United States Patent

Masuda et al.

[15] **3,676,828**

[45] **July 11, 1972**

[54] MAGNETIC SWITCHING APPARATUS

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[22] Filed: **Oct. 14, 1970**

[21] Appl. No.: **80,601**

[30] **Foreign Application Priority Data**

Oct. 16, 1969 Japan.....44/98424
Oct. 16, 1969 Japan.....44/98425
Oct. 25, 1969 Japan.....44/101030

[52] **U.S. Cl.**.....**338/32 H**, 323/94 H
[51] **Int. Cl.**.....**H01c 7/16**
[58] **Field of Search**.....338/52; 324/45, 46; 323/94 H; 317/235 H; 335/1; 307/309

[56] **References Cited**

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Primary Examiner—C. L. Albritton
Attorney—James E. Armstrong and Ronald S. Cornell

[57] **ABSTRACT**

A switching apparatus comprised of a base with a magnet and a block made of magnetic material coupled to the magnet while contacting a magnetic pole surface of the magnet, a spring plate which is magnetically coupled to the base and which is extended between both ends of the base, a short-circuiting portion made of magnetic material which is located at a position opposite to and near the magnetic pole of the magnet of the block made of magnetic material of the base while the short-circuiting portion remains away from the base whenever the spring plate is at the home position, and at least one galvano-magnetro effect device which is located at a position on the said magnetic block of the base so that the quantity of magnetic flux to which the galvano-magnetro effect device is exposed varies when the short-circuiting portion contacts the base.

