

- [54] CONTACTLESS SWITCHING APPARATUS

3,162,804 12/1964 Parsons..... 324/45 X

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- [30]
- Foreign Application Priority Data**

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- [52] U.S. Cl..... 338/32 H, 323/94 H, 338/32 R

- [51] **Int. Cl.**..... **H01c 7/16**

- [58] **Field of Search**..... 338/32 R, 32 H;
323/94 H; 324/45, 46

- [56]
- References Cited**

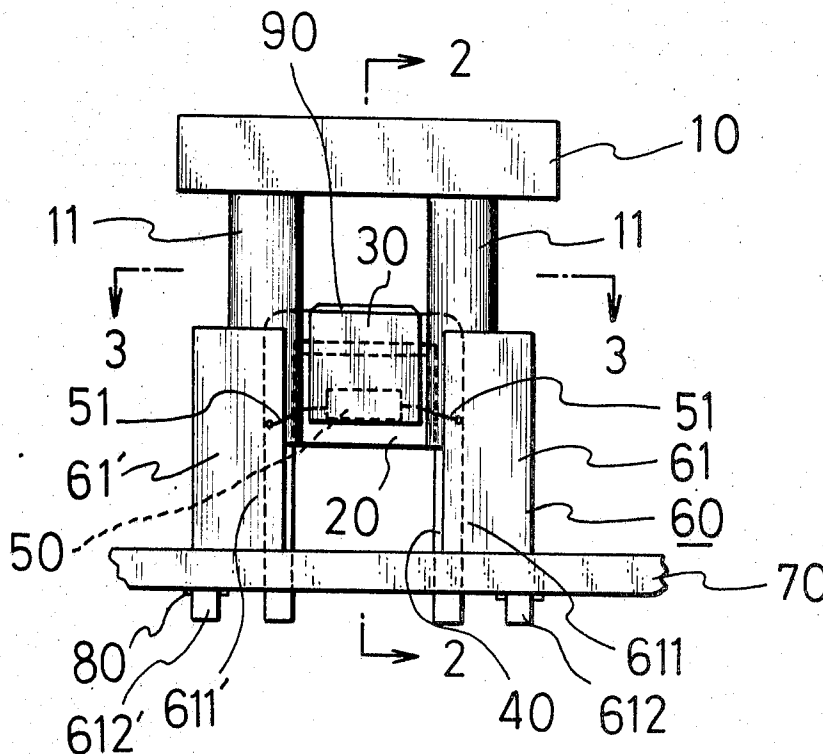
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- [57] ABSTRACT

A contactless switching apparatus comprised of a magnetic strip both ends of which are bent to form opposed terminal portions, a magnetic piece which is fitted in said strip and is attracted at its both ends by said bent terminal portions, a supporting member which fixes either the strip or the magnetic piece to a base and hold it at a position a certain distance away from the base, an actuating means which actuates the rest, which is not fixed at the base, of the strip and magnetic piece and galvano-magneto effect devices which are provided at the ends of the fixed magnetic member, wherein the magnetic field intensity applied to the device is varied with movement of the movable magnetic member actuated by said actuating means.

