

[54] **CONTACTLESS SWITCHING DEVICE**

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[58] Field of Search 338/32 H, 32 R;
323/94 H; 324/45, 46; 335/1, 2

[56] **References Cited**

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Primary Examiner—C. L. Albritton

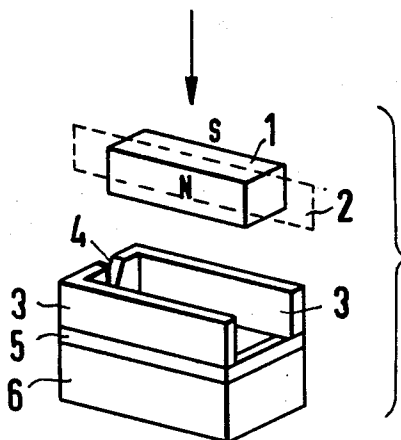
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[57]

ABSTRACT

In a contactless switching device, a permanent magnet can be moved relative to a magnetic field dependent resistance positioned between return yoke parts. The longitudinal axis of the magnetic field dependent resistance is in the direction of the neutral zone of the permanent magnet. The return yoke parts face the poles of the permanent magnet over a large area. In order to remove the lines of force from the magnetic field dependent resistance, a part causing a magnetic short-circuit is inserted after the return yokes in the direction of movement of the permanent magnet. It is thereby possible to relieve the magnetic flux practically completely in the OFF position of the device with a relatively small distance of travel of the permanent magnet.

8 Claims, 4 Drawing Figures



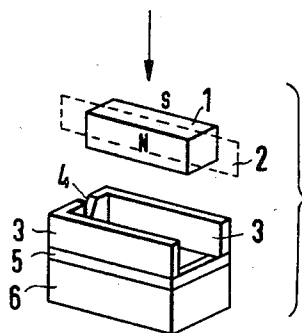


Fig. 1

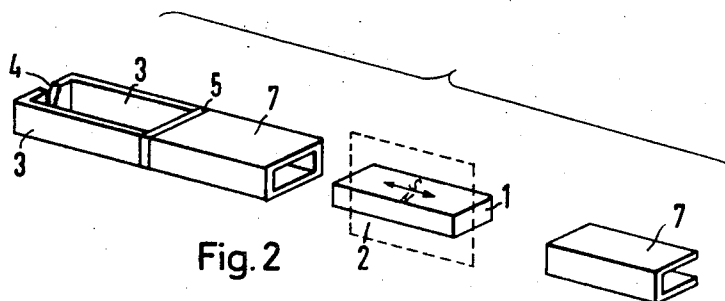


Fig. 2

Fig. 2a

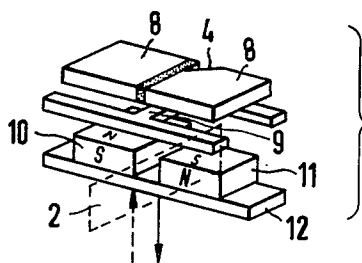


Fig. 3

CONTACTLESS SWITCHING DEVICE

The invention relates to a contactless switching device.

The contactless switching device of the invention comprises a permanent magnet which can be moved between at least two defined positions, of which one is the effective magnetic connection of the permanent magnet with a magnetic field dependent resistance between receiving return yoke parts and the other is the effective magnetic coupling of the permanent magnet with a short-circuiting part for the removal of the magnetic flux from the return yoke parts.

In a known switching device of the aforescribed type, two return yoke plates are provided in tandem. The return yoke plates accommodate the magnetic field dependent resistance between two end faces thereof. The permanent magnet, which is substantially a horseshoe magnet, first makes contact at its entire surface with a return yoke part, so that the permanent magnet is short-circuited. If the permanent magnet is moved in the direction to the other return yoke part on the surface of the return yoke parts, the magnetic field dependent resistance moves into the range of influence of the permanent magnet and obtains its strongest magnetic flux if one pole of the permanent magnet rests on one return yoke part and the other pole rests on the other return yoke part. Although in this known switching device, the entire magnetic flux is kept away from the magnetic field dependent resistance in the OFF condition, the stroke required for actuating it is relatively large and the active surfaces of the permanent magnet which come into contact with the return yoke plate are relatively small, as compared to the volume of the magnet.

The object of the invention is to provide a contactless switching device in which it is possible, with a small amount of travel, to draw a relatively large flux through the magnetic field dependent resistance and, in the OFF position of the switching device, to relieve the magnetic field dependent resistance practically completely of the magnetic flux.

