United States Patent

[11] 3,603,751

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[21] Appl. No. 843,404
[22] Filed July 22, 1969
[45] Patented Sept. 7, 1971
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[54] MAGNETIC CENTRIFUGAL SWITCH
8 Claims, 4 Drawing Figs.

[52] U.S. Cl. 200/80, 73/518, 73/538
[51] Int. Cl. H01h 35/10
[50] Field of Search 200/80; 73/535, 536, 544, 540, 51; 317/5; 102/79

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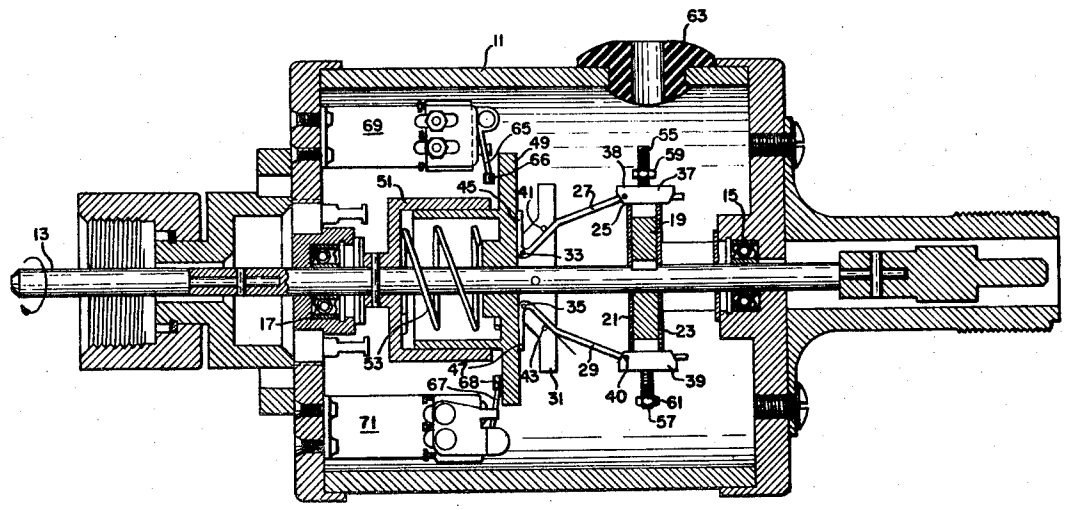
ABSTRACT: Centrifugal switching device having a magnet rotating with a shaft and an armature attracted by the magnet. The armature also rotates with the shaft and is pivoted so as to operate a switch when the centrifugal force is great enough to free the armature from the magnet. Adjustable nuts are provided to allow for a variation of the operating radius of the mass of the armature.



