May 6, 1952 W. Z. WEST, JR., ET AL 2,595,621

CENTRIFUGAL SWITCH

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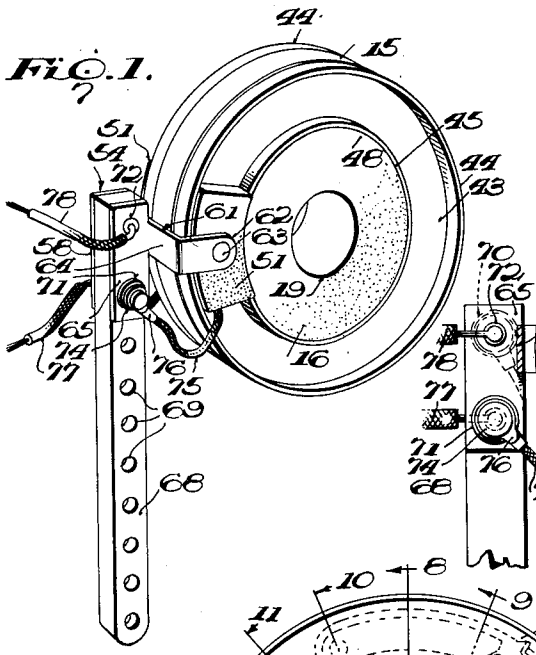

FIG. 1.

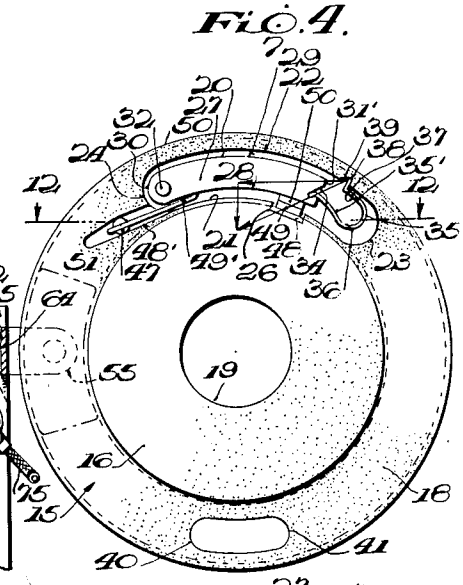

FIG. 4.

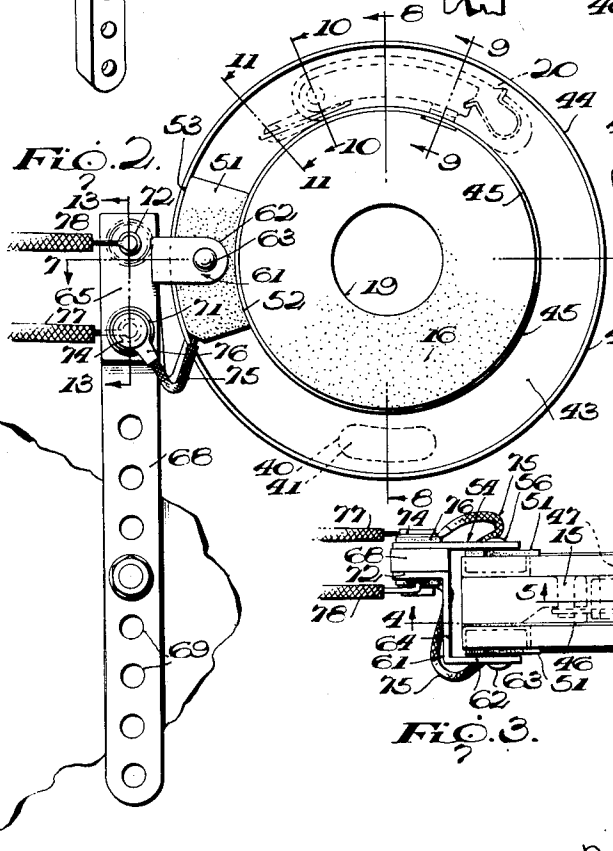

FIG. 2.

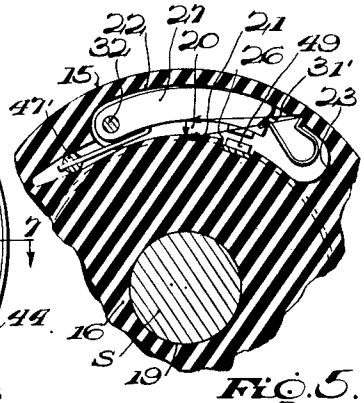

FIG. 5.

FIG. 3.

