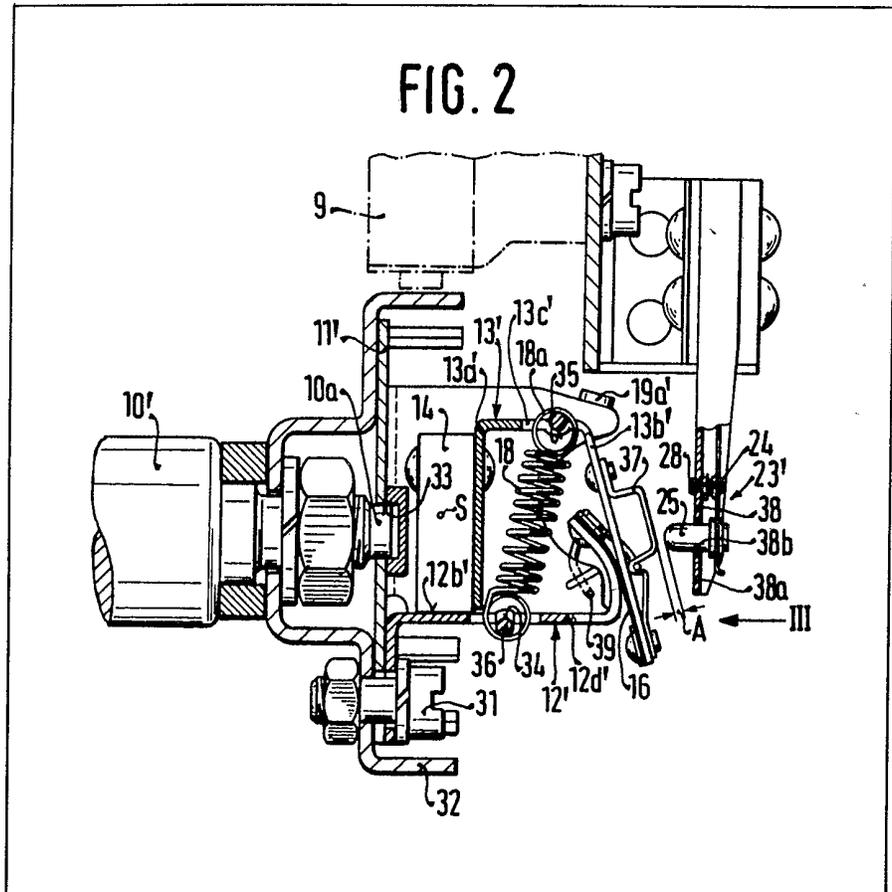


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(54) **A centrifugal switch**

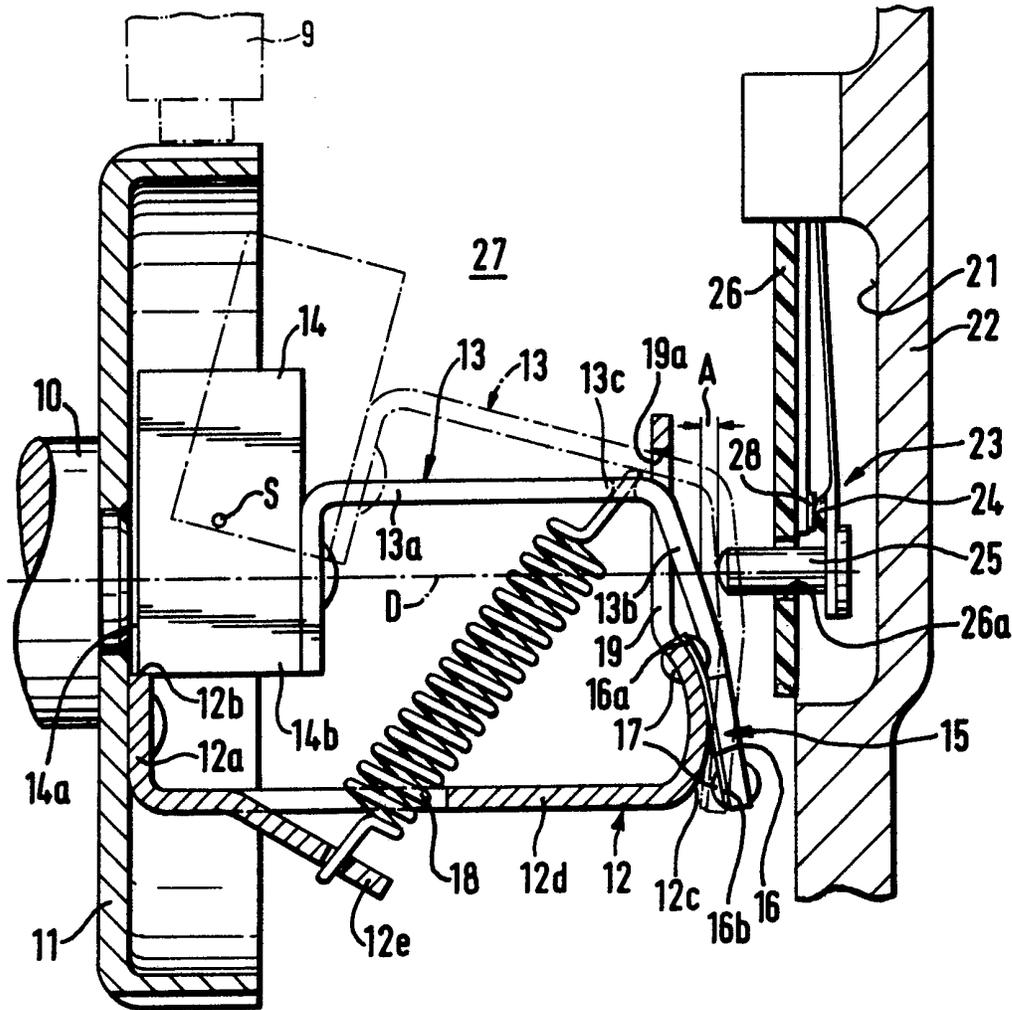
(57) A centrifugal switch, for electrically controlled or regulated fuel injection systems of internal combustion engines comprises a centrifugal pendulum (13') secured to a rotating carrier member (12') by means of a metal strip support (16) and a switch (23') which is secured relative to the housing and which has a switching clearance (A) relative to an actuating pin (25). The pendulum (13') carries a mass (14) on an arm (13a') which extends substantially in

