

[54] CONTACTLESS SWITCHING DEVICE

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[56]

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Primary Examiner—C. L. Albritton

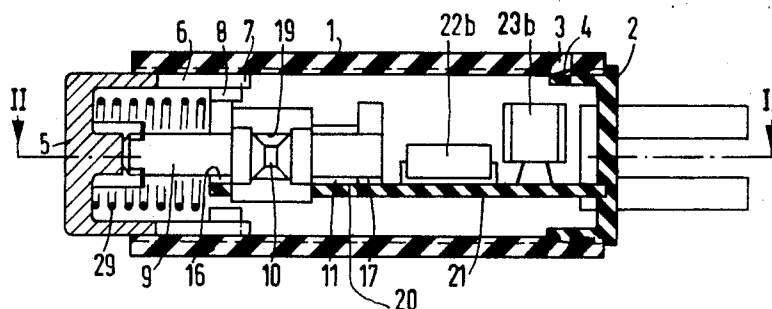
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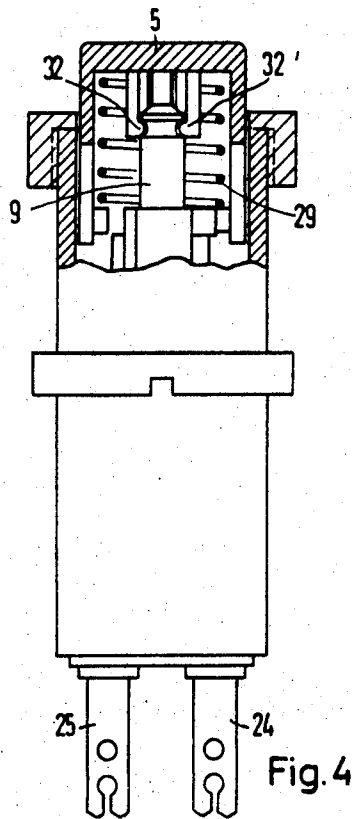
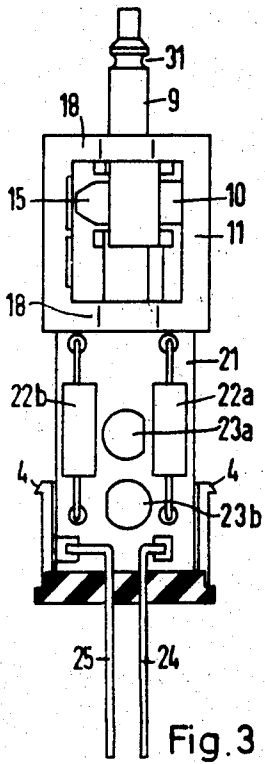
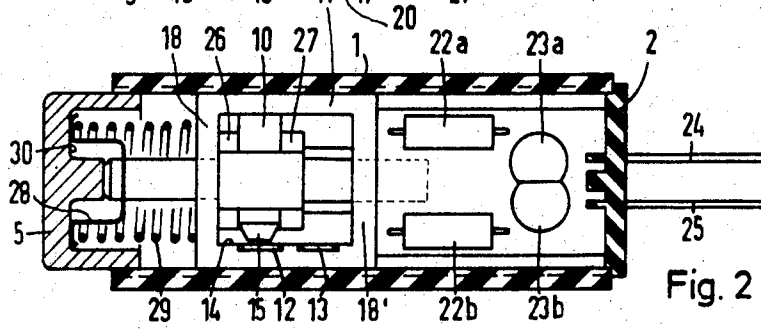
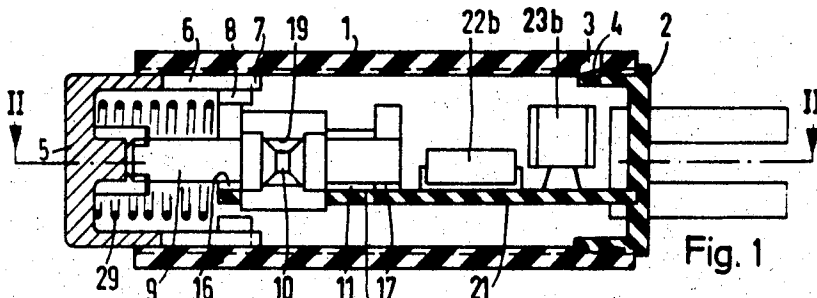
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ABSTRACT

A galvanomagnetic resistor is fixedly mounted on a magnetizable yoke structure. A displaceable actuator comprises a permanent magnet having a longitudinal axis and being rotatably mounted in the yoke structure at a part of the yoke structure opposite that at which the galvanomagnetic resistor is mounted. The actuator has a direction of travel substantially transverse to the longitudinal axis of the magnet.

