March 3, 1970 R. D. GUTTING 3,499,131

DEVICE FOR DETECTING AND INDICATING RELATIVE MOVEMENT OF ELEMENTS

Filed May 10, 1967

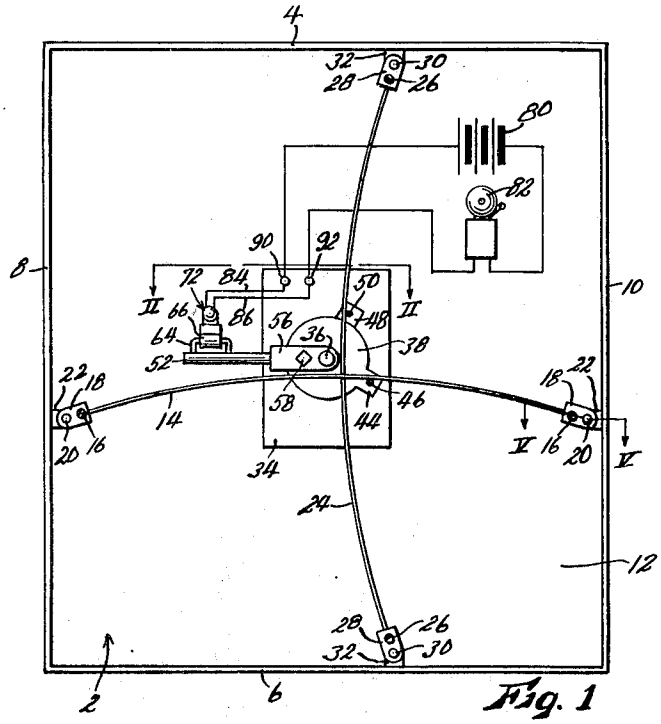


Fig. 1

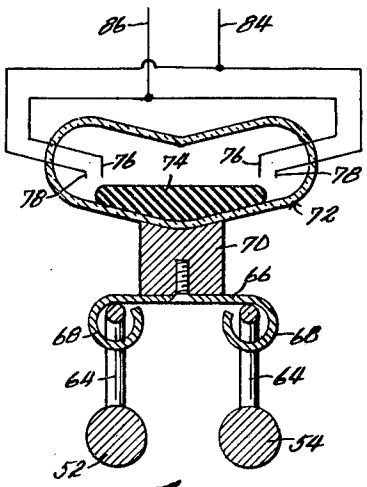


Fig. 6

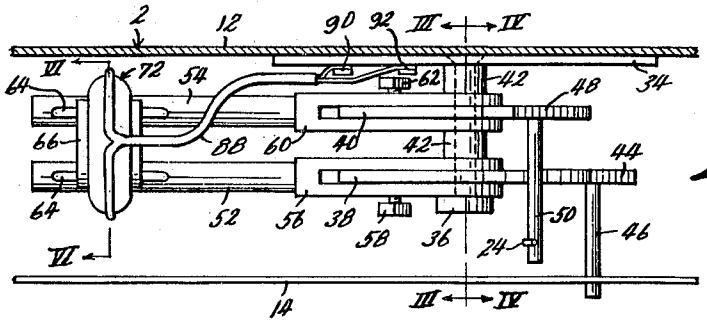


Fig. 2

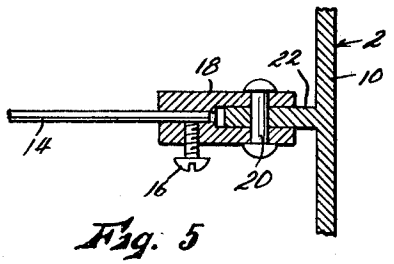


Fig. 5

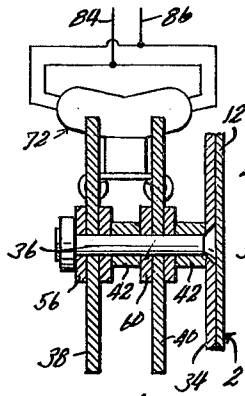


Fig. 3

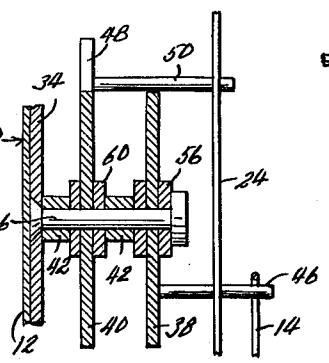


Fig. 4

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DEVICE FOR DETECTING AND INDICATING RELATIVE MOVEMENT OF ELEMENTS

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ABSTRACT OF THE DISCLOSURE

This application discloses a device for detecting and indicating relative movement between two elements, whether these elements are separate elements or different portions of a unitary structure, in which latter case the device is operable to indicate distortion of said unitary structure. The device comprises a flexible strand extending between and attached at its ends to said elements with its mid-portion laterally offset from a straight line interconnecting its ends, and a signal device engaged by the mid-portion of said strand and operable by lateral movement thereof to give any desired type of warning signal, either locally or remotely.

This invention relates to new and useful improvements in warning or alarm devices, and has particular reference to a warning or alarm device operable to detect and indicate relative movement of elements of virtually any type or description. The device has been conceived and developed primarily as a protection against the pilfering of coin-type vending machines of various types, and is designed to give a warning signal if any attempt is made to pry or force the door of such machine providing access to the coin box or coin compartment thereof. However, it will be readily apparent that use of the device is not limited to this application, but that it has a wide variety of applications in many different fields.

An important object of the present invention is the provision of a device of the character described which may be made extremely sensitive so as to be responsive to very slight movements. For example, in the vending machine application of the device given above, the device would most commonly be applied to detect and indicate distortion of the coin access door itself, or of its door frame, or both, and could easily be rendered sufficiently sensitive to give warning if any attempt were made to insert even the thinnest of prying tools between the door frame and an edge of the door.

Another object, particularly pertinent in the door application of the device as described, is the provision of such a device which will not give warning if the door is open and closed in the usual manner by authorized personnel using keys, and which need not be turned off, disconnected or in any way require the attention of said authorized personnel.

