March 30, 1948. H. L. LAMBERT 2,438,810

CENTRIFUGALLY OPERATED SWITCH

Filed Feb. 24, 1944

Fig. 1.

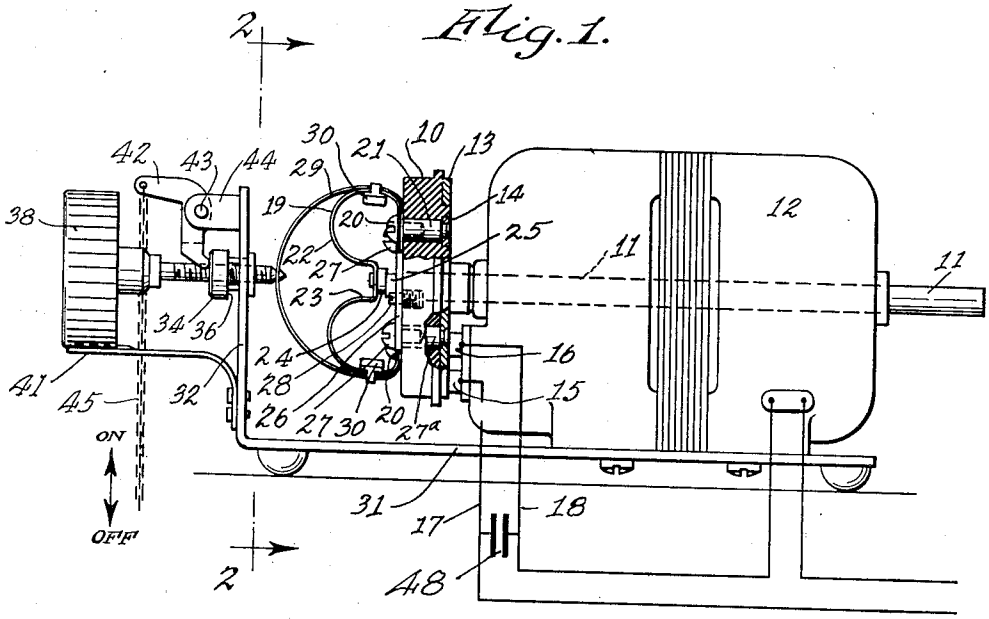
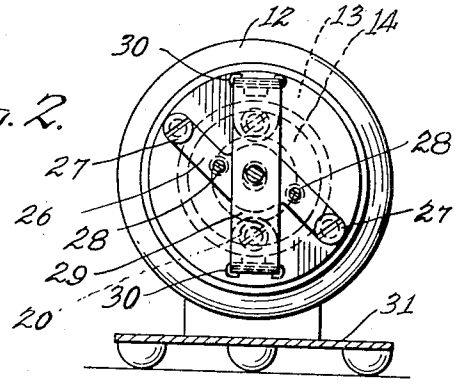


Fig. 2.



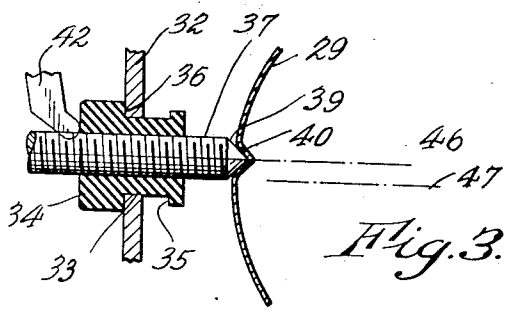


Fig. 3.

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CENTRIFUGALLY OPERATED SWITCH

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Application February 24, 1944, Serial No. 523,677

13 Claims. (Cl. 200—80)

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This invention relates to switches, and more particularly to those switches which are controlled by centrifugal forces.

Switches of this type have a variety of uses, such as to operate signals and various electrical controls and devices, and to control the speed of motors. There is a substantial commercial demand for small universal motors which will operate on either A. C. or D. C. current, but the speed of such motors varies with the load and fluctuations in voltage. Speed governors for such motors have been proposed, but they have been unsatisfactory because of their relatively large initial expense, the cost of maintenance, the space occupied, their inability to operate within sufficiently close limits, and the relatively weak power at reduced speeds of the motors so controlled.

