

April 5, 1966

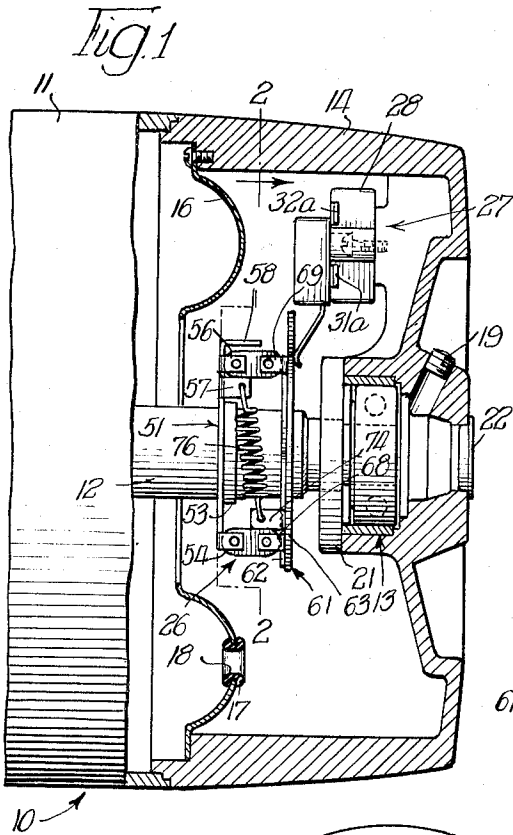
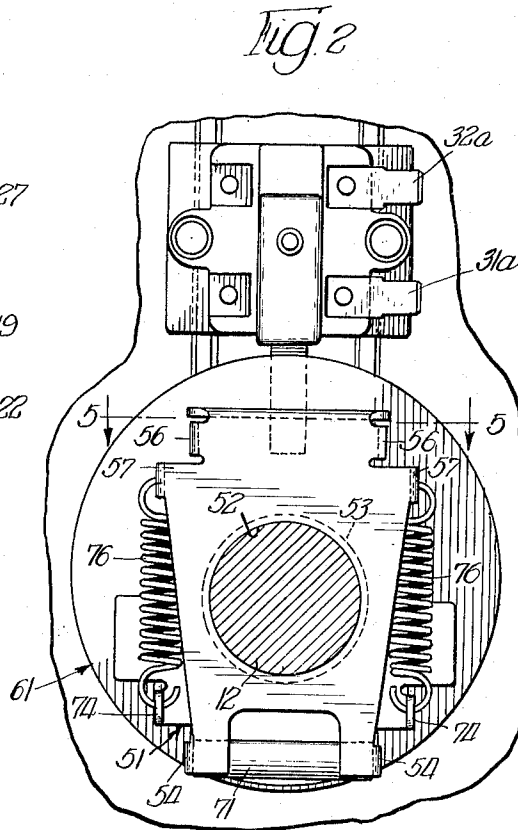
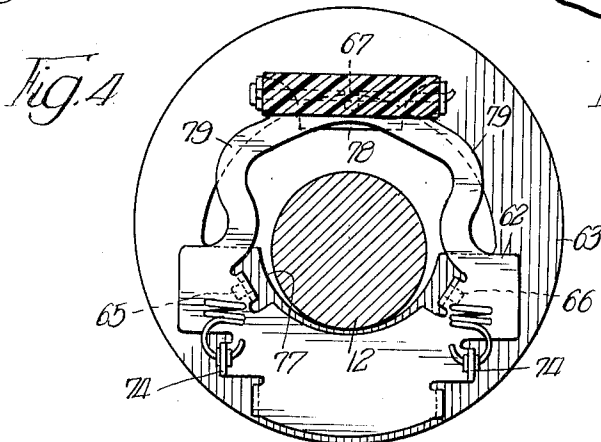
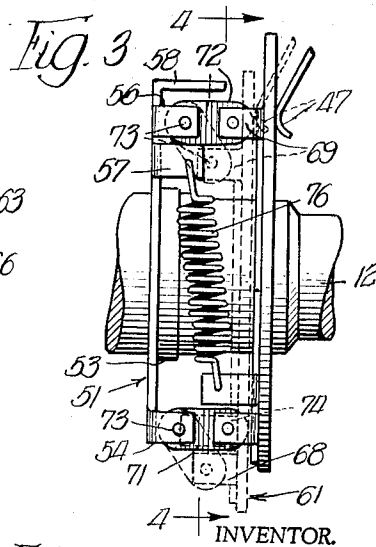
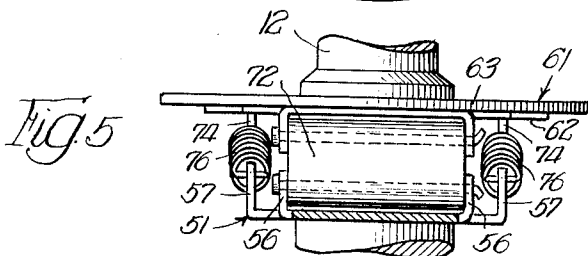
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3,244,832