3 Claims, 5 Drawing Figures





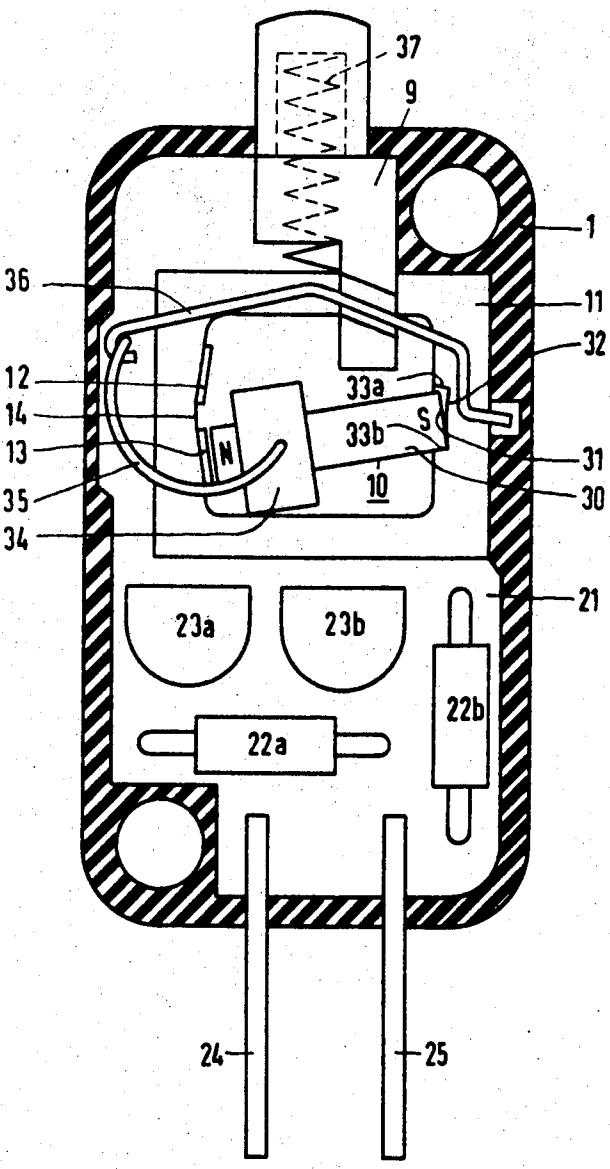


Fig.5

CONTACTLESS SWITCHING DEVICE

DESCRIPTION OF THE INVENTION

The invention relates to a contactless switching device. More particularly, the invention relates to a contactless pushbutton switch comprising a permanent magnet movably mounted relative to a fixed galvanomagnetic resistor such as, for example, a field plate affixed to a yoke structure.

In a known pushbutton switch of the aforescribed type, as disclosed in German Utility Model 1,993,051, a permanent magnet is provided with a pole shoe positioned separately, transverse to the longitudinal axis of the magnet. The magnet is movable in the magnetizing direction and in the direction of the longitudinal axis. The pole shoe points to a galvanomagnetic resistor which is affixed to an inserted part. The inserted part is positioned in a magnetically conductive tube which defines a yoke for the magnetic flux produced by the permanent magnet and passing over the pole shoe and the galvanomagnetic resistor. In order to close the magnetic circuit, the permanent magnet is provided, at its pole opposite the pole shoe, with a magnetically conductive carrier affixed to the yoke, via an air gap.

The pole shoe of the aforescribed pushbutton switch is wedge-shaped in order to concentrate the magnetic field lines on the surface of the galvanomagnetic resistor. The magnetic circuit of the switch includes a plurality of transition points from one medium to another, however, which increase the magnetic reluctance. Such transition points include, for example, the transition or junction from the permanent magnet to the carrier and to the pole shoe, as well as from the inserted part to the tubular yoke portion and from the carrier to the tubular yoke portion. It is therefore necessary to provide the permanent magnet with relatively large dimensions or size. This still does not take into consideration the occurring stray fluxes, which are not directed to the galvanomagnetic resistor. The return spring for the pushbutton member is mounted around the permanent magnet and is magnetically conductive, and draws part of its energy from the magnet.