the direction of the axis of rotation (D), and its second lever arm (13b') extends approximately at right angles to the axis of rotation (D) and, together with the metal strip support (16), is held in abutment against a rolling surface on the carrier member (12') by a return spring (18) and, preferably, by an additional spring clip (39). The spring constant of the return spring (18) is such that the increase in the force of the spring is less than the corresponding increase in centrifugal force when the pendulum (13') swings outwardly.

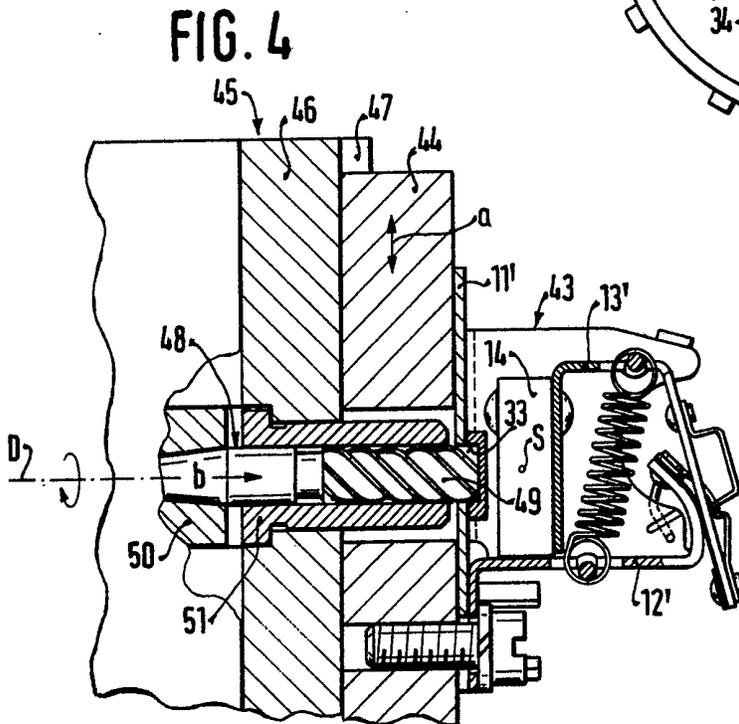
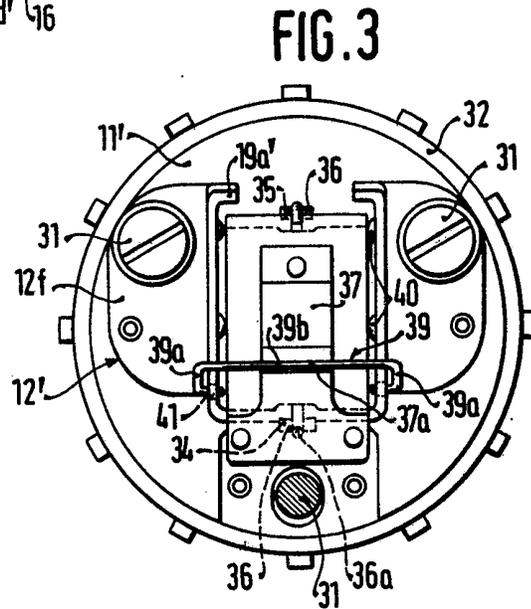
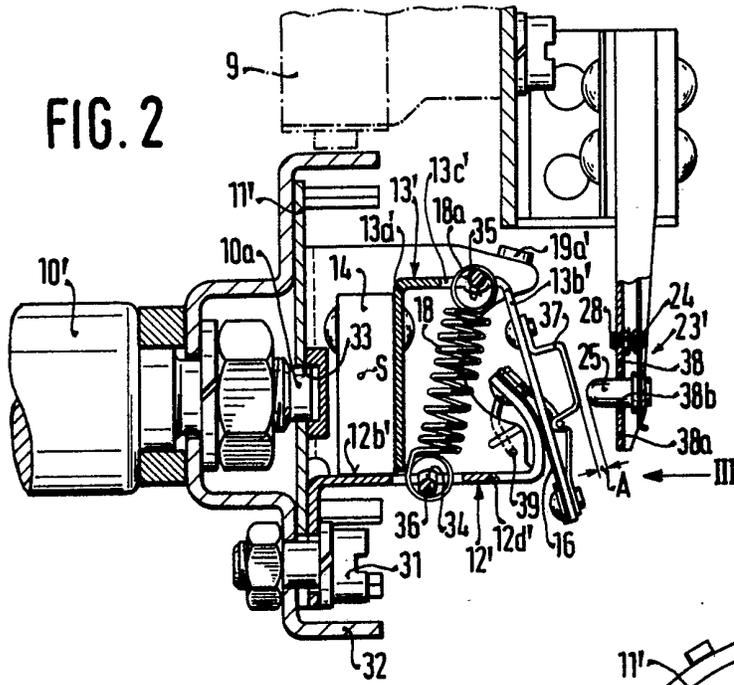


1/3.

FIG. 1



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3/3.