10 Claims, 10 Drawing Figures

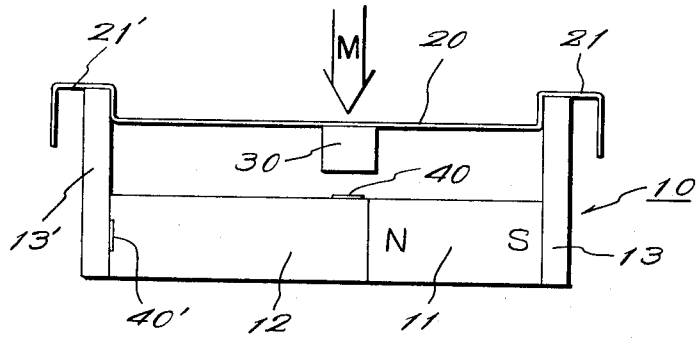


FIG. 1

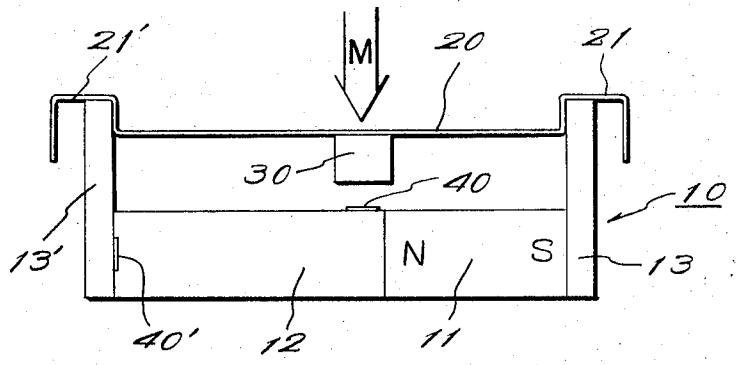


FIG. 2

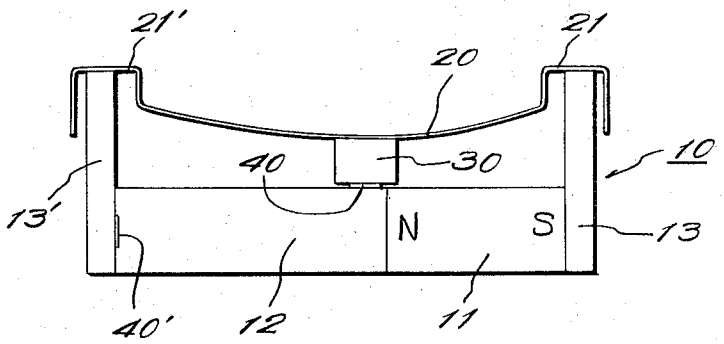


FIG. 3

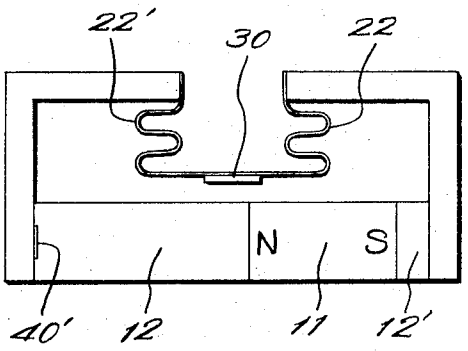


FIG. 4

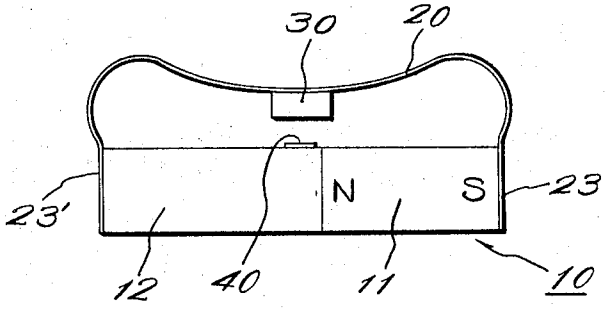


FIG. 5

