

Dec. 12, 1939.

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2,182,977

CENTRIFUGAL SWITCH

Filed Oct. 23, 1936

2 Sheets-Sheet 1

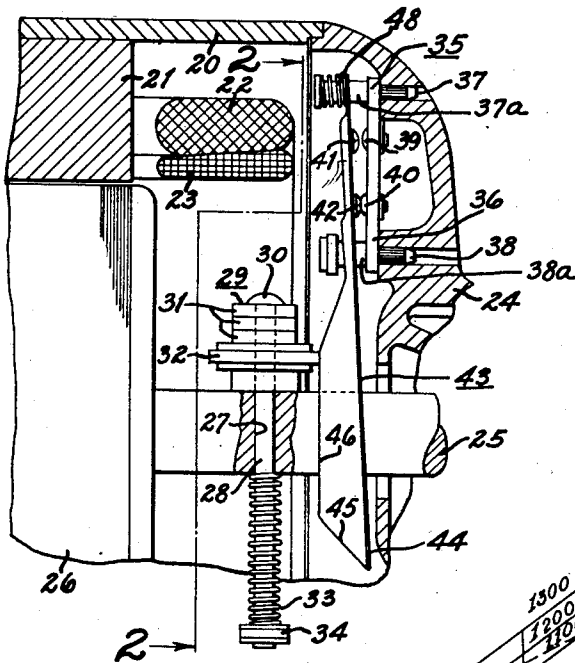


Fig. 1

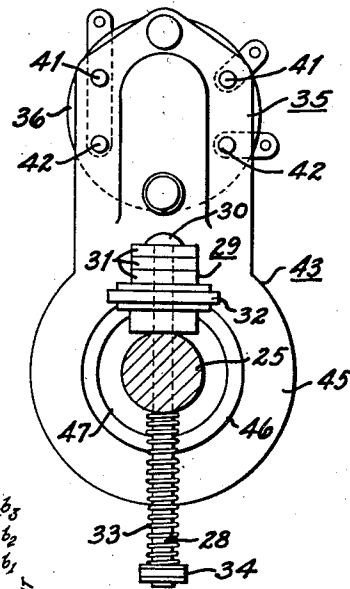


Fig. 2

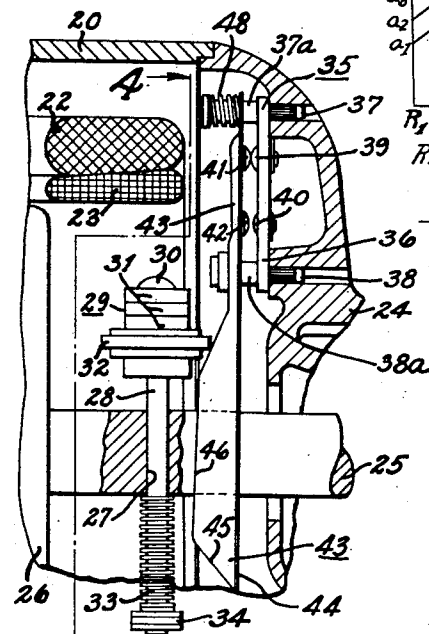


Fig. 3

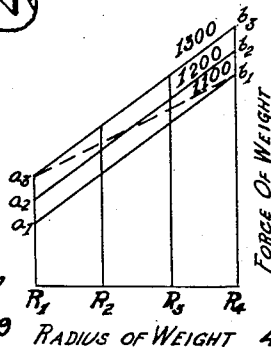


Fig. 9

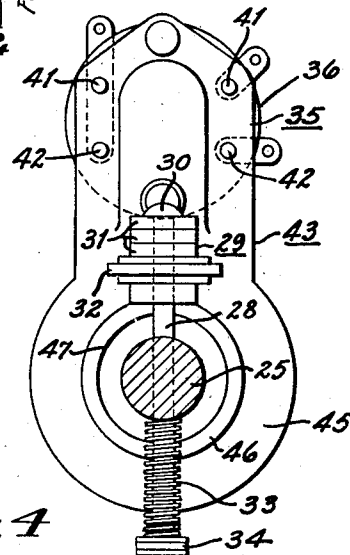


Fig. 4

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2 Sheets-Sheet 2

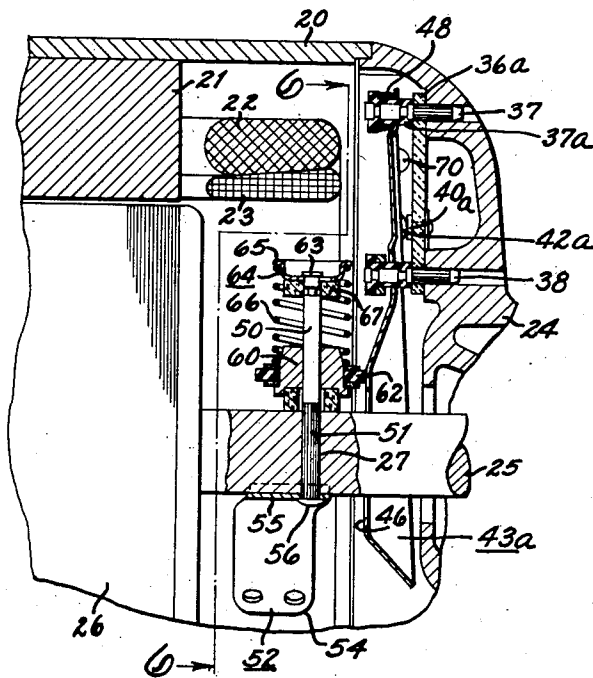