FIG. 5

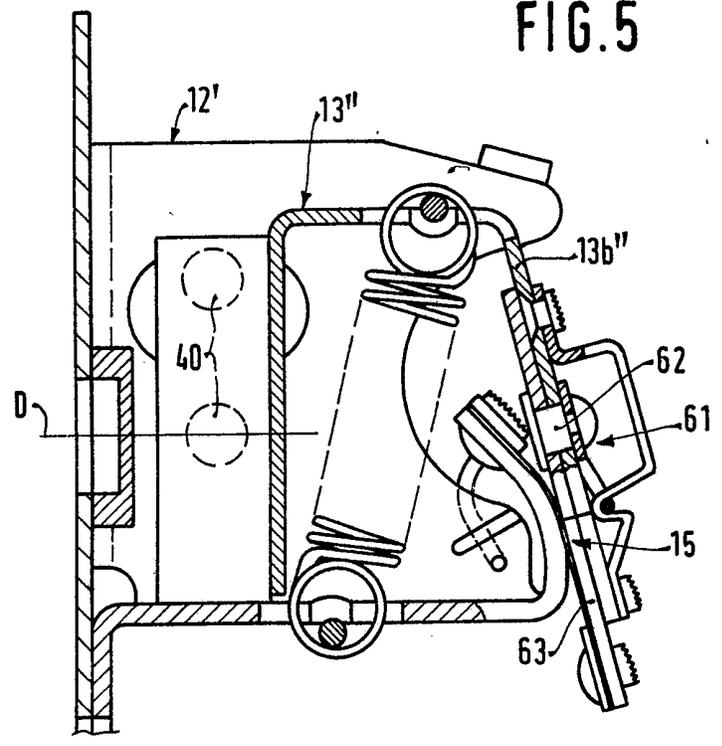
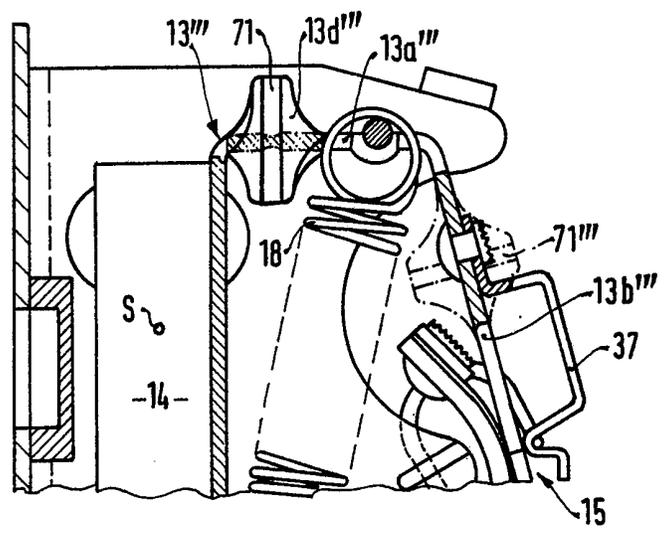


FIG. 6



SPECIFICATION
A centrifugal switch

The invention relates to a centrifugal switch.

In particular the invention relates to a
 5 centrifugal switch for safety switching-off upon
 reaching a cut-off speed, for electrically controlled
 or regulated fuel injection systems for internal
 combustion engines.

A known centrifugal switch has a bell-crank-
 10 lever-shaped centrifugal pendulum which is
 mounted on a carrier member, connected to a
 drive shaft, by means of a metal strip support. An
 electrical switch is secured relative to the housing
 and is provided with an actuating pin disposed in
 15 line with the axis of rotation of the centrifugal
 switch. The actuating pin is actuatable in a direction
 to interrupt contact by means of the centrifugal
 pendulum which moves under the action of
 centrifugal force and against the force of a return
 20 spring which is interposed between the centrifugal
 pendulum and the carrier member.

A centrifugal switch is already known from
 German published Patent Specification
 25 (Offenlegungsschrift) 1,490,452 in which the bell-
 crank-lever-shaped centrifugal pendulum is
 secured to the rotating carrier member by way of
 the metal strip support and acts upon a switching
 contact, fixed relative to the housing, by way of a
 30 contact screw disposed in line with the axis of
 rotation of the centrifugal switch. In order to
 reduce the wear due to friction, the contact screw
 is disposed centrally in line with the axis of
 rotation of the centrifugal switch, although the
 centrifugal pendulum abuts against the contact
 35 screw at all rotational speeds, so that,
 nevertheless, wear is caused at this location, even
 though it is a reduced amount of wear. The known
 centrifugal switch serves as a speed contact
 40 regulator for electric motors and is not suitable as
 a safety cut-out, upon attaining a cut-out speed,
 for electrically controlled or regulated fuel
 injection systems of internal combustion engines,
 and is particularly unsuitable for use in diesel
 engines.

Because the strip support constituting a leaf
 45 spring is secured in the form of a bridge between
 the carrier member and the centrifugal pendulum,
 and because the flyweight mass is disposed near
 to the axis of rotation of the centrifugal switch,
 50 this known centrifugal switch exhibits a very small
 increase in the centrifugal force upon small
 changes of rotational speed, and the type of
 cantilever strip support used results in an
 inaccurately defined pivot point. The slow opening
 55 of the contact causes contact pitting. The return
 spring which is in the form of a tension spring and
 which slopes relative to the axis of rotation and is
 attached to the carrier member and to the
 centrifugal pendulum is designed such that the
 60 centrifugal pendulum abuts against the contact
 screw acting as an actuating pin even before the
 rated speed has been attained, so that wear at this
 point is unavoidable. In order to actuate the
 movable contact member, the spring forces of the

65 contact and those of the strip support in the form
 of a leaf spring, and the initial stressing force of
 the return spring have to be overcome and the
 effective force remaining for lifting the movable
 contact member is very small. Incalculable forces
 70 also occur in the event of soiling of the contacts,
 sticking of the contacts, or external influences
 such as rotation oscillations and vibration, so that,
 with the known arrangement, it would be
 impossible accurately to comply with the safety
 75 switching-off upon attaining a predetermined
 rotational speed having close tolerances. The
 cantilever strip support in the form of a leaf spring
 bridging the distance between the carrier member
 and the centrifugal pendulum would also be
 80 unsuitable for absorbing the angular accelerative
 forces occurring in diesel engines.