In the disclosure of the German Utility Model 1,965,246 a galvanomagnetic resistor is positioned in the air gap of a biasing circuit which is excited by a permanent magnet. The air gap is bridged, in order to change the magnetic reluctance, with a soft magnetic body which is movable relative to the air gap. In this arrangement, the effectiveness of utilization of the useful flux produced by the permanent magnet is relatively low.

The principal object of the invention is to provide a new and improved contactless switching device.

An object of the invention is to provide a contactless switching device of simple structure and relatively small dimensions which provides good utilization of the useful flux produced by the permanent magnet.

An object of the invention is to provide a contactless switching device in which the active element of the device may be mounted outside the housing, thereby permitting adjustment of the device.

An object of the invention is to provide a contactless switching device which functions with efficiency, effectiveness and reliability.

In accordance with the invention, a contactless switching device comprising a magnetizable yoke structure. A galvanomagnetic resistor is fixedly mounted on the yoke structure. Displaceable actuator means comprises a permanent magnet. The permanent magnet has a longitudinal axis and is rotatably mounted in the yoke structure at a part of the yoke structure opposite that at which the galvanomagnetic resistor is mounted. The actuator means has a direction of travel substantially transverse to the longitudinal axis of the magnet.

The permanent magnet has a planar surface and the yoke structure has a convex roll-off surface at the first-mentioned part thereof in partial contact with the planar surface of the permanent magnet. The actuator means comprises a tappet and spring means interposed between the tappet and the permanent magnet.

In accordance with the invention, in a contactless switching device, the direction of movement is transverse to the longitudinal and magnetizing axis of the permanent magnet and the magnet is developed as a pole shoe.

Considerable splitting of the air gap chain in the magnetic circuit is permitted by mounting the magnet within a unitary frame-shaped yoke in movable relation to said yoke, and in relation to at least one galvanomagnetic resistor affixed to the inner longitudinal side of the yoke. This permits the mounting of the active component of the switch outside the housing of the switch, and thereby permits adjustment of said switch. It is advantageous, in order to accomplish this, to mount the magnet at the tappet of the pushbutton member and to guide the tappet in the transverse side of the frame. The tappet comprises insulating material. In order to permit the provision of the terminals for the galvanomagnetic resistor in premounted condition of the active parts and to insure a simple premounting process, it is preferable that the guide recesses for the installation of the tappet be open toward the flat side of the frame and that a plate of synthetic material, on which amplifier components are mounted, be positioned on the flat side and functions as a guide for the tappet.

A simple mounting of the permanent magnet at the tappet may be provided by inserting the magnet in self-holding relation into an opening in the tappet. In order to enlarge the premounting unit even further, so that all parts of said unit which are required for electrical operation are combined, and so that said unit need be inserted only into the switch housing, it is preferable to equip the plate of synthetic material with plug connections which are maintained in the cover portion of the switch housing. It may thus be preferable, in order to support the return spring, which is completely separate in accordance with the invention, to provide said spring in a manner whereby it first bears against the yoke structure and secondly bears against a metal bracket mounted on the end of the tappet. In such case, it is advantageous to provide the pushbutton switch with a pushbutton member which is separate from the tappet and which has an interior which bears, in force-locking relation, on the metal bracket and is held by noses protruding behind projections in the switch housing.

In order that the invention may be readily carried into effect, it will now be described with reference to the accompanying drawings, wherein:

FIG. 1 is a view, partly in section, of an embodiment of the switching device of the invention;

FIG. 2 is a sectional view taken along the line II—II of FIG. 1;

FIG. 3 is a view, partly in section, of another embodiment of the switching device of the invention without its housing;

FIG. 4 is a view, partly in section, of the embodiment of FIG. 3 inserted in its housing; and

FIG. 5 is a view, partly in section, of another embodiment of the switching device of the invention.

In the FIGS., the same components are identified by the same reference numerals.

FIGS. 1 and 2 illustrate an embodiment comprising a stationary tubular housing 1 of electrically insulating material which may be closed at one end, which may be the bottom, by a cover lid 2. The cover lid 2 may be snapped into the housing 1 by noses, projections, protrusions, extensions, or the like 4 which fit into recesses 3 in the housing. The switch is actuated by a pushbutton member 5 having arms 6 (FIG. 1). The pushbutton member 5 may be snapped into the housing 1 by noses, projections, protrusions, extensions, and the like 7 which extend beyond projections 8.

