United States Patent [19]

O'Connor

[11] **3,921,108**

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[54] **PUSHBUTTON FOR SOLID STATE WRISTWATCH**

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[73] Assignee: **Time Computer, Inc.,** Lancaster, Pa.

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[52] **U.S. Cl.** ..... **335/153;** 58/50 R

[51] **Int. Cl.²** **H01H 1/66**

[58] **Field of Search** ..... 58/50 R, 85.5; 335/151, 335/153, 154, 205

[56] **References Cited**

UNITED STATES PATENTS

3,205,323	9/1965	Deshautreaux	335/153 X
3,559,124	1/1971	Posey	335/205
3,789,601	2/1974	Bergey	58/85.5 X

FOREIGN PATENTS OR APPLICATIONS

1,174,890	7/1964	Germany	335/153

Primary Examiner—G. Harris

Attorney, Agent, or Firm—LeBlanc & Shur

[57] **ABSTRACT**

Disclosed is an improved push button assembly for thedemand switch of a wristwatch having a light emitting diode display. A permanent magnet is mounted inside the pushbutton on a curved leaf spring which forms the return spring for the button. When the button is depressed the spring is deformed moving the permanent magnet close to a reed switch inside the watch case. In this position, the polarization of the magnet is parallel to the reed switch contacts.