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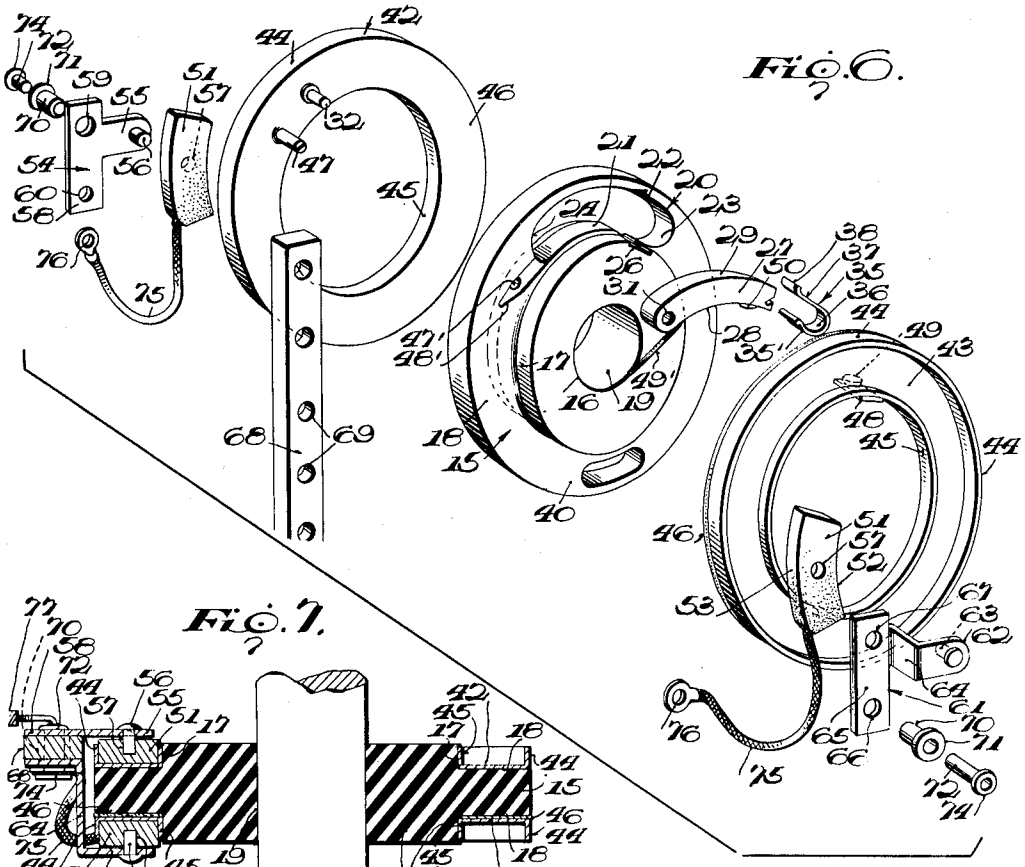

FIG. 6.

FIG. 7.

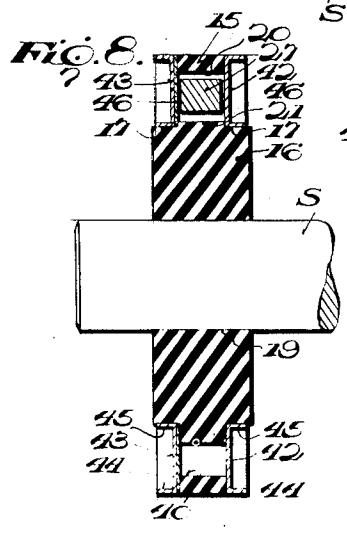

FIG. 8.

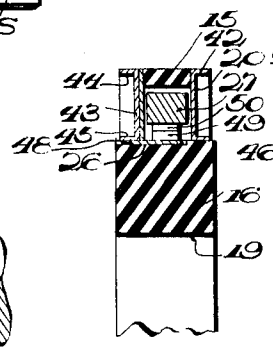

FIG. 9.

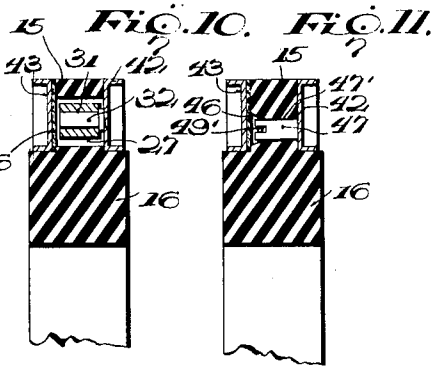

FIG. 10. FIG. 11.

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FIG. 12.

