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HERMETICALLY SEALED, PRESSURE RESPONSIVE, MAGNETICALLY ACTUATED SWITCH DEVICE

Original Filed May 31, 1963

2 Sheets-Sheet 1

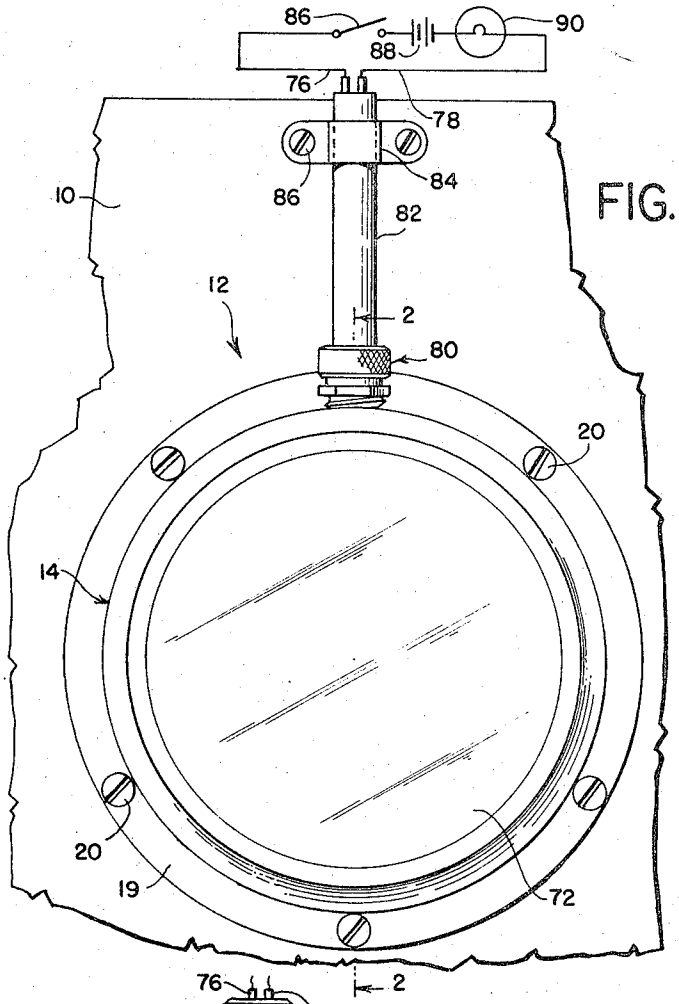

FIG. 1

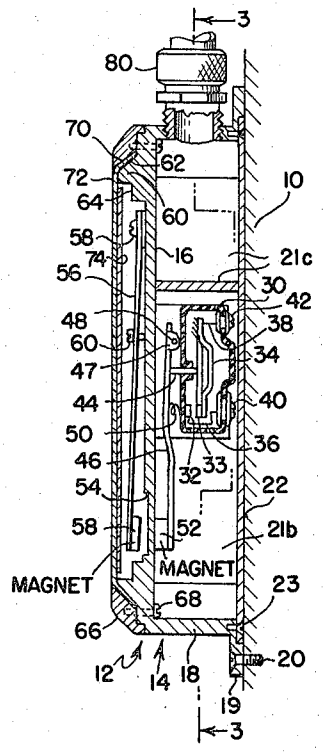

FIG. 2

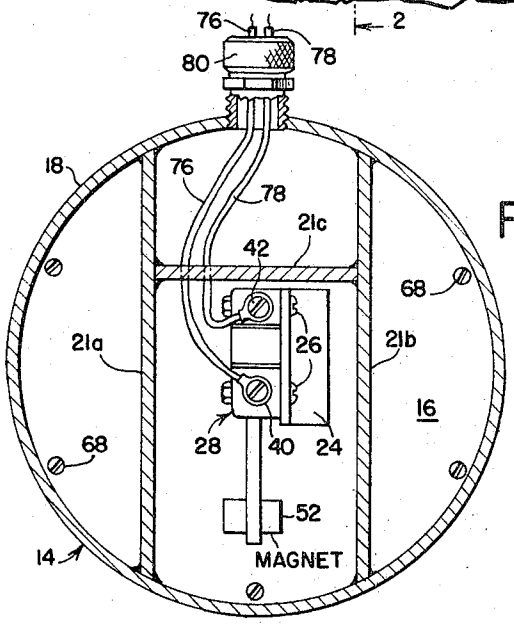

FIG 3

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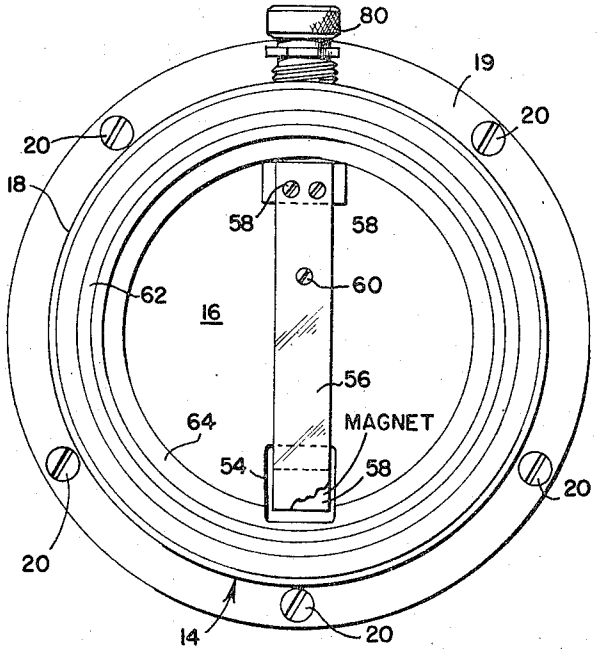
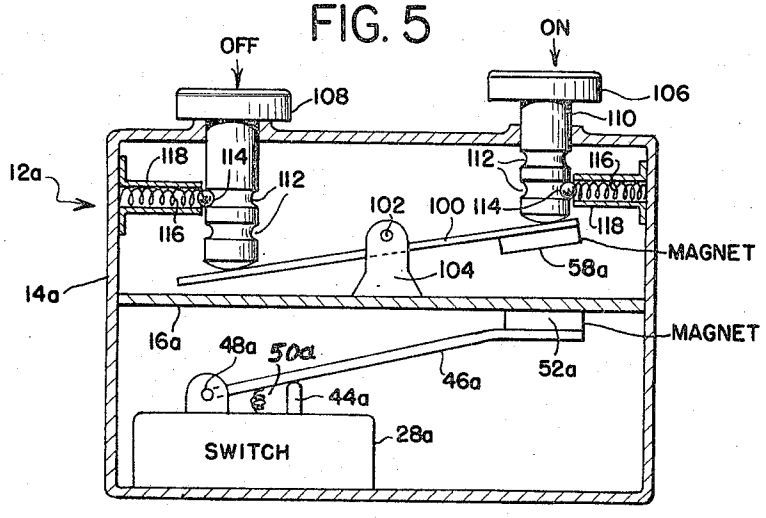


FIG. 4

FIG. 5



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HERMETICALLY SEALED, PRESSURE RESPONSIVE, MAGNETICALLY ACTUATED SWITCH DEVICE

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Continuation of application Ser. No. 284,566, May 31, 1963. This application Apr. 27, 1967, Ser. No. 634,392

4 Claims. (Cl. 335—207)

ABSTRACT OF THE DISCLOSURE

A hermetically seealed pressure responsive switch wherein pressure forces an arm with a first magnet on the end thereof toward a second magnet which is mounted on a microswitch actuator arm. The magnets are oriented with like pole faces facing each other such that the first magnet repels the second to actuate the microswitch.

This is a continuation of application Ser. No. 284,566 filed May 31, 1963, now abandoned.

This invention relates generally to electric switches, and pertains more particularly to a magnetically actuated switch device.

One object of the invention is to provide a switch device that can be used in explosive atmospheres without danger. In this regard, the present invention envisages a totally enclosed and hermetically sealed switch unit. The invention, therefore, has for a specific aim the omission of any mechanical linkage that would extend outwardly through the casing in which the switch mechanism is housed. Accordingly, a switch device constructed in accordance with the teachings of my invention will find especial utility in the determination of the level of various particulate materials contained in bins, hoppers, grain elevators and the like where such materials are apt to produce a dust-laden environment.

