

J. B. HANSELL.

CENTRIFUGAL STARTING SWITCH.

APPLICATION FILED SEPT. 25, 1914. RENEWED OCT. 30, 1917.

1,305,094.

Patented May 27, 1919.

2 SHEETS—SHEET 1.

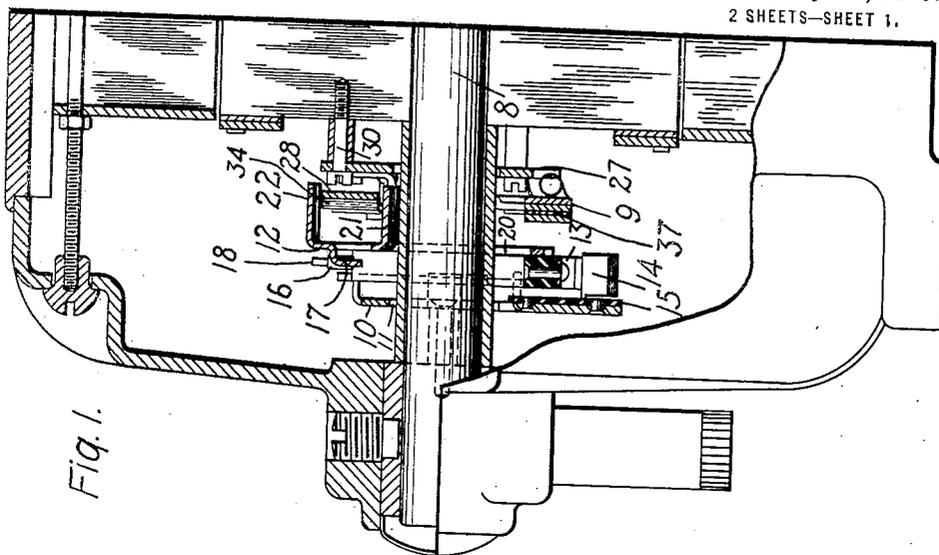


Fig. 1.