Fig. 5

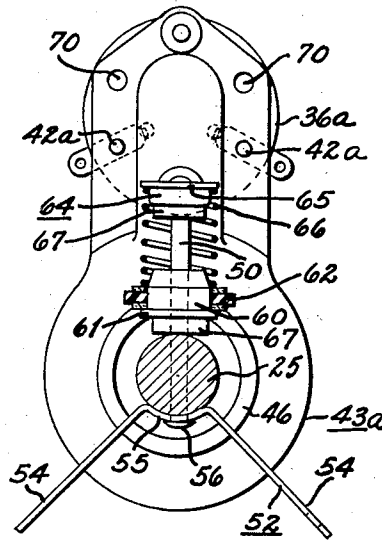


Fig. 6

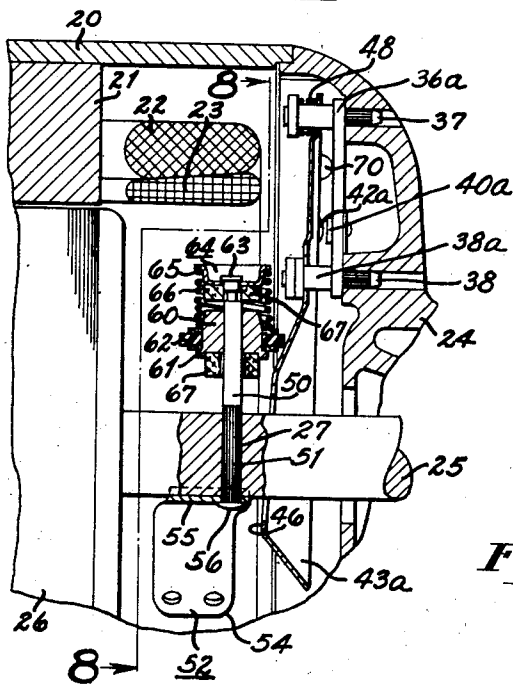


Fig. 7

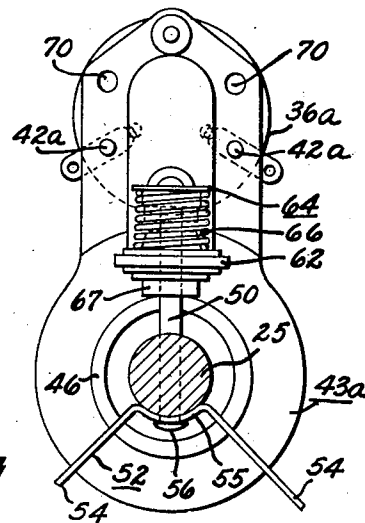


Fig. 8

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CENTRIFUGAL SWITCH

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13 Claims. (Cl. 200—80)

This invention relates to centrifugal switches and more particularly of the type used for controlling the starting circuit of an alternating current motor.