Another object of the invention is to provide a magnetically actuated switch device that will be positive in its operation as far as either closing or opening the electrical contacts belonging to the switch mechanism itself, and yet which will be very compact. More specifically, the invention envisages the use of two small ceramic magnets arranged with their like or similar poles opposed to each other, so that movement of one of the magnets in a direction toward the other will repel the other with sufficient force to always assure actuation of a switch mechanism associated with the second magnet.

The invention has for a further object provision for the reverse movement of such contacts. Stated somewhat differently, the invention has for an aim the provision of a considerable amount of actuating force in causing the switch contacts to open or close when subjected to the actuating force, yet not remain closed when the actuating force is removed.

While the instant invention will possess considerable usefulness as far as indicating the level of particulate or granular materials within a container, the switch device constituting the subject matter of the present invention will find utility in other environments. Hence, an object of the present invention is to provide a switch device of the foregoing character which will possess considerable versatility.

Another object of the invention is to provide a switch device that can be manufactured at a relatively low cost and which will be not only rugged but exceedingly reliable over a prolonged period of operation.

Still another object of the invention is to provide a magnetically actuated switch device that can be readily adjusted and which has its few simple parts accessible for servicing or change should circumstances so dictate, even though it is contemplated that very little maintenance of the switch device will be needed.

Yet another object of the invention is to provide a switch device that will not present any ledges that might result in an undesired accumulation of granular material when the switch device is used for level indication purposes.

Briefly, the invention involves the use of permanent magnets. One such permanent magnet will be disposed within the confines of the casing and the other will be located exteriorly thereof, there being an imperforate wall between the two magnets. By orienting the magnets so that they have their like or similar poles opposite each other, then a magnetic field is provided which causes the magnet within the casing to be repulsed when the outer magnet is moved toward the imperforate wall. The inner magnet is supported or carried on an arm which is instrumental in opening or closing the contacts of the switch mechanism contained within the casing. When the outer magnet is moved away from the imperforate wall, then the inner magnet is immediately free to assume its initial or normal position through the agency of a return spring.

These and other objects and advantages of my invention will more fully appear from the following description, made in connection with the accompanying drawing, wherein like reference characters refer to the same or similar parts throughout the several views and in which:

FIGURE 1 is a front elevational view of a switch device shown mounted to the wall of a bin;

FIGURE 2 is a longitudinal sectional view of the device of FIGURE 1 taken in the direction of line 2—2;

FIGURE 3 is a rear view of the device pictured in FIGURE 1 with the backing plate removed so as to expose the switch mechanism contained in the casing and a magnet for operating same;

FIGURE 4 is a front elevational view corresponding to FIGURE 1 with the diaphragm and retaining ring thereof removed so as to expose a leaf spring and an additional magnet carried thereby, and

FIGURE 5 is a vertical sectional view through the casing of a modified switch device employing the teachings of the invention.

Inasmuch as the present invention will have considerable utility in conjunction with indicating the level of bins, hoppers, grain elevators and similar structures, a fragmentary portion of a wall **10** of such a structure has been pictured in FIGURE 1. The unit or device for sensing the level of the material with respect to the height of the wall **10** has been denoted in its entirety by the reference numeral **12**. The device **12** includes a casing **14** comprised of an imperforate front wall **16** of non-magnetic material, such as aluminum, brass or appropriate plastic. Integral with the front wall **16** is a cylindrical side wall **18** having an outwardly directed flange **19**. The purpose of the flange **19** is to accommodate a plurality of screws **20** which serve to mount the unit **12** against the wall **10**. As will be discerned from FIGURE 3, the interior of the casing **14** is provided with several reinforcing ribs **21***a*, **21***b* and **21***c* that collectively have an H-shaped appearance. A removable backing plate **22** closes the rear of the casing **14**, there being a plurality of screws **23** that detachably secure the plate **22** in place.