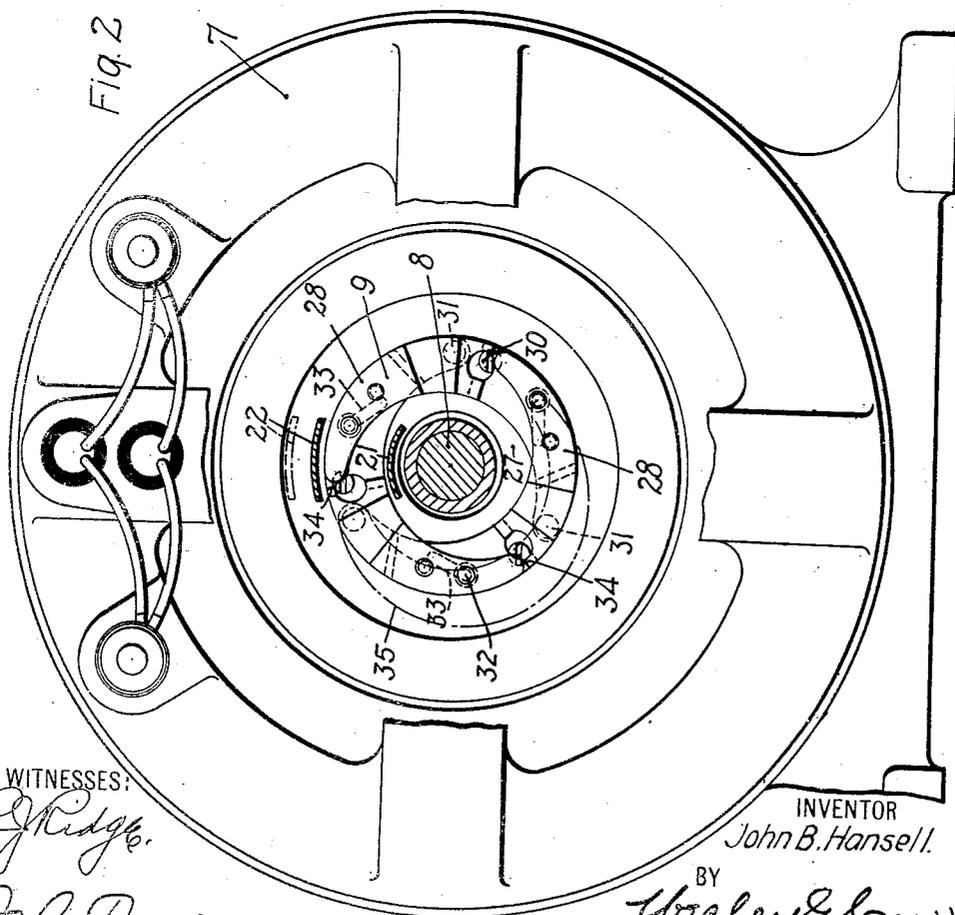


Fig. 2.

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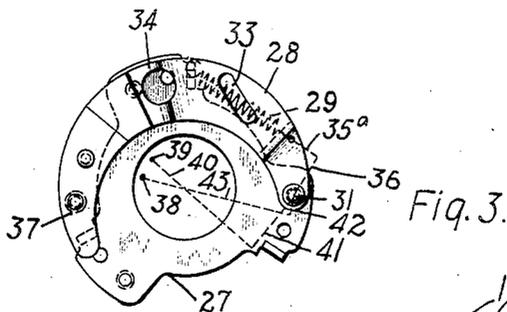


Fig. 3.

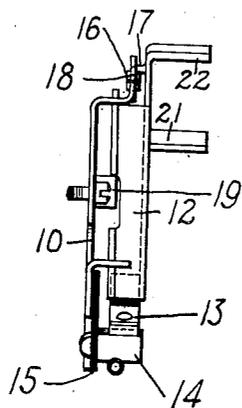


Fig. 4.

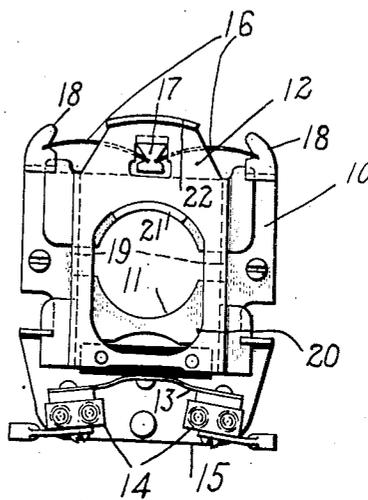


Fig. 5.

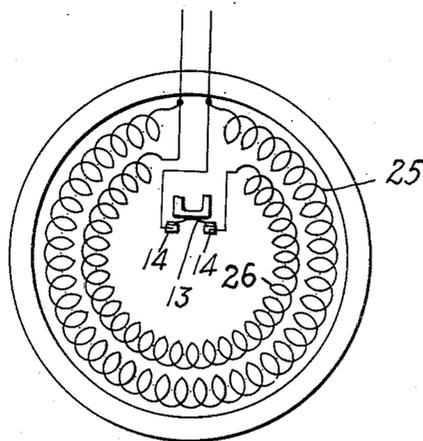


Fig. 6.

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# UNITED STATES PATENT OFFICE.

JOHN B. HANSELL, OF SUTTON, THIRSK, ENGLAND, ASSIGNOR TO WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

## CENTRIFUGAL STARTING-SWITCH.

1,305,094.

Specification of Letters Patent.

Patented May 27, 1919.

Application filed September 25, 1914, Serial No. 863,569. Renewed October 30, 1917. Serial No. 199,369.

*To all whom it may concern:*

Be it known that I, JOHN B. HANSELL, a subject of the King of Great Britain, and a resident of Sutton, Thirsk, in the county of Yorkshire, England, have invented a new and useful Improvement in Centrifugal Starting-Switches, of which the following is a specification.

