United States Patent

Mogi

[15] **3,662,315**

[45] **May 9, 1972**

[54] CONTACTLESS PUSH-BUTTON TYPE SWITCHING APPARATUS

[72] Inventor: **Toshio Mogi,** Ayasemachi, Japan

[73] Assignee: **Denki Onkyo Co., Ltd.,** Tokyo, Japan

[22] Filed: **Oct. 12, 1970**

[21] Appl. No.: **80,091**

[30] **Foreign Application Priority Data**

Oct. 13, 1969 Japan.....44/97451
Oct. 13, 1969 Japan.....44/97452
Oct. 13, 1969 Japan.....44/97453

[52] **U.S. Cl.**.....**338/32 H,** 323/94 H
[51] **Int. Cl.**.....**H01c 7/16**
[58] **Field of Search** .....338/32; 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 contactless push-button type switching apparatus comprised of a base, a push-button cap which is always held at the limit upward position by a resetting means, a guide tube for the cap, a magnetic path composed of a U-shaped magnetic frame, and a movable yoke which moves about one of its ends as a fulcrum at one leg of the U-shaped magnetic frame and the moving end of the yoke closely approaches the other of the legs whenever no pressure is applied to the push-button cap, a galvano-magnetro effect device fixed to the free end of the magnetic frame near the moving yoke and which varies the magnetic flux applied with rotation of the movable yoke, and a projection from the cap to cause the moving yoke to rotate when the cap is depressed.