Within the confines of the casing **14** is a bracket **24**, one

flange of this bracket being affixed to the inner side of the front wall 16 and through the agency of a couple of mounting screws 26 a switch mechanism 28 is fixedly mounted within the casing 24. The switch mechanism 28 is preferably of the snap-action variety and may be a micro switch. The construction of such switches is well known, but it can be pointed out that they usually include a plastic housing 30 in which a pair of cooperable electrical contacts 32, 33 are located. The contacts 32, 33 are normally open with the contact 33 being carried on a snap-action overcenter split spring 34. For the sake of completeness, a pair of interiorly disposed conductors 36, 38 have been illustrated, these conductors leading to respective terminals 40, 42. A reciprocable plunger 44 is utilized to press against the spring 34 to accomplish the desired snap-action and the concomitant closing of the contacts 32, 33.

Instrumental in effecting the closing of the contacts 32, 33 is an actuating arm 46 formed with integral ears 47 that are apertured for the accommodation of the ends of a pivot pin 48 mounted in a fixed relation with respect to the plastic housing 30 of the switch mechanism 28. A coil spring 50 is positioned between the arm 46 and the housing 30 so that the arm 46 is normally biased in a clockwise direction as viewed in FIGURE 2

Playing an important role in the practicing of the instant invention is a first permanent magnet 52. The preferred type of magnet to be used in this situation is a ceramic magnet composed of barium carbonate and iron oxide. Not only are magnets of this type quite small for their magnetic strength, but such magnets will not weaken one another when left in each other's fields or are positioned in an electrical field, the spring back being almost 100 percent. In addition, this type of magnet has a high electrical resistivity, thereby adding a further desirable attribute to its use in this situation.

The imperforate front wall 16 has already been referred to. At this time, attention is called to the fact that a recess or pocket 54 is formed in this wall so as to minimize the thickness of the wall 16 in the region of the magnetic field associated with the magnet 52. Anchored at one end to the outer surface of the front wall 16 is a leaf spring 56. A pair of screws 58 provide the anchoring action and a screw 60 permits adjustment to be made of the leaf spring with respect to its flexibility. The screw 60, as can be seen from FIGURE 2, is threadedly carried by the spring 56 and abuts at one end against the wall 16.

A second permanent magnet 58, which is indentical to the previously-mentioned magnet 52, is mounted at the free end of the leaf spring 56. Up to this point, nothing has been said concerning the pole arrangement of the magnets 52, 58, which are in the form of rectangular wafers. It will be understood that every permanent magnet has both a north and south pole. It is intended that the magnets 52, 58 be magnetized in the direction of their pressing. This causes a flux concentration to exist near each end of the magnet and on one face thereof. It is further intended that the two magnets be mounted with their magnetized faces nearer each other and with their like poles directly opposite. Hence, by reason of the fact that like magnetic poles repel each other, there is a strong magnetic field produced that causes the two magnets 52, 58 to be urged apart. Hence, when the magnet 58 is moved toward the imperforate wall 16, there is a magnetic field that acts upon the magnet 52 to repulse the magnet 52 and thereby move the actuating arm 46, and consequently the plunger 44, with the result that the spring 34 is deflected in such a way that the contact 33 carried thereon is moved into engagement with the contact 52. Preferably, the magnets 52 and 58, which are in the form of rectangular wafers as above indicated, are secured to the arm 46 in one instance and the leaf spring 56 in the other by a suitable adhesive, such as an epoxy resin. The point to be appreciated, though, is that similar

or like poles of the two magnets 52, 58 are oriented in a direction so that the magnetized faces thereof reside nearer the opposite faces of the imperforate wall 16 with like poles thereof directly opposed to each other.

As can be seen from FIGURES 2 and 4, the imperforate wall 16 is formed with an annular flange 60 having an outer inclined portion 62 and an inner shoulder portion 64. A bezel or retaining ring 66 is attached to the flange 60 by screws 68, the heads of these screws residing within the casing 14 but accessible by removing the backing plate 22 when the unit 12 is detached from the wall 10 by first having removed the screws 20. For a purpose described below, the retaining ring 66 is formed with a complemental inclined portion 70. Overlying the opening in the annular flange 60 is a flexible diaphragm 72, such as rubber, having a metal disc 74 adhered to the inner side thereof. In its normal condition, the diaphragm 72 biases the disc 74 away from the shoulder portion 64 of the flange 60. However, the diaphragm 72 can be readily flexed and the function of the shoulder portion 64 is to serve as a stop should the deflection reach sufficient proportions. Thus, when the unit 12 is installed in a bin such as fragmentarily shown by the wall 10 of FIGURE 1, whenever the granular material reaches the height of the unit 12, then the material presses against the diaphragm 72 to move the disc 74 against the leaf spring 56 and thereby shift the permanent magnet 58. Due to the orientation of the poles of the two magnets 52, 58, the magnet 58 repulses the magnet 52 which results in closing of the contacts 32, 33 within the housing 30 of the switch mechanism 28.