13 Claims, 6 Drawing Figures

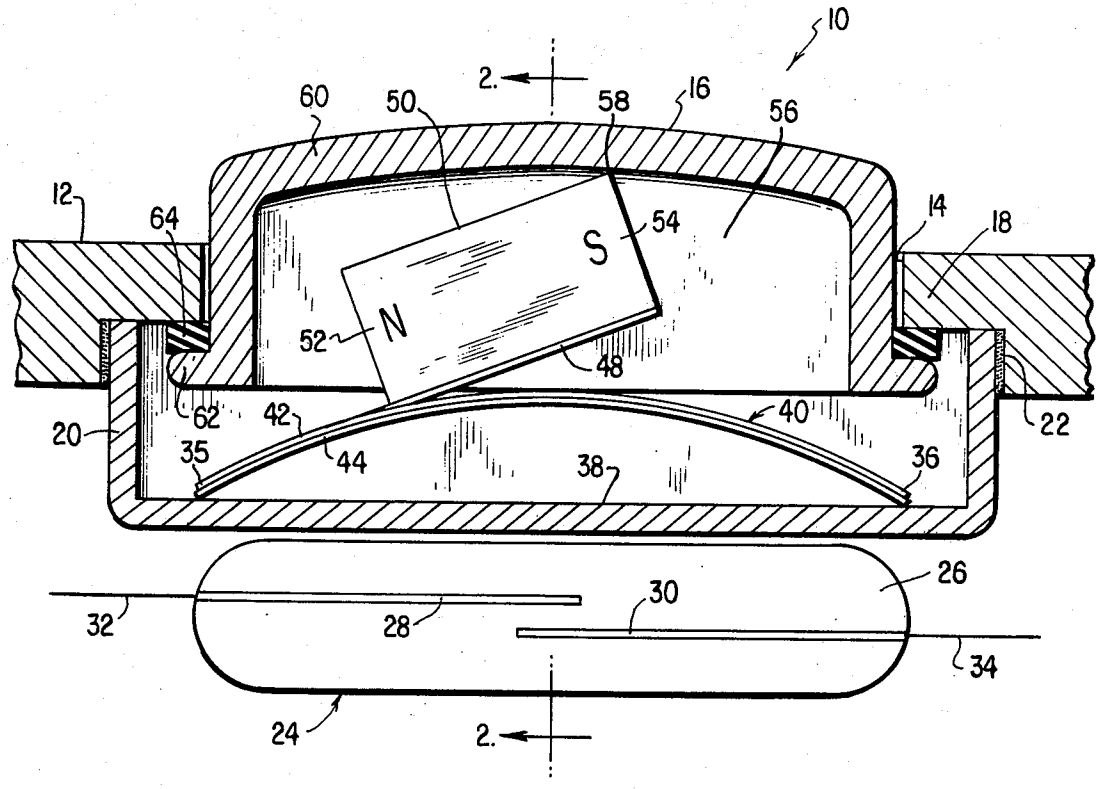
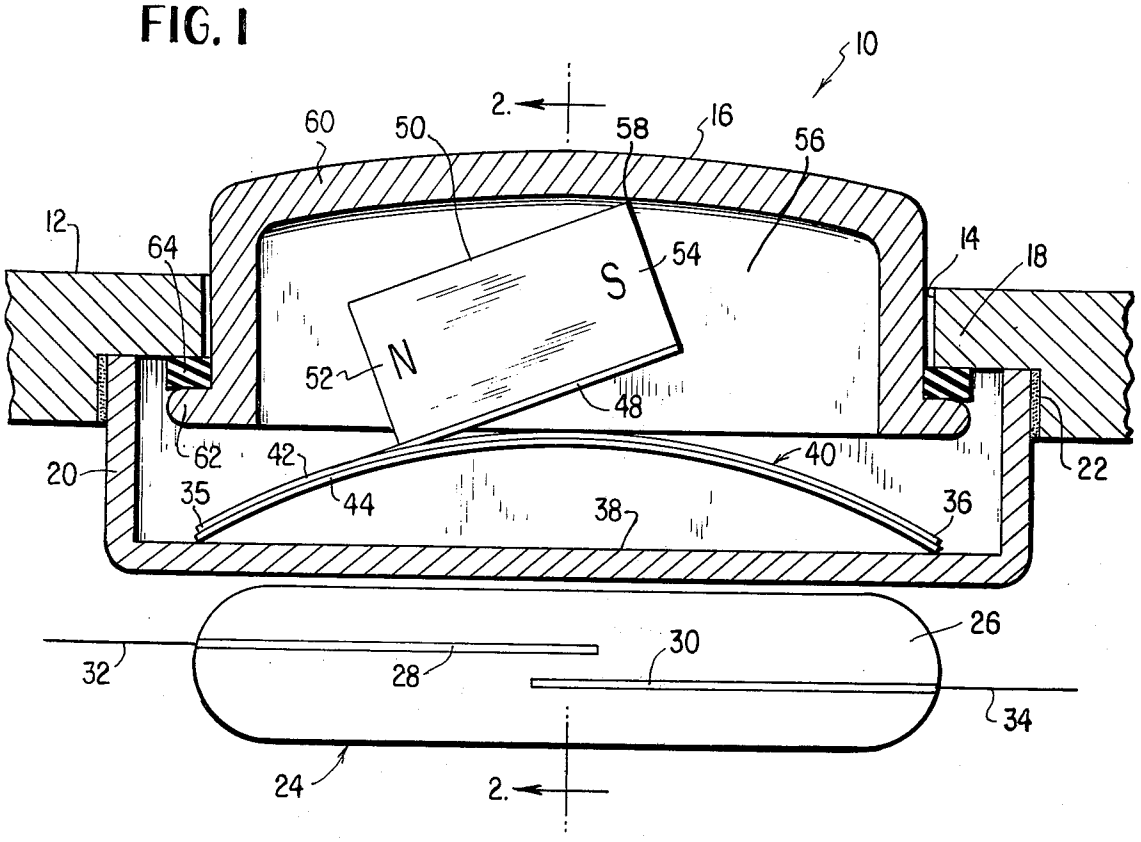


FIG. 1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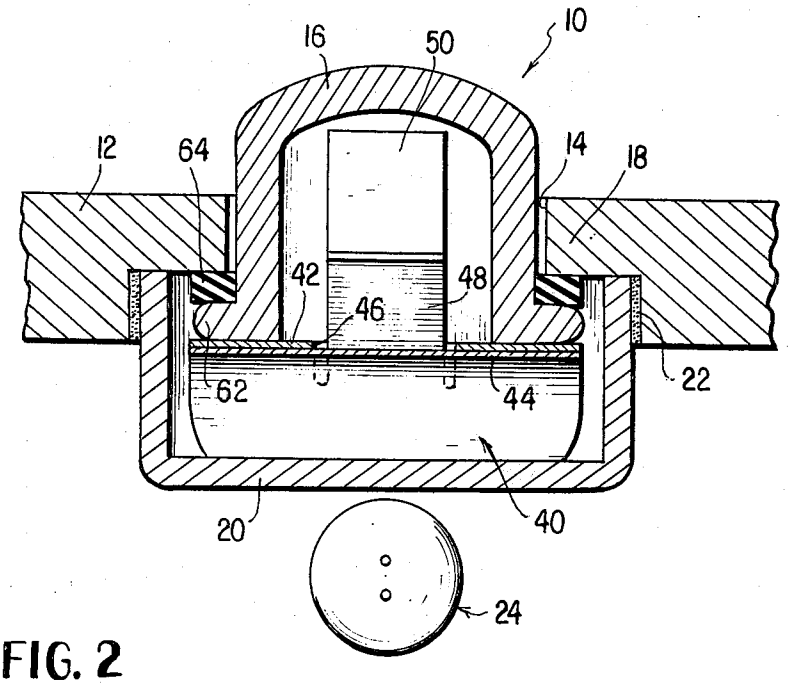
16
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FIG. 2