An object of the present invention is to provide a switch of the class indicated which is simple and economical in construction and highly efficient in operation.

More particularly it is an object of the present invention to provide, in combination with a shaft and a switch mounted adjacent thereto a speed responsive means carried by the shaft for normally holding the switch in one of its operating positions and for operating in a way such as to allow the switch to move quickly to another position when the speed of the shaft reaches a predetermined value. The speed responsive means also operates reversely to quickly return the switch to its normal position when the speed of the shaft is decreased to a certain value. This quick movement is generally known as snap action. This snap action of the switch is accomplished by a speed responsive device including a rod extending radially from the shaft, a weight slidable on the rod and a weight controlling spring that is so designed that its rate of build-up is less than the rate of build-up of the force of the weight due to centrifugal action. By this arrangement the weight is moved from a lesser to a greater radius with a quick action when the shaft has reached a certain speed; and the weight will move from the greater to the lesser radius when the speed of the shaft is decreased to a certain value.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is a fragmentary longitudinal sectional view of the electric motor segment with a centrifugal switch embodying the present invention.

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary sectional view similar to Fig. 1 showing the switch in its operative position.

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 3.

Fig. 5 is a fragmentary longitudinal sectional view of a motor showing a modified form of a centrifugal switch.

Fig. 6 is a view similar to Fig. 5 showing the switch in its operative position.

Figs. 7 and 8 are sectional views taken on the lines 7—7 and 8—8 of Figs. 5 and 6 respectively.

Fig. 9 is a diagram illustrating the action of the speed responsive means.

Referring to the drawings, a field frame 20 carries a stator frame 21 which in turn carries stator windings 22 and 23. The frame 20 supports end members 24 which provide suitable bearings, not shown, for an armature shaft 25 which supports a rotor 26.

The shaft 25 is provided with a transverse opening 27 through its axis to provide a bearing surface for a rod 28 of a centrifugal device 29. This centrifugal device comprises the rod 28 which is free to slide through the opening 27, a laminated weight 31 and a cam or washer 32 of hard felt or similar fibrous material. The weight and the cam are supported on the rod 28 between a head 30 provided by the rod and one side of the shaft 25. On the other side of the shaft, a spring 33 surrounds the rod 28, one end of the spring bearing against the shaft 25 and the other end bearing against an adjustable nut 34 to restrain the centrifugal action of the weight until a certain predetermined speed of the shaft 25 has been reached. The spring 33 normally urges the weight members 31 toward the motor shaft as shown in Fig. 1. When the shaft is rotating above a predetermined speed, the weight 31 and the cam 32 are moved radially outward against the tension of the spring 33, as shown in Fig. 3, to allow a switch 35 to be actuated with a quick action to open a starting circuit.

The switch construction includes a plate 36, preferably of insulating material, which is secured to the frame 24 by studs 37 and 38 carrying flanged bushings 37a and 38a, respectively, made of suitable insulating material. The plate also supports a pair of stationary terminals 39 and 40. Cooperating movable contacts 41 and 42 adapted to engage the stationary contacts 39 and 40 respectively, which are supported on a plate or lever member 43. The member is provided with spaced openings on its vertical dimension and is supported on the insulating bushings 37a and 38a. The openings are of greater dimensions than the bushings so as to provide a loose connection between the lever and the bushings.

The lower end 44 of the plate 43 is of dish form providing a conical portion 45 and a flat portion 46. The flat portion is provided with an opening 47 which is of greater dimension than

the shaft so as to permit free longitudinal movement of the lever relative to the shaft 25.