CENTRIFUGAL MECHANISM AND SWITCH CONSTRUCTION

Filed Nov. 29, 1962

2 Sheets-Sheet 1



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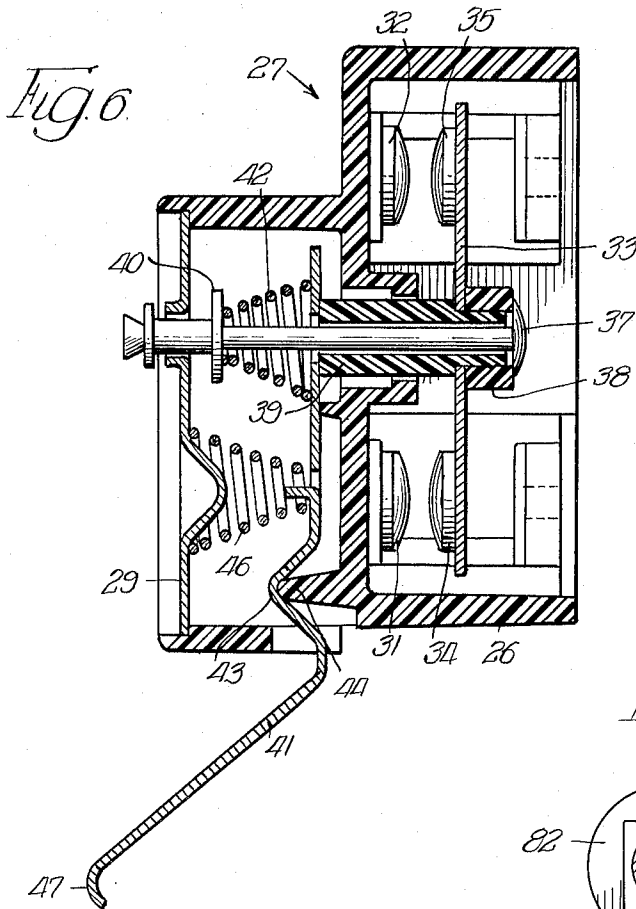
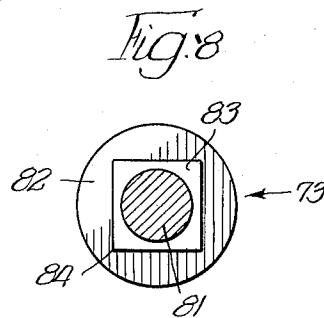
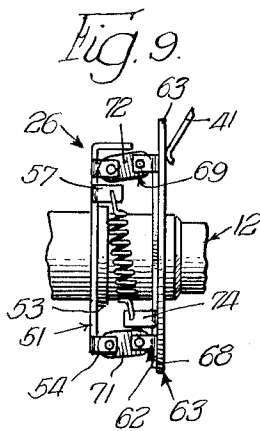
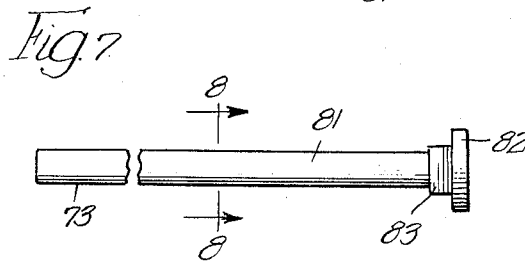
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CENTRIFUGAL MECHANISM AND SWITCH CONSTRUCTION