10 Claims, 16 Drawing Figures

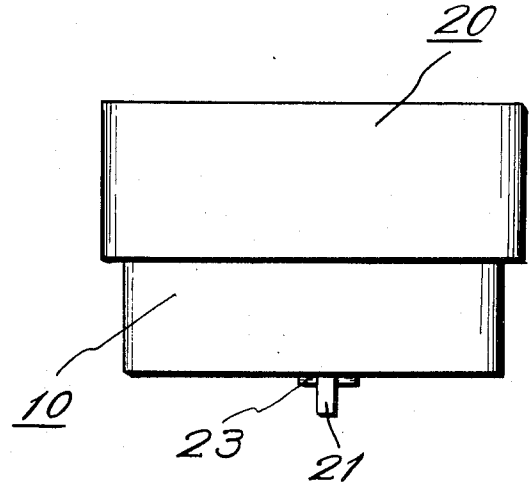


FIG. 1

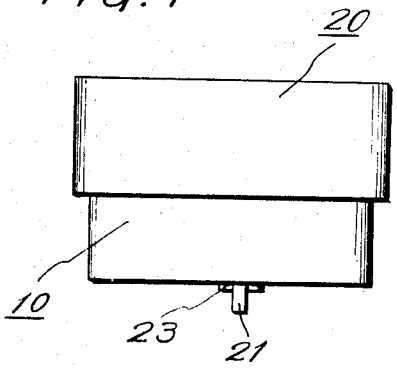


FIG. 2

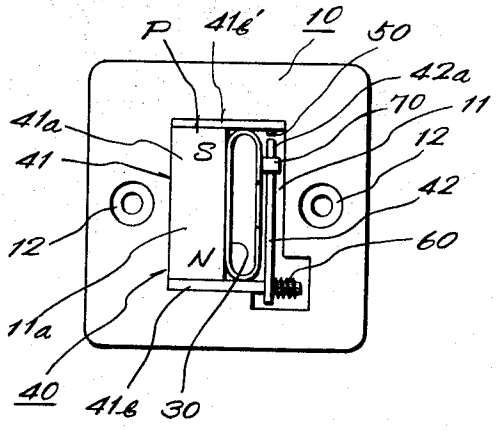


FIG. 3

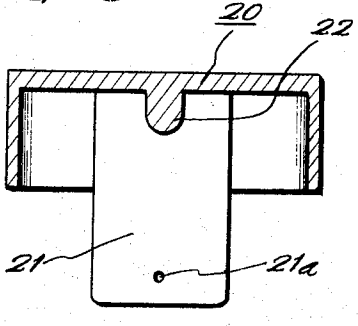


FIG. 4

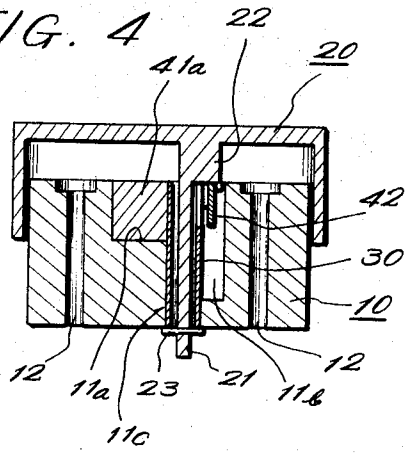


FIG. 5

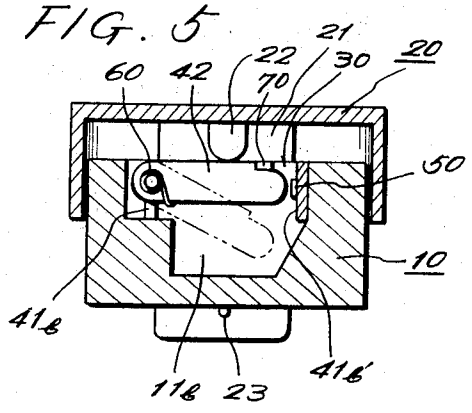


FIG. 6

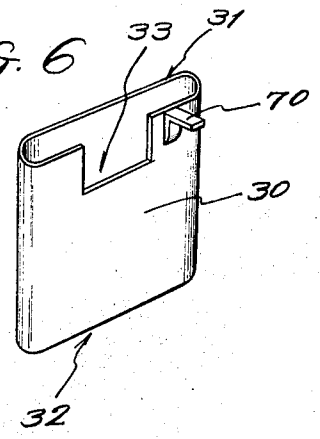


FIG 7

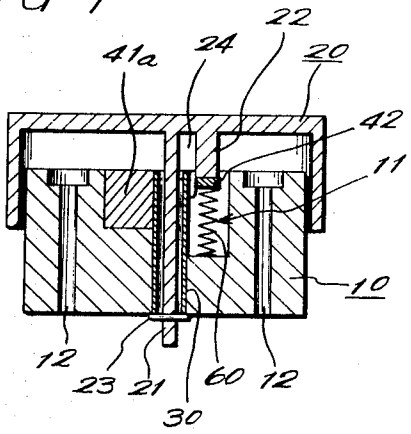


FIG. 8

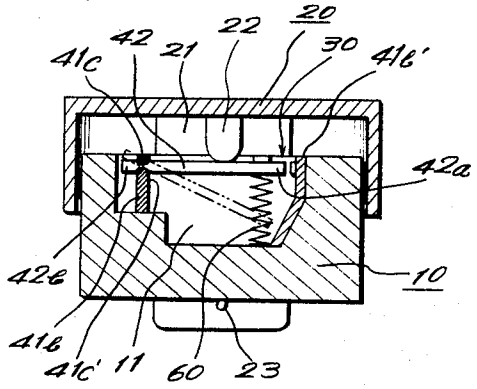


FIG. 9

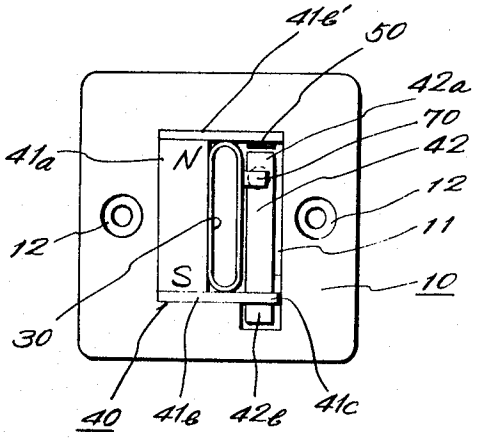


FIG. 10

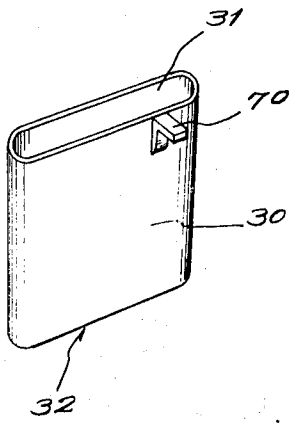


FIG. 11a