FIG. 3

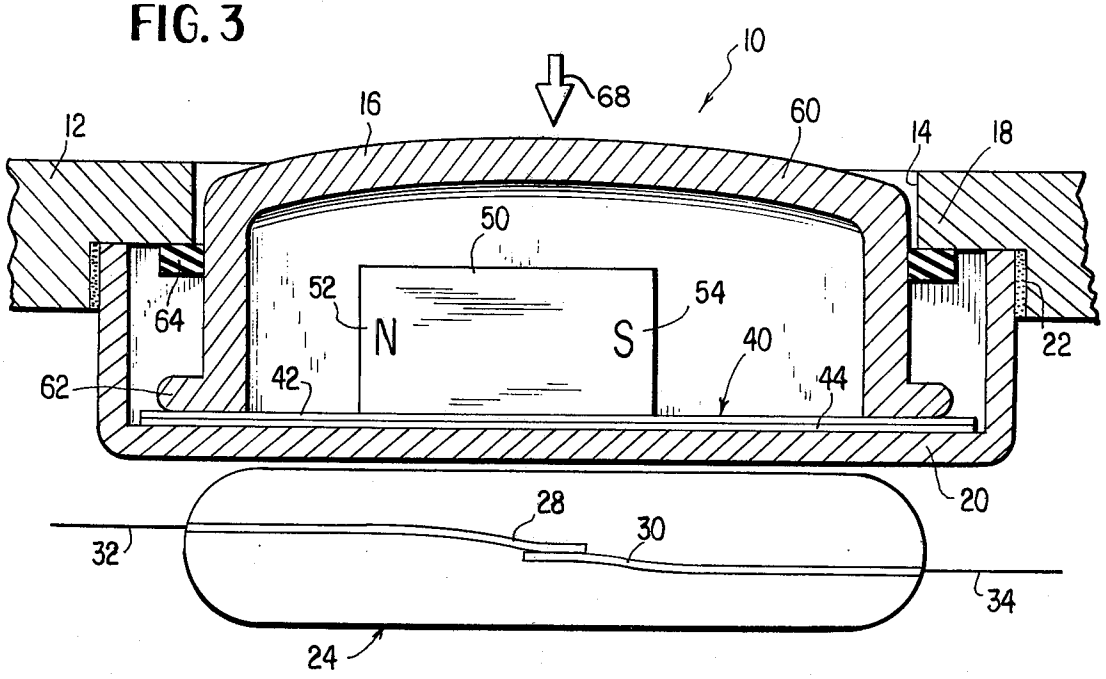
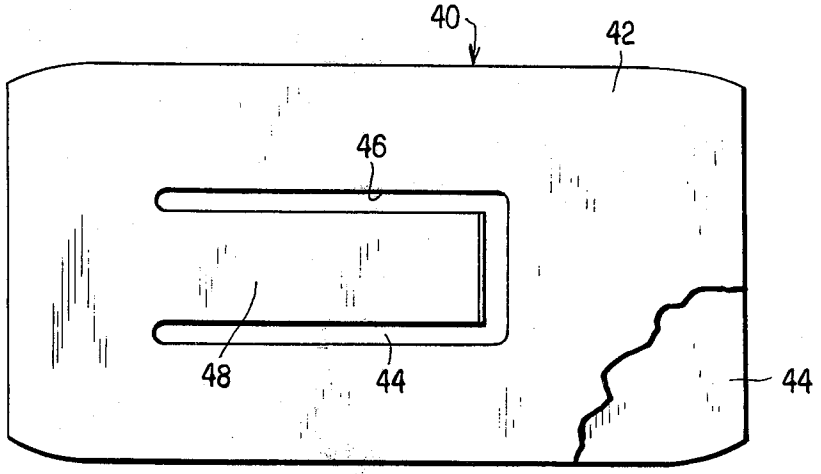