My invention relates to centrifugally operated switches and it has for its object to provide a device of the character specified which shall be simple, cheap and compact in construction, quick and positive in operation, and substantially free from vibration.

My invention finds extensive application in the electrical arts, being of particular application in cutting out the starting winding of single-phase motors when substantially full speed is attained and in operating safety circuits in connection with devices which are liable to dangerous over-speeds, such, for example, as inverted rotary converters and elevator hoists.

It is desirable that the incipient movement of the contact members of a switch, of the character specified, when a predetermined speed is attained, shall precipitate a rapid completion of the opening or the closing movement and it is also desirable that the switch shall not operate again until the rate of speed has been radically reduced, so that minor changes of speed, due to variations in load or other causes, will not produce an operating movement of the switch.

In the accompanying drawing, Figure 1 is a side view, partially in section and partially in elevation, of a portion of an induction motor embodying a switch constructed in accordance with my invention; Fig. 2 is an end view, partially in section and partially in elevation, of the motor shown in Fig. 1; Fig. 3 is a detail view of the centrifugal operating member employed in connection with my switch; Figs. 4 and 5 are plan and side views, respectively, of my improved switch mechanism, and Fig. 6 is a diagrammatic view of a motor showing the application of my switch thereto.

As shown in the drawings, an induction motor 7 is provided with an armature shaft 8 carrying a composite ring 9 sensitive to changes in the centrifugal force acting thereupon. A base plate 10 is mounted in a fixed

position within the motor frame and is provided with a large central aperture 11 through which the main shaft 8 projects. A carriage 12 is mounted in suitable slides on the base plate 10, is adapted to reciprocate therein, and carries a bridging member 13 at one end thereof adapted to make connection with a pair of fixed contact members 14—14 carried on an insulating extension 15 at one end of the base plate 10. A pair of bowed springs 16 are embraced between a portion 17 of the carriage 12 and extensions 18 carried by the base member 10. The adjustment is such that, when the carriage 12 is in the lower position, as shown in Fig. 5, with the switch closed, the action of the springs 16 will be such as to strongly hold the carriage in such lower position. When the carriage 12 is moved upwardly, to substantially the mid point of its movement path, the springs 16 will exert substantially no pressure in either direction of movement of the carriage. When, however, the carriage has passed the mid point of its movement path, the springs 16 will move it upwardly with a constantly increasing force until it is brought to rest by a suitable stop 19. It will thus be seen that the springs 16 so bias the carriage 12 toward either limit of its movement path as to insure a quick and positive snap action. The carriage 12 is provided with a slot 20, and the shaft 8 projects through this slot, as shown in Figs. 1 and 2. Suitable operating lugs 21 and 22 are mounted upon the carriage 12 and are adapted to embrace the composite ring 9 carried by the shaft 8.

The general structure of this composite ring is similar to that disclosed in the application of Joel R. Cook, Serial No. 748,858, filed Feb. 17, 1913, and assigned to the Westinghouse Electric & Manufacturing Company, but my apparatus is simpler, more compact and has fewer parts. As shown in Figs. 1, 2 and 3, a base plate 27 is rigidly mounted to rotate with the shaft 8, by means of screws 30. A plurality of crescent shaped movable members 28 are symmetrically disposed upon the base plate 27, around the shaft 8, as shown in Fig. 2 and each of them is pivoted thereto, at one end, as shown at 31. Each member 28 is biased inwardly by a spring 29 that con-

nects it to the base plate. The free end of each of the members 28 is restrained in movement, both inwardly and outwardly, by a pin 32 working freely in a slot 33 in the underlying crescent shaped member. The members 28 nest snugly with each other because of a lateral offset 34 in each of them, whereby the pivoted end lies closely adjacent to the base plate 27 and the free end overlies the adjacent member 28. When the device is at rest or revolving at low speeds, the crescent shaped members are all drawn inwardly by the springs 29, and their configuration is such that their outer edges combine to form an outer rim substantially circular in outline. When sufficient speed is attained by the shaft 8, each of the members 28 flies outwardly, under the influence of centrifugal force, until stopped by the engagement of the pins 32 with the ends of the slots 33. The extent of this outward movement is indicated at 35 in Fig. 2. The configuration of the inner edges of the crescent shaped members is such that, in this position, they all combine to form an inner rim substantially circular in outline.