According to the present invention there is
 provided an electrical centrifugal switch for
 electrically controlled or regulated fuel injection
 85 systems of internal combustion engines, for safety
 switching-off upon reaching a cut-off speed,
 which centrifugal switch comprises a carrier
 member which is secured to a drive shaft and a
 bell-crank-lever-shaped centrifugal pendulum
 90 which is mounted on the carrier member by
 means of a metal strip support, and an electrical
 switch provided with electrical contacts, which
 switch is secured relative to a housing and is
 provided with an actuating pin disposed in line
 95 with the axis of rotation of the centrifugal
 switch, which actuating pin is actuatable, in a
 direction to interrupt contact, by means of the
 centrifugal pendulum which moves under the
 action of centrifugal force and against the force
 100 of a return spring which is interposed between
 the centrifugal pendulum and the carrier member,
 the centrifugal pendulum carrying a flyweight
 mass at the end of a first lever arm which
 extends substantially in the direction of the
 105 axis of rotation of the drive shaft, and the
 metal strip of the strip support being secured
 between a second lever arm of the cantilever
 pendulum, which extends transversely to the
 axis of rotation of the drive shaft and the
 110 carrier member, the carrier member having a
 rolling surface which overlaps the lever arm,
 the said metal strip being held in abutment
 against the rolling surface under tensile stress
 by the return spring.

In contrast to this prior art, the centrifugal
 115 switch in accordance with the invention has the
 advantage that abrupt and rapid response of the
 switch is obtained by arranging the flyweight
 mass at the end of the lever arm of the
 centrifugal pendulum which extends chiefly in
 120 the direction of the axis of rotation, and that,
 by virtue of the chosen construction of the
 second lever arm of the centrifugal pendulum
 which is pulled towards a rolling face on the
 carrier member by the return spring together
 with the strip support, an accurately defined
 125 pivot point of the centrifugal pendulum is
 obtained which is insensitive to vibration but
 which is not

subjected to bearing friction.

Further advantageous developments and refinements of the centrifugal switch are made possible by arranging that a clearance exists
 5 between the level arm and the actuating pin. Thus no friction occurs between the actuating pin and the centrifugal pendulum during normal operation of the centrifugal switch. Advantageously, the metal strip of the strip support is always clamped
 10 between the centrifugal pendulum and the carrier member in a well-defined manner. Further, in centrifugal switch having a return spring in the form of a tension spring which slopes relative to the axis of rotation and which is attached to the carrier member and to the centrifugal pendulum,
 15 the metal strip of the strip support is subjected to tensile stress when the centrifugal pendulum is in any operating position, whereby no change of load occurs in the region of the strip support, and the instantaneous pivot point of the centrifugal
 20 pendulum, and thus the effective lever arm of the centrifugal pendulum, are always accurately determined. By virtue of the matching of the increase in the spring force relative to the corresponding increase in the centrifugal force, a
 25 "snap effect" is obtained which ensures reliable response of the switch.

Simple correction of the initial stressing force of the return spring is rendered possible without
 30 additional components by bending the sheet metal tongue of the carrier member to which the spring is attached. Conveniently the spring is attached to the carrier and pendulum by pins which are pressed home thereby dispensing with correction
 35 of the installation position of the spring, it being a simple matter to instal the spring and reliably to lock it in its installed position. The return spring pulls the pendulum against the rolling surface and towards its inner stop whereby the centrifugal
 40 pendulum when in its initial position abuts firmly against an inner stop during normal operation before the cut-off speed is attained, thus avoiding "rattling sounds" and wobbling movements and thus additional stressing of the strip support, and
 45 the strip bearing is always subjected to tensile stress. The centrifugal switch is of simple construction and in addition, the centrifugal pendulum is pressed against the rolling surface of the strip support by virtue of the fact that the
 50 centrifugal pendulum has been swung outwardly and is abutting against the outer stop, even after the cut-off speed has been exceeded. Thus, advantageously, the centrifugal pendulum cannot be raised from the strip support even when the cut-off speed has been exceeded to a substantial
 55 extent. The strip support is stressed to only a slight extent by virtue of the arcuate rolling track of the rolling surface, and the second lever arm of the outwardly swung centrifugal pendulum performs a horizontal pressing or switching movement by
 60 which an adequately large switching force is transmitted to the actuating pin at a high switching speed even in the case of sticking contacts. The "snap effect" can be additionally intensified in an advantageous manner by
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arranging for the centre of gravity of the flyweight to be disposed radially outwardly of the axis of rotation of the centrifugal switch in the direction
 70 of pivoting of the pendulum. Additionally, by arranging that the centre of gravity of the support strip is on the opposite side of the said axis to the centre of gravity of the flyweight the second lever arm of the centrifugal pendulum performs the required pressing movement towards the
 75 actuating pin.

By arranging for the actuating pin to pass with clearance through a bore, features of claims 14 or 15 in a cover plate which separates the switch from the pendulum cold engine oil within the
 80 housing accommodating the centrifugal switch is prevented from acting upon the movable switching contact and actuating the latter.

Advantageously, to ensure that the centrifugal pendulum always abuts reliably in the region of
 85 the strip support even at high speeds and extremely high angular acceleration, the abutment of the centrifugal pendulum against the carrier member effected by the return spring is intensified by an additional spring element which is in the
 90 form of a bow-type spring. The function of the centrifugal force is virtually unaffected by disposing this spring element in the region of the strip support, although the spring element contributes substantially to improved abutment of
 95 the strip support and to the fatigue strength of the latter. The bow-type spring is installed in a recess in a thrust member and the thrust member enables the point at which the switching movement is transmitted to the actuating pin of
 100 the switch to be optimised irrespective of the shape of the centrifugal pendulum. Transverse bending stress occurring in the case of very high torsional vibration can be considerably reduced by providing the second lever arm of the pendulum
 105 with a hinge point or a bending location.