An object of the invention is to improve, simplify and increase the effectiveness and accuracy of centrifugally operated electric switches.

Another object of this invention is to provide an improved centrifugally operated switch which will require a minimum of servicing attention; which will be closed and opened within relatively close, accurate speed limits; with which the speed at which the switch opens or closes may be varied over a considerable range, in a simple manner and even while the switch is operating; and with which the contacts will be kept clean through use.

Another object of this invention is to provide an improved, centrifugally operated switch which may be set to operate at different selected speeds within a possible range; which may be additionally and positively operated to open position and held open, irrespective of its speed of operation, even while the switch is rotating, and which, when released, will automatically return to the same condition, with respect to the speed at which it will operate, for which it was set before the switch was opened; with which the adjustment of the speed at which the switch opens and closes may be varied in a simple manner while the switch is in use; and which is relatively simple, dependable, compact and inexpensive.

Still another object of the invention is to provide an improved, centrifugally operated switch in which the circuit controlling contacts may be kept clean and effective in use, in a very simple and effective manner.

Other objects and advantages will be apparent from the following description of an embodiment of the invention, and the novel features will be

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particularly pointed out hereinafter in connection with the appended claims.

In the accompanying drawings:

Fig. 1 is a side elevation of a small electric motor of the universal type, having applied thereto a centrifugally operated switch constructed in accordance with this invention, with the switch in this illustration connected to control the speed of the motor which operates it;

Fig. 2 is a transverse sectional elevation of the motor and a portion of the switch shown in Fig. 1, the section being taken approximately along the line 2—2 of Fig. 1; and

Fig. 3 is a sectional elevation through a portion of the device to show the manner in which the abutment may be shifted to open or close the switch, whether the motor is operating or is idle, and to indicate more clearly the construction by which the contacts are kept clean in use.

The invention is in the nature of an improvement upon the centrifugally operated switch disclosed and claimed in my copending application No. 506,646 filed October 18, 1943.

In the illustrated embodiment of the invention, 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. This shaft 11 may be rotated from any suitable source of power, but in this particular illustration, the shaft 11 is the armature shaft of an electric motor 12 of the universal type, which is a motor that operates on either A. C. or D. C. current, as desired. One end of the shaft 11 is extended beyond the motor to support the block 10 of insulating material, and this block 10 is removably secured on the shaft extension in any suitable manner. Mounted on that end face of the block or element 10 which is nearest the motor are spaced, metal, annular collecting rings 13 and 14 which are concentric with one another and with the shaft 11. Suitable brushes 15 and 16 are carried by, but insulated from, the housing of the motor 12 and bear upon the collecting rings 13 and 14 so as to establish continuous electrical connections between the rings 13 and 14 with circuit wires 17 and 18 while the motor is operating.

A flexible, ribbon-like spring strip 19 of metal, such as spring steel, or brass, or similar resilient conducting material is disposed adjacent the opposite or outer end face of the block or element 10, with its ends extending toward one another and secured to that face of the block 10 by screws 20. The screws pass through apertures

in the ends of the strip 19, and are threaded into studs 21 which are secured in the block 10 and connected to one of the collecting rings, such as the ring 14. For this purpose, each stud 21 may have a reduced end which extends through an aperture in the ring 14, with the end that passes through the ring 14 upset to prevent its removal from the ring. The clamping of the ends of strip 19 against a face of the block 10 prevents removal of the collecting ring 14 and the studs 21, but the studs 21 are preferably snugly fitted in the apertures in the block 10 so that they are not easily removed after assembly.