Filed Nov. 29, 1962

2 Sheets-Sheet 2



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CENTRIFUGAL MECHANISM AND SWITCH CONSTRUCTION

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Filed Nov. 29, 1962, Ser. No. 240,845
17 Claims. (Cl. 200—80)

This invention relates to electrical switches, and more particularly, to a switch and centrifugal mechanism for use with a rotating member.

Certain types of electric motors have a running winding and a starting winding, and a motor speed responsive apparatus including a switch adapted to connect the starting winding to the power supply only at motor speeds below a predetermined speed. Usually, the switch is closed at standstill and it opens when the motor reaches the predetermined speed, and the switch automatically closes again when the motor speed later falls substantially to the predetermined speed.

In apparatus of this kind, it is important that the switch open or close quickly at the selected predetermined speed, and that interaction of the parts of the apparatus does not affect the selected speed at which the switch opens and closes. Frequently pressure of the switch on the centrifugal mechanism causes this mechanism to shift and actuate the switch at other than the selected speed. Further, it is important that the parts of the apparatus have minimum wear and friction so that the calibration of the switch will not change with use.

Accordingly, it is an object of this invention to provide a centrifugal mechanism and switch apparatus wherein force exerted by the switch on the mechanism does not affect the calibration of the apparatus.

It is another object to provide apparatus of the foregoing character, wherein there is minimum wear and friction between moving parts of the apparatus.

Still another object is to provide apparatus of the foregoing character, the construction of which prevents undesired vibration.

Other objects and advantages of the invention will become apparent from the following description taken in conjunction with the accompanying figures of the drawing, in which:

FIG. 1 is a fragmentary view partially in section of a motor equipped with a centrifugal mechanism and switch apparatus embodying the invention;

FIG. 2 is an enlarged sectional view taken generally along the line of 2—2 of FIG. 1;

FIG. 3 is an enlarged elevational view of a portion of the apparatus;

FIG. 4 is a view partially in section taken on the line 4—4 of FIG. 3;

FIG. 5 is a view partially in section taken on the line 5—5 of FIG. 2;

FIG. 6 is an enlarged sectional view of the switch of the apparatus;

FIG. 7 is an elevational view of a part of the centrifugal mechanism of the apparatus;

FIG. 8 is a sectional view taken on the line 8—8 of FIG. 7; and

FIG. 9 is a fragmentary view similar to a portion of FIG. 1 and showing a modified arrangement of the parts.

In general, apparatus embodying the invention is adapted to be used with a motor having a stationary housing and a rotatable drive shaft, and comprises a centrifugal mechanism and a switch. The switch is adapted to be attached to the motor housing and includes an arm positioned adjacent the drive shaft. The centrifugal mechanism includes a front plate having an

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opening formed therein, this plate being positioned adjacent the switch arm with the drive shaft extending through the opening. The front plate is hingedly connected to a back plate which in turn is adapted to be secured to the drive shaft of the motor. The hinge connection permits the front plate to move both axially and radially of the shaft between a rest position and a running position. Biasing means is connected between the front and back plates which urges the front plate toward its rest position. The mass distribution of the front plate is such that its center of gravity is always on one side of its axis of rotation, and centrifugal force due to this unbalance, when the drive shaft and the front plate rotate, urges the front plate from the rest to the running position. At a predetermined rate of rotation the front plate shifts to the running position. The front plate has a surface which, due to the type of hinge connection provided, is always in a radial plane. The arm of the switch engages this surface at one of the rest and running positions, and the switch is actuated by axial movement of the front plate between these two positions and the switch is unaffected by radial movement of the front plate. Further, the hinge connection is such that force exerted in an axial direction by the switch arm on the front plate cannot affect the position of the front plate until the front plate is rotating and moves somewhat in a radial direction.