No adjusting and setting devices are required for the return spring and for the inner position of the centrifugal pendulum, since, by providing the centering bore, which is machined in a position
 110 corresponding to the desired cut-off speed, the centrifugal switch mounted on the journal of the drive shaft responds accurately to the set cut-off speed.

The present invention will now be described further, by way of example only, with reference to the accompanying drawings, in which:—

Figure 1 is a longitudinal section, drawn to an enlarged scale, through a first embodiment of a centrifugal switch in accordance with the invention;

Figure 2 is a longitudinal section through a second embodiment;

Figure 3 is a view in the direction of the arrow III of Figure 2,

Figure 4 is a simplified illustration of a device for boring a centering bore, located in the carrier member, for the second embodiment illustrated in Figures 2 and 3, and

Figures 5 and 6 are each a section of features, essential to the invention, of third and fourth

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embodiments.

A flange 11 which, in the first embodiment illustrated in Figure 1, is in the form of a pulse wheel for an electronic tachogenerator 9 (indicated by dash-dot lines), is secured to a drive shaft 10 which can be the cam shaft of a diesel engine or of an injection pump or any other shaft driven by the engine. A bow-shaped carrier member 12 has an end 12a which is bent at right angles thereto and by which the carrier member 12 is riveted to the flange 11 and whose outer edge 12b directed towards the axis of rotation D (shown by a dash-dot line) of the centrifugal switch at the same time serves as an inner stop for a centrifugal pendulum 13.

The bell-crank-lever-like centrifugal pendulum 13 carries a flyweight mass 14 at the end of a first lever arm 13a which extends substantially in the direction of the rotational axis D, and a second lever arm 13b of the centrifugal pendulum 13 extends substantially at right angles to the axis of rotation D and is secured to the carrier member 12 by means of a strip support 15. For this purpose, a metal strip 16 of the strip support 15 is clamped between a rolling surface of 12c on the carrier member 12 and the second lever arm 13b of the centrifugal pendulum 13. One end 16a of the metal strip 13 is secured in the region of that end of the rolling surface 12c which extends towards the axis of rotation D by means of a riveted connection 17 comprising, for example, two rivets, and the other end 16b of the metal strip is secured by means of an identical riveted connection 17 to that end of the second lever arm 13b which extends radially outwardly away from the axis of rotation D.

The carrier member 12 is formed from a sheet metal bow and has a central bridge portion 12d which is located between the angled end 12a and the rolling surface 12c and which extends parallel to the axis of rotation D. A sheet metal tongue 12e is bent out of the bridge portion 12d and extends outwardly at an acute angle to the axis of rotation D, a return spring 18 in the form of a tension spring is attached to the sheet metal tongue 12e. The return spring 18 is fitted in the centrifugal switch so as to slope relative to the axis of rotation D at an angle of approximately 45° and, in addition to being attached to the tongue 12e, is also attached to a central region 13c of the centrifugal pendulum 13 which is located between the flyweight mass 14 and the outer end of the second lever arm 13b of the centrifugal pendulum 13. When the centrifugal pendulum 13 is swung outwardly, this central region 13c moves through an opening 19 in the carrier member 12 and an outer stop for the centrifugal pendulum 13 is formed by the inner edge 19a of the opening 19. The inner edge 19a is in a direction away from the axis of rotation D and opposite the bridge portion 12d of the carrier member 12.

When the centrifugal pendulum is swung outwardly into the position shown by dash-dot lines in the drawing, the central region 13d of the centrifugal pendulum 13 strikes against the outer

stop 19a, whereby, as a result of the flyweight mass 14 secured to the outermost end of the first lever arm 13a, the centrifugal pendulum 13 is subjected to a tilting moment which presses the outer end of the second lever arm 13b, and thus the metal strip 16 of the strip support 15, firmly against the rolling surface 12c on the carrier member 12, thereby preventing the centrifugal pendulum 13 from being raised from the strip support 15. This pressing action is also obtained when the centrifugal pendulum 13 is in its illustrated inner position by the sloping return spring 18 which pulls the outermost end 14a of the flyweight mass 14 against the stop 12b and the second lever arm 13b of the centrifugal pendulum 13 against the rolling surface 12c. By virtue of the arrangement of the stops 12b and 19a and the slope of the return spring 18, it is ensured that, both when the centrifugal pendulum 13 is in its inner position and when it is in its outer position, the metal strip 16 of the strip support 15 is always subjected to tensile stress, and the second lever arm 13b is always pulled or pressed against the rolling surface 12c together with the metal strip 16. Furthermore, the effective lever arm and the instantaneous pivot point are accurately determined for any position of the centrifugal pendulum 13.

The axis of rotation D passes through the flyweight mass 14 somewhat eccentrically when the flyweight mass is in its illustrated inner position, so that a smaller portion 14b of the mass 14 is located at that side of the axis of rotation D which is opposite to the direction of pivoting of the centrifugal pendulum 13. Thus, a large progressive increase in the centrifugal force is obtained which, together with additional measures which will be specified below, leads to the desired so-called "snap effect."

A switch 23 is disposed in a recess 21 in a cover 22 fixed relative to the housing, or in a housing portion, and its movable contact 24 carries an actuating pin 25. The actuating pin 25 extends in line with an axis of rotation D of the centrifugal switch through a bore 26a in a cover plate 26 and is secured to the movable contact 24. When the centrifugal pendulum 13 is in its illustrated inner position, any friction between the actuating pin 25 and the centrifugal pendulum 13 during normal operation of the centrifugal switch is excluded by a switching clearance A between that end of the actuating pin which extends into the interior 27 of the centrifugal switch and the second lever arm 13b of the centrifugal pendulum 13. The cover plate 26 provided with the bore 26a prevents actuation of the movable contact 24 by, for example, engine oil which has been thickened by cold within the interior space 27.