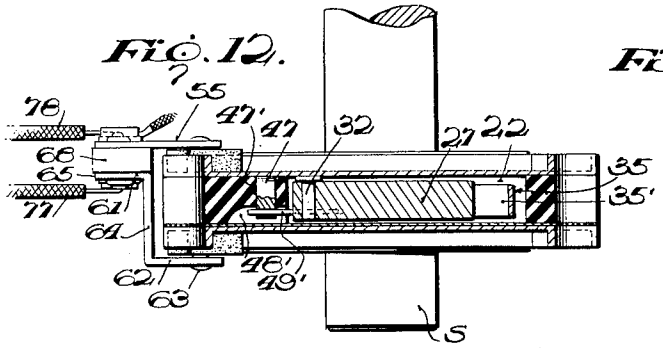


FIG. 13.

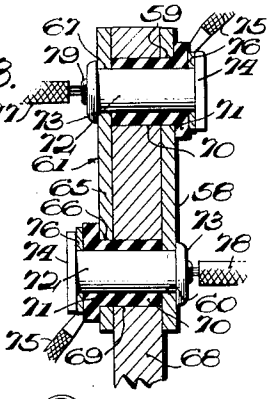


FIG. 14.

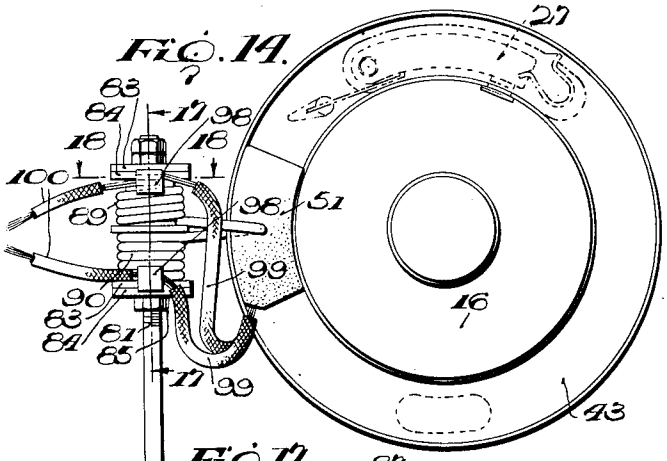


FIG. 15.

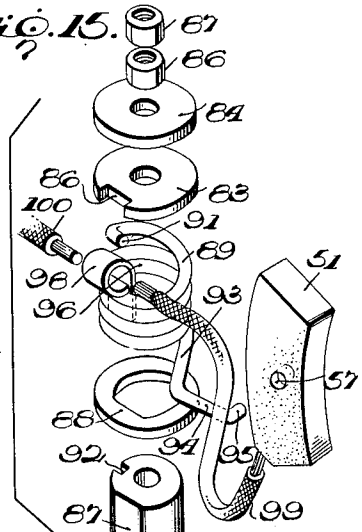


FIG. 17.

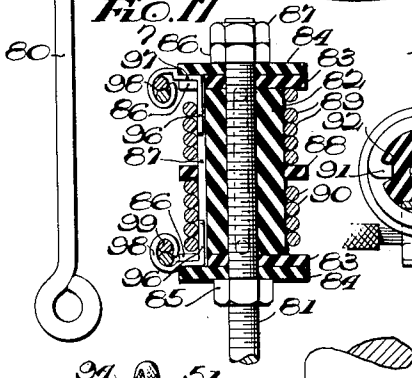
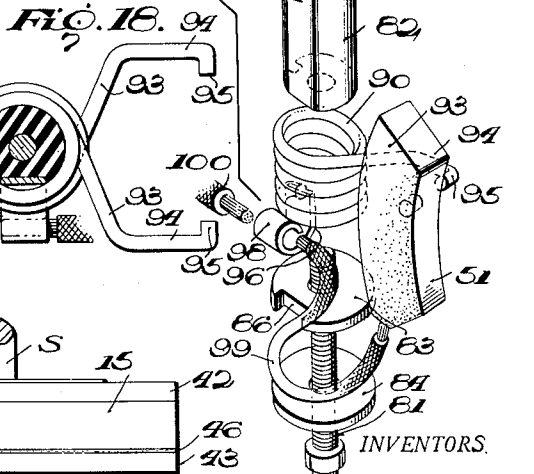


FIG. 18.



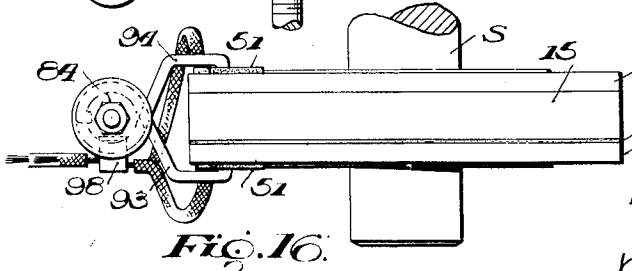


FIG. 16.