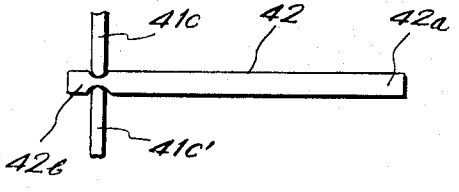


FIG. 11b

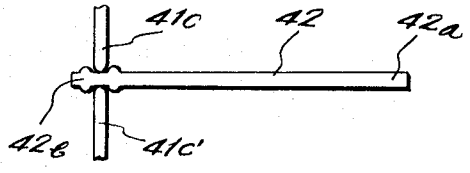


FIG. 12

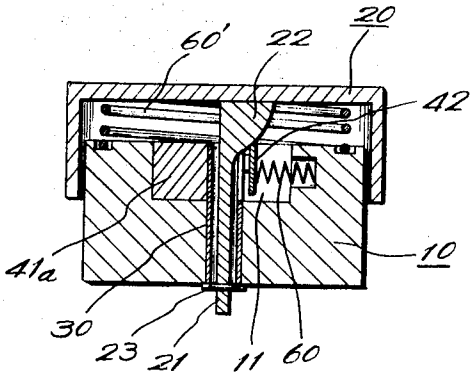


FIG. 13

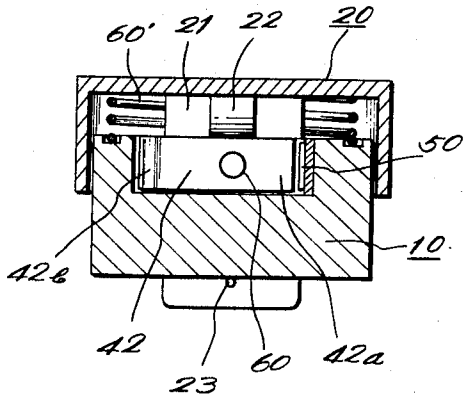


FIG. 14

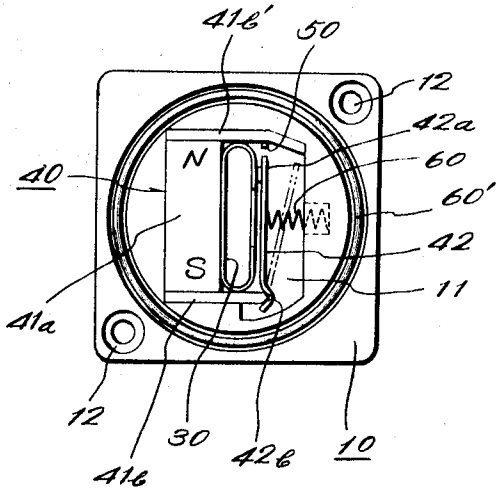
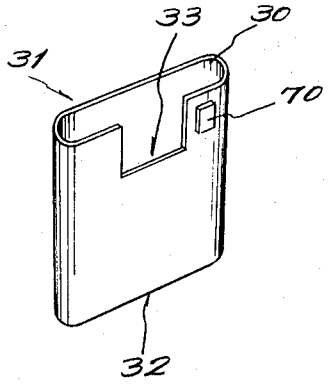


FIG. 15



CONTACTLESS PUSH-BUTTON TYPE SWITCHING APPARATUS

BACKGROUND OF THE INVENTION

Conventional push-button type switches which have been employed in various types of electric appliances are prone to incur defects such as poor contact due to wear of contact points and generation of chattering noise.