The screws 20 are disposed at approximately diametrically opposite sides of the axis of the rotation of the shaft 11, and the intermediate portion of the strip 19 is arcuately bowed away from block 10 and extends approximately across the axis of the shaft 11, so that centrifugal forces acting on the strip 19 as it rotates with the block 10 will tend to flex and straighten out the bow in the intermediate portion of the strip, which straightening out will cause a movement, in a direction parallel to shaft 11, of that part of the intermediate portion which crosses the axis of the shaft 11. Preferably, the intermediate portion of the strip 19 is arcuately bowed as at 22 from each end, with a re-entrant portion 23 between the bowed portions where it crosses the axis of the shaft 11. This re-entrant portion 23 carries a contact 24 which normally engages with a second contact 25 that is carried by the block 10 approximately at the axis of rotation of the shaft 11. When the intermediate, bowed or looped portion of the strip 19 is somewhat straightened out, or flattened either manually or by centrifugal forces created by rotation of the block 10 and strip 19, the re-entrant portion 23 will move endwise of the shaft 11 in a direction to carry its contact 24 away from the contact 25.

The contact 25 is provided on a metal contact strip 26 which abuts approximately flat against the outer end face of block 10 and extends somewhat crosswise of the strip 10, as shown clearly in Fig. 2. The ends of the strip 26 are secured by screws 27 to metal studs 27A that are carried by the block 10 and anchored to the other collector ring 13, in the same way that the screws 20 are secured to studs 21 that are similarly anchored to the collector ring 14. This places the contact 25, through ring 13 and brush 15, electrically in circuit with wire 17. The circuit wire 18, through the brush 16 and ring 14, is electrically connected to the strip 19 and through it to the contact 24.

Screws 28 are threaded into the outer end face of the block 10 beneath the intermediate portion of the strip 26, and each of these screws has a reduced outer end which passes through an aperture in the intermediate portion of the strip 26, so that the shoulder between the outer reduced end and the body of the screw 28 will abut against the underface of the strip 26. By turning the screws 28 in a direction tending to remove them from the block 10, they will, by their engagement against the underface of strip 26, bow or spring the intermediate portion of that strip in a direction toward the contact 24, so that more powerful forces will be required to straighten out the strip 19 sufficiently to separate the contact 24 from the contact 25. In other words, a greater straightening out of the intermediate portion of the strip 19 will be required before contact 24 will separate from contact 25. Similarly, when the screws 28 are threaded into the block 10, the strip 26 will be released and will spring toward the face of block 10. This flexing of strip 26 varies the speed at which the centrifugal forces will be sufficient to separate contacts 24 and 25.

A second, flexible, ribbon-like, spring strip 29 has its ends abutting face to face with the ends of the strip 19 and is secured to the block 10 by the same screws 20 which secure the ends of the strip 19 to block 10. The second strip 29 is convexly bowed with a large loop, as shown clearly in Fig. 1, without any re-entrant portion, and is also coupled to the strip 19 at the radially outermost parts of the intermediate portion of the strip 19. This coupling is conveniently established by clipping small weights 30 to both springs 19 and 29 adjacent the radially outermost parts of both strips, where the strips abut. These weights 30 increase the centrifugal forces acting on the strip 19 for any speed and tending to straighten out the bowed or looped intermediate portion, and thus increase the effectiveness of the centrifugal forces in tending to separate contacts 24 and 25. The weights are preferably placed on the insides of the loop so that centrifugal forces cannot pull them loose from strips 19 and 29.

The motor 12 is secured upon a base 31 which has an upstanding arm or flange 32 that crosses the axis of the shaft 11 in proximity to the convex, intermediate portion of the second strip 29. This upstanding arm 32 is provided with an aperture 33, Fig. 3, in which a bushing or sleeve 34, preferably of insulating material, is mounted to slide. This bushing has spaced shoulders 35 and 36 which by engagement with opposite sides of the arm 32 limit endwise, sliding movement of the bushing in aperture 33 to the extent permitted by the spaces between these shoulders and the adjacent faces of the arm 32. Threaded endwise through this bushing 34 is an abutment screw or member 37 having at its outer end an operating knob 38, and at its inner end a conical tip 39 which bears in a conical recess 40 provided in the second strip 29 approximately where it crosses the axis of the shaft 11. The periphery of knob 38 is provided with peripherally spaced grooves, that run parallel to the axis of screw 37, and into one of which a spring detent 41 carried by the arm 32 may snap when the knob is stopped in different positions. This knob may be turned to advance the conical end 39 toward or from the spring strip 29, and the spring detent 41 will hold the knob in the different adjusted positions.