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Patented May 6, 1952

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UNITED STATES PATENT OFFICE

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CENTRIFUGAL SWITCH

Willis Z. West, Jr., and Morgan F. Gamble,
Winston-Salem, N. C.

Application October 27, 1949, Serial No. 123,880

5 Claims. (Cl. 200—80)

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Our invention relates to a switch of the type actuated by centrifugal force to open or close a circuit.

A primary object of our invention is to provide a switch of the character mentioned, to be mounted upon an armature shaft of a motor, and having means for electrically connecting terminals of the switch when the armature shaft is at rest, or rotating slowly, and to disconnect the terminals when the rotational speed of the armature shaft increases.

A further object is to provide a centrifugal force actuated switch which employs a toggle spring to govern the movement of a conducting element within the switch when the switch rotates, so that the element will open a starting circuit at approximately 80 percent of full motor speed, and close the circuit when the motor is slowing down, at a lower motor speed, which is desirable.

A further object is to provide a switch of the above mentioned type which is axially thin and radially wide, so as to be very compact and occupy a minimum axial space upon the armature shaft.

A further object is to provide a switch of the class mentioned having a novel and simplified arrangement of exposed brushes which operate at opposite sides of the switch.

A further object is to provide a centrifugal force actuated switch which has exceptionally large contact areas for brushes, and large switch contacts.

A further object is to provide novel means for sealing the switch contacts from dust and dirt, to eliminate noise, and to guide the brushes so that their wear will be reduced to a minimum.

A still further object of our invention is to provide a switch of the above mentioned character which is extremely strong and durable so that it will have an exceptionally long life.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings, forming a part of this application, and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a perspective view of a switch embodying our invention,

Figure 2 is a side elevation of the same,

Figure 3 is a plan view of the switch as shown in Figure 2,

Figure 4 is a vertical section taken on line 4—4 of Figure 3, parts in elevation, and parts omitted,

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Figure 5 is an enlarged fragmentary vertical section taken on line 5—5 of Figure 4,

Figure 6 is an exploded perspective view of the switch,

Figure 7 is a horizontal section taken on line 7—7 of Figure 2,

Figure 8 is a vertical section taken on line 8—8 of Figure 2,

Figure 9 is a fragmentary radial section taken on line 9—9 of Figure 2,

Figure 10 is a similar section taken on line 10—10 of Figure 2,

Figure 11 is a fragmentary vertical section taken on line 11—11 of Figure 2,

Figure 12 is a planned view of the switch device, parts being taken in section substantially on the line 12—12 of Figure 4,

Figure 13 is a vertical section taken on line 13—13 of Figure 2,

Figure 14 is a side elevation of the switch, showing a modified form of holder for the plate brushes,

Figure 15 is an exploded perspective view of the plate brushes holder,

Figure 16 is a planned view of the complete device,

Figure 17 is a longitudinal section taken on line 17—17 of Figure 14, and,

Figure 18 is an enlarged horizontal section taken on line 18—18 of Figure 14.

In the drawings, where for the purpose of illustration is shown a preferred example of our invention, the numeral 15 designates a disc or carrier, formed of electric insulating material, which disc is cylindrical, axially thin, and radially wide, as shown. The disc or carrier 15 includes a central cylindrical hub portion 16, extending axially outwardly of the disc 15 upon both sides of the same, and forming axially oppositely disposed annular shoulders 17, which co-act with opposed flat radially wide annular faces 18 of the disc 15, in a manner to be described. The hub portion 16 has a central axial bore 19 for receiving the armature shaft S of an electric motor. The bore 19 is of such diameter that the switch may be pressed onto the armature shaft of the particular size for which the switch is designed. The hub 16 projects axially equidistantly upon opposite sides of the disc 15, and is preferably integral with the disc. The outside diameter of the hub 16 is substantially less than the outside diameter of the disc 15, as shown, and the combined axial length of the disc and hub is relatively short. The disc 15 is provided outwardly of the hub 16 with an arcuate opening or slot 20, which preferably

extends circumferentially for nearly 90 degrees, and which has an inner arcuate side 21, arranged near and slightly radially outwardly of the periphery of the hub 16. An outer arcuate side 22 of the slot 20 is arranged near and inwardly of the periphery of the disc 15, so that the slot 20 occupies nearly the entire radial width of the disc outwardly of the periphery of the hub, Figure 4. Arcuate sides 21 and 22 of the slot 20 are preferably concentric with the hub 16 and bore 19. The right and left ends 23 and 24 of the slot 20 are circularly curved. A shallow axial groove 26 is formed in the inner side 21 within the longitudinal center of the slot 20, Figures 2, 4, 5, 6, 9. The groove 26 extends through one end of the hub portion 16 and terminates short of the other end of the hub portion 16.