FIG. 4



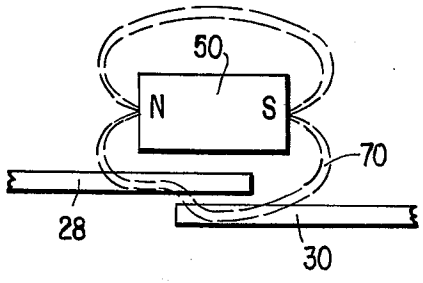


FIG. 5

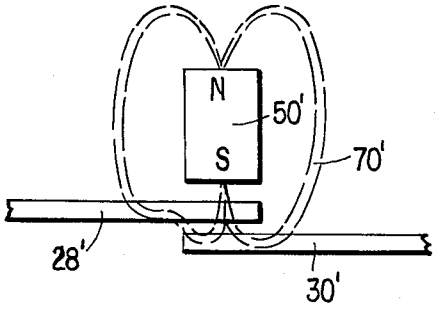


FIG. 6

PUSHBUTTON FOR SOLID STATE WRISTWATCH

This invention is directed to improvements in the construction of a solid state electronic wristwatch of the type disclosed in assignee's U.S. Pat. No. 3,803,827, issued Apr. 16, 1974, the disclosure of which is incorporated herein by reference, and more particularly to an improved demand button or pushbutton for illuminating the watch display elements.

There is disclosed in assignee's U.S. Pat. No. 3,576,099, issued Apr. 27, 1971, a solid state wristwatch in which the optical display is described as a plurality of light emitting diodes which are intermittently energized to assure minimum power consumption and an increasingly long life for the watch battery. Improved watch constructions of this general type incorporating solid state circuits and integrated circuit techniques are disclosed in assignee's U.S. Pat. No. 3,672,155 and U.S. Pat. No. 3,803,827, among others.

Each of these wristwatches is provided with a demand switch for illuminating a light emitting diode digital display when the wearer desires to ascertain the correct time. The reason for this is that the light emitting diodes utilize relatively large amounts of the limited energy available from the small wristwatch battery or batteries relative to the other watch components and by only displaying time on demand, substantial battery energy is conserved. In this way, it is possible to provide light emitting diode wristwatches with two one and one-half volt electrical power cells having a useful life of well over one year.

In the past, wristwatches of this type have employed a pushbutton for actuating the demand switch of the type shown and described in assignee's U.S. Pat. No. 3,782,102 issued Jan. 1, 1974. The demand button or pushbutton has formed movable with it a permanent magnet which, when the button is depressed, moves closer to a magnetic field responsive reed switch within the watch case to actuate the switch. By incorporating a permanent magnet which at all times is placed outside the case or case closure, all watch case shaft or stem sealing problems are eliminated.

The present invention is directed to an improved pushbutton assembly for a solid state wristwatch of the type described above and in particular to an improved magnetic circuit construction for the watch display demand switch. As contrasted with the previous construction in which the permanent magnet carried by the demand button is polarized perpendicular to the plane of the reed switch contacts, in the present invention, the permanent magnet carried by the demand button is polarized parallel to the plane of the reed switch contacts. This provides a simplified and less expensive construction and in particular significantly increases the reliability of the operation of the demand switch by insuring accurate switch closure when the demand button is depressed and switch opening when the demand button is released by the finger of the watch wearer.

An additional important feature of the present invention involves a novel mounting arrangement for the permanent magnet in the pushbutton assembly where the magnet is carried by an outwardly projecting tab on a normally curved flat spring or leaf spring which provides return bias for the demand button so as to resiliently urge the demand button to the uppermost or switch open position when finger pressure is removed.

It is therefore one object of the present invention to provide an improved switch assembly for solid state wristwatches.

Another object of the present invention is to provide an improved demand switch assembly for wristwatches having a light emitting diode display.