Suitable means is provided for also shifting the bushing 34 in a direction to compress the spring strip 29 sufficiently to cause separation of the contacts 24 and 25, and for this purpose, a bell crank lever 42 is pivoted at 43 on a bearing lug 44 carried by the upstanding arm 32. One arm of the bell crank 42 is forked to straddle the abutment screw 37 and abuts against an end face of the bushing 34, so that when the bell crank is rocked counter-clockwise in Fig. 1, the forked end will cam the bushing 34 bodily to the right into the position shown in Fig. 3, and thus advance the abutment member or screw 37 a definite amount determined by the shoulder 36. This compresses the convex, intermediate portion of spring strip 29, which forces the radially outermost portions of this spring strip further outwardly and stretches the intermediate portion 22 of the spring strip 19 in the same direction

that centrifugal forces tend to stretch it. As the speed of rotation increases, the centrifugal forces will become sufficient to separate contacts 24 and 25 and definitely open the circuit between them. This opens the circuit between conductors 17 and 18 regardless of the speed of shaft 11. When the bell crank 42 is released, the resiliency of strip 29 will shift the screw 37 back until shoulder 35 engages arm 32, and this then restores the parts automatically to the same initial position that the screw 37 occupied before the movement of the bell crank 42. The bell crank 42 may be operated to cause an opening or closing of the switch in any suitable manner, but for convenience, a chain 45 is shown connected to the bell crank. Obviously, other operating means for the bell crank and for holding it in its circuit opening position may be provided.

The screw 37 which bears against the spring strip 29 is preferably disposed with its axis (shown by the dot and dash line 46 in Fig. 3) disposed parallel to but slightly offset from the axis of the shaft 11 (shown by the dot and dash line 47 in Fig. 3), so that the screw 37 and its conical tip 39 will be slightly eccentric to the axis of rotation of the strip 29. Since the conical tip 39 runs in a recess 40, the recess 40 may also be slightly eccentric to shaft 11, and thus as the strip 29 rotates, this eccentricity will cause small sidewise movements of the strip 29, in addition to rotation, which will be communicated to the other strip 19, and through it to the contact 24. This small sidewise movement of the contact 24 upon the face of contact 25 is sufficient to keep the abutting surfaces of the contacts clean and free of oxide films or other agents that would interfere with the making of a good electrical contact when these contacts engage.

When the switch is used merely to operate a signal circuit, the wires 17 and 18 are, of course, connected in the circuit to be controlled, but in the example illustrated, the switch controls the speed of the motor 12 which operates it, and hence the wires 17 and 18 are shown as connected in series with the motor, so that opening of the circuit at the contacts 24 and 25 will open the circuit of the motor. An electrical condenser 48 of substantial size is connected across the conductors 17 and 18 for reducing radio interference due to the making and breaking of the circuit at the contacts 24 and 25, and also for the purpose of reducing arcing between those contacts, which arcing would cause pitting of the contact surfaces.

In the operation of the illustrated example of the invention, the circuit wires 17 and 18 are connected to a suitable source of commercial current, with the motor 12 in series in wire 18, and since the contacts 24 and 25 are normally in engagement with each other, a circuit will be established through the motor 12 and the shaft 11 will rotate. The block 10 and the springs 19 and 29 will also rotate with the shaft 11, and the centrifugal forces acting upon both of the strips 19 and 29 will tend to cause them to elongate radially or to flatten out the bows or bends therein. The centrifugal forces so created are increased by those created through the presence of the weights 30 which clip the two strips 19 and 29 together at their radially outermost points.