The lugs 21 and 22 embrace the members 28 and, as the composite ring 9, formed by these members, increases in radius, the outer edge thereof approximates a circular outline. As this edge impinges upon the lug 22, therefore, it pushes it outwardly in a uniform and gradual manner. Conversely, as the composite ring 9 decreases in radius, with a decrease in speed, the inner edges of the members 28 approximate a circular outline and the lug 21 is pushed inwardly with comparative freedom from blows or vibration. By suitable adjustment of the weights of the members 28 and of the strengths of the springs 29, the device may be designed to operate between any desired speed limits. The total range of movement of the carriage 12, and, consequently, of the lugs 21 and 22, exceeds the variation in the radius of the ring 9 throughout the normal speed range, for a purpose to be hereinafter pointed out.

Referring to Fig. 6, the main field winding of the motor 7 is shown diagrammatically at 25 and the auxiliary or starting field winding is shown at 26. The switch members 13 and 14 are inserted in circuit with the auxiliary field winding so that, when the motor has attained a certain predetermined speed, the auxiliary winding will be cut out of circuit, with attendant economy in current consumption.

At rest, the ring 9 is obviously of minimum radius and the switch is in the closed position, with the starting circuit 26 closed. As the motor comes up to speed, the members 28 fly outwardly, striking the lug 22 and forcing the carriage 12 upwardly until

the neutral point of the springs 16 is reached, when the carriage snaps to the upward limit of its movement. The operation of the members 28 on the carriage 12 is extremely rapid, as will be evident from a consideration of Fig. 3. One only of the crescent shaped members is shown for simplicity. The free end is weighted, as shown at 37, and, as the member covers an arc of more than  $180^\circ$ , the center of gravity of the moving mass will be located at some such position as 38, nearly diametrically opposite the pivot 31. At starting, the moment tending to throw the member 28 outwardly is produced by a radial force acting along the line 43, passing through the center of gravity and the center of rotation, and operating upon a relatively short-moment arm 42. The moment is overbalanced by the tension of the spring 29 acting along a line 35<sup>a</sup> through a moment arm 36. As soon, however, as the critical speed is reached, the centrifugal moment overbalances the moment of the spring and the member 28 moves outwardly, the center of gravity moving to a point such as 39. As a result of this movement, a relatively large radial force, due to the relatively high speed of rotation, acts along a line 40 upon a large and constantly increasing moment arm 41. On the other hand, the moment arm of the spring 29 remains substantially constant and the force exerted by the spring increases at a relatively slow rate, in accordance with Hooke's law. Therefore, at the time the critical speed is reached, for which the switch is set, the members 28 will all move outwardly and, for each increment of motion, the net moment-producing outward movement will increase, with the result that the members fly to the outer limit of their movement almost instantaneously, and an extremely rapid opening of the switch is attained, with resultant freedom from arcing at the contacts.

When the speed of the motor falls, as, for example, from overloading, to such an extent that it would otherwise fall out of step, the action of the inner surface of the ring 9 upon the lug 21 will again close the starting circuit 26, thus automatically introducing means to assist in maintaining the motor in operation. When the motor is stopped in the usual manner, the starting circuit 26 is obviously closed, so that the motor may be started by merely applying current thereto.

By so designing the switch that the total range of movement of the carriage 12 is greater than the variation in the radius of the ring 9, the crescent shaped members 28 will not bear upon the lugs 21 and 22 at normal speeds, whereby friction and heating are eliminated.

If it is desired to have the switch open at low speeds and close at high speeds, as, for

example, in the protection of inverted rotaries or in elevator safety appliances, it is obvious to those skilled in the art that the contact members 13 and 14 may readily be transposed with respect to each other without modification of other portions of the switch structure or of the switch-operating mechanism.