17 Claims, 15 Drawing Figures



SHEET 1 OF 4

FIG. 1

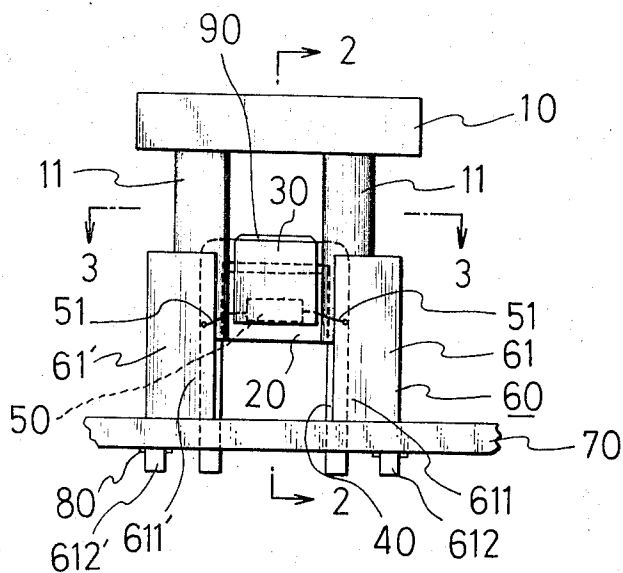


FIG. 2

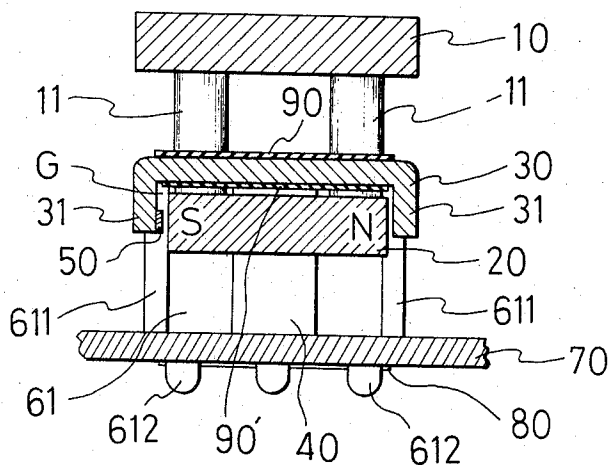


FIG. 3

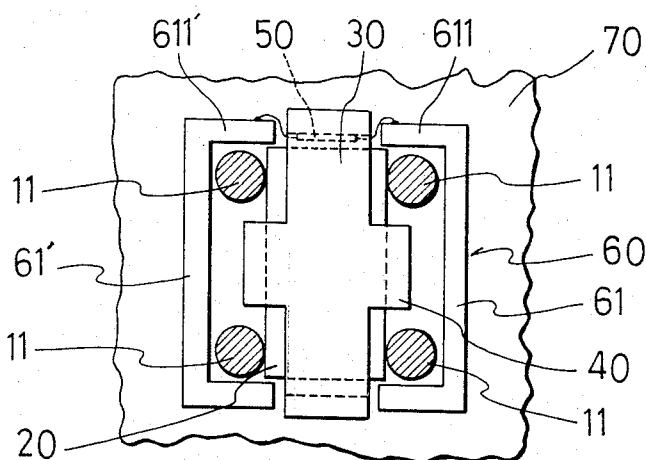


FIG. 4

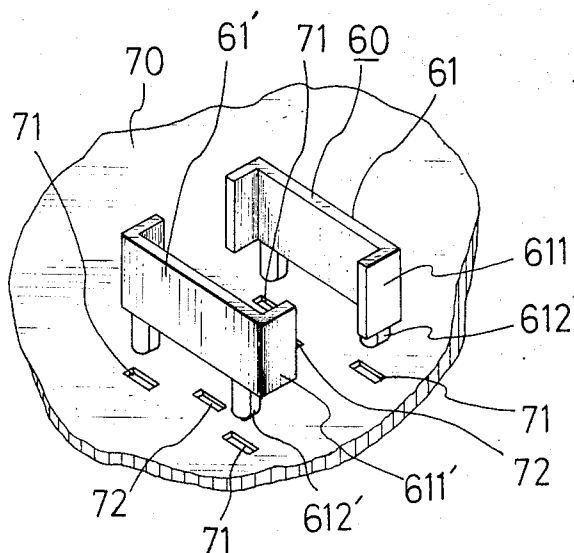
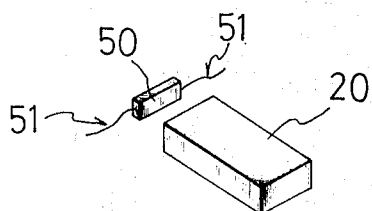
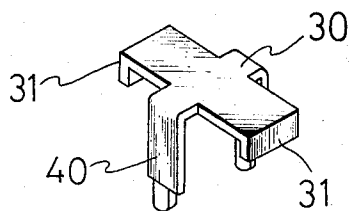
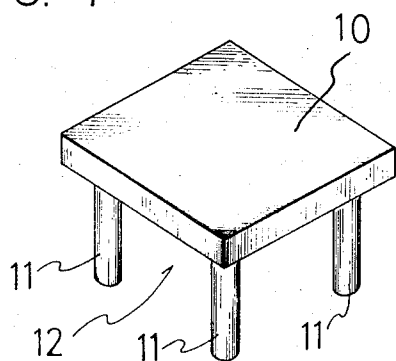