A light spring 48 is coiled about the insulating bushing 37a around the stud 37 and is disposed between the plate 43 and the flange portion of the insulating bushing 37a. The spring normally urges the end of the lever member 43 adjacent which it is mounted toward the insulating plate 36, thereby tending to rock the contact 42 on the terminal 40, which provides a pivot for the lever while the contacts are in engagement.

When the motor is at rest, the spring 33 urges the weight and the cam 32 toward the shaft 25, see Fig. 1. In this position the cam 32 will engage the flat portion 46 to urge the dish portion of the actuating plate 43 toward the end member 24 and hold the contact 42 of the switch 35 in good electrical engagement with the contact terminal 40. When the motor shaft 25 is rotated and reaches a certain speed the force of the weight 31, due to centrifugal action, is equal to or slightly greater than the resisting effort of the spring 33. This creates an unstable condition, therefore the weight 31 will move outwardly to a greater radius and cause the switch to operate with a snap action to open the starting circuit. This is accomplished due to the fact that the spring 33 is so designed that its rate of build up is less than the rate of build up of the force of the weight 31 due to centrifugal action. This causes the weight to move to a greater radius with a quick action. A similar action of the weight takes place when the speed of the motor decreases to cause the switch to be operated to close the starting circuit with a quick action.

The action of the weight 31 with respect to the spring 33 can be understood with reference to the diagram shown in Fig. 9. In Fig. 9 the horizontal base line represents various radii R_1 , R_2 , R_3 and R_4 of the weight 31, the radius being the distance from the center of the shaft 25 to the center of the mass of the weight 31 and parts moving radially therewith. R_1 is the radius of the weight 31 when the shaft 25 is at rest. Lines a_1-b_1 , a_2-b_2 and a_3-b_3 represent, respectively the law of action of the weight at various speeds, namely, 1100 R. P. M., 1200 R. P. M. and 1300 R. P. M., respectively. Assuming that the weight 31 is to start to move outwardly from the shaft 25 at 1300 R. P. M., the spring 33 is so constructed that its law of action will conform to the line a_3-b_1 which has a slope less than the line a_3-b_3 . In other words, the spring 33 is so designed that its rate of build-up is less than the rate of build-up of the force of the weight 31 due to centrifugal action. It will be observed by comparing the slopes of lines a_3-b_1 and a_3-b_3 that, once the weight starts to move away from the shaft, it will move quickly to its outer position designated by the vertical line from point R_4 . Having once moved to the radius R_4 the weight 31 will remain at that radius until the shaft speed is reduced to slightly below 1100 R. P. M. whereupon the spring 33 becomes effective quickly to move the weight 31 toward the shaft 25 so that its radius returns to the value R_1 . To summarize, the weight 31 moves rapidly from radius R_1 to radius R_4 when the shaft speed has increased to 1300 R. P. M.; and the weight 31 will move from radius R_4 to radius R_1 quickly when the shaft speed has decreased to 1100 R. P. M. This operation of the weight 31 is used to effect rapid movements of a switch actuating plate or contact carrier 43 between its two extreme positions of operation. In this

way switch contacts controlled by the plate 43 are caused to be engaged or separated quickly by a movement which is generally called a snap action.

The operation of the switch 35 to open the starting circuit is as follows: When the weight 31 moves outwardly the cam 32 moves with it as shown in Fig. 3. When the weight 31 and the cam 32 are in this position, the spring 48 moves the end of the lever member adjacent the spring 48 toward the member 24 using the contacts 40 and 42 as a pivot for the plate until the contact 41 engages the contact 39, then the pivot for the plate is shifted to the contacts 41 and 39 which causes the contact 42 to break quickly from the contact 40 to open the starting circuit of the motor. By this arrangement, the contacts not only break quickly, but the contact points are kept clean and free of surface deposits that result from arcing at the contact points.