Removably mounted within the arcuate slot 20 is an arcuate conducting element of segment 27 of brass, bronze or the like. This conducting segment 27 has a radial thickness substantially less than the radial width of the slot 20 and the segment is substantially shorter than the slot, Figure 5. The inner and outer arcuate sides 28 and 29 of the conducting segment are preferably substantially concentric with the sides of the slot 20. The left end of the conducting segment 27, Figure 4, adjacent to the end 24, is rounded and is provided with a transverse opening 31 for receiving a metal pin 32, secured to a slip ring to be described. The opposite end 31' of the conducting segment 27 is provided with a notch 34, detachably holding one end of a generally U-shaped toggle spring 35 of suitable metal. The toggle spring has an inner side 35', and the closed end 36 of the toggle spring 35 is arranged near the end 23 of the slot. The outer side 37 of the toggle spring is arranged near and spaced from the outer side 22 of the slot. The free end of the side 37 is bent radially outwardly to form a short radial extension 38, engaging in a notch 39 formed in the outer side 22 and extending through the axial length of the disc 15.

Arranged diametrically opposite the conducting segment 27 and formed in the disc 15, is an arcuate slot 40, extending through both ends of the disc 15. The slot 40 receives an arcuate counter weight 41 rigidly secured therein. The counterweight has substantially the same weight as the conducting segment 27 and serves to balance the switch during rotation. Removably mounted upon the opposite sides of the disc or carrier 15 are flat annular brush plates or slip rings 42 and 43, which are axially thin and radially wide. The brush plates 42 and 43 have the same radial width as the faces 18 of the disc, and are provided adjacent to their peripheries with axially extending annular flanges 44. The brush plates or slip rings are also provided with axially extending annular inner flanges 45. The flanges 44 and 45 extend axially for equal distances, and are substantially flush with the opposite ends of the hub portion 16, Figure 7. The annular flanges 44 have their peripheries flush with the periphery of the disc 15, and the inner annular flange 45 engage over the periphery of the hub portion 16 upon opposite sides of the disc 15 and have a snug fit therewith so that they will not turn therein, yet may be removed by a suitable tool. A thin flat annular insulating washer 46 is arranged between the brush plate or slip ring 43 and the adjacent face of the disc 15, covers the adjacent sides of the slots 20 and 40, and maintains the brush plate or slip ring 43 insulated from the conducting segment 27 and counterweight 41.

The metal pin 32 is carried by the slip ring 42, and pivotly supports the conducting segment 27 and also electrically connects it with the slip ring 42. A metallic conducting pin 47 is rigidly secured to the slip ring 42 and extends through an axial opening 47' formed in the disc 15 and this opening leads into a groove 48' formed in one face 18 of the disc 15. The free end of the conducting pin 47 is slotted to receive a wire 49' which is secured within the slotted end by solder or the like. The wire 49' is permanently electrically connected with the conducting segment 27. It is thus seen that the conducting segment is in permanent electrical connection with the slip ring 42. The slip ring 43 carries a short flat metallic conducting tab 48 rigidly secured to the inner face of the inner flange 45, as by welding, and the tab 48 projects axially inwardly beyond the slip ring 43 and is held within the groove 26. This groove 26 terminates short of the slip ring 42 so that the tab is insulated from the slip ring 42. The conducting tab 48 has a contact point 49 secured to its outer side, and this contact point is arranged to engage and disengage a contact point 50 secured to the inner side 28 of the arcuate conducting segment 27. It is thus seen that the contact points 49 and 50 serve to electrically connect and disconnect conducting segment 27 with and from the slip ring 43, while the conducting segment 27 is in permanent electrical connection with the slip ring 42. Attention is called to the fact that when the parts are assembled as shown in Figure 2, the slip rings 42 and 43 seal the slot 20 against dirt or other foreign matter and the conducting tab 48 also closes the groove 26. The inner flanges 45 snugly engages over the periphery of the hub portion 16. It is thus seen that the slot 20 is held dirt or dust proof, to a high degree, thus protecting the contact points 49 and 50, and associated elements arranged within the groove 20.

Freely slidably mounted between the inner and outer annular flanges 45 and 44 upon the metal brush plates 42 and 43, are flat thin plate brushes 51 formed of carbon or the like. These plate brushes are circumferentially elongated and arcuate, as shown, and have their inner flat faces slidably contacting the outer faces of the brush plates 42 and 43. The plate brushes 51 are radially wide and extend between the annular flanges 44 and 45 and their inner and outer arcuate sides 52 and 53 slidably contact the flanges 44 and 45 to be guided thereby. The plate brushes 51 are slightly thicker axially than the axial widths of the flanges 44 and 45, so that the plate brushes project axially beyond the ends of the hub portions 16, Figure 7. The flanges 44 and 45, in addition to guiding the plate brushes, serve to make their operation very quiet.