Still further, the front plate is mounted such that it does not slide on the drive shaft as it moves axially, and the novel hinge connection between the front and back plates reduces wear and friction to a minimum.

In greater detail, in FIG. 1 there is illustrated an electric motor 10 including a cylindrical frame 11 which houses the stator and armature (not shown).

The armature is mounted on a drive shaft 12 which is mounted by bearing 13 for rotation in an end bell 14. The end bell 14 is firmly fastened to the frame 11. A diaphragm 16 may be attached to the end bell 14 for separating the stator cavity from the interior of the end bell 14, when desired. A grommet 17 may be fastened within an opening 18 formed in the diaphragm 16 through which wires may be passed.

The bearing 13 may be any suitable type such as a ball bearing having its outer race secured to the end bell 14 and its inner race secured to the drive shaft 12. A grease plug 19 may be provided adjacent the bearing 13 for lubrication purposes. Also, a bearing cap 21 is positioned around the drive shaft 12 and holds the bearing assembly 13 in place, the cap 21 being secured to the end bell 14 over the bearing 13. An end cap 22 is preferably attached to the end bell 14 over the end of the drive shaft 12.

Apparatus embodying the invention is adapted to be responsive to the rate of rotation of the motor rotor and the drive shaft 12, and be actuated when these members reach a predetermined speed. This apparatus includes a centrifugal mechanism, indicated generally by the numeral 26, secured to the drive shaft 12, and a switch indicated generally by the numeral 27, secured to the end bell 14. The switch 27 (see FIG. 6) includes a switch case 28 and a cover 29. Mounted within the case 28 are a pair of stationary contacts 31 and 32 and a movable contact arm 33. A pair of contacts 34 and 35 are secured to the movable contact arm 33 and are positioned such that, when the arm 33 is moved toward the left the two contacts 31 and 32 are electrically connected through the contacts 34 and 35 and the arm 33. Electrical connection between the two stationary contacts 31 and 32 is broken when the arm 33 is moved toward the right as seen in FIG. 6 which moves the contacts 34 and 35 away from the stationary contacts. The contacts 31 and 32 are connected to termi-

nals 31a and 32a (FIG. 2) for connection to the motor circuit.

The movable contact arm 33 is mounted on the reduced end of a sleeve or actuator button 39 slidably mounted within the case 28. Extending through the sleeve 39 is a pin 37, and the left end of the pin as shown in FIG. 6 slides in the cover 29. The right end of the pin 37 is provided with an enlarged head, and a washer 38 is mounted on the reduced end of the sleeve 39 between the contact arm 33 and the head of the pin 37. A switch arm 41 bears against the left end of the sleeve 39 and the pin 37 extends through the switch arm 41. An actuator spring 42 bears against the left face of the switch arm 41 and a retainer washer 40 is secured to the pin 37 and bears against the spring 42. The left end of the pin 37 is slidably supported in the cover 29.