FIG. 5

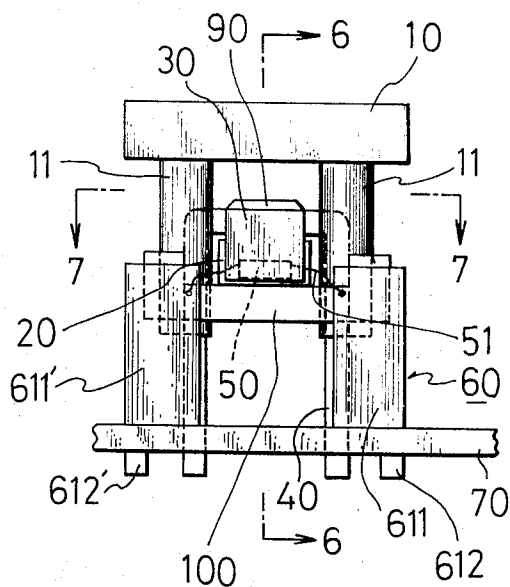


FIG. 6

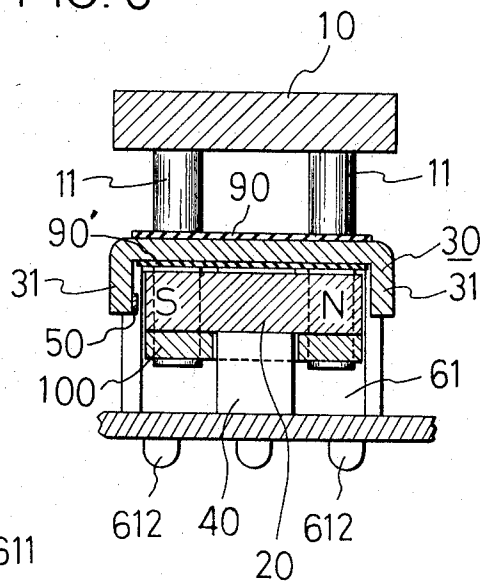


FIG. 7

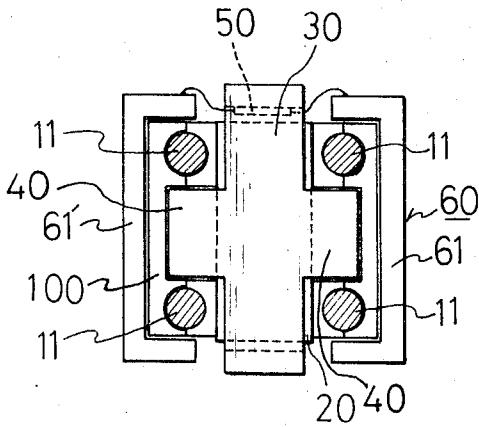


FIG. 10

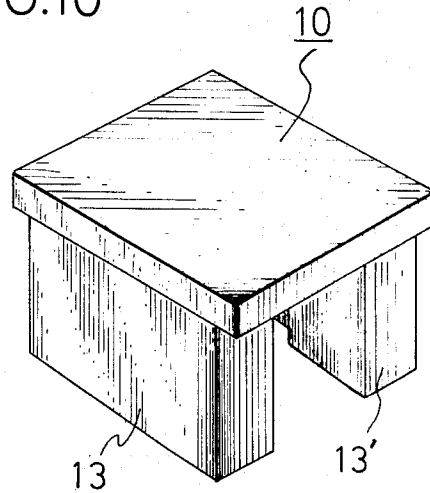


FIG. 8

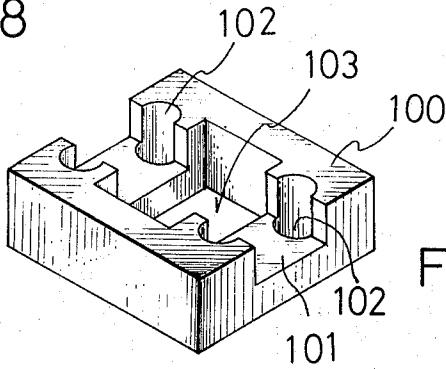


FIG. 11

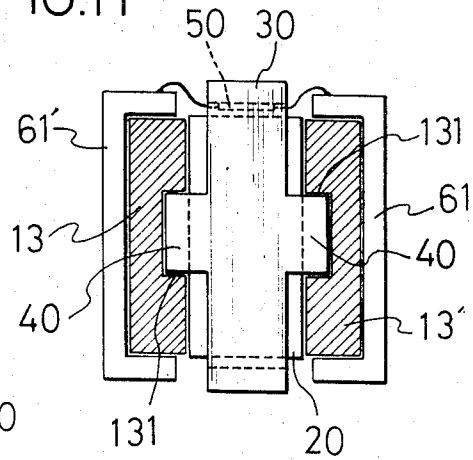


FIG. 9

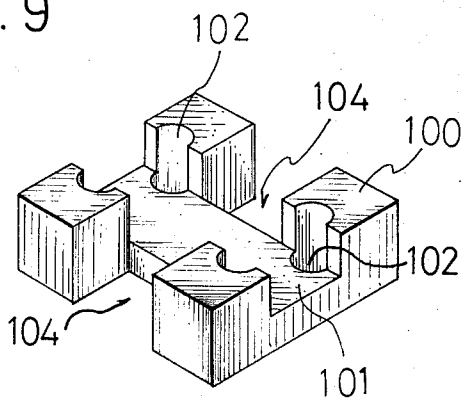