Means are provided to hold the plate brushes 51 against rotation with the carrier or disc 15. These means include a flat thin plate 54 arranged upon one side of the switch and having a radially inwardly extending arm 55, having rigidly secured thereto an axially inwardly extending pin or trunnion 56. The arm 55 lies adjacent to the outer side of one plate brush 51, and the pin 56 engages within an opening 57 formed in the outer side of each plate brush, at the longitudinal center of the same. The plate 54 further includes a rectangular main body portion 58, integral with the extension 55 and arranged near the periphery of the disc 15 and spaced therefrom, Figure 7. The body portion 58 is provided in one end with a relatively large opening 59, and in its opposite end with a small opening 60, for the

purposes to be described. A generally Z-shaped plate 61 is provided opposite the plate 54. The Z-shaped plate includes a radially inwardly extending arm 62, arranged opposite the arm 55 and adjacent to the outer face of the other plate brush 51. The arm 62 carries an axially inwardly extending pin or trunnion 63, identical with the trunnion 56 for engagement in the opening 57 of the adjacent plate brush 51. The Z-shaped plate 61 further includes an axially extending portion 64 which extends near and spaced from the periphery of the disc 15, Figure 7; and secured to the inner end of the portion 64 is a main body portion 65, which is rectangular and arranged opposite the rectangular main body portion 58 and spaced therefrom. The main body portion 65 is provided in one end with a relatively large opening 66, having the same diameter as the opening 59, and in its opposite end with a small opening 67, having the same diameter as the opening 60. The opening 66 is arranged in axial alignment with the opening 60, while the opening 67 is in axial alignment with the opening 59.

A non-conducting fiber strip or bar 68 having a plurality of longitudinally spaced adjusting openings 69 is arranged between the body portions 58 and 65 of the plates 54 and 61, as shown. The openings 69 are of the same diameter as the openings 59 and 66. Tubular insulating bushings 70 are inserted from opposite sides of the bar 68, through the large openings 59 and 66, of the plates 54 and 61, Figure 13. The bushings 70 are of such length that when their heads 71 engage the outer faces of the plates 54 and 61, their inner ends are flush with the opposite sides of the bar 68, Figure 13. Tubular conducting rivets 72, of copper, brass, or the like, are to be inserted through the bushings 70 from their ends having the heads 71. These tubular conducting rivets extend entirely through the insulating bushings and through the openings 60 and 67 of the plates 54 and 61, which are upon opposite sides of the bar 68. The ends of the rivets 72 which extend through the openings 60 and 67 are peened over as shown at 73, for rigidly securing the parts together in assembly. The rivets 72 have heads 74 spaced from the heads 71. The plate brushes 51 have short conducting wires or jumpers 75 secured thereto in a conventional manner, and at their free ends the jumpers 75 carry terminal washers 76 for engagement beneath the heads 74 of the conducting rivets, Figure 13. Lead wires 77 and 78 from the starting stator winding of the motor have their free ends inserted within the bores of the tubular rivets 72, from the ends of the rivets remote from their heads 74. The lead wires have their ends soldered in place within the rivets, as shown at 79. The extensions or arms 55 and 62 are sufficiently resilient so that they may be sprung outwardly for removing the pins 56 and 63 from the openings 57 of the plate brushes, as when changing the plate brushes, or the like. The bar 68 may be secured to some stationary part of the motor by a bolt, or the like, as shown, passed through one of the openings 69.

The operation of the switch is as follows:

The disc or carrier 15 is applied to the armature shaft S for rotation therewith, the bore 19 receiving the armature shaft. The motor may be of the split phase type or of the capacitive type. The split phase motor has a starting stator winding, and a running stator winding. As is well known, in starting a motor of this type, current is first supplied to the starting and running stator windings, and when the motor speed increases to the desired point, the current to the starting stator winding is cut off. The present switch is employed to supply current to the starting stator winding to start the motor, and to cut the current off when the motor speeds up. It is desirable to cut off the current to the starting stator winding when the motor reaches approximately 80 percent of motor speed. It is further desirable, when the motor is slowing down, to have the circuit through the starting stator winding closed at a motor speed somewhat lower than 80 percent of full speed, and our switch accomplishes these objectives.