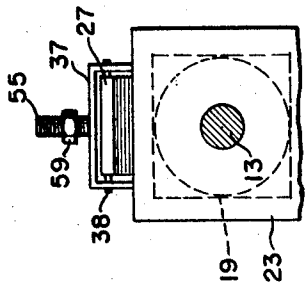


FIG. 2

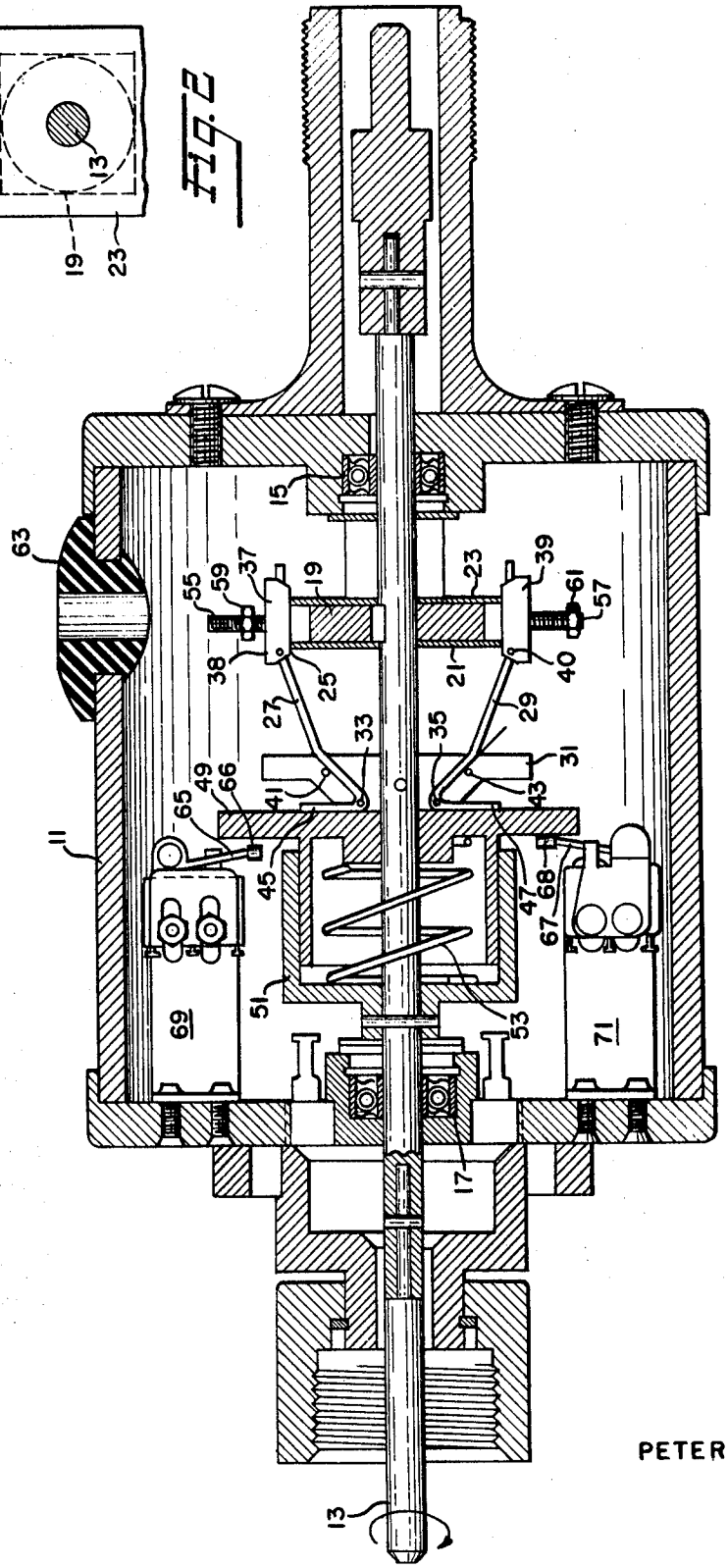


FIG. 1

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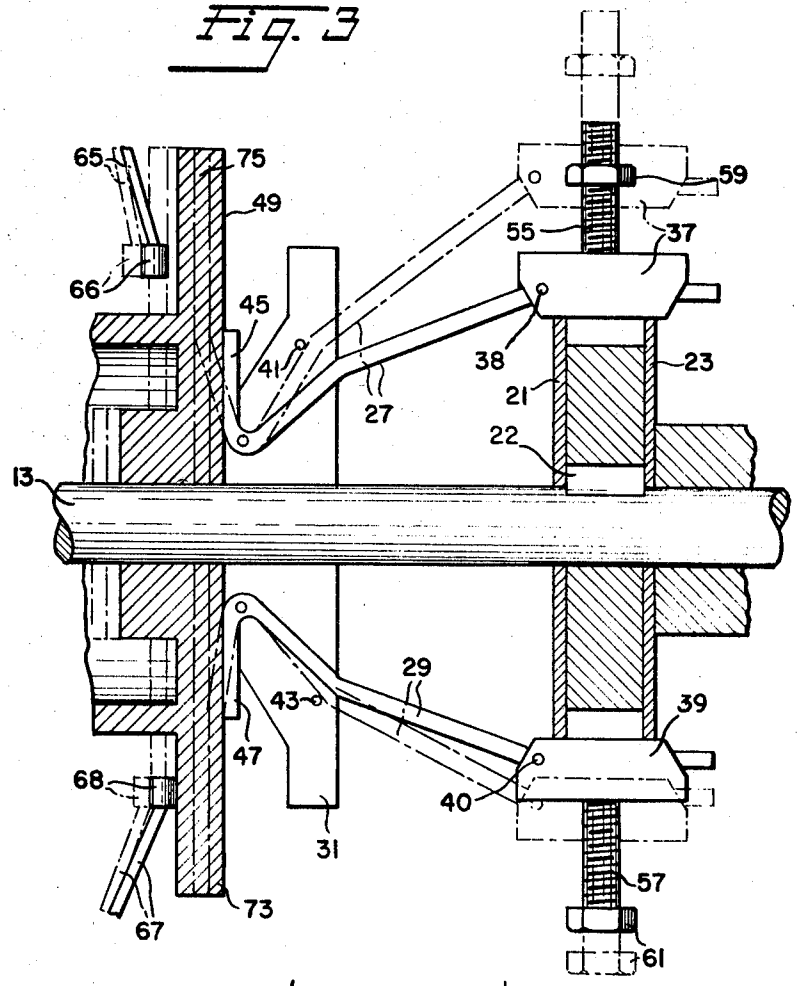
Fig. 3