FIG.12

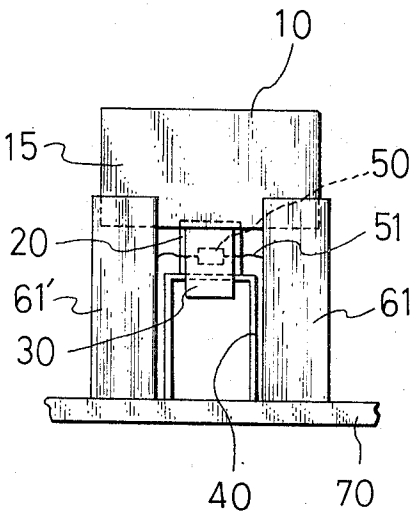


FIG.14

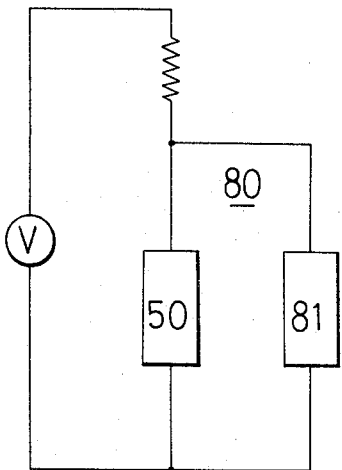


FIG.13

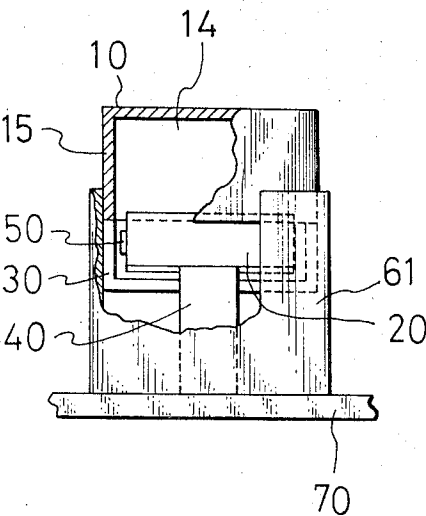
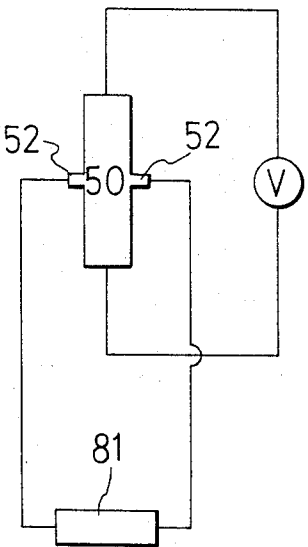


FIG.15



CONTACTLESS SWITCHING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a contactless switching apparatus employing a galvano-magneto effect device.