The object of the present invention is to provide a contactless push-button type switching apparatus free from the defects.

SUMMARY

The present invention provides a contactless push-button type switching apparatus comprised of a base made of non-magnetic material with an internal chamber which is formed with an opening facing upward at the center, a push-button cap made of non-magnetic material which slides to cap the base so as to cover the internal chamber, a flat guide tube made of non-magnetic material which is provided at the center of the internal chamber so that the opening of the guide tube faces upward and the internal chamber is divided into two parts, a U-shaped magnetic frame which houses the guide tube in the internal cavity of two parallel yokes so that the free ends project oppositely from both ends of the guide tube and is fixed in the internal chamber, a moving yoke which rotates at one as the fulcrum of the free ends of the magnetic frame and the rotating end which closely approaches the other end of the said free ends, a galvano-magnetro effect device, for example, Hall effect device or magneto-resistance device, which is positioned so that it receives the magnetic flux flowing in the magnetic path formed by the magnetic frame and moving yoke and the magnetic flux density to which the galvano-magnetro effect device is exposed with rotation of the moving yoke, a guide strip which projects downward at the internal surface of the push-button cap so that the guide strip can be slid into the guide tube, a projection which is provided inside the push-button cap so that the moving yoke is rotated when the push-button cap is lowered, a resetting means which resets the moving yoke at a position under the projection.

BRIEF DESCRIPTION OF DRAWINGS

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

FIG. **1** is a side view of the contactless push-button type switching apparatus of an embodiment of the present invention;

FIG. **2** is a plan view of the base of the switching apparatus;

FIG. **3** is a cross-sectional front view of the push-button cap of the switching apparatus;

FIG. **4** is a cross-sectional side view of the switching apparatus;

FIG. **5** is a cross-sectional front view of the switching apparatus;

FIG. **6** is an isometric view of the guide tube to be employed in the switching apparatus;

FIG. **7** is a cross-sectional side view of the switching apparatus of another embodiment of the present invention;

FIG. **8** is a cross-sectional front view of the switching apparatus shown in FIG. **7**;

FIG. **9** is a plan view of the base of the switching apparatus shown in FIG. **7**;

FIG. **10** is an isometric view of the guide tube of the switching apparatus shown in FIG. **7**;

FIGS. **11***a* and **11***b* are front views of the moving yoke mounting means of the switching apparatus shown in FIG. **7**;

FIG. **12** is a cross-sectional side view of the switching apparatus of another embodiment of the present invention;

FIG. **13** is a cross-sectional front view of the switching apparatus shown in FIG. **12**;

FIG. **14** is a plan view of the base of the switching apparatus shown in FIG. **12**, and FIG. **15** is an isometric view of the guide tube of the switching apparatus shown in FIG. **12**.

DETAILED DESCRIPTION

Referring to FIGS. **1** to **6** of the drawings, there is shown a contactless push-button type switching apparatus comprised of a base **10** made of non-magnetic material with internal chamber **11** which is formed with an opening facing upward at the center, a push-button cap **20** made of non-magnetic material which caps the base so as to cover the internal chamber, a flat guide tube **30** made of non-magnetic material which is put in the internal chamber, a magnetic path **40** composed of U-shaped magnetic frame **41** which is housed in the internal chamber and moving yoke **42** which is attached to one side of a free end of the magnetic frame, and a galvano-magnetro effect device **50** provided in the magnetic path.

Said base **10** is provided with a plurality of threaded holes **12** which pass through the base in the vertical direction so that the base can be fixed on a mount (which is not shown) with screws to be used in the threaded holes.

Said internal chamber **11** is composed of two cavities, **11***a* and **11***b*, which have different depths. At the border of these two cavities, opening **11***c* is provided by chipping the bottom of deeper cavity **11***b*.

Said push-button cap **20** is provided with guide strip **21** suspended from its inside ceiling so that the guide strip protrudes beyond the lower surface of base **10** through the opening **11***c*. This guide strip **21** is provided with projection **22** at its base portion so that the projection is positioned corresponding to deeper cavity **11***b* of internal chamber **11**.