The rolling surface 12c is provided with an arcuate rolling track which is designed such that, when the centrifugal pendulum 13 has been swung outwardly, that portion of the lever arm 13b which acts upon the actuating pin 25 effects a horizontal movement in the direction of the axis of rotation D. Thus, transverse forces are not

transmitted to the actuating pin 25, and wear at this location is avoided. It is also essential to the invention that the centre of gravity S of the flyweight mass 14 and the strip support 15 are located at opposite sides of the axis of rotation D, whereby the lever arm 13*b* always transmits a thrust movement to the actuating pin 25.

The "snap effect" already mentioned above is intensified in a desired manner by the flyweight mass 14 mounted at the end of the centrifugal pendulum 13 and by the portion 14*b* of the flyweight mass which swings outwardly beyond the axis of rotation D, and by the slope and relatively weak spring constant of the return spring 18, that is to say, as soon as an excess speed, to be designated "cut-off speed" is reached, the centrifugal force causes the flyweight 14 to pivot abruptly outwardly and the lever arm 13*b* of the centrifugal pendulum 13 bridges the switching clearance A and, before reaching the outer stop 19*a*, actuates the actuating pin 25 of the switch 23. The movable contact 24 is thereby raised from the fixed contact 28 secured to the cover plate 26, and the current supply (not further illustrated here) for an electrically controlled or regulated fuel injection system is thereby interrupted.

In the embodiments hereinafter described with reference to Figures 2, 3, 5 and 6, parts which are the same, or which act in the same way, are provided with the same reference numerals, modified parts are provided with index marks, and new parts are provided with new reference numerals.

In the second embodiment, the carrier member 12' is in the form of a substantially box-like member formed from sheet metal and has three angled flange portions which are secured by spot welding to a flange 11' in the form of a sheet metal disc. The flange 11' provided with the carrier member 12' is bolted by means of three bolted connections 31 to a pulse wheel 32, secured to the drive shaft 10', of the electronic tachogenerator 9. The illustrated installation position of the carrier member 12' is fixed by a centering bore 33 which receives a journal 10*a* of the drive shaft 10'.

The flyweight mass 14 of the centrifugal pendulum 13' is secured to the lever arm 13*a*' and, when in its inner or rest position, abuts against an inner stop 12*b*' formed by the bridge portion 12*d*', and the return spring 18 is attached to the carrier member 12' and to the centrifugal pendulum 13' by means of pins 36 which are located in pressed-in portions 34 of the bridge portion 12*d*' and in pressed-in portions 35 in the central region 13*c* of the centrifugal pendulum 13' and which are inserted through eyes 18*a* of the return spring 18. Two inwardly bent sheet metal portions 19*a*' of the carrier member 12' serve as an outer stop for the centrifugal pendulum 13', and the flyweight mass 14 is laterally guided in a low-friction manner by protuberances 40 on the side walls of the carrier member 12'.

A thrust member 37 in the form of a sheet

metal strip is secured to the second lever arm 13*b*' of the centrifugal pendulum 13' and serves to transmit the switching movement of the centrifugal pendulum 13' to the actuating pin 25 of the switch designated 23' in the present instance. The switching clearance A is determined by the variable installation position of the switch 23', and, as in the first embodiment, the actuating pin 25 extends through a bore 38*b* in a fixed carrier plate 38 which receives the fixed switching contact 28 and which surrounds the actuating pin 25 with a rim region 38*a* which is at least one centimetre in width. This rim region 38*a* is sufficient to screen the movable contact 24 of the switch 23' from the motor oil which, when in a cold state, is delivered substantially concentrically in an axial direction.

This second embodiment illustrated in Figures 2 and 3 differs from the embodiment illustrated in Figure 1 chiefly by virtue of a spring element 39 which is in the form of a bow-type spring and which is subjected to an initial stressing force and, in the region of contact with the strip support 15, that is to say, the points of contact between the second lever arm 13*b*' of the centrifugal pendulum 13' and the metal strip 16 and between the latter and the carrier member 12', surrounds these parts and holds them together. For this purpose, the bow-type spring 39 has two angled ends 39*a* which are inserted into bores 41 in the carrier member 12', and a central portion 39*b* of the bow is located in a spring reception portion 37*a* in the form of a depression which is formed in the thrust member 37 by a corresponding bent configuration thereof.

The most important components of a device for producing the centering bore 33 in the flange 11' of the carrier member 12' and for simultaneous adjustment of the predetermined cut-off speed of the centrifugal switch are shown in a simplified form in Figure 4.

For this purpose, the flyweight sub-assembly 43 of the centrifugal switch described with reference to Figures 2 and 3, and which chiefly comprises the flange 11', the support member 12' and the centrifugal pendulum 13', is secured to a reception flange 44 of the boring device 45 with the centre of gravity S of the flyweight mass 14 initially located substantially in the axis of rotation D. The reception flange 44 can be rotated about the axis of rotation D by means of a drive flange 46 of the boring device 45 and, by means of a sliding guide 47, is displaceable on the drive flange 46 in the direction of the pivoting movement of the centrifugal pendulum 13' and at right angles to the axis of rotation D, such that the centre of gravity S can be displaced from its original position into a position in which it is at a greater distance from the axis of rotation D.

The adjustment of the cut-off speed and the boring of the centering bore 33 are effected in the following manner:

- a) the flyweight sub-assembly 43 is bolted to the reception flange 44 of the boring device 45;
- b) the reception flange 44 is driven at the

prescribed cut-off speed together with the drive flange 46;

c) the installation position of the flyweight sub-assembly 43 is displaced from the original position into a position which is further from the axis of rotation D relative to the centre of gravity S either continuously when the drive flange 46 is running by means of the reception flange 44 which is adjustable at right angles to the axis of rotation D, or iteratively by stepwise adjustment of the reception flange 44 or by stepwise displacement of the flyweight sub-assembly 43 on the reception flange 44, until the centrifugal pendulum 13' swings outwardly for the purpose of contact breaking;

d) when the flyweight sub-assembly 43 is in its position determined by the method step c), the centering bore 33 is bored by means of a boring tool 48 which is located in the axis of rotation of the drive flange 46 and which, in the simplified illustration of Figure 4, chiefly comprises an end-milling cutter or a blind bore drill 49 which is driven by a boring spindle 50 and which can be displaced in the direction of the arrow *b* and which is guided in a drill bushing 51 secured in the drive flange 46.