Conventional switching apparatuses of this type have been provided with a magnetic path formed by combining the magnetic fixed yoke and the magnetic movable yoke and the reluctance of the magnetic path has been varied by shifting the movable yoke actuated with an actuating means such as a push button. The intensity of the magnetic field acting on the galvano-magneto effect device has been changed with variation of this reluctance to generate the output signal. Accordingly, conventional switching apparatuses are disadvantageous in the following points.

Since a plural number of yokes are required, the parts required increase in number, the production cost is high and assembly work is troublesome and complicated. Since the magnetic path becomes large in size, the entire apparatus cannot be compacted.

Generally, the actuating means of a conventional apparatus is required to have a resetting spring. Therefore, the production cost is high and the assembly work troublesome.

The present invention provides a switching apparatus which eliminates the above disadvantages.

SUMMARY

A contactless switching apparatus comprising a high magnetic permeability strip both ends of which are bent to form a pair of terminal portions, a magnetic piece such as, for example, a permanent magnet having magnetic poles at its both ends which is fitted between the terminal portions of said strip so that both ends of the magnetic piece are opposed respectively to said terminal portions of the strip with a gap at each side, a supporting member provided at one of said strip and magnetic piece, an actuating means provided at either the strip or the magnetic piece at which the supporting member is not provided, and a galvano-magneto effect device such as, for example, a Hall effect device or a magneto-resistance effect device which is fixed at at least one end of the strip or the magnetic piece at the side where said supporting member is provided so that the device is located in said gap, wherein the supporting member is made and arranged so that the magnetic member supported by said supporting member is fixed at the base and the magnetic member is held with a specified space between the magnetic member and the base, and said actuating means is designed so that it may be isolated from the magnetic member at the fixing side by shifting said magnetic member held as above if desired, thereby the movable magnetic member provided with the actuating means is secured while being attracted at both ends by the fixing side magnetic member always held with the supporting member, is released from the fixing side magnetic member against the attracting force active on the fixing side magnetic member when actuated by the actuating means while being kept parallel with the fixing side magnetic member, and is reset to the home position by attraction to the fixing side magnetic member when released from the actuating means and said galvano-magneto effect device is connected to the load which detects a galvano-magneto effect to detect the variation of the out-

put when the intensity of the magnetic field applied to the device is varied by action of the moving side magnetic member and the output of the device is therefore varied.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated in detail by the accompanying drawings wherein:

FIG. 1 is a front view of the apparatus according to the present invention,

FIG. 2 is a sectional view as seen along line 2—2 in FIG. 1,

FIG. 3 is a sectional view as seen along line 3—3 in FIG. 1,

FIG. 4 is isometric views of disassembled parts of the apparatus shown in FIG. 1,

FIG. 5 is a front view showing another embodiment of the apparatus,

FIG. 6 is a sectional view as seen along line 6—6 in FIG. 5,

FIG. 7 is a sectional view as seen along line 7—7 in FIG. 5,

FIG. 8 is an isometric view of a receiving member employed in the apparatus shown in FIG. 5,

FIG. 9 is an isometric view illustrating another embodiment of said receiving member,

FIG. 10 is an isometric view illustrating an embodiment of a push button employed in the apparatus,

FIG. 11 is a horizontal sectional view of a switching apparatus employing a push button shown in FIG. 10,

FIG. 12 is a front view illustrating another embodiment of the apparatus,

FIG. 13 is a cutaway side view of the apparatus shown in FIG. 12,

FIG. 14 is a circuit diagram of the apparatus employing the galvano-magneto effect device, and

FIG. 15 is a circuit diagram of the apparatus employing the Hall effect device.