The lower end of said guide strip **21** is provided with through-hole **21***a* to which pin **23** is attached as the stopper to limit movement of the push-button cap along the upward stroke.

Said guide tube **30** is made as a hollow cylinder which is open at both its ends **31** and **32**. This guide tube is fixed in internal chamber **11** so that lower open end **32** can align with opening **11***c* of said internal chamber **11** and is provided with notched portion **33** by chipping the upper end facing to deeper cavity **11***b* so that said projection **22** of push-button cap **20** can mesh with the said notched portion.

U-shaped magnetic frame **41** of said magnetic path **40** is comprised of magnet **41**a which is mounted in shallower cavity **11***a* of said internal chamber **11** so that the magnetic poles *N* and *S* of the magnetic frame are positioned at both lengthwise ends of said guide tube **30** and two yokes **41***b* and **41***b*′ which are fixed at the both ends of the magnet and the free ends of which are projected in parallel from both lengthwise ends of said guide tube **30** toward deeper cavity **11***b*.

The base portion of moving yoke **42** is rotatably fixed at one free end **41***b* of the yoke so that moving end **42***a* closely approaches yoke **41***b*′ ; thereby said magnetic path **40** is closed in a normal condition, that is, whenever no pressure is applied to the push-button cap.

To retain this moving yoke **42** at the upward limit position at all times, spring **60** is provided as a resetting means at yoke **41***b* located at the bearing side where the moving yoke is attached. To stop moving yoke **42**, which is raised by the spring, in front of notched portion **33** of said guide tube **30**, stopper **70** which inhibits upward movement of moving yoke **42** is provided at the outer surface of the upper end of guide tube **30**.

Said galvano-magnetro effect device **50** is connected in a conventional manner to an external input power supply and a load circuit. This galvano-magnetro effect device **50** is fixed at the internal surface of yoke **41***b*′ opposite to the moving yoke so that the device will be positioned close to moving end **42***a* of moving yoke **42** in the normal condition; accordingly, the device is arranged so that it can concentrate the magnetic flux onto a corresponding portion when moving yoke **42** is in a given position.

The switching apparatus according to the present invention is as described above. Depression of push-button cap **20** results in sliding down of guide strip **21** in guide tube **30** and controlling the position of push-button cap in lowering; accordingly, projection **22** fits in notched portion **33** of guide

tube **30** from above. With projection **22** fitted in notched portion **33**, moving yoke **42** is pushed down and moving end **42***a* of moving yoke **42** turns down as shown with broken line in FIG. **5**.

When moving yoke **42** turns, the magnetic flux density applied to galvano-magnetro effect device **50** decreases and the output voltage and current of galvano-magnetro effect device **50** varies in accordance with the decrease of the magnetic flux density, thus an external load circuit is actuated.

When push-button cap **20** is released, moving yoke **42** is raised and reset by virtue of spring **60** and at the same time push-button cap **20** is raised and reset to the upward limit position.

Since the magnetic flux is accordingly concentrated again on galvano-magnetro effect device **50**, the output voltage and current of galvano-magnetro effect device **50** and the load circuit is forced to operate so that the push-button cap returns to the home position.

Hereupon the resetting means for said moving yoke **42** and push-button cap **20** cannot always employ spring **60** and moving yoke **42** and push-button cap **20** can be held at the upward limit position by utilizing the magnetic force of yoke **41***b*′ which attracts moving yoke **42** at the opposite side to said yoke **41***b*′.

Generally, said galvano-magnetro effect device **50** is fixed at the internal surface of yoke **41***b*′ at the opposite to moving end **42***a* of moving yoke **42**, as shown in FIG. **2**. In the case of the switching apparatus in magnetic path **40** of which the density of the magnetic flux varies with movement of the moving yoke as an embodiment of the present invention, said galvano-magnetro effect device **50** can be inserted into a desired portion of the magnetic path, for example, the jointed portion *P* of magnet **41***a* and yoke **41***b*′.