Another object of the present invention is to provide a light emitting diode display wristwatch with a demand button having an improved magnetic circuit for operating a reed switch within the watch case.

Another object of the present invention is to provide an improved permanent magnet and flat spring construction for the pushbutton of the demand switch of a light emitting diode solid state wristwatch.

These and further objects and advantages of the invention will be more apparent upon reference to the following specification, claims and appended drawings wherein:

FIG. **1** is a cross section through the demand switch assembly of the present invention with the switch in the open contact position;

FIG. **2** is a cross section through the switch assembly taken along line **2—2** of FIG. **1**;

FIG. **3** is a cross section similar to FIG. **1** showing the pushbutton depressed and the reed switch contacts in the switch closed position;

FIG. **4** is a plan view of the flat spring or leaf spring forming a part of the switch assembly of FIGS. **1–3**;

FIG. **5** is a diagrammatic view of the switch assembly of the present invention showing the improved magnetic circuit arrangement; and

FIG. **6** is a schematic diagram similar to FIG. **5** useful in the explanation of the improvement.

Referring to the drawings, the novel switch assembly of the present invention is generally indicated at **10** in FIG. **1**. That FIGURE shows in cross section a portion of the wristwatch case **12** in which is provided a rectangular aperture **14** slidably receiving a demand button or pushbutton **16**. The lower end of aperture **14** is stepped to a larger size to provide a ledge **18**. Its lower end is closed off and permanently sealed by a metal pan **20** which is secured preferably by an epoxy as indicated at **22** to the watch case **12**.

Suitably mounted on a frame (not shown) inside the watch case is a magnetic field responsive reed switch **24** comprising envelope **26** and a pair of normally spaced contacts **28** and **30**. Reed switch **24** is of conventional construction and electrical connection to the contacts **28** and **30** is made through the envelope **26** to a pair of electrical leads **32** and **34**.

Located within pan **20** with its outer ends **35** and **36** resting on the bottom **38** of the pan is an arcuately curved metal leaf spring **40**. While the spring may be formed from a single flat rectangular layer of metal, it is preferably formed as illustrated in FIG. **1** from two suitably joined spring metal layers **42** and **44**. Upper layer **42** is provided with a cutout **46** as illustrated in FIG. **4** defining an upwardly projecting substantially straight tab **48**. Secured to the tab again by epoxy or the like, and carried by the tab is a rectangular cross section permanent magnet **50** preferably formed from a rare earth cobalt such as Sammarium cobalt or the like. The magnet is polarized to define north and south poles at its respective ends **52** and **54**.

Permanent magnet **50** is received within a central cavity **56** of pushbutton **16** and its uppermost tip **58** in the position shown in FIG. **1** just clears the top **60** of the pushbutton. Formed integral with the top or cover

60 of the pushbutton are the downwardly extending sides which terminate in an outwardly extending annular flange 62. This flange in the position illustrated in FIGS. 1 and 2 engages a resilient sealing ring 64 suitably secured to the underside of ledge 18 so as to limit upward movement of pushbutton 16. The pushbutton is urged upwardly by the engagement of a portion of the legs and flange 62 with the leaf spring 40 as best seen in FIG. 2.

FIG. 3 is a view similar to FIG. 1, but shows the pushbutton 16 depressed by downward pressure on it as indicated by the arrow 70. In this position, spring 40 assumes a completely flat position in engagement with the bottom 38 of pan 20 and the magnetic field from the permanent magnet 50 acts on the contacts 28 and 30 of the reed switch 24 to bring them together closing the electrical circuit between electrical leads 32 and 34. The pushbutton 16 is illustrated in FIG. 3 in its downward most position which is limited by the bottom of pan 20.

FIGS. 5 and 6 are diagrammatic views illustrating the approximate magnetic fields of a permanent magnet adjacent the leaf spring contacts 28 and 30. FIG. 5 is a diagrammatic representation of the construction of the present invention where the magnet 50 is polarized parallel to the planes of the reed switch contacts 28 and 30. FIG. 6 shows a similar permanent magnet 50' representative of prior constructions in which the magnet is polarized perpendicular to the planes of switch contacts 28' and 30'. The improved nature of the magnetic circuit afforded by the parallel polarization of the present invention as illustrated in FIG. 5, is apparent from the more uniform nature of the magnetic flux lines 70 in passing through the adjacent ends of the contacts 28 and 30 as compared to the flux lines 70' of magnet 50' in FIG. 6.