Another object is the provision of a device of the character described which is operable to give warning of relative movement of more than one pair of elements, between which relative movement can occur in different directions.

Still another object is the provision of a device of the character described which is well adapted to provide a local signal, such as a loud bell, klaxon or other audible sound to warn intruders away, or to give a remote signal to alert guards, police or other security personnel.

Other objects are simplicity and economy of construction, efficiency and dependability of operation, and adaptability for use in a wide variety of circumstances.

With these objects in view, as well as other objects which will appear in the course of the specification, reference will be had to the accompanying drawing, wherein:

FIG. 1 is an elevational view, partially schematic of a door having a device embodying the present invention applied operatively thereto.

FIG. 2 is an enlarged, fragmentary sectional view taken on line II—II of FIG. 1,

FIG. 3 is a sectional view taken on line III—III of FIG. 2,

FIG. 4 is a sectional view taken on line IV—IV of FIG. 2,

FIG. 5 is an enlarged fragmentary sectional view taken on line V—V of FIG. 1, and

FIG. 6 is an enlarged sectional view taken on line VI—VI of FIG. 2.

Like reference numerals apply to similar parts throughout the several views, and the numeral **2** applies to a planar rectangular member which could be a door or the like, said door having flanges **4** and **6** respectively at the top and bottom thereof, and flanges **8** and **10** respectively at opposite vertical side edges thereof. Extending generally horizontally across said door, adjacent but spaced apart from the body portion **12** thereof, is a flexible strand **14** which may constitute a spring wire. Each end of said wire is secured adjustably by a set screw **16** in a bracket **18** pivoted at **20** to a lug **22** affixed to the associated door flange. The two pivots **20** are parallel and normal to the general plane of the door. The length of wire **14** is such that it assumes an arcuately bowed position, as best shown in FIG. 1. The degree of bowing, or the lateral offset of the midpoint of the wire from a straight line connecting pivots **20** can be predetermined by cutting the wire to the proper length, and can further be adjusted by loosening set screws **16** and moving said wire longitudinally in brackets **18**. Similarly, a second flexible strand or wire **24** extends generally vertically across the door, each end thereof being fixed by a set screw **26** in a bracket **28** pivoted at **30** to a lug **32** fixed to the associated top or bottom flange of the door. The two wires **14** and **24** of course intersect each other at the central portion of the door.