DETAILED DESCRIPTION

Referring to FIGS. 1 to 4, there is shown a switching apparatus comprised of actuating means 10 employing a push button made of a non-magnetic material, a magnetic piece 20 such as, for example, permanent magnet which is vertically moved by said actuating means, magnetic strip 30 into which said permanent magnet is fitted, supporting member 40 which supports said strip 30, galvano-magneto effect device 50 provided at said strip, guide frame 60 for movement of said magnetic piece, and base 70 such as, for example, a printed board on which said supporting member 40 and guide frame 60 are mounted.

Guide frame 60 is formed with a pair of U-shaped guide plates 61 and 61' made of a conductive material and a pair of said guide plates are mounted on base 70 so that a square space is formed between the guide plates by oppositely arranging bent free end 611 and 611'.

Base 70 is provided with through holes 71 at positions where said guide plates are mounted and the guide plates are provided with claws 612 and 612' at positions corresponding to through holes 71, thereby the guide plates are fixed at the base by inserting the claws into through holes 71 and securing them.

Strip 30 is fixed at the space in guide frame 60 while being supported by supporting members 40. Strip 30 is made of a high permeability magnetic material and its

both ends in the lengthwise direction are bent to form terminal portions 31 which are opposed each other. Strip 30 is inserted into the guide frame in the position that said terminal portions face base 70.

Supporting members 40 are provided at both sides in the center portion of strip 30 with the end portions of said supporting members being inserted into through holes 72 provided at base 70.

Accordingly, strip 30 is held to oppose base 70 through a space with a specified height.

Permanent magnet 20 is fitted into the underside of strip 30 so that the permanent magnet can be slid vertically in a space between supporting members 40.

Permanent magnet 20 is magnetized so as to have magnetic poles N and S at its both ends and these pole ends are assembled with strip 30 so that the pole ends are opposed respectively to terminal portions 31 of strip 30 with gap G at each side. Accordingly, permanent magnet 20 is secured while its pole ends are usually attracted to the terminal portions of strip 30.

Permanent magnet 20 is operated by push button 10. Push button 10 is provided with mounting portions such as, for example, four pins 11 which are extended to both sides of strip 30. Accordingly, strip 30 is housed in space 12 formed inside said pins 11.

Pins 11 are arranged so that they can slide along the internal surfaces of guide plates 61 and 61' of guide frame 60 and therefore movement of push button 10 is directionally controlled by guide plates 61 and 61'.

Permanent magnet 20 is fixed at the lower ends of pins 11 of push button 10 with a bonding agent. Therefore, push button 10 is kept at the upper limit position due to that permanent magnet 20 attracts strip 30.

Galvano-magneto effect device 50 such as, for example, a magnetro-resistance effect device is fixed at the inside surface of at least one terminal portion 31 of strip 30 so that the device is opposed to one magnetic pole of permanent magnet 20.

Leads 51 are respectively connected to two electrodes of device 50 and are further connected to guide plates 61 and 61' respectively.

Since guide plates 61 and 61' are made of a conductive material, the device can be connected to detection circuit such as, for example, printed circuit 80 using the guide plates as the terminals by soldering claws 612 and 612' to the printed circuit of base 70.

Circuit 80 can be formed as desired. For example, device 50 and load 81 should be connected in parallel with supply V as shown in FIG. 14 if the magnetro-resistance effect device is employed as the device, and load 81 should be connected to output terminal 52 of the device as shown in FIG. 15 if the Hall effect device is employed as the device.

In FIG. 14, if load 81 is a transistor, device 50 can be connected to the base of the transistor to control the function of the transistor with variation of the resistance of the device.

The switching apparatus as the embodiment of the present invention is as described above. When push button 10 is depressed, magnet 20 is lowered away from strip 30. When magnet 20 is lowered, the closed magnetic path formed by magnet 20 and strip 30 is opened. Therefore, the magnetic flux density applied to device 50 is reduced to decrease the internal resistance of the device.