Referring to Figs. 5 to 8 inclusive, the modification of the centrifugal device and of the switch structure are shown. The centrifugal device mounted on the shaft 25 comprises a rod 50 having a knurled portion 51. In this instance, the knurled portion is forced into the transverse opening 27 provided by the shaft 25 to firmly hold the rod to the shaft. A fan 52 is secured on one side of the shaft by the rod in order to maintain a circulation of air within the motor frame. The fan comprises two arms 54 and an intermediate arcuate portion 55 complementary to the circumference of the shaft 25. The arcuate portion is provided with an opening through which a portion of knurl on the rod protrudes and riveted over, as at 56, to firmly hold the fan on the shaft. On the other side of the shaft, the rod 50 is smooth and extends radially from the shaft and slidably supports a weight 60 having an annular flange 61 upon which rests a cam member 62 made of hard felt or similar fibrous material. The rod is provided with an integral flange 63, said flange forming a stop for a cup-shaped member 64 having an annular flange 65 to form a seat for a coil spring 66 interposed between the inner side of the seat and the cam 62 to normally hold the weight and cam member toward the shaft 25. Felt or cork washers 67 are supported on the rod, one being disposed between the cup-shaped member 64 and the weight and another washer being disposed between the weight and the shaft. The washers serve to prevent noise which might occur if the weight was to engage metal parts while the shaft is rotating.

The switch construction shown in Figs. 5 to 8 inclusive, is similar to that previously described with the exception that the plate 36a supports only one set of stationary terminals, namely, 40a. The actuating plate or lever 43a supports a set of movable contacts 42a and is provided with a set of spherical shaped bosses 70 which provide a pivot for the lever during the separation of the contacts.

Now referring to Figs. 5 to 8 and when the motor is at rest the spring 66 holds the weight 60 and the cam member 62 adjacent the shaft 25, see Fig. 5. While the centrifugal device is in this position the cam 62 engages the flat portion 46 to urge the dish shaped portion of the lever member 43a toward the end member 24 and causes the contacts 42a and 40a to be in good electrical engagement with each other. When the shaft 24 is rotated at a certain speed the force of the weight 60, due to centrifugal action,

is equal to or slightly greater than the resisting effort of the spring 66 and allows the weight to move outwardly to a greater radius with a quick action and causes the switch to be operated with a quick action. This quick action of the switch is accomplished in the following manner: As the cam 62 moves outwardly with the weight 66 to a greater radius, the spring 48 will move the end of the lever member 43a adjacent the spring toward the insulating plate 36a. When this happens the contacts 40a and 42a act as a pivot for the plate 43a until the bosses 70 engage the plate 36a. When this occurs the pivot for the lever 43a is shifted from the contacts to the bosses 70 and the adjacent surface of plate 36a and causes the contacts 40a and 42a of the switch to be separated quickly by a movement which is generally called a snap action.

It is obvious that the constructions of the switches disclosed and the means by which the switches are operated are such as to provide an efficient contact engagement in either position of the switch shown in Figs. 1 to 4 while that construction shown in Figs. 5 to 8 the contacts must be well closed or fully opened, and that the centrifugal devices for actuating the movable switch member will operate to produce a rapid breaking of the contacts, thus reducing to a minimum the tendency to arc when the contacts are separated.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A centrifugal switch comprising in combination; a stationary frame; fixed and movable contacts carried by the frame; a rotary shaft journaled in the frame; a speed responsive device radially supported from the shaft for normally holding the movable contact in one of its operating positions, said device including a rod extending through the shaft, a weight carried by the rod and spring balanced so as to be speed responsive; and means carried by the weight for controlling the movable contact.

2. A centrifugal switch comprising in combination; a stationary frame; fixed and movable contacts carried by the frame; a rotary shaft journaled in the frame; a speed responsive device supported on the shaft for normally holding the movable contact in one of its operating positions, said device including a rod slidable through the shaft and in a direction transverse to the axis of the shaft, a weight supported on the rod on one side of the shaft, and a spring carried by the rod on the opposite side of the shaft tending to restrain the movement of the rod through the shaft; and means carried by the weight for controlling the movable contact.