The switch arm 41 includes bent portion 43, which is seated on a ridge 44 formed on the case 28, and the switch arm 41 pivots on the ridge 44. The outer end of the switch arm 41 extends exteriorly of the case 28 and is curved as at 47. A compression spring 46 positioned between the cover 29 and the switch arm 41 urges the switch arm 41 in the clockwise direction. The actuator spring 42 urges the pin 37 toward the left relative to the switch arm 41. The switch 27 is a normally open type because the spring 46 urges the switch arm 41 in a clockwise direction and the pin 37 and the movable contact arm 33 toward the right, away from the stationary contacts 31 and 32. Pressure on the curved end 47 of the switch arm 41 toward the right, as shown in FIG. 6, will pivot the switch arm 41 counterclockwise against the force of the compression spring 46. The pin 37 also moves with the switch arm 41 because of the compression spring 42 positioned between the switch arm 41 and the retainer washer 40. Sufficient movement of the switch arm 41 in the counterclockwise direction moves the switch arm 33 and the contacts 34 and 35 into engagement with the stationary contacts 31 and 32 and closes an electrical circuit through the switch 27. When the force on the end 47 of the switch 41 is removed, the force of the compression spring 46 returns the switch arm 41 to its normal position where the contacts 31 and 32 are out of engagement with the contacts 34 and 35.

The centrifugal mechanism 26 includes a back plate 51 having an opening 52 (FIG. 2) formed therein, the drive shaft 12 extending through the opening 52. A flange 53 (FIG. 3) is formed around the opening 52, the flange engaging the shaft and securing the back plate 51 to the shaft as by a press fit. A pair of spaced-apart hinge lugs 54 are formed at one end of the back plate 51 and a pair of spaced-apart hinge lugs 56 are formed at the other end of the back plate 51, while a pair of spaced-apart spring lugs 57 are formed on the back plate adjacent the lugs 56. All of the lugs extend axially of the shaft toward the right as seen in FIG. 1. The end of the back plate 51 adjacent the hinge lugs 56 is turned over and also extends axially toward the right, as at 58.

The mechanism 26 further includes a front plate 61 comprising a base member 62 and a disk member 63. The base member 62 is preferably made of a material such as metal and the disk member 63 is preferably made of a relatively stiff material such as pressed fiber, and these two members 62 and 63 are rigidly secured together by forming three tabs 65, 66 and 67 (FIG. 4) on the base member 62, inserting the tabs through suitable openings formed in the disk member 63, and turning them over. Preferably, the tab 67 is turned radially inward and the tabs 65 and 66 are turned radially outward.

Each one of the members 62 and 63 has an opening formed therein through which the shaft 12 extends. The base 62 is positioned adjacent the back plate 51, and two pairs of hinge lugs 68 and 69 are formed on the base 62, which extend axially of the shaft toward the back plate 51. The lugs 68 and 69 of each pair are spaced apart the

same distance as the lugs 54 and 56 of the back plate 51, and a pair of hinge links 71 and 72 in the form of blocks are provided, the link 71 being positioned between the lugs 54 and 68 and the link 72 being positioned between the lugs 56 and 69. The links 71 and 72 are pivotally connected to the lugs by pins 73, holes being formed through each of the lugs 54, 56, 68 and 69, and through each of the links 71 and 72 through which the pins 73 extend, as shown in FIG. 5. The pins 73 are preferably made of metal and the hinge links 71 and 72 are preferably made of a low friction material such as nylon. As shown in FIG. 3, as the links 71 and 72 pivot about the axis of the pins 73 on the back plate 51, the front plate 61 moves both radially and axially of the shaft 12. The disk 63 of the front plate 61 will always be in a radial plane throughout this movement, however, because it is initially mounted in a radial plane and the links 71 and 72 are positioned parallel to each other and have equal length. The pins 73 form the corners of a parallelogram, two sides of the parallelogram always extending radially and the other two sides pivoting about the axis of the pins 73 on the back plate 51.

Also formed in the base 62 of the front plate 61 is a pair of spring lugs 74. Two coiled tension springs 76 are connected between these lugs 74 and the pair of spring lugs 57 of the back plate 51, the springs 76 tending to swing this front plate 61 upwardly and to the right as shown in FIGS. 1 and 3.