The improved magnetic circuit not only decreases the size of the magnet necessary, but optionally makes it possible to utilize the same size magnet if desired, and attain significantly improved operating characteristics for switch closure and opening. This is particularly facilitated by the novel leaf spring construction of the present invention which brings the magnet in close proximity to the reed switch 24 for switch closure but which, at the same time, positively urges the magnet away from the switch causing it to open when the downward pressure represented by arrow 68 in FIG. 3 is removed. Typical operating characteristics for the switch assembly as illustrated in FIGS. 1 and 2, makes it possible to close the switch with a magnetic field pulling strength of between approximately 25 and 60 ampere turns and provides for drop out or switch opening at a value not less than 70 percent of the pull in field, i.e., 70 percent of the 25 to 60 ampere turn pull in field. This insures that the reed switch 24 will be closed with a minimum of pressure on the pushbutton 16 and further it insures rapid and positive opening of the reed switch when the pressure is removed. Typically, the demand button 16 is operated by depressing it with the index finger of the other hand of the watch wearer.

It is apparent that the present invention provides a simplified and inexpensive pushbutton construction particularly adapted for solid state wristwatches having light emitting diode displays where the display is only energized when the demand button is depressed. Substantial increases in reliability of operation are brought about by the parallel polarization of the permanent magnet and by the automatic and positive action of leaf spring 40 in returning pushbutton 16 to its initial position and, at the same time, by means of the tab or projection 48, positively returning the permanent magnet 50 to its rest position as illustrated in FIG. 1, remote from switch contacts 28 and 30, so that the switch contacts are permitted to positively reopen with the magnet well away from the pull in position.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is, therefor, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A wristwatch comprising a watch case, a magnetic field responsive switch in said case, said switch comprising a pair of electrical contacts lying in at least substantially parallel planes, a permanent magnet mounted on said case in a first position adjacent said switch contacts where the polarization of said magnet is oriented at an acute angle relative to the planes of said contacts, and means on said case responsive to manual pressure for moving said permanent magnet by both rotation and translation into a second position closer to said switch contacts where the polarization of said magnet is at least substantially parallel to the planes of said contacts.

2. A wristwatch according to claim 1 wherein said magnetic field responsive switch is a reed switch.

3. A wristwatch according to claim 1 wherein said contacts are normally spaced and close in the presence of a magnetic field.

4. A wristwatch according to claim 1 including means on said case resiliently biasing said permanent magnet toward said first position.

5. A wristwatch according to claim 4 wherein said biasing means comprises a curved leaf spring.

6. A wristwatch according to claim 5 wherein said leaf spring includes a straight portion on which said magnet is mounted.

7. A wristwatch according to claim 6 wherein said straight portion comprises a tab projecting outwardly adjacent the center of said leaf spring.

8. A wristwatch according to claim 7 wherein said leaf spring comprises two layers, said tab projecting from only one of said layers.

9. A wristwatch according to claim 7 wherein said leaf spring is curved with its central portion furthest from said switch contacts.

10. A wristwatch comprising a watch case having an aperture, an inverted cup shaped demand button slidably mounted in said aperture, a support secured to said case and closing off the inner end of said aperture, said button being movable along an axis from outside said case toward and away from said support, a magnetic field responsive switch in said case adjacent said support, a curved leaf spring having its convex side toward said button resiliently urging said button toward the outer end of said aperture, said leaf spring having a straight portion extending outwardly of the remainder of said spring into the hollow cup portion of said button, and a permanent magnet mounted on said straight portion of said spring, said magnet being movable with said spring when said button is pressed from a first posi-

tion remote from said contacts to a second position adjacent said contacts, said magnet in said second position being polarized perpendicular to the axis of motion of said button.

11. A wristwatch according to claim **10** wherein said aperture is enlarged at its inner end to define a ledge, said button having a flange movable between said ledge and said support.

12. A wristwatch according to claim **11** wherein said spring engages said button flange.

13. A wristwatch according to claim **10** wherein said magnet is comprised of a rare earth cobalt material.

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