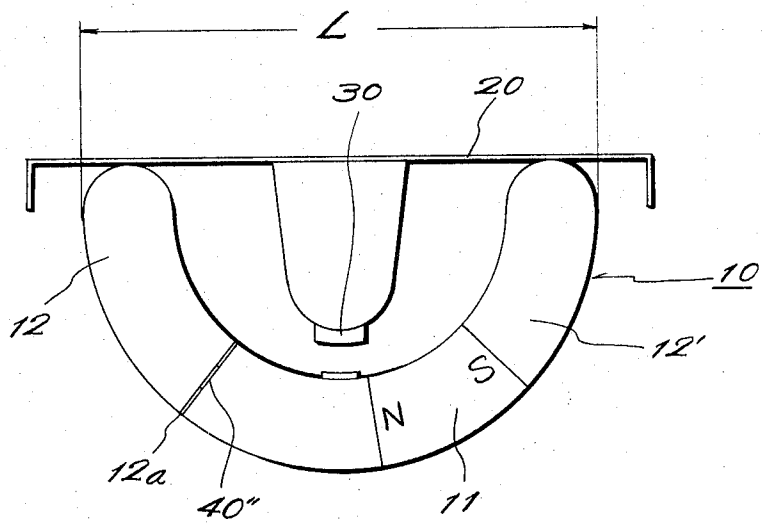


FIG. 6

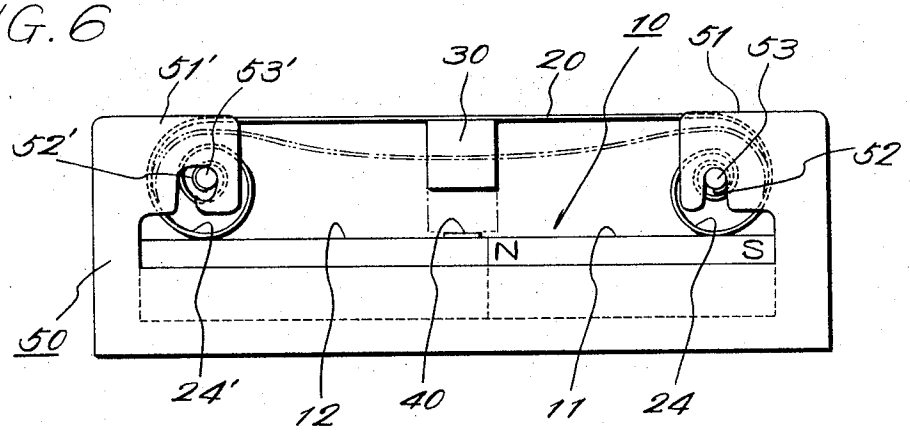


FIG. 7

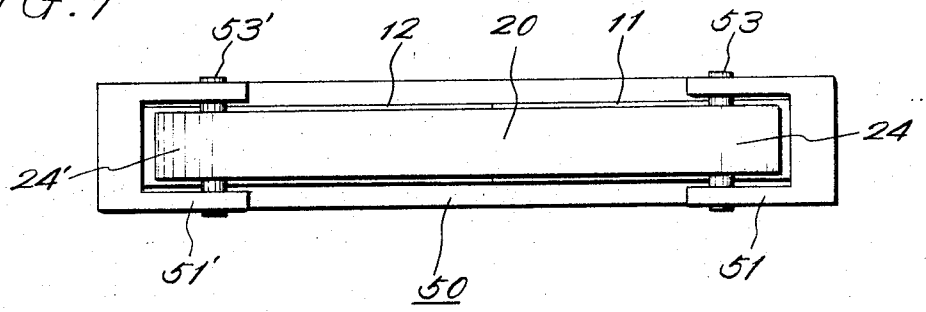


FIG. 8

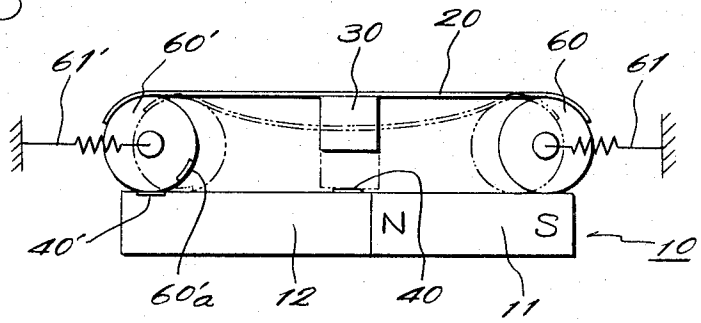


FIG. 9

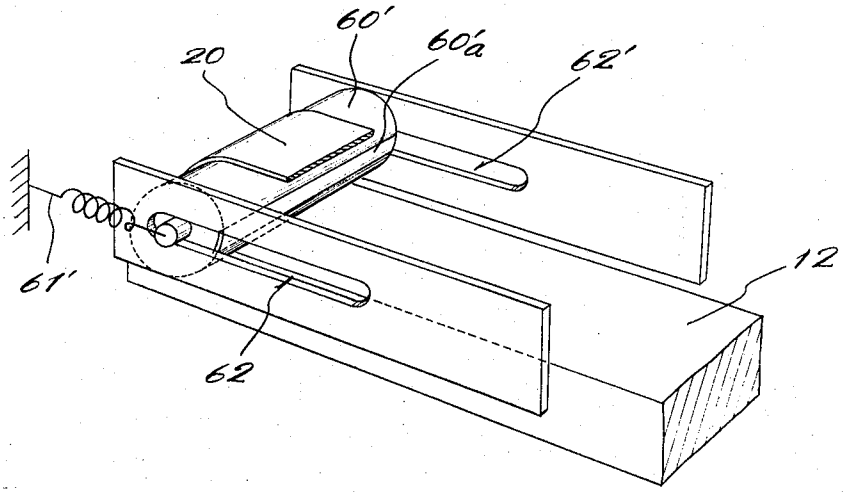
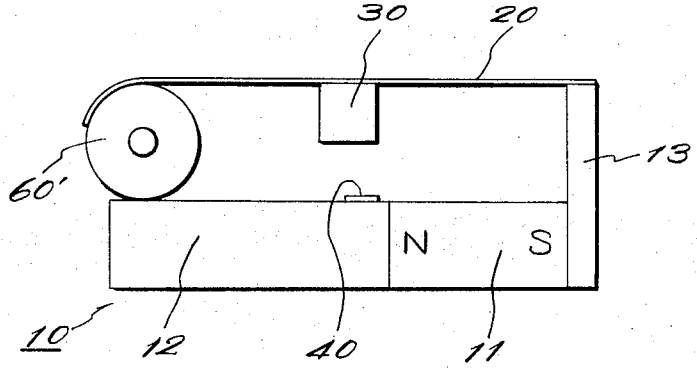