For the purpose of indicating when the contacts 32, 33 have been closed in the above-explained manner, a pair of conductors 76, 78 are shown attached to the previously-mentioned terminals 40, 42. As can be seen from FIGURE 3, the conductors 76, 78 extend upwardly through a coupling 80 which is connected to a conduit or pipe 82. The conduit or pipe 82 is mounted in place against the wall 10 by reason of a U-shaped clip 84 and mounting screws 86.

Continuing with the portion of the description pertaining to the manner in which the contact closing is indicated, it will be observed from FIGURE 1 that the conductors 76, 78 have in circuit therewith a disconnect switch 86 which will first be closed so that a battery 88 and a signal light 90 are connected in series when the contacts 32, 33 are actuated into engagement with each other. In other words, the light 90 will be energized whenever the material in the bin has reached the height of the unit 12 mounted to the wall 10 of such bin.

Although only one unit 12 has been illustrated, this particular unit indicating only when the bin has been completely filled, it will be understood that additional such units 12 can be mounted at lower elevations on the wall 10 and that similar circuitry will signify when the level within the bin has reached predetermined lesser heights. For instance, it might be desirable to indicate when the bin is one-quarter full, one-half full and three-quarters full plus the full indication shown in the accompanying drawing.

Since the operation of the unit 12 has been dealt with as the description has progressed, little need is seen for reviewing the operation in any detail. The heart of the invention, however, resides in the use of the two permanent magnets 52 and 58, one being at one side of the imperforate non-magnetic wall 16 and the other at the other side. Owing to the pole arrangement of the magnets 52, 58, a repulsive magnetic field is created which results in the inner magnet 52 being urged farther into the confines of the casing 14 whenever the leaf spring 56 is deflected sufficiently. Whenever the magnet 58 is retracted or withdrawn, though, the magnet 52 is immediately permitted to return to its normal position, this being the position depicted in FIGURE 2, by action of the expanding coil spring 50.

It will be appreciated that the casing **14** can be hermetically sealed so that there is no likelihood whatsoever of a spark igniting a dust-laden atmosphere or other explosive atmosphere. Consequently, the unit **12** is completely safe in all respects and performs a very worthwhile purpose when used in conjunction with containers of various sorts for particulate and granular materials.

While the embodiment **12** has dealt with a construction particularly suited for use in bin level sensing, it is contemplated that the invention will find other practical uses. With this in mind, a modified switch device has been illustrated in FIGURE 5, the embodiment being labeled **12***a*. Because a number of parts are either identical or closely similar to those mentioned in conjunction with the unit **12**, such parts will bear only a distinguishing suffix *a* and need not be described again in detail.

As will be discerned from FIGURE 5, a lever **100** is fulcrummed intermediate its ends by a transverse pivot pin **102** carried by a pair of laterally spaced bearings or supports **104**. The magnet **58***a* is attached to one end of the lever **100** in the same manner that the magnet **58** is affixed to arm **56** in the unit **12**.

However, instead of the diaphragm **72**, it is intended that the lever **100** be actuated manually via pushbuttons **106** and **108**, each having a cylindrical shank **110** formed with a pair of vertically spaced annular grooves **12**. Engageable in the grooves in each instance is a spring-pressed detent in the form of a small ball **114** urged by a coil spring **116** contained in a flanged tubular sleeve member **118** fixedly anchored at its flanged end to the casing **14***a*.

The operation of the switch device **12***a* is very simple. When the switch **28***a* is to be closed, the pushbutton **106** is pressed, thereby causing its shank **110** to be moved downwardly as viewed in FIGURE 5; the ball **114** will be forced out of its engaged position and to allow the shank to move. Simultaneously with this happening is the rocking of the lever **100** about the pin **102** in a clockwise direction, whereby the magnet **58***a* is moved toward the wall **16***a*.