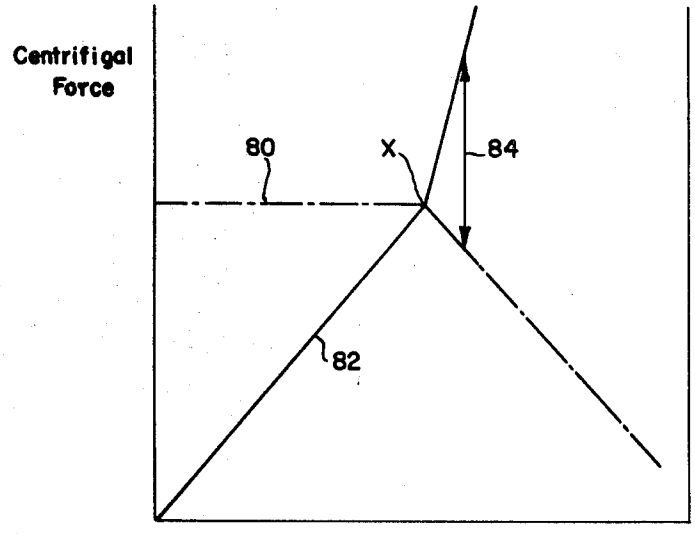


Fig. 4

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MAGNETIC CENTRIFUGAL SWITCH

This invention relates generally to centrifugal switches and more particularly to magnetic centrifugal switches.

The normal method of operation for a centrifugal type of switch is to provide a pair of flyballs held down by springs which, when acted upon by centrifugal force to an extent necessary to overcome the bias of the springs, will move outwardly and thereby actuate the switch. One of the major problems of this type of switch results from the fact that the springs form part of the switching action and the whole switch is subject to set point variation due to external vibrations acting on the springs.

This set point variation is particularly true when such switches are used on internal combustion engines. Under certain load and speed conditions, various torsional vibrations occur. These torsional vibrations can excite the springs at their natural frequency which effectively changes the spring rate and hence the retaining force exerted by the springs. Such a change drastically affects the set point of the switch. Because of the heavy masses involved in this kind of switch, wear occurs at pivot and fulcrum points which in turn changes the set point.

A number of switches have been developed which employ some type of magnetic attraction to hold a switch closed until such attraction is overcome by centrifugal force from means such as weights attached to a shaft. However, all such devices, to the best of my knowledge, are manufactured with a fixed point at which the switch will open and are not readily variable for different operations by the user.

Accordingly, it is an object of this invention to provide a centrifugal switch which uses no restraining springs for biasing against centrifugal force.

Another object of this invention is to provide a centrifugal switch wherein a magnet is used as a restraining means for biasing against centrifugal force and includes means for varying the operating radius of the mass of the armature.

These and other objects of the invention will become apparent from the following description when taken in conjunction with the drawings wherein:

FIG. **1** is a sectional view of the switching device of the present invention;

FIG. **2** is a fragmentary view of the magnet and armature used in FIG. **1**;

FIG. **3** is a partial sectional view of the details of the centrifugal mechanism of FIG. **1**; and

FIG. **4** is a graphic illustration relating centrifugal and magnetic forces to the rotational speed of the shaft on which the switch is mounted.

Turning now more specifically to the drawings, there is shown in FIG. **1** a switch housing **11** enclosing the shaft **13** which extends through the housing **11** and is rotatably secured therein by means of bearings **15** and **17**.

A magnet **19** is secured to and rotatable with shaft **13**. Magnet **19** is of the sandwich type and includes pole pieces **21** and These pole pieces are preferably flattened such as at **25** for reasons which will become apparent as the description proceeds.

Armatures **27** and **29** are pivotally secured to plate **31** at pivot points **33** and **35**. Mounted at the outer ends of the armatures **27** and **29** are rocker arms **37** and **39** which are of a U-shaped channel configuration, as is more clearly shown in FIG. **2**, and which are pivotally mounted to the armature at pivot points **38** and **40** and pass therethrough. Again as shown in FIG. **2**, the open edges of the rocker arms make the actual abutting contact with the pole pieces **21** and **23** of magnet **19**. This configuration assures a positive and even contact across the pole pieces.

Plate **31** is secured to a male cup member **49** which slidably extends within the female cup member **51** and is biased outwardly therefrom by means of a light spring **53**. Plate **31** and cup members **49** and **51** are all secured to and rotate with shaft **13**.

Microswitches **69** and **71** are actuated by means of switch arms **65** and **67**, respectively. These arms terminate in rolling contacts **66** and **68** which are contacted by the back face of the male cup member **49**.

Threaded bolts **55** and **57** are secured to the outer faces of rocker arms **37** and **39** respectively by means such as welding. Each bolt has a rotatable nut **59**, **61** associated therewith for purposes which will become apparent as the description proceeds.

Turning now to FIG. **3**, there is illustrated the operation of the switch arms as previously described in FIGS. **1** and **2**.