FIG. 10



MAGNETIC SWITCHING APPARATUS

BACKGROUND OF THE INVENTION

Conventional switching apparatus generally exhibit such disadvantages as poor contact due to wear of the contact point resulting from frequent sliding; therefore, it has been demanded in recent years that a contactless switching apparatus be produced using the galvano-magnetro effect device. Since this type of switching apparatus is designed so that the moving yoke is arranged to form one side of the magnetic path and a gap in the magnetic path and the width of this gap is changed in accordance with movement of a moving yoke to vary the quantity of the magnetic flux which is applied to the galvano-magnetro effect device, the contactless switching apparatus is defective because the magnetic force of the magnet which forms the magnetic path reduces due to repeated variation of reluctance and the gap width cannot be greatly varied because the switching apparatus is compact and, accordingly, it is difficult to greatly vary the magnetic flux to be applied onto the galvano-magnetro effect devices.

The present invention is intended to provide a switching apparatus with simple and inexpensive construction using galvano-magnetro effect devices, devised to eliminate the said disadvantages.

SUMMARY

The present invention provides a switching apparatus comprised of a base made of magnetic material which is composed of a magnet and magnetic block coupled contacting the magnetic pole surface of the magnet, a spring plate made of magnetic material which is magnetically coupled to the base and is extended between both ends of the base to form a closed magnetic path which connects magnetically both ends of the base and the center portion of the spring plate which is located opposite to the base, a depressing means which depresses the center portion of the spring plate to bend toward the base, a short-circuiting portion made of magnetic material which is provided at a position on the internal surface of the spring plate which is opposite to a portion of the magnetic block near the magnetic pole of the magnet and which forms a closed short-circuiting magnetic path which shorts both magnetic poles of the magnet when the spring plate is bent to contact or approach the base, at least one galvano-magnetro effect device such as, for example, a Hall effect device and a magnetro-resistance device, which is arranged at the base so that the quantity of magnetic flux is varied when the closed short-circuiting magnetic path is formed between the both magnetic poles of the magnet by the short-circuiting portion, and an external input power supply and external load connected to the galvano-magnetro effect device.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated in detail in the accompanying drawings whereof:

FIG. **1** is a front view of the switching apparatus of an embodiment of the present invention;

FIG. **2** is a front view of the actuated state of the switching apparatus shown in FIG. **1**;

FIGS. **3** to **6** are the front views of the switching apparatus of other embodiments of the present invention;

FIG. **7** is a plan view of the switching apparatus shown in FIG. **6**;

FIG. **8** is a front view of the switching apparatus of another embodiment of the present invention;

FIG. **9** is a isometric view illustrating part of the switching apparatus shown in FIG. **8**; and,

FIG. **10** is a plan view of the switching apparatus of another embodiment of the present invention.

DETAILED DESCRIPTION

Referring to FIGS. **1** and **2** of the drawings, there is shown an apparatus comprised of a base **10** composed of magnet **11**,

magnetic block **12** which is coupled to the magnet, contacting one pole, such as N magnetic pole of the magnet, yoke **13** which is fixed to the S magnetic pole of said magnet **11** and projects upward and yoke **13'** which is fixed to the free end of said magnetic block **12** and projects upward at a position opposite to yoke **13**.

Straight elastic spring plate **20** made of magnetic material is mounted on the free ends of said yokes **13** and **13'** so that both ends of the spring plate can be slid.

Both ends **21** and **21'** of said spring plate **20** are formed in the reversed U-shape and are mounted on the free ends of yokes **13** and **13'** so that both ends of the spring plate do not come off the yokes even when the spring plate is depressed and bent.