A mounting plate **34** is affixed by any suitable means, not shown, to the body portion **12** of door **2**, so as to be generally aligned with the intersection of wires **14** and **24** as shown in FIG. 1. A stub shaft **36** is fixed in said mounting plate and extends therefrom normally to the general plane of the door. Mounted coaxially on said shaft for free rotation are a pair of discs **38** and **40**, said discs being maintained in spaced apart relation on said shaft by spacer bushings **42** on said shaft. Disc **38**, being the disc farthest from plate **34**, is provided with a radially projecting ear **44** in which is fixed a pin or finger **46** extending parallel to shaft **36** and away from plate **34**, said pin resting laterally against an intermediate portion of wire **14**. Similarly disc **40** is provided with a radial ear **48** in which is fixed a pin or finger **50** which is parallel to pin **46** and which projects past the edge of disc **38** to rest against an intermediate portion of wire **24**.

A pair of arms **52** and **54** project radially from shaft **36**, one in combination with each of discs **38** and **40**. Arm **52** is provided at its inner end with a clevis **56** bridging the edge of disc **38** and mounted for free rotation on shaft **36**, said clevis having a set screw **58** engageable with said disc to prevent relative rotation of said arm and said disc. Similarly, arm **54** is provided at its inner end with a clevis **60** bridging the edge of disc **40** and rotatably mounted on shaft **36**, clevis **60** having a set screw **62** engageable with disc **40** to prevent relative rotation thereof. Arms **52** and **54** extend radially and generally horizontally from shaft **36**, and each has a bracket **64** of inverted U-shape affixed thereto adjacent its outer end, the base or connecting portion of each bracket being parallel to its associated arm. Extending between said

brackets is a switch mounting plate **66**, each end of said plate being bent into a cylindrical tube **68** loosely engaged about the base portion of the associated bracket **64**. Attached to plate **66** intermeditae arms **52** and **54** is an upstanding switch base **70** on the upper end of which is mounted a mercury tilt-responsive switch. As best shown in FIG. 6, said switch comprises a generally horizontal tube of wide V-shape so that its ends are slightly higher than its mid-portion, having a pool of mercury **74** therein, and having a pair of electrodes **76** and **78** sealed in each end thereof so as not to engage said mercury as long as the tube remains horizontal.

The warning signal system is electrical, being energized by the closure of switch **72**. Such a system is shown schematically in FIG. 1 in a most rudimentary form. As shown, it consists of an electric circiut including, in series, switch **72**, a source of electric power represented by battery **80**, and a signal device represented by an electric bell **82**. The lead wires **84** and **86** to switch **72** are connected respectively to the electrodes **76** and **78** of the switch, so that the circuit will be completed regardless of which direction the switch is tilted, and may be enclosed in a light weigth flexible cable **88** (see FIG. 2) extending from terminal posts **90** and **92** on mounting plate **34**, so as not to interfere with the free pivotability of arms **52** and **54** relative to shaft **34**. Bell **82** may of course be mounted on or directly adjacent the door if desired, or at any desired remote station.