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

In accordance with the invention, the desired results are accomplished by providing the permanent magnet so that it can be moved with its neutral zone in the longitudinal direction of the magnetic field dependent resistance. The return yoke and short-circuiting parts are positioned in the direction of movement of the permanent magnet, magnetically separated from each other and in tandem.

It is particularly advantageous if the permanent magnet is a slab magnet surrounded by a U-shaped return yoke which accommodates the magnetic field dependent resistance in the back of the return yoke in order to form the one defined position, and that the short-circuiting part is formed by a frame which in the second defined position of the permanent magnet surrounds four of the outer surfaces of said magnet. It is advantageous if the permanent magnet is magnetized with the poles at the lateral faces having large areas, so that the return yoke parts can be brought into effective coupling or connection with the slab magnet over a large surface. In order to prevent stray fields from the short-circuiting part to the return yoke parts, it is advanta-

geous if the frame and the return yoke part are magnetically separated from each other by a spacer.

If a U-shaped permanent magnet is used, the switching device is advantageously designed so that the return yoke parts, which accommodate between them the magnetic field dependent resistance, are formed by pole pieces. The return yoke part is affixed as a bridge between the U legs of the permanent magnet at a spacing from the pole pieces in a direction toward the back of the permanent magnet. Since the stroke for actuating the switching device is relatively small, it is advantageous in order to avoid stray fields to the pole pieces, if the bridge is formed by the cross piece of an H-shaped part which extends partly around the poles of the magnet.

In order to avoid the need for a special manufacture of U-shaped permanent magnets, the U-shaped permanent magnet of another embodiment of the contactless switching device of the invention comprises two slab magnets placed on a magnetic carrier. In this embodiment, it is of advantage if the end faces of the slab magnet in contact with the pole pieces have areas as large as possible.

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

FIG. 1 is a perspective schematic diagram of a switching device of the invention, having a magnet movable transverse to its longitudinal axis and a U-shaped return yoke part;

FIG. 2 is a perspective schematic diagram of another embodiment of the switching device of the invention, having a permanent magnet movable in its longitudinal direction;

FIG. 2a is a perspective schematic diagram of a U-shaped short-circuiting part of the switching device of FIG. 2; and

FIG. 3 is a perspective schematic diagram of another embodiment of the switching device of the invention having a permanent magnet of U-shape and pole pieces accommodating between them the magnetic field dependent resistance.

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

In FIG. 1, a permanent magnet 1 comprises a slab magnet and is movably arranged for movement in the direction of the arrow. This is not shown in detail in FIG. 1. The direction of magnetization of the permanent magnet 1 is transverse to its longitudinal axis and is indicated by the letters N and S. The permanent magnet 1 has a plane 2, shown in broken lines, which is to be considered the neutral zone.

A magnetic field dependent resistance or field plate 4 is positioned between angle-shaped return yoke parts 3, assembled to form a U, in the embodiment of FIG. 1. The magnetic field dependent resistance 4 is positioned with its longitudinal extension practically in the indicated plane 2. A frame-shaped short-circuiting yoke 6 is positioned after the angle-shaped return yoke pieces 3 and is separated from said yoke pieces by a non-magnetic spacer 5. A frame-shaped short-circuiting yoke 6 is magnetically more advantageous, but under some circumstances, a U-shaped short-circuiting yoke may be sufficient. The U-shaped short-circuiting yoke may be manufactured more easily.

If the permanent magnet 1 is moved to a position between the angle-shaped return yoke parts 3, the mag-

netic flux is closed from the North pole of said permanent magnet via one of said angle-shaped return yoke parts, the magnetic field dependent resistance 4, the other of said angle-shaped return yoke parts and the South pole of said magnet. The full main flux supplied by the permanent magnet 1 is therefore conducted via the magnetic field dependent resistance 4.

As soon as the permanent magnet 1 is moved further in the direction of the arrow, so that it is moved into the frame-shaped short-circuiting yoke 6, the magnetic field dependent resistance 4 is completely free of magnetic lines of force, since said permanent magnet is then completely shielded by said short-circuiting yoke. The spacer 5 can be kept relatively thin, so that the travel distance of the permanent magnet 1 can be kept small.

The embodiment of FIG. 2 of the switching device of the invention is similar to that of FIG. 1. In the embodiment of FIG. 2, however, the permanent magnet 1 is movable in the longitudinal direction and the frame-shaped short-circuiting yoke 7 is of tubular configuration and is in a position to short-circuit the entire magnetic flux of the permanent magnet 1 and to keep it from the return yoke parts 3. In the embodiment of FIG. 2, however, the permanent magnet 1 is required to travel a greater distance. However, the return yoke parts 3 are in contact with the permanent magnet 1 over a large area.