When the centrifugal forces tending to straighten out the strip 19 are sufficient to overcome the resistance due to the resilience of the parts 19 and 29, the re-entrant portion 23 will move in a direction away from the contact 25 and separate contacts 24 and 25. When the circuit opens, the speed of the motor will fall and at the same time the centrifugal forces will decrease with this decreasing motor speed so that the resilience of the strips 19 and 29 will immediately return towards their former shapes and re-engage contact 24 with contact 25. This reestablishes the circuit to the motor and the motor again accelerates in speed. The motor will, therefore, be held at a particular speed for which the switch is set.

When the bowed part of the strip 29 is flattened to different extents by turning of knob 38, it will tend to separate the radially outermost parts of the strips 19 and 29 in the same direction that the centrifugal forces tend to elongate or flatten these strips, so that the centrifugal forces necessary to complete the flattening and separate contacts 24 and 25 will be less than before the abutment screw 37 was adjusted to increase the flattening of strip 29. The speed at which the switch will open is, therefore, less as the knob 38 is turned to the right, or as the screw 37 is advanced to the right in Fig. 1. If one desires to stop the motor, it is merely necessary to pull down on the chain 45 which will rock the bell crank 42 and shift bushing 34 to the right from the position shown in Fig. 1 to the position shown in Fig. 3, which flattens the strip 29 sufficiently to carry the contact 24 out of engagement with contact 25. This opens the circuit of the motor 12 and holds it open.

If the conductors 17 and 18 from the switch are not connected in series with the motor, but to a signal or other device to be controlled, this separation of the contacts 24 and 25, obtained by pulling the chain 45, will open the circuit through the conductors 17 and 18 and thus incapacitate the signal or other device controlled thereby. When the chain 45 is released, the resilience of strips 19 and 29 will return the bushing 34 to the position shown in Fig. 1, and since the abutment screw 37 occupies the same relative position therein as before, the switch will be set to open at the same speed as before. Thus one may, by using the same switch, open or close the switch in the circuit it controls or vary the speed at which the switch will open under the action of centrifugal forces. The slight eccentricity between the conical tip 39 of the screw 37 and the axis of rotation of the spring strip 29 with shaft 11 will cause repeated wiping of the abutting surfaces of the contacts 24 and 25 and keep them clean.

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 claims.

I claim as my invention:

1. A centrifugally operated switch comprising an element mounted for rotation about an axis, a flexible, ribbon-like, spring strip anchored to said element for rotation therewith, said strip having a portion thereof yieldingly urged, by the resiliency of the strip, away from the position into which it would be urged by centrifugal forces caused by said rotation, but movable in a direction generally parallel to said axis, in opposition to the resiliency of said strip by the action of said centrifugal forces, contact means engaged and separated by said movement of said portion of the strip, and means acting on said portion of said

strip and controlling the pressure exerted by said strip in opposition to centrifugal forces whereby the speed at which movement of said strip under centrifugal forces will cause engagement or disengagement of said contact means, may be predetermined, said last named means including an abutment disposed approximately at the axis of rotation of said element and non-rotatable with said element, and a member rotating with said element, engaging said abutment, and acting upon said spring strip in a direction to move said strip against its resiliency and lessen the centrifugal forces necessary to cause relative movement of said contacts whereby the setting of said abutment will determine the speed necessary to create centrifugal forces of a size that will cause relative movement of said contact means in an opening or closing direction.