FIG. 4 shows the geometry or mass distribution of the front plate 61 relative to the axis of the drive shaft 12. It will be noted that most of the mass of the relatively heavy base 62 is below, as shown in FIG. 4, the axis of the shaft 12, so that the center of gravity of the front plate 61 is below the shaft axis. FIG. 4 shows the rest position of the front plate, which exists when the shaft 12 and the front plate 61 are not rotating. In the rest position, the front plate 61 occupies an upward position where the lower edge of the opening of the disk 63, indicated by the numeral 77, engages the shaft 12. The edge 77 could engage the shaft 12 in a position where the hinge links 71 and 72 extend slightly upwardly from the pins 73 but in FIGS. 1 and 3 the hinge links 71 and 72 are shown as extending substantially axially of the shaft when the edge 77 engages the shaft. When the shaft 12 and the mechanism 26 rotate, centrifugal force on the front plate 61 causes it to shift radially toward its weighted side against the force of the springs 76. When the rotative speed of the front plate 61 is sufficient, it swings radially and also axially toward the back plate 51 to its running position, shown by the dashed line position of FIG. 3. A tab 78 (FIG. 4) formed on the disk 63 engages the shaft 12 at the running position and since the disk 63 is made of fiber, the tab 78 acts to cushion the impact between the front plate 61 and the shaft 12. Further, the base 62 includes two arms 79 (FIG. 4) each having a reverse curve in order to reduce impact stress on these arms when the front plate moves between its rest and running positions.

The pins 73 are constructed to reduce wear on the moving parts of the centrifugal mechanism 26. With reference to FIGS. 7 and 8, each pin 73 includes a cylindrical shank 81, and an enlarged circular head 82 at one end of the shank 81. An anchoring portion 83 is formed between the shank 81 and the head 82, the portion 83 having a plurality of corners 84 which extend outwardly from the surface of the shank 81 but not to the outer surface of the head 82. In the present instance, the anchoring portion 83 is square.

The pairs of hinge lugs 54, 56, 68 and 69 of the back plate 51 and the base 62 having openings shaped to receive the pins 73. One lug of each pair has a circular opening to receive the shank 81 and the other lug of each pair has an opening shaped to receive the anchoring portion 83, in the present instance this latter opening being square. After a pin 73 is inserted through the lug openings

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and through a hinge link opening with the anchoring portion 83 within its mating opening, the end of the shank 81 opposite the head 82 is turned over (FIG. 5) to prevent the pin from coming out. This construction prevents the pins 73 from rotating relative to the hinge lugs but permits rotation relative to the links 71 and 72. This is advantageous because the coefficient of friction between the links and the pins is much less than that between the pins and lugs, and the sliding surface area between the links and the pins is much greater than that between the pins and the lugs, so that the pins will not be subjected to excess wear.

When the centrifugal mechanism 26 is in its rest position, the disk 63 engages the arm 41 of the switch 27 and holds the switch closed. When the shaft 12 and the mechanism 26 reach a predetermined speed, centrifugal force moves the front plate radially and also axially of the shaft, the disk 63 remaining in a radial plane throughout this movement. The disk 63 begins its movement at the predetermined speed and it may travel to its running position within a fraction or a number of turns, depending on the rate of acceleration of the shaft 12 and the mechanism 26. Once movement of the disk 63 begins, it travels to its running position with a snap action even though the speed of rotation does not increase. This is true because, even though the speed remains constant, once movement of the disk 63 begins the radius of its center of gravity increases, thereby increasing the centrifugal force. This action continues until the disk 63 reaches its running position. Because the disk 63 remains in a radial plane throughout its movement, at no point in its movement does the switch arm 41 oscillate as the disk turns. Axial movement of the disk 63 permits actuation of the switch 27. The switch arm 41 exerts an axial force on the face of the disk 63, but, because the links 71 and 72 extend axially of the shaft 12 when the mechanism is in its rest position, the force of the switch arm 41 cannot affect the calibration of the centrifugal mechanism. Some radial movement of the front plate 61 is required before it can move axially and permit actuation of the switch, and this radial movement does not occur until the speed of the shaft 12 and the mechanism 26 reaches the predetermined speed.