The arms 6 of the pushbutton member 5 function as a guide during the actuation, operation or movement of said pushbutton member. The movement of the pushbutton member 5 is transmitted via a tappet 9 having a permanent magnet 10 affixed thereon. The pushbutton member 5 is movable relative to a yoke structure 11 which comprises iron. Two galvanomagnetic resistors 12 and 13 are affixed to the yoke structure 11 and may comprise field plates.

In accordance with the invention, the longitudinal and magnetizing axis of the permanent magnet 10 is positioned transversely to the direction of movement of the tappet 9. The yoke structure 11 is a unitary frame-shaped structure and the galvanomagnetic resistors 12 and 13 are affixed to the inner longitudinal side 14 of said yoke structure. The permanent magnet 10 is provided with a pole shoe type attachment 15 in order to further concentrate the field lines on the galvanomagnetic resistors 12 and 13.

The yoke structure 11 has two guide recesses 16 and 17 formed therein for guiding the tappet 9 along the transverse sides 18 and 18' of said yoke structure. The magnet 10 is preferably inserted in self-holding relation into a recess 19 formed in the tappet 9. This may be accomplished by noses, protrusions, extensions, projections, or the like, which are depressed during the insertion of the permanent magnet. To permit the positioning of the tappet 9 into the yoke structure 11 in a simple manner, the guide recesses 16 and 17 are open toward the flat side 20 of said yoke structure.

The guide recesses 16 and 17 are covered by a plate 21 of synthetic material which is positioned on the flat side 20 of the yoke structure 11. The plate 21 supports amplifier components 22a, 22b, 23a and 23b which are interconnected on said plate via a printed circuit. The terminals of the amplifier components 22a, 22b, 23a and 23b are led to the outside of the housing via plugs 24 and 25. The plugs 24 and 25 are mounted in the cover lid 2, so that said cover lid forms a unit with the plate 21 and said plugs.

In the embodiment of FIGS. 1 and 2, the tappet 9 is provided with guide attachments 26 and 27 which bear upon the synthetic plate 21 when said plate and yoke structure are assembled. The guide attachments 26 and 27 simultaneously function to better hold the magnet in the tappet 9. The unit comprising the yoke structure 11, the tappet 9, the synthetic plate 21 and the cover lid 2, prior to its installation in its housing 1 in the embodiment of FIGS. 1 and 2, is further provided with a metal retainer structure or bracket 28.

The metal retainer structure or bracket 28 functions as one end abutment for the return spring 29. The other end of the return spring 29 abuts against the yoke structure 11. The bracket 28 engages a recess 30 formed in the pushbutton member 5 at the free end of said bracket, as soon as the pushbutton switch has been fully assembled.

The complete unit is inserted into the tubular housing 1 from an end thereof until the projections 4 are arrested in the corresponding recesses 3. The recesses 3 function to open the switch, since the projections 7 of the pushbutton member 5 are no longer accessible from the outside after the assembly of the switch. The pushbutton member 5 preferably engages with the housing 1 via its projections 7, prior to the insertion of the unit.

In the embodiment of FIGS. 3 and 4, contrary to the embodiment of FIGS. 1 and 2, the metal bracket 28 is eliminated. In the embodiment of FIGS. 3 and 4, the tappet 9 has an annular groove 31 formed therein. The groove 31 is utilized to catch spring-like attachments 32 and 32' of the pushbutton member 5. The return movement of the tappet 9 is effected in the embodiment of FIGS. 3 and 4 directly by the pushbutton member 5 which also carries the tappet across the spring-like attachments 32 and 32'.

In addition to eliminating the bracket 28, the embodiment of FIGS. 3 and 4 provides a new mounting method. The mounting is provided in a manner whereby the plate 21 is first inserted into the housing 1 from one end thereof until the projections 4 snap into the corresponding recesses 3. The return spring 29 is then inserted into the housing 1 from the other end thereof and the pushbutton member 5 is snapped on. This causes the projections 7 to engage with the housing 1 and causes the spring-like attachments 32 and 32' to engage with the annular groove 31.

FIG. 3 further shows that the transversely positioned permanent magnet 10 may preferably be designed without a separate pole shoe 15. Even without the pole shoe 15, adequate

bunching may be provided for the switch of the invention. The function of the switch is clear from the drawing. The full useful flux of the magnet 10 is passed into the yoke structure 11 via the pole shoe type attachment 15, across the galvanomagnetic resistor 12. Since the yoke structure 11 no longer has any air gap, the magnetic flux is distributed at both transverse sides of said yoke structure and enters the pole of the magnet 10 positioned opposite the galvanomagnetic resistor 12.