It will be appreciated that any number of switch arms could be used with this type of magnetic switch although only two have been illustrated for descriptive purposes. It is understood that if more than one switch is used, it would be for purposes of operating separate control functions at different speeds of rotation of the shaft.

As the shaft reaches the particular speed at which one switch, such as switch **71**, is to be operated, the armature **29** develops enough centrifugal force to overcome the attraction of the magnet **19** and the armature moves outwardly to the dotted line position shown in FIG. **3**. This in turn moves the male cup member **49** into the female cup member **51** to the dotted line position indicated as **73** and causes the switch arm **67** to move to its dotted line position which actuates switch **71**. A stop member **43** is mounted on plate **31** to prevent the armature **29** from exceeding the predetermined limits.

As the speed of the motor further increases, the operating point for the armature **27** is reached and it passes outwardly to the position shown in the dotted line which further extends the male cup member **49** into the female cup member **51** and contacts the roller **66** of switch arm **65** moving it to its dotted line position and actuating switch **69**.

In order to obtain a fine adjustment of the operating points for the armatures, screws **55** and **57** may be mounted on the rocker arms **37** and **39**. Adjustable nuts **59** and **61** may be run up and down the screw to the position desired and a grommet **63** may be provided in the housing **11** for access to the adjustable nuts. The principle of operation is as follows.

The operation of the switch is dependent on the fact that at a given speed, the centrifugal force imposed on the mass of the armature becomes equal to and subsequently greater than the restraining force caused by the magnetic attraction between the armature and the magnet. As shown in FIG. **4**, the magnetic attraction depicted by line **80** is constant until such time as the armature leaves the magnet, at which time the magnetic force decreases as the square of the distance between the armature and the magnet (air gap).

The centrifugal force shown as line **82**, increases proportionally to the rotating speed, assuming mass and operating radius of the mass to be constant. At the point shown as "X" in FIG. **4**, where the increasing centrifugal force becomes greater than the fixed magnetic force, the armature starts to leave the magnet. At this point, there are two changes which occur in the forces between the armature and magnet. 1. As the armature leaves the magnet, its mass moving outwards operates at a larger radius (original radius plus air gap). Thus, the centrifugal force is increasing as the air gap becomes greater. 2. The magnetic force holding the armature to the magnet is decreasing as the square of the air gap distance.

Therefore, we have an outward force increasing proportionally to the operating radius of its mass and an inward force decreasing by the square of the air gap which causes a true snap action. The point of separation, point "X", may be moved along the speed axis by varying the operating radius of the mass of the armature. This is achieved by repositioning the nuts **59** and **61** which form a part of such mass. With the nuts positioned as shown in FIG. **3**, armature **29** will move to its dotted line position at a lower rotation speed than will armature **27** since nut **61** is at the extreme outer end of threaded bolt **57**.

The nuts **59** and **61** are easily adjustable by access to the interior of the switch when grommet **63** is removed.

It will be obvious from the above description and drawings that a switch has been provided which eliminates the normal springs used in centrifugal switches and, therefore, makes it insensitive to torsional vibrations particularly as used with engines and the like. Further, there has been provided a means for manually adjusting the points of operation of the switches relative to the rotational speed of the shaft. Further tests have shown a set point repeatability of better than 3 r.p.m. when set for 2000 r.p.m.

It is to be understood that the above description and drawings are illustrative only and that equivalent parts may be substituted in the basic device without departing from the scope of the invention.

I claim:

1. A switching device responsive to shaft rotational speed comprising

a magnet mounted on and rotatable with said shaft,

at least one armature having one end held by the attractive force of said magnet,

means for pivotally mounting said armature adjacent said shaft and rotatable therewith,

switch means operated by said armature when said armature is moved away from said magnet by centrifugal force, and

adjustable means varying the point at which centrifugal force will separate said armature away from said magnet.

2. The device of claim 1 further comprising

pole pieces on said magnet, said pole pieces having at least one flat edge for contact with said armature.

3. The device of claim 2 further comprising

a rocker arm mounted on said one end of said armature for contacting said flat edges of said pole pieces.

4. The device of claim 1 wherein said adjustable means comprises

a threaded bolt mounted on said armature and extending outwardly from said magnet, and

a rotatable nut adjustable to predetermined positions on said bolt.

5. The device of claim 1 further comprising

a second armature having adjustable means and magnetically attracted to and rotatable with said magnet, said second armature being adjusted so as to separate from said magnet at a different predetermined centrifugal force than said other armature, and

a second switch coupled to said second armature and activated thereby.

6. The device of claim 5 wherein the adjustable means for each of said armatures comprises

a threaded bolt mounted on each of said armatures, and

a rotatable nut adjustable to predetermined positions on each of said bolts.

7. The device of claim 1 wherein the adjustable means comprises screw threaded means carried by said armature.

8. The device of claim 5 wherein the adjustable means comprise screw threaded means carried by each of said armatures.