The short-circuiting part of FIG. 2a comprises a short-circuiting yoke of U-shaped configuration.

In the embodiment of FIG. 3 the return yoke comprises two pole pieces 8 having end faces. The pole pieces 8 are mounted in fixed relation to the housing of the switching device of the invention, which housing is not shown in the FIGS. The magnetic field dependent resistance 4 is positioned between two end faces of the pole pieces 8. The short-circuiting part comprises a bridge or cross piece 9 mounted in fixed relation to the housing of the switching device of the invention at a predetermined distance from the pole pieces 8.

The bridge 9 has the shape of an H, in the embodiment of FIG. 3, so that it can partially surround a pair of spaced permanent magnets 10 and 11, when said magnets are moved in the direction of the broken-line arrow toward said bridge. The permanent magnets 10 and 11 are mounted on a magnetically conducting magnet carrier or head member 12, thereby providing a type of U magnet. The direction of magnetization of the individual permanent magnets 10 and 11 is again indicated by N and S. The plane in which the magnetic field dependent resistance or field plate 4 is positioned is indicated by broken lines.

If the magnet carrier 12 and the permanent magnets 10 and 11 mounted thereon are moved in the direction toward the bridge 9, indicated by the broken-line arrow, practically the entire flux of the U-shaped magnet is first short-circuited by said bridge, so that the pole pieces 8 are free of magnetic lines of force. If the magnet carrier 12 is moved further in the direction toward the pole pieces 8, the bridge 9 becomes a reinforcement of said magnet carrier 12, so that the full flux becomes effective at the magnetic field dependent resistance 4 via said pole pieces.

The embodiment of FIG. 3 can also operate with very little travel distance and with the largest possible contact over a large area of the pole faces of the permanent magnets 10 and 11 with the pole pieces 8. In addition,

the usable flux can be utilized as the restoring force for the plunger of the device (not shown in the FIGS.). At practically no cost, a mechanical toggle action is thereby obtained for the embodiment of FIG. 3 of the contactless switching device of the invention.

While the invention has been described by means of specific examples and in specific embodiments, it should not 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 return yoke having return yoke parts;
 - a magnetic field dependent resistance having a longitudinal extension positioned between the return yoke parts;
 - a short-circuiting part for short-circuiting the magnetic flux of a magnet;
 - a permanent magnet having a neutral zone, the permanent magnet being movable with the neutral zone in the direction of the longitudinal extension of the magnetic field dependent resistance between at least two defined positions, in one of which the permanent magnet is effectively magnetically coupled to the return yoke parts thereby providing magnetic flux through the return yoke and the magnetic field dependent resistance and in another of which the permanent magnet is effectively coupled to the short-circuiting part thereby removing the magnetic flux from the return yoke and the magnetic field dependent resistance, the return yoke and the short-circuiting part being positioned in tandem and being magnetically separated from each other in the direction of movement of the permanent magnet.
2. A contactless switching device as claimed in claim 1, wherein the permanent magnet is a slab magnet, the return yoke is of U-shape having a back in which the magnetic field dependent resistance is accommodated, the return yoke surrounding the permanent magnet in the one position of said magnet, and the short-circuiting part comprises a frame surrounding four outer surfaces of the permanent magnet in the other position of said magnet.
3. A contactless switching device as claimed in claim 1, further comprising a spacer interposed between and magnetically separating the return yoke from the short-circuiting part.
4. A contactless switching device as claimed in claim 1, wherein the short-circuiting part comprises a short-circuiting yoke of U-shaped configuration.
5. A contactless switching device as claimed in claim 1, wherein the permanent magnet is of substantially U-shape having a head member and spaced legs extending therefrom, the return yoke comprises a pair of pole pieces having end faces and the magnetic field dependent resistance positioned between said end faces, and the short-circuiting part comprises a bridge between the legs of the permanent magnet at a space from said pole pieces in the direction of the head member of the permanent magnet.
6. A contactless switching device as claimed in claim 5, wherein the short-circuiting part comprises a bridge partly surrounding the legs of the permanent magnet.
7. A contactless switching device as claimed in claim 5, wherein the short-circuiting part comprises a bridge

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cross piece of H-shape partly extending around the legs of the permanent magnet.

8. A contactless switching device as claimed in claim 5, wherein the head member of the permanent magnet

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comprises a magnet carrier and the legs of said magnet comprise two slab magnets mounted on said magnet carrier.

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