While I have shown my switch and its operating mechanism in the preferred form, it is obvious to those skilled in the art that it is susceptible of various minor changes and modifications without departing from the spirit thereof and I desire, therefore, that no limitations shall be placed thereupon except such as are imposed by the prior art or are specifically set forth in the appended claims.

I claim as my invention:

1. The combination with a rotatable shaft, of a composite ring carried thereby, said ring being adapted to increase in diameter with an increase in the speed of rotation of said shaft and to decrease in diameter with a decrease in the speed of the shaft, a movable switch member, means for biasing said switch member toward either its open or its closed position, and two operating members carried by said switch member, one of which is mounted to be engaged by the outer surface of said ring to move said switch member to one position and the other of which is mounted to be engaged by the inner surface of said ring to move said switch member to another position.

2. The combination with a rotatable shaft, of a composite ring carried thereby, said ring being adapted to increase in diameter with an increase in the speed of rotation of said shaft and to decrease in diameter with a decrease in the speed of the shaft, a movable switch member, means for biasing said switch member toward either its open or its closed position, and two operating members carried by said switch member, one of which is mounted to be engaged by the outer surface of said ring to move said switch member to one position and the other of which is mounted to be engaged by the inner surface of said ring to move said switch member to another position, the total range of movement of said switch member from its open to its closed position exceeding the change in radius of said ring under normal variations in speed.

3. The combination with a rotatable shaft, of a switch member transversely movable with respect thereto and comprising a contact-carrying portion having a slot, said shaft projecting through said slot and carrying mechanism adapted to operate said switch member under variations in the speed of shaft rotation.

4. The combination with a rotatable shaft, of a fixed base plate provided with an open-

ing therethrough, said shaft projecting through said opening, an extension on said base plate composed of insulating material and carrying two contact members, a slotted member mounted to reciprocate upon said base plate and carrying a bridging member arranged to cooperate with said fixed contact members, said shaft projecting through the slot in said reciprocating member and carrying mechanism adapted to operate said reciprocating member under variations in speed.

5. The combination with a rotatable shaft, of a fixed base plate provided with an opening therethrough, said shaft projecting through said opening, an extension on said base plate composed of insulating material and carrying two contact members, a slotted member mounted to reciprocate upon said base plate and carrying a bridging member arranged to cooperate with said fixed contact members, said shaft projecting through the slot in said member and carrying a composite ring adapted to increase in diameter under an increase in the speed of rotation of said shaft and to decrease in diameter under a decrease in the speed thereof, and operating members carried by said reciprocating member and adapted to be engaged by the inner and outer surfaces, respectively, of said ring, whereby said bridging member may be operated by variations in the speed of said shaft.

6. The combination with a rotatable element, of a centrifugally operated device carried thereby and comprising a base plate attached thereto, a plurality of substantially crescent shaped members, one end of each of which is pivoted to said base plate, a spring connecting the body of each of said crescent shaped members to said base plate and tending to draw said members inwardly and means carried by each of said members and adapted to coact with another crescent shaped member to limit the pivotal movement of said members.

7. The combination with a rotatable element, of a centrifugally operated device carried thereby and comprising a base plate attached thereto, a plurality of substantially crescent shaped members, one end of each of which is pivoted to said base plate, a spring connecting the body of each of said crescent shaped members to said base plate and tending to draw said members inwardly, and a pin carried by each of said members adjacent its free end and working freely in a slot in another crescent shaped member, whereby the inward and outward movements of said members are limited.

8. The combination with a rotatable element, of a centrifugally operated device carried thereby and comprising a base plate attached thereto, a plurality of substantially crescent shaped members symmetrically dis-

posed upon said base plate about said rotatable element, one end of each of said members being pivoted to said base plate, and a spring connecting the body of each of said crescent shaped members to said base plate and tending to draw said members inwardly, whereby, when said rotatable element is rotating at relatively low speeds, said members will be drawn inwardly and their outer edges will combine to constitute a substantially circular operating surface and, when said rotatable element is rotating at relatively high speeds, said member will be thrown outwardly and their inner edges will unite to constitute a substantially circular operating surface.