The apparatus has further advantages in that axial movement of the centrifugal mechanism is accomplished without a member sliding on the drive shaft 12, which would result in undesirable friction. Further, vibration of the switch arm which would cause undesired multiple breaks of the contacts is eliminated because the disk 63 is in a radial plane throughout its movement.

There is a frictional component of force exerted by the switch arm 41 on the disk 63 when the disk rotates, which for one-half revolution is in a direction to urge the disk 63 to begin its outward movement and for the other half revolution is in a direction to hinder the outward movement of the disk 63. However, this frictional force is so minor that it does not affect the calibration of the mechanism and may be ignored.

Throughout the description and claims, where the position or plane of the disk 63 is referred to as "radial," it is intended to mean that it is in a plane substantially perpendicular to its axis of rotation.

In the event the mechanism is used with a very low speed motor, the centrifugal mechanism may not move from its rest position to its running position with the required amount of snap action. To intensify the snap action, the edge 77 of the disk 63 may be so formed as to engage the shaft 12 when the links 71 and 72 are displaced slightly upwardly from their axial position as shown in FIG. 9. In this position of the links, the initial axial movement of the disk 63 is to the right, and the force exerted by the switch arm 41 opposes such movement. When the centrifugal force becomes sufficient to overcome the force of the switch arm 41, which is at the predetermined speed, the disk and links will then move

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and when the links move past their true axial position, the force of the switch arm is added to the centrifugal force to give the increased snap action.

I claim:

1. A centrifugal mechanism adapted to be mounted on the drive shaft of a motor for movement of a switch actuating arm adjacent said drive shaft, said mechanism comprising supporting means for rigidly mounting said mechanism on said shaft for rotation therewith, a plate disposed adjacent said supporting means and adapted to actuate said switch arm, and means connecting said plate to said support means for radial movement of said plate with respect to said shaft and for axial movement with respect thereto as a result of said radial movement, said plate having an opening therein adapted to surround said shaft and being of sufficient size to prevent interference of said plate with said shaft during said radial movement.

2. A centrifugal mechanism as in claim 1, wherein one face of said plate is adapted to engage said switch arm, and said means connecting said plate to said support means holds said face in a radial position throughout the movement of said plate, said radial position of said face preventing vibration of said switch arm.

3. A centrifugal mechanism adapted to be mounted on the drive shaft of a motor for movement of a switch-actuating arm adjacent said drive shaft, said mechanism comprising a back plate, means for securing said back plate to said drive shaft, a front plate having an opening therein for receiving said drive shaft, and means hingedly connecting said front plate to said back plate for radial and axial movement of said front plate with respect to said shaft between a rest position and a running position, the mass distribution of said front plate being such that centrifugal force due to rotation of the drive shaft and said front plate urges said front plate toward said running position, and biasing means connected between said front and back plates and urging said front plate toward said rest position, said front plate having one face adapted to engage said switch actuating arm for actuating said switch on movement of said front plate between said rest and running positions.

4. A mechanism as in claim 3, wherein said means hingedly connecting said front plate to said back plate maintains said front plate in a radial plane during movement between said rest and running positions.

5. A mechanism as in claim 3, wherein the axial movement of said front plate between said rest and running positions is adapted to actuate said switch arm.

6. A mechanism as in claim 3, wherein said back plate is adjacent said front plate when said front plate is in said running position, and said front plate is axially displaced from said back plate when said front plate is in said rest position.

7. A mechanism as in claim 3, wherein said means hingedly connecting said front plate to said back plate comprises a pair of links, each of said links being pivotally connected to both said front plate and said back plate, said links being parallel to each other and of equal length, said links extending axially of the shaft when said front plate is in said rest position.

8. A mechanism as in claim 7, wherein diametrically opposite portions of the margin of said opening in said front plate are engageable with the shaft at the respective running and rest positions.