The centering bore 33 in the form of a blind bore has the advantage that the swarf is kept away from the flyweight sub-assembly 43 during drilling, although, basically, a through bore drilled by a twist drill could serve as the centering bore.

The cut-off speed of the centrifugal switch is determined in an accurate and invariable manner by this working method incorporating the steps *a* to *d*, and no adjusting or setting operations are necessary, since the flyweight sub-assembly 43 is centered on the journal 10*a* of the drive shaft 10' (see Figure 2) upon mounting the flyweight sub-assembly onto the pulse wheel 32.

If the reception flange 44 of the boring device 45 is constructed such that it can be adjusted when the device is running, there is a considerable saving of time particularly in mass-production.

To ensure that the return spring 18 always remains in the central position, and as is shown in Figure 3, the pins 36 are provided with a concentric groove 36*a* in the outer surface of pin for the eyes 18*a* of the return spring 18, and the depressions 34 and 35 in the carrier member 12' and in the centrifugal pendulum 13' also receive the pins in their axial direction, such that their installation position is fixed in the centre of the two components in a well-defined manner. Thus, the return spring 18 cannot be laterally displaced, and the cut-off speed cannot change as a result of friction between the spring and the components.

The features, essential to the invention, of the third and fourth embodiments are drawn to a larger scale in Figures 5 and 6. The two embodiments include measures to prevent bending stress from being transmitted to the strip support 15 at right angles to the normal bending stress. Bending stress of this kind occurs to a particularly great extent when the centrifugal switch is mounted directly on the camshaft of the

injection pump, and thus has to absorb the torque impacts originating from the cams. For this purpose, the centrifugal pendulum 13'' of the third embodiment illustrated in Figure 5 is provided with a hinge point 61. A portion of the centrifugal pendulum 13'' is formed by the second lever arm 13*b*'' and is rigidly connected to the flyweight mass 14 and is flexibly connected by means of the rivet-like connection portion 62 of the hinge point 61 to a sheet metal tongue 63 riveted to the strip support 15. The hinge point 61 is in the form of a pivot bearing and is arranged in the axis of rotation D in order to largely isolate the strip support 15 from the tilting movements which are effected by the flyweight mass 14 and by the centrifugal pendulum 13'' and which, although they are only slight tilting movements, cannot be prevented by the lateral protuberances 40 on the carrier member 12'. Thus the second lever arm 13*b*'' is permitted to pivot with respect to the tongue 63 about the axis of the portion 62.

Only a portion of the centrifugal pendulum 13''' of the fourth embodiment is shown in Figure 6 and it is provided with a desired bending location 71 instead of the hinge point 61 described with reference to Figure 5. The desired bending location 71 is formed by a thin wall location within an upended region 13*d*'' of the second lever arm 13*a*''' of the centrifugal pendulum 13'''. This upended region 13*d*''' is produced by twisting the flat strip cross section of the second lever arm 13*a*''', and the small wall thickness required for the resilient desired bending location 71 is indicated by the cross section, indicated by dash-dot lines, of the region 13*d*'''. The wobbling movements which are performed by the flyweight mass 14 and which are produced by torsional vibration, are kept away from the strip support 15 by the desired bending location 71 disposed between the return spring 18 and the flyweight mass 14. If tilting movements of the flyweight mass 14 should preponderate as a result of the eccentric centre of gravity S of the flyweight mass 14, the desired bending location can be provided on the second lever arm 13*b*''', as is indicated by dash-dot lines at 71'''. For this purpose, the configuration of the thrust member 37 would have to be slightly modified.

The centrifugal switch in accordance with the invention intentionally has a large hysteresis by which the switch 23 or 23' is only closed again when the rotational speed has dropped to a considerable extent. Thus, in the event of a fault, and with only a slight reduction in the rotational speed, the supply of current cannot be immediately restored and the engine cannot commence to "hunt".

A centering bore may be formed in the pulse wheel 11 of the embodiment of Fig. 1 utilising the device according to the description relating to Fig. 4.

CLAIMS

1. An electrical centrifugal switch, for electrically controlled or regulated fuel injection

systems of internal combustion engines, for safety switching-off upon reaching a cut-off speed, which centrifugal switch comprises a carrier member which is secured to a drive shaft and a bell-crank-lever-shaped centrifugal pendulum which is mounted on the carrier member by means of a metal strip support, and an electrical switch, provided with electrical contacts, which switch is secured relative to a housing and is provided with an actuating pin disposed in line with the axis of rotation of the centrifugal switch, which actuating pin is actuatable, in a direction to interrupt contact, by means of the centrifugal pendulum which moves under the action of centrifugal force and against the force of a return spring which is interposed between the centrifugal pendulum and the carrier member, the centrifugal pendulum carrying a flyweight mass at the end of a first lever arm which extends substantially in the direction of the axis of rotation of the drive shaft, and the metal strip of the strip support being secured between a second lever arm, of the cantilever pendulum, which extends transversely to the axis of rotation of the drive shaft, and the carrier member, the carrier member having a rolling surface which overlaps the lever arm, the said metal strip being held in abutment against the rolling surface under tensile stress by the return spring.

2. A centrifugal switch as claimed in claim 1, in which, when the centrifugal pendulum is abutting against an inner stop when in its rest position, there is a switching clearance between the second lever arm and the actuating pin.

3. A centrifugal switch as claimed in claim 1 or 2, in which the metal strip of the strip support is clamped between the rolling surface and the second lever arm and one end of the metal strip is secured in the region of that end of the rolling surface which extends towards the axis of rotation of the centrifugal switch, and its other end is secured to that end of the second lever arm which extends radially outwardly away from the axis of rotation of the centrifugal switch.