3. A centrifugal switch comprising in combination; a shaft; a frame member providing a bearing for the shaft; a stationary contact insulatingly supported on the frame member; a movable contact pivotally supported from the frame member; spring means tending to urge the movable contact away from the stationary contact; speed responsive means radially supported on the shaft; means associated with speed responsive means for normally holding the movable contact in engagement with the stationary contact and adapted to move radially outwardly after a certain predetermined speed permitting the spring to separate the contacts.

4. A centrifugal switch comprising in combination; a stationary frame; fixed and movable contacts carried by the frame; a rotary shaft journaled in the frame; a speed responsive device supported on the shaft to normally hold the movable contact in engagement with the fixed contact, said device including a rod fixed to the shaft and having one end thereof extending radially from the shaft; a weight slidable on the rod; a spring for restraining the weight against centrifugal force up to a predetermined value; and means carried by the weight for controlling the movable contact.

5. A centrifugal switch comprising in combination; a stationary support; a rotary shaft journaled in the support; a fixed terminal carried by the support; a plate loosely carried by the support; a contact carried by the plate; a spring acting upon the plate and tending to urge the contact out of engagement with the terminal; a speed responsive device radially supported on the shaft to normally hold the movable contact in engagement with the terminal, said device including a weight adapted to move radially from the shaft; resilient means for restraining the movement of the weight against centrifugal force up to a predetermined value; and means carried by the weight and engaging the plate to normally hold the contact carried thereby in engagement with the terminal and to place the spring under compression and permitting the spring to actuate the plate to separate the contact from the terminal when the weight has moved radially a predetermined distance.

6. A centrifugal switch comprising in combination; a rotary shaft; a support; a fixed terminal insulatingly supported on the support; a movable plate pivotally supported on the support, said plate carrying with a contact, a spring tending to move the plate and the contact from the terminal; speed responsive means carried by the shaft to control the movable contact, said means including a slidable weight adapted to move radially with respect to the shaft; a disc carried by the weight; and resilient means normally urging the weight toward the shaft and the disc against the plate whereby the contact is normally held in engagement with the terminal, and said disc permitting the spring to move the plate to separate the contact from the terminal when the weight has moved outwardly a certain distance in opposition to the resilient means by centrifugal force.

7. A centrifugal switch comprising in combination a rotary shaft; a stationary support, a fixed contact insulatingly carried by the support; a spring urged movable member slidably mounted on the support; a boss and a contact carried by a member in spaced relation thereon and providing pivot points for the member; and means carried by the shaft for normally holding the contacts in engagement with each other, said means being responsive to centrifugal force produced by rotation of the shaft to permit the contact carried by the movable member to form a pivot therefor until the boss engages the support whereby the pivot for the movable member is shifted to cause the contacts to break quickly.

8. In a device of the character described, the combination comprising, a support; spaced terminals carried by the support; a lever loosely mounted on the support and carrying spaced contacts adapted to engage the terminals, the contacts being arranged on the lever that one or the other acts as a pivot for the lever depending

upon the position of the lever; a rotary shaft; speed responsive device supported from the shaft for normally holding one of the contacts in engagement with a terminal controlling the lever; and spring means for shifting the lever to change the pivotal point of the lever in accordance with the speed of the shaft.

9. A centrifugal switch comprising in combination; a support; spaced stationary terminals mounted on the support; a lever loosely mounted on the support and carrying contacts adapted to engage the terminals, the contacts being spaced that one or the other engages a terminal to form a pivot for the lever depending on the position of the lever; a rotary shaft; and means carried by the shaft and responsive to centrifugal force induced by rotation of the shaft for normally holding one of the contacts in engagement with a terminal; and resilient means for actuating the lever after a predetermined movement of the speed responsive device.