9. A mechanism as in claim 3, wherein said front plate is shaped to engage the shaft for preventing movement of said front plate beyond said rest and running positions.

10. A mechanism as in claim 3, wherein said biasing means comprises at least one tension spring extending generally transversely of said shaft.

11. A mechanism as in claim 3, wherein said hingedly connecting means comprises two pairs of hinge lugs formed on each of said back and front plates, the lugs

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of each pair being spaced apart a distance which is substantially greater than the thickness of said lugs, a pair of links, each link positioned between the lugs of a pair on both said front and back plates, two pair of elongated pins, one of said pins extending through openings formed in each pair of lugs and through an opening formed through each of said links, and each of said pins being anchored to one of said lugs to prevent movement of said pins relative to said lugs but permitting free rotation of said links relative to said pins.

12. A mechanism as in claim 11, wherein each of said pins has a non-circular portion adjacent one end, and one lug of each of said pairs of lugs has a correspondingly shaped opening which receives said non-circular portion of the associated pin.

13. A mechanism as in claim 3, wherein said means hingedly connecting said front plate to said back plate comprises a pair of links, each of said links being pivotally connected to both said front plate and said back plate, said links being parallel to each other and of equal length, said links moving through a position where they extend axially of the shaft from a rest position at one side of said axial position to a running position at the other side of said axial position when the centrifugal force of said front plate overcomes the force exerted by said switch actuating arm.

14. The combination of a centrifugal mechanism and a switch for use with a motor having a drive shaft, said mechanism comprising a back plate adapted to be secured to the drive shaft, a front plate having an opening formed therein adapted to receive the drive shaft, said front plate being hinged to said back plate for radial and axial movement between a rest position and a running position, said front plate being weighted on one side so that centrifugal force due to rotation of the drive shaft and the mechanism causes movement of said front plate to its running position, biasing means connected between said front and back plates for urging said front plate toward said rest position, said switch comprising a case, a stationary contact mounted on said case, a movable contact mounted on said case for movement into and out of engagement with said stationary contact, an actuator arm pivotally mounted on said case and connected to move said movable contact, said switch being positioned adjacent said mechanism and said actuator arm engaging said front plate and exerting a force on said front plate which is substantially only axial of said front plate at one of said rest and running positions, axial movement of said front plate between said rest and running positions acting through said actuator arm to move said movable contact into and out of engagement with said stationary contact, the hinging of said front plate on said back plate being such that the action of said centrifugal mechanism is unchanged by said axially directed force before initial movement of said

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front plate from said rest position toward said running position but after said initial movement said axially directed force assists in movement of said front plate to said running position throughout the major portion of the movement of said front plate.

15. The combination of claim 14, wherein said front plate engages said actuator arm and holds said movable contact in engagement with said stationary contact when said front plate is in said rest position, said switch further includes a spring urging said contacts out of engagement, said spring also acting through said actuator arm to exert said axially directed force on said front plate.

16. A switch for use with a centrifugal mechanism for actuation thereby, comprising a case, a pair of stationary contacts mounted in said case and adapted to be connected in an external circuit, an actuator pin slidably mounted in one wall of said case, a contact arm connected to said pin and having a pair of contacts, movement of said pin moving said contacts on said contact arm into and out of engagement with said stationary contacts, an actuator arm pivotally mounted in said case and connected to said pin, pivotal movement of said actuator arm causing movement of said pin, spring means connected to said actuator arm and tending to pivot said actuator arm in one direction, said actuator arm extending externally of said case and being adapted to be pivoted in the other direction against the force of said spring by said centrifugal mechanism.

17. A switch as in claim 16, wherein said actuator arm is slidable relative to said pin, and further including a second spring means having one end engaging said pin and its other end engaging said actuator arm, said actuator arm being movable relative to said pin against the force of said second spring means when the contacts on said actuator arm are in engagement with said stationary contacts.

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