2. A centrifugally operated switch comprising an element mounted for rotation about an axis, a flexible, ribbon-like, spring strip anchored to said element for rotation therewith, said strip having a free portion yieldingly urged, by the resiliency of the strip, away from the position into which it would be urged by centrifugal forces caused by said rotation, but movable in a direction generally parallel to said axis, in opposition to the resiliency of said strip by the action of said centrifugal forces, contact means engaged and separated by said movement of said free portion of the strip, and means acting on said free portion of said strip and controlling the pressure exerted by said strip in opposition to centrifugal forces whereby the speed at which movement of said strip under centrifugal forces will cause engagement or disengagement of said contact means, may be predetermined, said last named means including an abutment disposed approximately at the axis of rotation of said element and non-rotatable with said element, and a second spring strip rotating with said element, engaging said abutment, and acting upon the first mentioned spring strip in a direction to move said strip against its resiliency and lessen the centrifugal forces necessary to cause relative movement of said contacts whereby the setting of said abutment will determine the speed necessary to create centrifugal forces of a size that will cause relative movement of said contact means in an opening or closing direction, said abutment and said second spring strip having interengaging surfaces slightly eccentric to the axis of rotation, whereby rotation of said second spring strip and the first mentioned spring strip relatively to said abutment will cause limited relative movement of said contact means in a direction crosswise of the axis of rotation.

3. A centrifugally operated switch comprising an element mounted for rotation about an axis, a flexible ribbon-like string strip anchored to said element for rotation therewith, said strip having a free portion yieldingly urged, by the resiliency of the strip away from the position into which it would be urged by centrifugal forces caused by said rotation, but movable in a direction generally parallel to said axis, in opposition to the resiliency of said strip by the action of said centrifugal forces, contact means engaged and separated by said movement of said free portion of the strip, means acting on said free portion of said strip and controlling the pressure exerted by said strip in opposition to centrifugal forces whereby the speed at which movement of said strip under centrifugal forces will cause engagement or disengagement of said contact means, may be predetermined, said last named means including an abutment disposed approximately at the axis of rotation of said element and non-rotatable with said element and a member rotating with said element, engaging said abutment, and acting upon said spring strip in a direction to move said strip against its resiliency and lessen the centrifugal forces necessary to cause relative movement of said contacts whereby the setting of said abutment will determine the speed necessary to create centrifugal forces of a size that will cause relative movement of said contact means in an opening or closing direction, means mounting said abutment for relative movement in a direction parallel to said axis of rotation, a support carrying said mounting means for limited movement in a direction parallel to said axis, and means for selectively shifting said mounting means, and with it said abutment in said support so as to carry said abutment rapidly between said limits of movement.

4. A centrifugally operated switch comprising a rotatable element, a flexible, ribbon-like, spring strip secured at both ends to said element at approximately diametrically opposite sides of the axis of rotation of said element, with an intermediate, free, bowed portion extending generally across the axis of rotation, a contact carried by said element at approximately said axis of rotation, a contact carried by said intermediate, bowed portion also at approximately said axis of rotation, said contacts being arranged on that side of said strip which will cause their separation from each other in a direction parallel to said axis when the centrifugal force set up in said spring strip by its rotation is sufficient to overcome the resiliency of the strip and move said intermediate portion in a direction parallel to said axis, spring means acting on said spring strip in a direction to decrease the pressure of said strip in opposition to the centrifugal force, and an abutment acting on said spring means to determine the pressure exerted by said spring means on said strip, whereby the pressure which the centrifugal force acting on said strip must overcome in order to cause relative movement of said contacts through a straightening of the intermediate portion of strip may be varied by moving said abutment to various predetermined position.

5. 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 at approximately diametrically opposite sides of said axis and having its intermediate portion free, re-entrant and bowed, whereby centrifugal forces acting on said strip when said strip and element rotate, will tend to straighten out said bowed and re-entrant portion and cause movement of said re-entrant portion in a direction parallel to the axis of said shaft, a contact carried by said re-entrant portion, another contact carried by said element, both contacts being disposed approximately at said axis, a second flexible, ribbon-like, spring strip coupled to said first strip adjacent the anchored ends of said first strip and convexly bowed in its intermediate portion spaced from the re-entrant portion, and an abutment engaging with said bowed, intermediate portion of said second strip in proximity to said axis, by which said bowed intermediate portion may be flattened to selected extents, whereby by predetermining the position of said abutment in a direction along said axis the speeds at which the centrifugal forces will

cause separation and approach of said contacts may be varied.