10. A centrifugal switch comprising in combination; a support; spaced stationary terminals carried by the support; a shaft rotatably mounted with respect to the support; a movable lever mounted on the support and carrying contacts adapted to engage the terminals, the contacts being so arranged on the lever that one or the other acts as a pivot for the lever depending upon the position of the lever; and speed responsive means radially supported from the shaft for normally holding one of the contacts in engagement with a terminal; and resilient means for shifting the lever to change the pivotal point thereof after a certain radial movement of the speed responsive means.

11. In a switch, the combination comprising; a support; spaced terminals carried by the support; a lever loosely mounted on the support and carrying spaced contacts, the contacts being so arranged on the lever that one or the other acts as pivot for the lever depending upon the position of the lever; a shaft; a device carried by the shaft and responsive to the speed of the shaft for normally holding one of the contacts in engagement with one of the terminals; and spring means associated with the lever and operable after a certain radial movement of the device to shift the lever causing another contact to engage another terminal whereby the first mentioned contact is separated quickly from its terminal.

12. In a device of the class described, the combination comprising; a support; a terminal insulatingly carried by the support; a lever loosely mounted on the support and provided with a boss and carrying a contact, said contact and boss being so arranged on the lever that either the boss or the contact provides a pivot for the lever depending upon the position of the lever; a shaft; a device carried by the shaft and responsive to the speed of the shaft for normally holding the contact in engagement with the terminal; and spring means acting on the lever after a certain radial movement of the device to shift the lever causing the boss to engage the support whereby the contact is separated quickly from the terminal.

13. The combination of a motor governor having a weight member adapted to travel radially in a certain path and to control an electric power circuit connected with the motor; a movable switch member normally held in a circuit closed position by the weight member; and resilient means normally held under compression when said member is in its normal position, said resilient

means operating to move the switch member to its open position when the weight member has moved outwardly a predetermined distance by centrifugal force.

14. A centrifugal switch comprising in combination; a shaft; a stationary support; a plurality of fixed terminals carried by the support; a spring urged movable member slidably mounted on the support; a plurality of contacts carried by the member and providing pivot points for the member; and means carried by the shaft for normally holding one of the contacts in engagement with a terminal, said means being responsive to centrifugal force produced by rotation of the shaft for permitting the engaged contact to form a pivot for the member until another contact engages another terminal whereby the pivot for the movable member is shifted thereby causing the first mentioned contact to separate quickly from its terminal.

15. A centrifugal switch comprising in combination; a shaft; a support; a terminal carried by the support; a movable contact; means carried by the shaft and movable radially of the shaft in response to the rotational speed of the shaft, said means normally holding the movable contact in engagement with the terminal; a spring for separating the movable contact from the terminal when said means has moved radially outward a certain distance in response to the rotational speed of the shaft; and means associated with the movable contact and cooperating with the support to cause the movable contact to separate quickly from the terminal.

16. A centrifugal switch comprising in combination; a fixed contact; a movable contact; a rotatable member; means carried by and movable radially of the rotatable member, said means normally holding the movable contact in engagement with the stationary contact; and resilient means for separating the movable contact from the stationary contact when the first mentioned means has moved radially outward a certain distance in response to the rotational speed of the rotatable member.

17. A centrifugal switch comprising in combination; a fixed contact; a movable contact; a shaft; a speed responsive device carried by the shaft and including a part adapted to travel radially of the shaft, said part normally holding the movable contact in engagement with the stationary contact, and spring means for separating the movable contact from the stationary contact when the part is moved outwardly a predetermined distance in response to the rotational speed of the shaft.

18. In a starting switch for an electric motor having a stationary frame and a rotor therein, the combination with a pair of fixed terminals carried by the frame; a lever loosely mounted relative to the fixed terminals and carrying spaced contacts, said contacts forming pivots for the lever on the fixed terminal contacts; centrifugally actuated means radially supported from the shaft for normally holding one of the contacts in engagement with one of the fixed terminals; and yieldable means for shifting the length of the lever whereby the other contact is moved into engagement with the other fixed terminal causing the normally engaged contact to be separated with a snap action when the centrifugal actuated means has moved radially outwardly a predetermined distance.

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