4. A centrifugal switch as claimed in any of claims 1 to 3, in which the return spring is in the form of a tension spring and is attached to the carrier member and to the centrifugal pendulum so as to slope relative to the axis of rotation of the centrifugal switch, the slope and the spring constant of the return spring being such that the second lever arm, and the metal strip are pulled towards the rolling surface when the centrifugal pendulum is in any position.

5. A centrifugal switch as claimed in claim 4, in which the slope and the spring constant of the return spring are such that the increase in the spring force is smaller than the corresponding increase in the centrifugal force when the centrifugal pendulum is swinging outwardly.

6. A centrifugal switch as claimed in claim 4 or 5, in which the carrier member is in the form of a member shaped from sheet metal, and in which the return spring is attached to a sheet metal tongue which is bent out of the carrier member

and whose position is variable by bending for the purpose of correcting the initial stressing force of the return spring.

7. A centrifugal switch as claimed in claim 4 or 5, in which the carrier member is in the form of a member shaped from sheet metal, and in which the return spring is attached to the carrier member and to the centrifugal pendulum by means of pins which are located in depressions in the carrier member and/or in the centrifugal pendulum and which are inserted through eyes of the return spring.

8. A centrifugal switch as claimed in any of claims 4 to 7, when dependent on claim 2, in which the return spring pulls the centrifugal pendulum against the rolling surface and also towards the inner stop when the centrifugal pendulum is in its rest position.

9. A centrifugal switch as claimed in claim 8, in which the carrier member incorporates the inner stop for an outer end of the flyweight mass which abuts against this stop when the flyweight mass is in its rest position, and also an outer stop for the centrifugal pendulum, and that, when the centrifugal pendulum is pivoted against the force of the return spring after the cut-out speed has been attained, a central region of the centrifugal pendulum which is located between the flyweight mass and that end of the second lever arm which is secured to the strip support, abuts against the outer stop.

10. A centrifugal switch as claimed in claim 9, in which the return spring is attached to the central region of the centrifugal pendulum.

11. A centrifugal switch as claimed in any of claims 1 to 10, in which the rolling surface is formed by an arcuate rolling track.

12. A centrifugal switch as claimed in any of claims 1 to 11, in which, when the centrifugal pendulum is in its rest position, the axis of rotation of the centrifugal switch passes through the flyweight mass, and a smaller portion of the mass is located at that side of the axis of rotation of the centrifugal switch which is averse to the direction of pivoting of the centrifugal pendulum.

13. A centrifugal switch as claimed in any of claims 1 to 12, in which the centre of gravity of the flyweight mass and the rolling surface of the strip support are arranged on opposite sides of the axis of rotation of the centrifugal switch.

14. A centrifugal switch as claimed in any of claims 1 to 13, in which the actuating pin of the switch is secured to the movable contact and extends with a small amount of clearance through a bore in a cover plate which separates a recess, accommodating the switch, in a cover from an interior space accommodating the other components.

15. A centrifugal switch as claimed in any of claims 1 to 13, in which the actuating pin of the switch is secured to the movable contact and passes with a small amount of clearance through a bore in a rigid carrier plate which receives preferably the fixed switching contact, and that the carrier plate surrounds the actuating pin with

an edge region which is at least 1 cm wide.

5 16. A centrifugal switch as claimed in any of claims 1 to 15, in which the second lever arm of the centrifugal pendulum, the metal strip and the carrier member are held together by a spring element which is subjected to an initial stressing force and which surrounds these parts in the region of the contact points of the strip support.

10 17. A centrifugal switch as claimed in claim 16, in which the spring element is in the form of a bow-type spring and has two angled ends which are inserted into bores in the carrier member, and a central portion of the bow-type spring rests in a spring reception portion located on the second lever arm of the centrifugal pendulum.

15 18. A centrifugal switch as claimed in claim 17, in which the spring reception portion is in the form of a depression in a thrust member which is secured to the second lever arm of the centrifugal pendulum and which serves to displace the actuating pin.

20 19. A centrifugal switch as claimed in any of claims 1 to 18, in which there is provided on the centrifugal pendulum a hinge point which is located between a member of the centrifugal pendulum which is rigidly connected to the flyweight mass and a sheet metal tongue which is rigidly connected to the strip support.

25 20. A centrifugal switch as claimed in claim 19, in which the hinge point is provided on the second lever arm of the centrifugal pendulum and in the axis of rotation of the centrifugal switch.

30 21. A centrifugal switch as claimed in any of claims 1 to 18, in which a desired bending location, which is resistant to bending in the direction of pivoting but which is resilient at right angles thereto, is provided on the centrifugal pendulum between the flyweight mass and the

strip support.

40 22. A centrifugal switch as claimed in any of claims 1 to 6 or 8 to 21, in which the carrier member, or a component rigidly connected thereto, is provided with a centering bore which receives a journal of the drive shaft.

45 23. A method for producing the centering bore, specified in claim 22, in a centrifugal switch constructed in accordance with claims 1 to 6 or 8 to 21, in which:—

50 a) the rotating flyweight sub-assembly of the centrifugal switch is secured to a reception flange of a boring device with the centre of gravity (S) of the flyweight mass lying substantially in the axis of rotation;

55 b) the reception flange is driven by way of a drive flange at the prescribed cut-out speed;

60 c) the installation position of the flyweight subassembly is displaced from the original position into a position which is further from the axis of rotation relative to the centre of gravity either continuously when the drive flange is running by means of the reception flange which is adjustable at right angles to the axis of rotation, or iteratively by stepwise adjustment of the reception flange or by stepwise displacement of the flyweight sub-assembly on the reception flange, until the centrifugal pendulum swings outwardly for the purpose of contact breaking;

65 d) when the flyweight sub-assembly is in its position determined by the method step c, the centering bore is bored by means of a boring tool which is located in the axis of rotation of the drive flange.

70 24. A centrifugal switch constructed and adapted to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.