When push button 10 is released, magnet 20 is reset with attraction onto strip 30 and the magnetic flux den-

sity applied to the device increases to cause the internal resistance of the device to increase. Accordingly, the output of the device varies with operation of push button 10, thus making it possible to perform the switching operation.

The apparatus can be constructed as described below. It is desirable to attach cushion member 90 such as, for example, a rubber plate to the surfaces of strip 30 and magnetic piece 20. For example, as shown in FIG. 2, if rubber plates 90 and 90' are provided at the upper and lower surfaces of strip 30, magnet 20 and push button 10 are buffered in their movement, and the relative position of the moving side magnetic member, that is, magnetic piece 20 shown in the embodiment to the terminal portion of said strip can be adjusted in accordance with the thickness of rubber plate 90'. At least one of magnetic piece 20 and strip 30 are preferred to have a magnet; for example, a magnet can be employed in strip 30.

The magnetic piece which is actuated by actuating means 10 need not be fixed directly to the actuating means. For example, as shown in FIGS. 5 to 7, non-magnetic receiving member 100 can be attached to the push button mounting portion such as, for example, pins 11 and magnet 20 can be retained by this receiving member 100. The embodiment of said receiving member 100 is shown in FIGS. 8 and 9. The receiving member shown in FIG. 8 is a non-magnetic block provided with groove 101 into the center of which the magnet is fitted, through holes 102 into which pins 11 are inserted at both sides of groove 101 and cut-off window 103 into which supporting member 40 can be slid at the center bottom of the groove. This receiving member is employed in the apparatus shown in FIG. 5.

The receiving member shown in FIG. 9 is such that both sides of the center of groove 101 are chipped and supporting member 40 slides along the chipped portions, thus forming slide recess 104. This receiving member is used as that shown in FIG. 8.

The mounting portion of said push button 10 can be formed with a pair of opposed walls 13 and 13' as shown in FIG. 10. In this case, the fixing side magnetic member is provided in the space between a pair of walls as shown in FIG. 11 and recesses 131 along which supporting member 40 slides are provided at the internal surfaces of walls 13 and 13'.

Either magnetic piece 20 or strip 30 can be fixed.

As shown in FIGS. 12 and 13, strip 30 is attached to push button as the moving side and magnetic piece 20 can be fixed at base 70 with supporting member 40. In this case, terminal portions 31 of strip 30 are projected upwardly because strip 30 moves vertically and magnetic piece 20 is housed in cavity 14 formed in the push button when the push button is lowered.

In this embodiment, the mounting portion is formed with peripheral wall 15 inside which cavity 14 is formed and the peripheral wall is arranged to lightly contact the guide plates to improve directional control of movement.

In this type of the apparatus, since the push button is provided with the strip, the total weight of the push button and strip is reduced and the magnetic piece can be large and a large magnet can be employed as the fixing side magnetic member.

In the above embodiments, each area of the terminal portions of the strip and the end portions of the magnetic piece which form the gap in which the device is

located is preferred to be larger than that of the device and the magnetic piece preferably projects from the terminal portions as shown in FIG. 2 to improve the resetting ability.

If the fixing side magnetic member is employed as the strip as shown in FIG. 1, supporting member 40 can be made integral with the strip but can be independent of the strip, depending on the case. If the magnet is employed as the fixing side magnetic member, the non-magnetic supporting member is generally employed.

Since the apparatus according to the present invention is as described above, it provides the following advantages when employed.

The resetting means such as, for example, a spring is not required because the moving side magnetic member is secured by being attracted to the fixing side magnetic member.

Because the magnetic path is formed by fitting the magnetic piece into the strip, the magnetic path can be compact in size and since the magnetic path can be formed with the magnetic piece and strip only, the parts employed can be reduced in number and assembly work is easy.

Because the magnetic path is opened and closed with mutual approach and departure of the strip and the magnetic piece which are kept in parallel, the stroke of the moving side magnetic member can be small and the terminal portions of the strip and the end portions of the magnetic piece approach each other or depart from each other at the same time; therefore, the reluctance of the magnetic path greatly varies and correspondingly the magnetic flux density applied to the device.