6. 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 at approximately diametrically opposite sides of said axis and having its intermediate portion free, re-entrant and bowed, whereby centrifugal forces acting on said strip when said strip and element rotate, will tend to straighten out said bowed and re-entrant portion and cause movement of said re-entrant portion in a direction parallel to the axis of said shaft, a contact carried by said re-entrant portion, another contact carried by said element, both contacts being disposed approximately at said axis, a second flexible, ribbon-like, spring strip coupled to said first strip adjacent the anchored ends of said first strip and convexly bowed in its intermediate portion spaced from the re-entrant portion, and an abutment engaging with said bowed, intermediate portion of said second strip in proximity to said axis, by which said bowed intermediate portion may be flattened to selected extents, whereby by predetermining the position of said abutment in a direction along said axis the speeds at which the centrifugal forces will cause separation and approach of said contacts may be varied, said abutment being selectively shiftable along said shaft axis to straighten said second strip to selected extents and, if shifted sufficiently, to separate said contacts.

7. 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 at approximately diametrically opposite sides of said axis and having its intermediate portion free, re-entrant and bowed, whereby centrifugal forces acting on said strip when said strip and element rotate, will tend to straighten out said bowed and re-entrant portion and cause movement of said re-entrant portion in a direction parallel to the axis of said shaft, a contact carried by said re-entrant portion, another contact carried by said element, both contacts being disposed approximately at said axis, a second flexible, ribbon-like, spring strip coupled to said first strip adjacent the anchored ends of said first strip and convexly bowed in its intermediate portion spaced from the re-entrant portion, a support, a member disposed approximately at said axis, mounted on said support and shiftable thereon in directions parallel to said axis to limited extents, an abutment adjustably mounted in said member for additional movement therein in a direction parallel to said axis and engaging the bowed intermediate portion of said second strip, the resiliency of said second strip being sufficient to keep said member at one of its limits of movement, and means for quickly shifting said member in the opposite direction to flatten the bowed part of said second strip and cause straightening of said intermediate portion of said first strip sufficiently to separate said contacts.

8. 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 at approximately diametrically opposite sides of said axis and having its intermediate portion free, re-entrant and bowed, whereby centrifugal forces acting on said strip when said strip and element rotate, will tend to straighten out said bowed and re-entrant portion and cause movement of said re-entrant portion in a direction parallel to the axis of said shaft, a contact carried by said re-entrant portion, another contact carried by said element, both contacts being disposed approximately at said axis, a second flexible, ribbon-like, spring strip coupled to said first strip adjacent the anchored ends of said first strip and convexly bowed in its intermediate portion spaced from the re-entrant portion, a support having an aperture approximately aligned with said shaft, a sleeve member slidable in said aperture in directions parallel to said shaft and having stops limiting said sliding movement in both directions, an abutment member threaded lengthwise through said sleeve member and disposed in a position approximately parallel to said shaft and abutting at one end against the intermediate portion of said second strip to flatten said intermediate portion to extents depending upon the adjustment of said abutment member along said axis and means for bodily shifting said sleeve member endwise in said support to one limit of its movement so as to flatten said intermediate portion of said second strip sufficiently to cause a separation of said contacts by a straightening of the intermediate portion of said first strip, whereby when said sleeve member is released, the resiliency of the intermediate portion of said second strip will immediately return said sleeve member to its initial limit of movement with said abutment member in the same relative position along said shaft.

9. 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 at approximately diametrically opposite sides of said axis and having its intermediate portion free, re-entrant and bowed, whereby centrifugal forces acting on said strip when said strip and element rotate, will tend to straighten out said bowed and re-entrant portion and cause movement of said re-entrant portion in a direction parallel to the axis of said shaft, a contact carried by said re-entrant portion, another contact carried by said element, both contacts being disposed approximately at said axis, a second flexible, ribbon-like, spring strip coupled to said first strip adjacent the anchored ends of said first strip and convexly bowed in its intermediate portion spaced from the re-entrant portion, a support having an aperture approximately aligned in directions parallel to said shaft and having stops limiting said sliding movement in both directions, an abutment member threaded lengthwise through said sleeve member and disposed in a position approximately parallel to said shaft and abutting at one end against the intermediate portion of said second strip to flatten said intermediate portion to extents depending upon the adjustment of said abutment member along said axis and means for bodily shifting said sleeve member endwise in said support to one limit of its movement so as to flatten said intermediate portion of said second strip sufficiently to cause a separation of said contacts by a straightening of the intermediate portion of said first strip, whereby when said sleeve member is released, the resiliency of the intermediate portion of said second strip will immediately return said sleeve member to its initial limit of movement with said abutment member in the same relative position along said shaft, said abutment member and intermediate portion of said second strip having slightly overrunning