When the motor armature shaft S is at rest, the switch is closed, Figure 4. The toggle spring 35 swings the conducting segment 27 radially inwardly so that the contact 50 engages the contact 49, thus closing the circuit between the slip rings 42 and 43 and plate brushes 51, in turn closing a circuit through the starting stator winding. As the speed of the armature shaft increases, the disc 15 has its rotational speed correspondingly increased and the pivoted conducting segment 27 swings radially outwardly within the slot 20 by centrifugal force in opposition to the spring 35 when the selected speed is reached. When the conducting segment 27 thus swings radially outwardly the engagement between contacting pins 49 and 50 is broken and the circuit is opened. As previously stated, the conducting segment 27 should swing radially outwardly to break the circuit at the contact points 49 and 50 when the motor has reached approximately 80 percent of full speed, although this figure may vary slightly with different motors. The toggle spring 35 is accordingly designed to permit the segment 27 to open at the proper speed for the particular motor. The toggle spring 35 is designed and mounted so that the segment 27 will be moved inwardly radially by the toggle spring for again closing the circuit through the starting stator winding when the motor is slowing down and has reached a speed somewhat lower than 80 percent of full speed. In order that the segment 27 may swing inwardly at a lower rotational speed than was required to shift it outwardly, the toggle switch 35 exerts a lesser force radially inwardly when the segment 27 is in the outer position, Figure 5, than it exerts when the segment 27 is in the innermost position. With the conducting segment 27 in the inner position, Figure 4, the free end of the inner side 35' of the toggle spring is positioned radially inwardly of the central longitudinal axis of the pin 32 and this toggle switch exerts a relatively large component of force in the radial inward direction to swing the segment 27 inwardly. When the segment 27 swings outwardly at 80 percent of full motor speed, to the position shown in Figure 5, the side 35' of the toggle spring as its free end swung outwardly and such free end is now in substantial alignment with the central longitudinal axis of pin 32. The component force in the radially inward direction exerted by the side 35' is relatively less than it previously exerted in the position of Figure 4, and consequently the spring 35 will not cause the segment 27 to again swing to the inner position of Figure 4, until the speed of the motor has decreased to a point somewhat below 80 percent of full speed, which is desirable. This toggle action produced by the spring 35 for causing the circuit through the starting stator winding to open and close at different speeds cannot

be produced by a spring which exerts a constant radial component of force.

To further illustrate the differential forces produced by the spring 35, for different positions of the side 35', see the vector diagrams, Figures 4 and 5. In Figure 4, the diagonal vector illustrates the resultant force produced by the spring when the conducting segment 27 is closed. The vertical or radial component of this resultant force is relatively large. In Figure 5, the diagonal vector again represents the resultant force produced by the spring and here the vertical or radial component is relatively small, with the segment in its outermost position.

Our centrifugal switch is highly compact and narrow. The parts are subject to substantially no wear, except where the plate brushes 51 engage the brush plates 42 and 43, and here, wear is slight, since the contact area between the plate brushes and slip rings is large. It is practically impossible for dirt to enter the slot 20, as previously stated. Due to the construction including the plates 54 and 61 and associated elements, it is highly improbable that a short circuit ever will occur.

The switch is very easily assembled and disassembled. The plate brushes 51 may be disengaged from between the annular flanges 45 and 44 by springing the arms 55 and 62 outwardly. The brush plates 42 and 43 are readily removable and may be lifted from contact with the opposite sides of the disc 15. When the insulating washer 46 has been removed, the contact segment and spring 35 may be pushed laterally from the slot 20.

In Figures 14 to 18, inclusive, I have shown a modified form of means for holding the plate brushes in place. This means comprises an upstanding metal rod 80 to be connected at its lower end with a stationary part of the motor. The upper portion of this rod is screw threaded as shown at 81. Mounted upon the screw threaded portion 81 of the rod is an insulating sleeve 82, and insulating washers 83 and 84 are mounted upon the screw threaded portion 81 above and below the sleeve 81. The screw threaded portion 81 carries a lower nut 85 and an upper nut 86 and a lock nut 87. The washers 83 have notches 86 formed therein. The sleeve 82 has a flat 87. The sleeve 82 carries an insulating washer 88.

Tortional coil springs 89 and 90 are mounted upon the sleeve 82 between the insulating washers 83 and 88 and are insulated from each other. Corresponding outer ends of the coil springs are bent to provide radial extensions 91, Figure 18, held within a longitudinal groove 92, formed in the sleeve 82. The inner ends of the springs 89 and 90 are continued in the form of resilient arms 93, having extensions 94, provided with ends 95, bent at a right angle thereto. These ends 95 are inserted within the openings 57 of the plate brushes 51. The springs serve to hold the plate brushes in place and yieldingly press the same into engagement with the faces of the slip rings 42 and 43. The springs are in electrical connection with the slip rings.