The apparatus according to the present invention is useful as the contactless switching apparatus for which the demand will increase more and more in the future for the advantages described above.

What is claimed is:

1. A contactless switching apparatus comprising:
 - a. A magnetic strip having a pair of ends bent to form opposed terminal portions,
 - b. a magnetic piece having a pair of ends, inserted between the terminal portions of said magnetic strip, each of said ends respectively opposing a different one of said terminal portions and being separated therefrom by a gap, said magnetic piece and said magnetic strip being reciprocally displaceable along a predetermined path, one of said magnetic piece and said magnetic strip being a fixed magnetic member and the other being a movable magnetic member,
 - c. a base,
 - d. a supporting member attached between said base and said fixed magnetic member to provide a space therebetween,
 - e. at least one galvano-magneto effect device within one of said gaps formed between said magnetic strip and said magnetic piece, wherein said galvano-magneto effect device is positioned in the flux path between the magnetic strip and the magnetic piece,
 - f. a depressible push button actuating means adapted to displace along said pre-determined path said movable magnetic member whereby the magnetic flux density through said galvano-magneto effect device is changed.
2. An apparatus according to claim 1, wherein said depressible push button actuating means is provided

with a mounting portion for holding the movable magnetic member.

3. An apparatus according to claim 2, wherein the mounting portion is comprised of a plurality of pins between which the movable magnetic member is fixed.

4. An apparatus according to claim 2, wherein the mounting portion is comprised of a pair of oppositely-arranged walls, the fixed magnetic member being disposed in the space formed therebetween, the walls having on the internal surfaces thereof recesses for slidably engaging the supporting member.

5. An apparatus according to claim 2, wherein the mounting portion is a peripherally enclosing wall forming an open-ended cavity in the push button actuating means, the ends of the magnetic strip are fixed at the lower end of the peripherally enclosing wall and the magnetic piece is positioned in the open-ended cavity of the push button actuating means.

6. An apparatus according to claim 3, wherein the mounting portion is provided with a receiving member supporting the movable magnetic member.

7. An apparatus according to claim 6, wherein the receiving member is a block at the center of which is a groove receiving the magnetic piece.

8. An apparatus according to claim 7, wherein through holes for securing the pins of the push button actuating means are provided at both sides of the groove and a cut-off window is provided at the center of the bottom of the groove to slidably receive therein the supporting member.

9. An apparatus according to claim 7, wherein through holes into which the pins of the push button actuating means are fixed are provided at both sides of the groove and recesses along which the supporting member slides are provided at both sides of the center of the groove.

10. An apparatus according to claim 1, wherein the magnetic strip is fixed by the supporting member so that the terminal portions are positioned to face the base and the magnetic piece is movably positioned in the space between the magnetic strip and the base.

11. An apparatus according to claim 1, wherein a cushion member is provided at at least one of the magnetic strip and piece so that the cushion member is positioned between the magnetic strip and piece when the magnetic strip is attracted to the magnetic piece.

12. An apparatus according to claim 1, wherein a guide frame is provided at the base so that the direction of movement of the movable magnetic member is controlled.

13. An apparatus according to claim 12, wherein the guide frame is comprised of a pair of opposed guide plates, the mounting portion of the push button actuating means is inserted into a space formed between said guide plates and moves vertically therebetween with the mounting portion keeping light contact with the internal surfaces of the opposed guide plates.

14. An apparatus according to claim 12, wherein the guide frame is comprised of a pair of opposed guide plates and a receiving member is inserted into a space formed between said guide plates and moves vertically while keeping light contact with the internal surfaces of the guide plates.

15. An apparatus according to claim 12, wherein the guide frame is comprised of a pair of conductive guide plates, lead wires of a galvano-magneto effect device are connected respectively to said guide plates and the

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guide plates are connected respectively to an electrical circuit provided at the base.

16. An apparatus according to claim 15, wherein the base includes a printed circuit.

17. An apparatus according to claim 1, wherein the

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magnetic piece is the movable magnetic member and composed of a magnet and the magnetic strip is the fixed magnetic member.

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