portions in the direction along said shaft, but slightly eccentric to said axis, whereby rotation of said strips relatively to said abutment member will cause a limited crosswise movement of said strips relatively to said axis, and thereby a relative sidewise movement of said contacts to keep the abutting surfaces of the contacts clean.

10. A centrifugally operated switch comprising an element mounted for rotation about an axis, a flexible, ribbon-like, spring strip anchored to said element for rotation therewith, said strip having a portion extending approximately across said axis and urged, by the resiliency of the strip, in a direction approximately parallel to said axis and away from that position towards which it may be moved by centrifugal forces created by its rotation about said axis, contact means closed and opened by said movement of said portion of the strip during rotation of said element, and means for resiliently urging said strip towards its said position in aid of centrifugal forces, whereby the speed at which said forces will operate said contact means may be predetermined by the extent of said resilient urging.

11. A centrifugally operated switch comprising an element mounted for rotation about an axis, a flexible, ribbon-like, spring strip anchored to said element for rotation therewith, said strip having a free portion extending approximately across said axis and urged, by the resiliency of the strip, in a direction approximately parallel to said axis and away from that position towards which it may be moved by centrifugal forces created by its rotation about said axis, contact means closed and opened by said movement of said free portion of the strip during rotation of said element, and means for resiliently urging said strip towards its said position in aid of centrifugal forces, whereby the speed at which said forces will operate said contact means may be predetermined by the extent of said resilient urging, said resilient urging means including a spring member engaging and rotating with said free portion of said strip and an abutment engaging said spring member and relatively stationary as to said rotation of said spring member but determining, by its position along said axis, the pressure exerted by said spring member on said free portion of said strip.

12. A centrifugally operated switch comprising an element mounted for rotation about an axis, a pair of flexible, ribbon-like, spring strips having corresponding ends secured face to face and to said element at opposite sides of said axis, with the intermediate portions of both first extending radially away from said axis adjacent both of its anchored ends, and then bowed in a direction generally along said axis, and approximately crossing said axis, the intermediate free portions of one of said strips having a re-entrant portion adjacent said axis and spaced from the corresponding free, bowed portion of the other strip, a contact carried by said re-entrant portion, a second contact toward and from which said first contact moves as said one strip straightens its bowed portions under centrifugal forces created in said strips by their rotation, and means acting against the bowed free portion of the other of said strips for flattening it and, thereby flattening said intermediate bowed portion of said one strip to reduce the speed necessary to create centrifugal forces that will cause relative movement of said contacts along said axis.

13. A centrifugally operated switch comprising an element mounted for rotation about an axis, a contact mounted on said element, a flexible, ribbon-like, spring strip secured at its ends to said element at approximately opposite sides of said axis and having a bowed intermediate portion extending across said axis, a contact secured to the intermediate portion of said spring strip which may engage with and separate from the first-mentioned contact when the centrifugal forces acting on said strip during its rotation at different speeds causes straightening of the bowed intermediate portion to different extents to cause relative axial movement between said contacts, selectively adjustable means continuously acting on said strip to control the pressure exerted by said strip in opposition to said centrifugal forces thereby determining the speed at which separation of said contacts due to said centrifugal forces will occur, means to adjust said control means, and means to impart additional movement to the control means to cause said contacts to be separated irrespective of the speed of rotation of said element.

HARRY L. LAMBERT.

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