In comparison with the known switching device, the switching device of my invention has only two increases of magnetic resistance which are considered. If the pushbutton member 5, and thus the tappet 9 and the magnet 10, are moved opposite the yoke structure 11 and the galvanomagnetic resistor 12, the lines of force produced by said magnet penetrate directly into said yoke structure. The magnetic lines of force penetrate directly into the yoke structure 11 for such period of time until the pole shoe type attachment 15 lies in the range of the galvanomagnetic resistor 13. The galvanomagnetic resistors 12 and 13 thus function as a make or break contact.

In the embodiment of FIG. 5, the switch comprises a housing 1 of electrically insulating material. The yoke structure 11 is affixed in the housing 1 and the actuating tappet 9 is displaceably guided in said housing. The yoke structure 11 is a unitary structure of frame shape and the galvanomagnetic resistors 12 and 13 are affixed to the inside of the longitudinal side 14 of said yoke structure. A plate 21 of synthetic material is positioned in the housing and amplifier components 22a, 22b, 23a and 23b are mounted on said plate and are connected via a printed circuit on said plate in electrically conducting relation. The terminals of the electrical circuit are conducted to the outside of the housing and terminate in the plugs 24 and 25.

In accordance with the invention, in the embodiment of FIG. 5, the permanent magnet 10 is rotatably positioned in the yoke structure 11 via a front surface 31 on the side 30 of said magnet which faces away from the galvanomagnetic resistors 12 and 13. To accomplish this, the yoke surface 11 is provided with a convex roll-off surface 32. The roll-off surface 32 of the yoke structure 11 is limited by edges 33a and 33b to prevent displacement of the magnet 10. A part 34 of synthetic material is fitted onto the magnet 10 and functions to limit the rotation of said magnet by abutting the yoke structure 11.

In the embodiment of FIG. 5, the magnet 10 is actuated via an arcuate leaf spring 35 which is triggered by a rocker 36. The rocker 36 is coupled to the tappet 9. The tappet 9 is biased by a return spring 37. The leaf spring 35 functions additionally to press the magnet 10 against the roll-off surface of the yoke structure 11. In practical application, therefore, only the air gap between the field plates 12 and 13 and the front surface of the magnet 10 appears. Thus, the required power for the magnet may be further reduced relative to the replaceable arrangement of said magnet.

In order to produce an adequate magnetic field, a very small air gap must be maintained across the field plate in the embodiment of FIGS. 1, 2 and 3, 4. It is therefore necessary to lead the magnet exactly during its displacement, so that, first, the air gap should have the correct size and, second, the mechanically sensitive field plate should not be impaired by contact. The accurate guidance is unfavorable to production of the device and requires considerable actuating force. Beyond this, the relatively long path of movement across which the switching function is performed cannot be reduced without additional components. It is thus impossible to reduce the size of the device below a minimum structural size.

The device of the invention may be improved by the embodiment of FIG. 5 by mounting the permanent magnet 10 on the yoke structure 11 at the surface of said magnet opposite the galvanomagnetic resistor. Small friction, and therefore a small actuating force, is obtained when the yoke structure is provided with a convex roll-off surface for the planar front face of the permanent magnet 10.

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The actuating path may be kept short when the actuating or pushbutton member engages the permanent magnet 10 in the area of the mounting of said magnet. In order to safeguard the end positions of the switch even when the actuation of the actuating member is incomplete, it is preferable to provide a snap action spring between said actuating member and the permanent magnet 10. A simple arcuate leaf spring is preferable to accomplish this.

While the invention has been described by means of specific examples and in specific embodiments, I do not wish to be limited thereto, for obvious modifications will occur to those skilled in the art without departing from the spirit and scope of the invention.

I claim:

1. A contactless switching device comprising a magnetizable yoke structure; a galvanomagnetic resistor fixedly mounted on said yoke structure; and

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displaceable actuator means comprising a permanent magnet having a longitudinal axis and being rotatably mounted in the yoke structure at a part of said yoke structure opposite that at which said galvanomagnetic resistor is mounted, said actuator means having a direction of travel substantially transverse to the longitudinal axis of the magnet.

2. A contactless switching device as claimed in claim 1, wherein the permanent magnet has a planar surface and the yoke structure has a convex roll-off surface at the first-mentioned part thereof in partial contact with the planar surface of the permanent magnet.

3. A contactless switching device as claimed in claim 1, wherein the actuator means comprises a tappet and spring means interposed between the tappet and the permanent magnet.

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