Short-circuiting portion **30** made of magnetic material is provided at the internal surface of spring plate **20** which is adjacent to the base **10** so that portion **30** can approach or contact a portion near the end of said magnetic block **12** which contacts the magnet when the spring plate is bent.

Galvano-magnetro effect devices **40** and **40'** are respectively provided at a portion which comes in contact with said short-circuit portion **30** and a surface which contacts yoke **13'**, of said magnetic block **12** and are connected to the same or different power supplies and load circuits which are not shown.

The switching apparatus according to the present invention is devised as mentioned above. Spring plate **20** by virtue of its spring memory, stretches between yokes **13** and **13'** as shown in FIG. **1**, when the spring plate is released and returned to the home position. When spring plate **20** is depressed towards the base by a depressing means M spring plate **20** is bent and short-circuiting portion **30** contacts galvano-magnetro effect device **40** on the base. Accordingly, in this embodiment of the present invention, a closed circuit in which magnetic block **12** and magnet **11** are connected in series is formed when no pressure is applied to the spring plate whereby the magnetic flux is concentrated onto galvano-magnetro effect device **40'** at the yoke side and the closed short-circuiting magnetic path, which shorts both ends of magnet **11**, is formed when spring plate **20** is bent. Thus the magnetic flux concentrates on galvano-magnetro effect device **40** on the base.

In this embodiment, therefore, it is possible to alternately concentrate the magnetic flux onto one of the two galvano-magnetro effect devices **40** and **40'** by depressing or releasing spring plate **20**, and to thereby actuate the galvano-magnetro effect devices.

In said embodiment, the short-circuiting portion can be arranged to contact galvano-magnetro effect device **40** or to approach it. When arranging the short-circuiting portion to contact the galvano-magnetro effect device, it is desirable to coat the external surface of galvano-magnetro effect device **40** with a protective cover.

The switching apparatus according to the present invention can also be constructed as illustrated in FIGS. **3** to **5**.

FIG. **3** illustrates a switching apparatus which is provided with magnetic blocks **12** and **12'** respectively connected to both ends of magnet **11** and corrugated flexible springs **22** and **22'** which causes the short-circuiting portion to contact and separate from the upper surface of the base. With this embodiment, the spring plate can operate lightly.

FIG. **4** illustrates a switching apparatus which is provided with a spring plate the both ends **23** and **23'** of which are bent to be oppositely arranged at their free ends and are fixed directly to both ends of base **10**.

The switching apparatus of the said embodiment is advantageous in the point that its construction can be simplified because it is not necessary to provide a yoke at the said base.

FIG. **5** illustrates the switching apparatus in which base **10** is U-shaped, spring plate **20** is extended between free ends of the said base and galvano-magnetro effect device **40''** is fitted into slit **12***a* provided at magnetic block **12**.

With this embodiment, the switching apparatus is advantageous in the point that length L of base **10** can be reduced.

As shown in the above embodiments, the galvano-magnetro effect devices of the switching apparatus according to the present invention can be plural in number as FIG. 1 or single as shown in FIGS. 3 to 5. When galvano-magnetro effect device 40' is inserted between yoke 13' and magnetic block 12 only, as shown in FIG. 3, the density of the magnetic flux to galvano-magnetro effect device 40' is forced to suddenly decrease by contacting short-circuiting portion to said base 10 and is thus inhibited to operate.

When galvano-magnetro effect device 40 is mounted on the base only, as shown in the FIG. 4, the magnetic flux is concentrated onto galvano-magnetro effect device 40 by contacting the short-circuiting portion to base 10 and said device 40 can be actuated; when galvano-magnetro effect device 40'' is inserted into the barrel portion of magnetic block 12, as shown in FIG. 5, galvano-magnetro effect device 40'' can be actuated as in the case of the switching apparatus illustrated in FIG. 3.

FIGS. 6 and 7 illustrate a switching apparatus in which both ends of said spring plate 20 are made up as coiled portions 24 and 24' so that the spring plate can be bent by virtue of coiled portions 24 and 24'.