9. The combination with a rotatable element, of a centrifugally operated device carried thereby and comprising a base plate attached thereto, a plurality of substantially crescent shaped members symmetrically disposed upon said base plate about said rotatable element, one end of each of said members being pivoted to said base plate, and a spring connecting the body of each of said crescent shaped members to said base plate and tending to draw said members inwardly, whereby, when said rotatable element is rotating at relatively low speeds, said members will be drawn inwardly and their outer edges will combine to constitute a substantially circular operating surface and, when said rotatable element is rotating at relatively high speeds, said members will be thrown outwardly and their inner edges will unite to constitute a substantially circular operating surface, a reciprocating switch member provided with a pair of operating lugs which embrace said crescent shaped members, whereby, when said members fly outwardly, their outer edges will engage one lug to impel said switch member to one position and, when said members are drawn inwardly, their inner edges will engage the other lug to impel said switch member to another position.

10. In a centrifugally operated device, the combination with a rotatable element, of a base plate mounted to rotate therewith, a plurality of crescent shaped operating members mounted upon said base plate and symmetrically disposed about said rotatable element, one end of each of said operating members being pivoted to said base plate and having its mass so disposed that its center of gravity is approximately diametrically opposite the pivot thereof, a spring connecting each of said operating members to said base plate and tending to swing it toward said rotatable element, the configuration of said operating members being such that, when they are swung inwardly by said springs, their outer edges combine to constitute a substantially circular external rim and, when said operating members are

swung outwardly under the influence of centrifugal force, the inner edges thereof unite to constitute a substantially circular inner rim.

11. In a centrifugal switch, the combination with a rotatable member, of a base plate carried thereby, a plurality of crescent shaped operating members mounted on said base plate and symmetrically disposed about said rotatable element, one end of each of said operating members being pivoted and its other end being weighted so that the center of gravity of the entire operating member is separated from the pivot thereof by nearly 180°, a spring connecting each of the operating members to the base plate and tending to force said members toward the rotatable member, and a switch member provided with a portion to be engaged by said operating members, when moving outwardly under the influence of centrifugal force, whereby, when said rotatable member attains a predetermined speed, the moment produced by the centrifugal force acting upon each of said operating members overpowers the moment exerted by the spring attached thereto and the member flies outwardly under the influence of a constantly increasing force and operates said switch member with a quick snap action.

12. The combination with a rotatable shaft, of a switching mechanism operable thereby and comprising a longitudinally reciprocating carriage movable transversely to said shaft and carrying a switch member, a fixed switch member, and a centrifugally actuated device mounted on said shaft and operable to move said carriage in one or the other direction and to cause relative engagement or disengagement of said switch members in accordance with the speed of rotation of said shaft.

13. The combination with a rotatable shaft, of a switching mechanism operable thereby and comprising a slotted longitudinally reciprocating carriage movable transversely to said shaft and carrying a switch member, said shaft traversing the slot in said carriage, a fixed switch member, and a centrifugally actuated device mounted on said shaft and operable to move said carriage in one or the other direction and to cause relative engagement or disengagement of said switch members in accordance with the speed of rotation of said shaft.

14. The combination with a rotatable shaft, of a switching mechanism operable thereby and comprising a slotted longitudinally reciprocating carriage movable transversely to said shaft and carrying a switch member, said shaft traversing the slot in said carriage, biasing means for maintaining said carriage at one or the other of its limits of travel, a fixed switch mem-

ber, and a centrifugally actuated device mounted on said shaft and operable to move said carriage in one or the other direction and to cause relative engagement or  
5 disengagement of said switch members in accordance with the speed of rotation of said shaft.

In testimony whereof, I have hereunto subscribed my name this 10th day of September, 1914.

JOHN B. HANSELL.

Witnesses:

J. L. CHANTEMERLE,  
B. B. HINES.