To set the device for use the mounting plate **34** is first attached to the door, and wires **14** and **24** are cut and mounted in brackets **18** and **28** so as to have at least a slight lateral deflection, and so as to intersect generally over the discs **38** and **40**, as shown in FIG. 1. Then with set screws **58** and **62** of arms **52** and **54** loosened, the two arms are adjusted to extend in parallel and generally horizontal relation from shaft **36**, as pins **46** and **50** of discs **38** and **40** rest laterally against wires **14** and **24** respectively. Set screws **58** and **62** are then tightened. The weight of arms **52** and **54**, and the switch structure supported thereby, then tend to rotate discs **38** and **40** in a counter-clockwise direction as viewed in FIG. 1, but this rotation is prevented by the engagement of pins **46** and **50** with wires **14** and **24**. The pins must of course be disposed at the proper sides of the wires to provide this obstruction, in other words at the "clockwise" sides of the wires as relates to shaft **36**. Thus, if the parts have been properly adjusted so that arms **52** and **54** are parallel and generally horizontal, switch **72** will then be open. The relative angular adjustability of the arms on the discs, plus the adjustability of the wires in brackets **18** and **28** provided by set screws **20** and **30**, make the setting a comparatively simple matter. In this connection, it will be noted that each of pins **46** and **50** should be so set that a radial line drawn from shaft **36** to said pin is disposed at an acute angle to the general extent of the associated wire, so that lateral movement of said wire will cause corresponding movement of the pin and rotation of the associated disc.

Switch **72** will remain open, and the alarm system inactive, so long as the spatial relationship between the ends of the two wires remains unchanged, and the door may be opened and closed in the usual manner without closing the switch or activating the alarm, and without requiring the attention of the operator to switch off the alarm, or for any other purpose. However, should any attempt be made to force the door open, as by inserting a prying tool between the edge of the door and its door frame, the door will be distorted somewhat, and the alarm will be activated. For example, if a prying tool is inserted between the door frame (not shown) and either of the vertical side edges of the door, the prying force will tend either to crush or compress the door laterally, or to move flanges **8** and **10** therof closer together. This moves the ends of wire **14** slightly closer together, causing said wire to be bowed more sharply, allowing pin **46** to move upwardly, whereby disc **38** is turned in a counter-clockwise direction by the weight of arm **52**. The resultant lowering of the outer end of arm **52**, causes switch **72** to tilt so that mercury **74** interconnects electrodes **76** and **78** at the left end thereof, as viewed in FIG. 6, whereupon the circuit of bell **82** is completed to give warning that the door is being tampered with. The bell could of course be directly at or adjacent the door, with the purpose of frightening the intruder away, or at any desired remote location to alert police, guards, or other security personnel. On the other hand, if the door, or flanges **8** and **10** thereof, should be distorted so as to become laterally wider, wire **14** will tend to be straightened, lowering the central portion thereof to act on pin **46** to turn disc **38** in a clockwise direction, elevating arm **52** to tilt switch **72** in the opposite direction to cause mercury **74** to interconnect electrodes **76** and **78** at the right end thereof, which completes the bell circuit as before. Similarly, any change in the vertical dimension of the door will cause either additional bowing or straightening of wire **24** to cause rotation of disc **40** in one direction or the other, thereby raising or lowering arm **54** to tilt switch **72** in one direction or the other, both of which will cause closure of said switch. Also, lateral compression of the door may cause simultaneous vertical elongation of the door, so that lowering of arm **52** will be accompanied by a corresponding elevation of arm **54**, to cause even more rapid and sharp tilting of the switch. This results in even greater sensitivity of the device to compound distortion of the door. Thus, almost any change in the spatial relationship of the ends of wires, in the general plane established by said wires, will cause actuation of the alarm or signal device.