In this embodiment, said base 10 is made straight, on both ends of which coiled portions 24 and 24' of spring plate 20 are mounted.

Said base 10 is housed in base frame 50, made of non-magnetic material, which is open upward. Support frames 51 and 51', which project above the upper surface of base 10, are provided at both ends of said base frame 50.

Said support frames 51 and 51' are provided with long holes 52 and 52' through which shafts 53 and 53' fixing coiled portions 24 and 24' of the spring plate at their centers are mounted so that the shaft can be lowered.

In the switching apparatus shown in this embodiment, coiled portions 24 and 24' expand between the shafts and the base when spring plate 20 is released and pressure-contact base 10 while pressing said shafts 53 and 53' onto the upper ends of long holes 52 and 52' as illustrated in FIG. 6 to keep magnetic connection. When spring plate 20 is depressed and bent as shown with broken lines, coiled portions 24 and 24' are constricted an amount equal to the bend of spring plate 20 at its center and are pressed onto base 10 by a force applied to spring plate 20 while lowering shafts 53 and 53' in long holes 52 and 52' thus maintaining magnetic connection.

As clearly known from the above description, this embodiment of the present invention provides a switching apparatus in which constriction and expansion of coiled portions 24 formed at both ends of spring plate 20 bends or stretches the spring plate. Accordingly, a coiled portion can be formed at only one end of said spring plate 20 or, to maintain magnetic connection of coiled portion 24 and base 10, shaft 53 to support the coiled portion can be made of magnetic material and can be attached to a support frame made of magnetic material such as, for example, the yoke which is fixed at base 10.

In this embodiment, spring plate 20 is reset by coiled portion 24 and, therefore, the ability is that restoration of the spring plate can be large. For this reason, further ability is that a spring plate bending means which is not shown can be simultaneously restored along with restoration of the spring plate and base 10 can be secured in base frame 50 with a pressing force taking shaft 53 and 53' of coiled portions 24 and 24' as the fulcrum if the switching apparatus is constructed as illustrated in FIG. 6.

FIGS. 8 through 10 illustrate a switching apparatus in which rollers 60 and 60' made of magnetic material are arranged opposite to both ends of base 10 which is formed straight, making it possible to bend spring plate 20.

Said rollers 60 and 60' are mounted at both ends of base 10 so that they can roll toward each other and are provided with resetting springs 61 and 61' which hold the rollers at a given position at all times.

Both ends of spring plate 20 are fixed to the outer surfaces of said rollers 60 and 60' so that the spring plate is magnetically coupled to base 10; accordingly, rollers 60 and 60' are rotated in a direction to approach each other as shown with broken lines when spring plate 20 is bent and are rotated by resetting means 61 and 61' apart from each other when spring plate 20 is released.

A spring is not always necessary for resetting the rollers and the spring plate (or the repercussion of the spring plate) can be used as the resetting means for the rollers by curling the ends of the spring plate along the surface of each roller.

As clearly known from the above description, this embodiment makes roller 60 possible to bend the spring plate as well as to maintain magnetic connection of spring plate 20 with base 10; accordingly, a roller can be attached to one end only of spring plate 20 as illustrated in FIG. 10. It is desirable to provide guides 62 and 62' to ensure movement of the rollers as shown in FIG. 9.

This embodiment is intended to rotate rollers 60 and 60' when spring plate 20 is bent. A reluctance increasing part 60'*a* is provided. Means 60'*a* can, for example, be a non-magnetic insulating layer of an elongated groove positioned along the axial direction of roller 60' mounted on the end of magnetic block 12. The groove 60'*a* contacts base 10 when spring plate 20 is bent as shown in dotted lines in FIG. 8. This ensures that the density of the magnetic flux applied to galvano-magnetro effect device 40 can be large when short-circuiting portion 30 forms the closed short-circuiting magnetic path.

With the same reason as above, the reluctance increasing part can be provided at the base side. In this case, it is satisfactory to provide an insulating layer on the base where roller 60' comes when spring plate 60' is bent toward the upper surface of the magnetic block of the base.

