shaft 11, but the strip 17 may advantageously be placed off center with respect to the axis of rotation, as shown in Fig. 4, so as to additionally obtain a wiping action regardless of any lateral movement of the motor while it is operating.

It will be understood that the speed at which a circuit is made or broken may be adjusted by adjustment of the contact 24 either by the mechanism shown in Figs. 1 to 3, or as shown in Fig. 6.

It will be understood that various changes in the details, materials and arrangements of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claim.

I claim:

A centrifugally operated switch comprising an element mounted for rotation about an axis; a flexible, ribbon-like spring strip secured at its ends to said element and between its ends bowed in a broad loop with an intermediate portion additionally bowed in a direction along said axis so that centrifugal forces acting on said strip due to its rotation about said axis will tend to straighten out said bowed zones and will cause said intermediate portion to move in a direction generally lengthwise along said axis; a member secured to the element and disposed in the path of movement of said intermediate portion generally parallel to said axis; contacts carried by said intermediate portion and by said member, which contacts rotate with the element and are engaged and separated by the movements of said intermediate portion while rotating with said element; and means for shifting the contact carried by said member in a direction generally parallel to said axis of rotation to vary the position of this contact relative to the contact carried by the spring strip to control the speeds at which said contacts will be engaged or separated, said contacts being eccentrically mounted with respect to the axis of rotation so that the contact on the spring strip may, due to the resiliency of the strip, receive a slight lateral wiping movement relative to the contact on the member without affecting the speeds at which the contacts will be engaged and disengaged.

HARRY L. LAMBERT.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,293,996	Naul	Aug. 25, 1942
2,311,409	Merrill	Feb. 16, 1943

FOREIGN PATENTS

Number	Country	Date
65,887	Sweden	May 26, 1924