Metal strips or tabs 96 are inserted within the outer ends of springs 89 and 90 and engage the flat 87 and are in electrical contact with these springs and have lateral extensions 97, held within the notches 86. The outer ends of these lateral extensions are bent into loops 98, as shown. Insulated wires 99, corresponding to wires 75 are permanently electrically connected with the plate brushes 51 and the outer ends of these wires 99 are inserted within the loops 98. The ends of lead wires 100 are also inserted in these loops and the loops are pinched upon the wires to form a firm electrical engagement. All other parts of the switch remain identical with those shown described in connection with the first form of the invention.

In view of the description of the portion of the first form of the invention it is thought that it is unnecessary to describe any further operation.

It is to be understood that the forms of our invention herewith shown and described are to be taken as preferred examples of the same, and that various changes in the shape, size, and arrangement of parts, may be resorted to without departing from the spirit of our invention or the scope of the subjoined claims.

Having thus described our invention, we claim:

1. A centrifugal force actuated switch, comprising an insulating disc to be mounted upon the armature shaft of a motor, said disc having opposed substantially radial faces, said disc having a recess formed therein which extends through the opposed faces, brush plates arranged substantially radially on edge and disposed adjacent to the opposed faces of the disc and secured to the disc, the brush plates having substantially annular guide flanges projecting axially beyond the outer faces of the brush plates, centrifugally operated means arranged within the recess to electrically connect and disconnect the brush plates, the ends of the recess being covered by the brush plates, plate brushes arranges substantially radially on edge and having side faces contacting with the outer faces of the brush plates and engaging the substantially annular flanges to be guided thereby, and resiliant means engaging the plate brushes to force them against the opposed faces of the brush plates and to hold them against rotation with the brush plates.

2. A centrifugal force actuated switch, comprising an insulating disc to be mounted upon the armature shaft of a motor, said disc having opposed substantially radial faces, brush plates arranged substantially radially on edge and disposed adjacent to the opposed faces of the disc and secured to the disc, each brush plate having substantially annular guide flanges projecting axially beyond the outer face of the brush plates, centrifugally operated means mounted upon the disc to electrically connect and disconnect the brush plates, plate brushes arranged substantially radially on edge and having side faces contacting with the outer faces of the brush plates, the plate brushes being arranged between the annular flanges to be held in place thereby, and resilient means engaging the plate brushes to force them against the opposed faces of the brush plates and to hold them against rotation with the brush plates.

3. A centrifugal force actuated switch, comprising an insulating disc to be mounted upon the armature shaft of a motor, said disc having opposed substantially radially extending faces, brush plates arranged substantially radially on edge and arranged adjacent to the opposed faces and secured to the discs, each brush plate having spaced substantially annular guide flanges projecting axially beyond the outer face of the brush plate, means including plate brushes arranged substantially radially on edge and having inner faces engaging the outer faces of the brush plates and arranged between the flanges to be held in

place by the flanges, and centrifugally operated means mounted upon the disc to electrically connect and disconnect the brush plates.

4. A centrifugal force actuated switch, comprising a rotatable supporting member, an elongated centrifugally operated current conducting member, means pivotally mounting one end of the current conducting member upon the supporting member, the opposite end of the current conducting member being free and moved radially outwardly by centrifugal force, a relatively stationary contact mounted upon the supporting member for electrical connection with the current conducting member when such current conducting member is in the inner position, means for connecting the current conducting member with one side of a circuit, means for connecting the contact with the opposite side of the circuit, and a spring consisting of a single substantially U-shaped portion including opposed overlapping inner and outer arms, the outer arm engaging the supporting member near the free end of the outer arm so that the U-shaped portion may rock bodily upon the supporting member and the inner arm of the substantially U-shaped portion engaging the free end of the current conducting member, the U-shaped portion having its open end arranged next to the free end of the current conducting member and disposed in end-to-end relation with the current conducting member, the point of engagement between the free end of the inner arm and the current conducting member being changed with respect to the pivot of the current conducting member when the free end of such current conducting member moves radially.

5. A centrifugal force actuated switch, comprising a rotatable supporting member, a rigid centrifugally operated current conducting member extending circumferentially of the supporting member and having one end pivotally mounted upon the supporting member, a relatively stationary contact mounted upon the supporting member and arranged upon the inner side of the current conducting member for coaction therewith, means for connecting the current conducting member with one side of a circuit, means for connecting the contact with the opposite side of the circuit, and a single substantially U-shaped differential spring having opposed inner and outer overlapping arms, the substantially U-shaped spring being arranged in end-to-end relation with the current conducting member and having its open end disposed next to the free end of the current conducting member, the outer arm having its free end mounted upon the supporting member, the inner arm engaging the free end of the current conducting member, the point of engagement between the inner arm and the current conducting member being changed with respect to the pivot of the current conducting member when the free end of the current conducting member moves radially.

WILLIS Z. WEST, JR.
MORGAN F. GAMBLE.

REFERENCES CITED

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

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Number	Name	Date
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