When constructed as mentioned above, the switching apparatus according to this embodiment makes it possible for the density of the magnetic flux applied to galvano-magnetro effect device 40' to be greatly reduced because roller 60' separates from galvano-magnetro effect device 40' when the spring plate is bent if a galvano-magnetro effect device is arranged between roller 60' at the magnetic block side and magnetic block 12.

The switching apparatus according to the present invention is devised as illustrated with said embodiments; therefore use of this switching apparatus results in the following advantages.

The switching apparatus can be mass-produced at low cost because of its simple construction and the galvano-magnetro effect device permits designing of the entire apparatus in a compact size.

The demagnetization of the magnet can be inhibited because a closed magnetic path including the magnetic block is formed when the spring plate is stretched and the closed short-circuiting magnetic path including the short-circuiting portion is formed when the spring plate is bent.

The density of the magnetic flux applied to the galvano-magnetro effect device being suddenly changed with contact and separation of the short-circuiting portion from the base ensures accurate motion of the galvano-magnetro effect device.

In the case of switching apparatus in which the short-circuiting portion contacts the base, the short-circuiting portion comes in contact with the base without friction and therefore wear is extremely small and, even though it wears, poor contact will not be caused because the short-circuiting portion can be pressed onto the base.

What is claimed is:

1. A switching apparatus comprised of

a. a base made of magnetic material which is composed of a magnet and a magnetic block coupled to and contacting a magnetic pole surface of the magnet, said base having ends;

b. a spring plate made of magnetic material which is extended between the ends of the base while being coupled magnetically to the base and arranged so that it is positioned opposite to the base;

c. means to bend the spring plate toward the base;

d. a short-circuiting portion which is arranged between the spring plate and the base so that it can approach the base to form a closed short-circuiting magnetic path including the magnet when the spring plate is bent toward the base; and

e. at least one galvano-magnetro effect device which is provided on the base so that the density of the magnetic flux applied to the device varies when a closed short-circuiting magnetic path is formed with the short-circuiting portion by bending of the spring plate.

2. A switching apparatus, according to claim 1, wherein at least one galvano-magnetro effect device is provided at the magnetic block of the base so that the short-circuiting portion can contact or approach the base when the spring plate is bent.

3. A switching apparatus, according to claim 1, wherein yokes are provided at both ends of the base so that these yokes project parallel to each other above the base and the ends of the spring plate are slidably attached to the yokes.

4. A switching apparatus, according to claim 1, wherein the ends of the spring plate are curved to form free ends opposite to each other and these free ends are fixed to the ends of the base.

5. A switching apparatus, according to claim 1, wherein at least one end of the spring plate is coiled and the portions thus coiled are magnetically connected to the base.

6. A switching apparatus, according to claim 5, wherein the center of each coiled portion is fixed to a movable shaft so that the shaft approaches the base when the spring plate is bent, and the coiled portions are forced to contact the base with the shafts as their fulcrum when the spring plate is released.

7. A switching apparatus, according to claim 1, wherein at least one roller made of magnetic material is mounted on at least one end of the base which is formed to be straight so that the roller can roll toward the center of the base and can be kept by resetting means at the end of the base in a normal condition whenever no pressure is applied to the spring plate, and at least one end of the spring plate is fixed to the outer surface of the roller so that the spring plate can be magnetically connected to the base through the roller and the intermediate portion of the spring plate can be bent with rotation of the roller.

8. A switching apparatus, according to claim 7, wherein at least one galvano-magnetro effect device is provided at the free end side of the magnetic block so that the galvano-magnetro effect device contacts the roller when the spring plate is released.

9. A switching apparatus, according to claim 7, wherein a reluctance increasing part is provided in the axial direction of the roller on the outer surface of the roller mounted at the free end side of the magnetic block so that the reluctance increasing part contacts the base when the roller rotates with bending of the spring plate.

10. A switching apparatus, according to claim 7, wherein a reluctance increasing part is provided at the end of the magnetic block the roller contacting said reluctance increasing part when the roller is rotated with bending of the spring plate.

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