It will be recalled that the corresponding poles of the magnets **58** and **52** are oriented with their like or similar poles directly opposite each other; this same orientation exists in this instance. Hence, the movement of the magnet **58***a* toward the wall **16***a*, and consequently in the direction of the magnet **52***a*, repels the magnet **52***a*, causing it to be forced downward against the biasing action of the coil spring **50***a*. Such action results in the switch arm **46***a* being rotated in a clockwise direction about the pivot pin **48***a* to urge the plunger **44***a* downwardly to operate the switch **28***a* just as the switch **28** is operated.

On the other hand, when the switch **28***a* is to be opened, then, the pushbutton **108** is depressed to cause the lever **100** to pivot in a counterclockwise direction. This withdraws or raises the magnet **58***a* and the coil spring **50***a* promptly returns the switch arm **46***a* to the position in which it appears in FIGURE 5. The push button **106** readily yields in permitting the foregoing action to take place.

It will, of course, be understood that various changes may be made in the form, details, arrangements and proportions of the parts without departing from the scope of my invention as set forth in the appended claims.

What is claimed is:

1. A magnetically actuated switch device comprising:

(a) a casing forming a compartment having a non-magnetic wall;

(b) a switch mechanism disposed within said compartment;

(c) a pivotal arm mounted within said compartment for operating said switch mechanism;

(d) a permanent magnet mounted on said arm with at least one of its poles adjacent the compartment side of said wall;

(e) a flexible diaphragm mounted in a spaced relationship with the other side of said wall;

(f) a second permanent magnet;

(g) a second pivotal arm on which said second magnet is mounted, said second pivotal arm being biased in a direction to cause said second magnet to normally reside in a proximal relationship with said diaphragm, said second magnet having a pole corresponding to said one pole of said first magnet facing toward said wall, whereby flexing of said diaphragm toward said wall causes said second magnet to be moved relative to said first magnet to act on the same and cause said pivotal arm to operate said switch mechanism;

(h) a non-magnetic plate secured to the side of said diaphragm facing toward said wall, and

(i) means fixedly disposed with respect to said wall for arresting movement of said plate before said second magnet engages said wall.

2. A magnetically actuated device as set forth in claim **1** wherein the bias urging the second pivotal arm in a direction to cause the second magnet to normally reside in a proximal relationship with said diaphragm includes adjustable means whereby the amount of pressure required to flex the diaphragm can be varied.

3. A magnetically actuated device comprising:

(a) a casing forming a compartment having a non-magnetic wall;

(b) a switch mechanism disposed within said compartment;

(c) a pivotal arm mounted within said compartment for operating said switch mechanism;

(d) a first permanent magnet mounted on said arm with at least one of its poles adjacent the compartment side of said wall;

(e) a flexible diaphragm mounted in a spaced relationship with the other side of said wall;

(f) a second permanent magnet mounted between said diaphragm and said wall for movement toward and away from said wall and normally biased away from said wall so that flexing of said diaphragm toward said wall causes said second magnet to be moved toward said wall, said second magnet having a pole corresponding to said one pole of said first magnet facing toward said wall whereby movement of said diaphragm and said second magnet toward said wall causes movement of said first magnet, said pivotal arm and operation of said switch mechanism;

(g) a non-magnetic plate positioned in juxtaposition to the side of said diaphragm facing toward said wall; and

(h) means fixedly disposed with respect to said wall for arresting movement of said plate before said second magnet engages said wall.

4. A magnetically actuated device comprising:

(a) a casing forming a compartment having a non-magnetic wall;

(b) a switch mechanism disposed within said compartment;

(c) a first magnet mounted within said compartment for movement between a normal position in which at least one pole of said magnet is adjacent the compartment side of said wall and a second position in which said switch mechanism is engaged and caused to operate;

(d) a flexible diaphragm mounted in a spaced relationship with the other side of said wall; and

(e) a second magnet mounted between said diaphragm and said wall for movement toward and away from said wall and normally biased away from said wall so that flexing of said diaphragm toward said wall causes said second magnet to be moved toward said wall, said second magnet having a pole corresponding to said one pole of said first magnet facing toward said wall whereby movement of said diaphragm and said second magnet toward said wall causes

movement of said first magnet toward said second position and consequent operation of said switch mechanism.

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