FIGS. **7** to **11** illustrate a switching apparatus comprised of a magnetic path **40** which is formed by moving yoke **42**, basic portion **42***b* of which is inserted between forked holding pieces **41***c* and **41***c*′ which are made by dividing the free end of yoke **41***b* at the bearing side into upper and lower parts and yoke **41***b*′ at the opposite side which is formed to be long vertically so that it coincides with the stroke of moving end **42**a of moving yoke, a guide tube **30** which is not provided with a notched portion at its upper end and a push-button cap **20** which is provided with groove **24** where the upper end of guide tube **30** can be freely inserted between guide strip **21** and projection **22**.

In this embodiment of the present invention, when push-button cap **20** is pressed down, the upper end of guide tube **30** fits into groove **24** and projection **22** can push down moving yoke **42**; therefore the density of the magnetic flux applied to galvano-magnetro effect device **50** can be varied like the switching apparatus shown in FIG. **2**.

In this embodiment, however, it is necessary to provide spring **60** as the resetting means because yoke **41***b*′ is opposite to moving end **42***a* of the moving yoke even when moving yoke **42** rotates and to provide galvano-magnetro effect device **50** at the internal surface of yoke **41***b*′ at the opposite side because the density of magnetic flux flowing in magnetic path **40** does not vary.

In this embodiment, since moving yoke **42** approaches yoke **41***b*′ at the opposite side even at the upward or downward limit position, the switching apparatus is advantageous in the point that it permits designing of the switching apparatus so that the magnetic flux can be concentrated onto galvano-magnetro effect device **50** when moving yoke **42** lowers or push-button cap **20** is depressed down by providing galvano-magnetro effect device **50** at a lower portion of yoke **41***b*′ at the opposite side and so that each galvano-magnetro effect device **50** can be selectively actuated when moving yoke **42** rises and lowers by providing two galvano-magnetro effect devices at both upper and lower portions of yoke **41***b*′ at the opposite side. Furthermore, it is also advantageous in the point that reduction of magnetic flux of the magnet can be prevented because the magneto-resistance of magnetic path **40** does not vary even when moving yoke **42** rotates.

Since basic portion **42***b* of said moving yoke **42** is chucked by chuck holders **41***c* and **41***c*′ of yoke **41***b* at the bearing side, it is desirable to concave the surfaces of basic portion **41***b* which come in contact with chuck holders **41***c* and **41***c*′ as illustrated in FIGS. **11***a* and **11***b*.

Since the switching apparatus of this embodiment of the present invention is such that moving yoke **42** is thus mounted on the free end of yoke **41***b*, the switching apparatus is advantageous in the points that magnetic loss can be reduced and another coupling means is not required.

FIGS. **12** to **15** illustrate a switching apparatus comprised of moving yoke **42** which is designed so that base portion **42***b* is attracted by yoke **41***b* at the bearing side and moving end **42***a* approaches and separates from tube **30**, that is, the moving end turns forward, resetting spring **60** which causes moving yoke **42** to contact guide tube **30**, projection **22** which is formed in the form of wedge so as to turn said moving yoke **42** forwardly and spring **60**′ which retains push-button cap **20** at the upward limit position.

Also in this embodiment of the present invention, it is possible to reset moving yoke **42** with yoke **41***b*′ at the opposite side which attracts the moving yoke; however, it is desirable to use another spring to reset push-button cap **20** because base portion **42***b* of moving yoke **42** is attracted by yoke **41***b* at the bearing side.

In this embodiment, projection **22** is provided with a slanted surface which develops upwardly and comes in contact with moving yoke **42**, and stopper **70** is used as a separator to keep a fixed distance between moving yoke **42** and guide tube **30**. Basic portion **42***b* of said moving yoke **42** is formed in a curve and this curved basic portion is attracted onto the free end of yoke **41***b* at the bearing side which is formed to have a curved surface meeting the curved basic portion.

In this embodiment, the switching apparatus is advantageous in the point that any other attaching means is not required because moving yoke **42** is attracted by yoke **41***b* at the bearing side.

Thus, as illustrated in the examples of embodiments mentioned above, the switching apparatus according to the present invention is not provided with contacts. Therefore, the switching apparatus is advantageous because it is completely free from poor contact due to wear of the contacts and from generation of chattering noise during use, and because employment of the galvano-magnetro effect devices enables designing of the switching apparatus in a compact size and light weight.

What is claimed is:

1. A contactless push-button type switching apparatus comprised of

a. a base made of non-magnetic material and having an internal chamber;

b. a cap made of non-magnetic material and having an internal surface, said cap slidably mounted on said base so as to cover the internal chamber;

c. a guide tube made of non-magnetic material mounted near the center of the internal chamber to divide it into two parts said guide tube having an opening facing upward;

d. a guide strip depending from the internal surface of said cap and projecting downwardly within said guide tube;

e. a magnetic path composed of

1. a U-shaped magnetic frame including legs which is fixed in the internal chamber so that the guide tube is positioned in a space formed between the legs of the U-shaped frame, and

2. a movable yoke pivotally mounted at one end thereof on one of said legs of the magnetic frame and the other, moving end of which approaches the other of said legs of the magnetic frame;

f. at least one galvano-magnetro effect device mounted in the internal chamber in such position that it can be exposed to the magnetic flux flowing in the magnetic path and positioned so that the density of magnetic flux varies with movement of the movable yoke;

g. means on said cap to move the movable yoke when the push-button cap is depressed;

h. biasing means to force the push-button cap to remain at its limit upward position whenever no downward pressure is applied onto it;

i. and means to maintain the movable yoke in a predetermined position when the cap is in its limit upward position.

2. A contactless push-button type switching apparatus, according to claim **1**, wherein the legs of the U-shaped magnetic frame nearest to the moving end of the movable yoke is constructed so as to be adjacent to the moving end of the movable yoke only when the movable yoke is in said predetermined position.

3. A contactless push-button type switching apparatus, according to claim **1**, wherein one leg of the U-shaped magnetic frame is formed to be larger in the direction of movement of the movable yoke than the maximum stroke of the movable yoke so that the moving end of the movable yoke can at all times be adjacent to that leg.

4. A contactless push-button type switching apparatus, according to claim **3**, wherein galvano-magnetro effect device is positioned adjacent to the moving end of the movable yoke in its normal condition and a second galvano-magnetro effect device is positioned adjacent to the moving end of the movable yoke in the position it reaches upon depression of said cap.

5. A contactless push-button type switching apparatus, according to claim **1**, wherein the movable yoke is normally positioned in front of a notch formed in the upper end of the surface of the guide tube , a projection is provided integral with said cap, which projection enters into the said notch when said cap is depressed.

6. A contactless push-button type switching apparatus, according to claim **1**, wherein a groove is provided between the guide strip and the means on the cap to cause the movable yoke to pivot so that the upper end of the guide tube enters into the groove when the push-button cap is depressed.

7. A contactless push-button type switching apparatus, according to claim **1**, wherein the base portion of the moving yoke is pivotally fixed at one free end of the magnetic frame and a spring which always pushes up the moving yoke is attached to the moving yoke.

8. A contactless push-button type switching apparatus, according to claim **1**, wherein one leg of the U-shaped magnetic frame is formed in the shape of forked chuck holder and the base portion of the moving yoke is mounted in the forked chuck holder.

9. A contactless push-button type switching apparatus, according to claim **1**, wherein the base portion of the moving yoke is curved and this curved base portion is capped on one leg of the U-shaped magnetic path.

10. A contactless push-button type switching apparatus, according to Claim **1**, wherein the moving yoke is attached to one leg of the U-shaped magnetic frame so that its moving end turns in a direction away from the guide tube, and the means on the cap for moving the yoke is so formed that the surface contacting the movable yoke is a sloped surface so that said movable yoke is moved laterally by the sloped surface when the push-button cap is depressed.

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