One outstanding advantage of the device is the extreme sensitivity obtainable, so that extremely slight relative movement between the opposite ends of either wire will actuate the signal. Switch **72** itself may of course be made to close on very slight tilting thereof. The sensitivity is also greatly increased by the fact that very slight relative movement of the ends of either wire results in a multiplied lateral movement of its mid-portion, and it is of course the lateral movement which directly actuates the switch. This multiplication ratio is generally approximately equal to the ratio between half the distance between the ends of a wire, and the lateral offset of the middle portion of the wire. For example, if there is 30 inches between the ends of a wire, and its midportion is offset one and one-half inches, any change in the distance between the wire ends will product 10 times as great a change in the lateral offset of the midportion of the wire. Sensitivity is further multiplied by the ratio between the distance of switch **72** from shaft **36** and the distance of pins **46** and **50** from said shaft since a given movement of either pin by its associated wire will produce a correspondingly greater vertical movement of arm **52** and **54**. Sensitivity is further increased by increasing the angle between a radius line from shaft **36** to either pin, relative to the general extent of the associated wire. The greater this angle, less than 90 degrees, the greater the angle the associated disc will be turned by a given transverse movement of the wire. Sensitivity is still further increased by the ratio between the length of either arm **52** or **54** and the distance between the pivotal mounts **68** of the switch, since a given degree of tilt between said arms will produce a correspondingly greater degree of tilting of the switch.

While I have shown and described a specific embodiment of my invention, it will be readily apparent that many minor changes of structure and operation could be made within the purview of the invention. For example, any flexible strands such as pliable strings could be substituted for wires **14** and **24**, though the wires have been found generally preferable since they tend to hold fixed positions better than strings, and are not subject to longi-

tudinal stretching or contraction as a result of moisture, as are strings. Other switches, such as mechanical microswitches, or other mechanically actuated members, could be substituted for switch **72**. The mercury switch of course is also sensitive to agitation so as to actuate the signal if the door is shaken or agitated even if not distorted. This may be highly desirable in the vending machine application described, so as to give a signal if the machine is tilted or moved, as if being stolen, without any attempt being made to force the door. If this type of actuation is not desired, other types of switches or actuators could be used. The signal circuit actually shown is of course only rudimentary, and could be varied widely within the scope of the invention. For example, any type of signal device, local or remote, could be used, such as buzzers, sirens, flashing lights or others could be used. A holding circuit could be added to insure continuous operation of the signal once started, even if distortion of the door were relieved and switch **72** opened, or a timer to cause operation for a pre-determined time to frighten an intruder away. Another possibility, particularly applicable in the vending machine use, is to actuate the signal device for a pre-determined time period on the first closure of switch **72**, then to actuate the signal continuously on the second closure of switch **72**, in the event the intruder is not frightened by the first operation, and tries again. These and many other variations of circuitry are of course possible, but the details thereof are not considered pertinent to the present invention, which primarily concerns the actuating means for such circuits.

The device is also subject to other variations. For example, in some applications only one of wires **14** and **24** would be needed, for detecting relative movement between two elements only. In such cases, only one wire pin, disc and arm would be used, and switch **72** could be fixed directly on the single arm, with its longitudinal axis generally parallel to said arm. It is perhaps also to be emphasized that the application of the device to a door, as shown, is exemplary only. The device could also be mounted with the wires extending across a door frame, so as to detect and indicate distortion of the door frame rather than the door itself. In some applications this would be objectionable since the wires would then obstruct the door opening, However, in vending machines the access doors to be protected often provide access only to shallow recesses, and the wires can easily be arranged so as not to obstruct access to coin boxes and the like within said recesses. In this application the mounting plate **34** could be attached to nearly any support, even to an arm projecting from the door frame itself, since even then relative movement of opposite sides of the frame would still actuate the device. Also, use of the device is of course not restricted to doors or door frames, or to applications in which it detects distortion of structures. Most broadly stated, it is adapted for use in detecting and indicating relative movement between elements of any sort, whether said movement represents distortion or is normal and expected. The wire could be extended between elements of a machine, for example, where relative movement of said elements might indicate a need for servicing or repair of the machine. In this connection, it is important to note that the present device can be calibrated not only to give a signal of relative movement per se, but to give a signal as a result of a predetermined degree of relative movement. This calibration can be performed by adjusting the sensitivity of the device, as for example by varying the curvature of the wires, or by varying the angularity of the radius line from shaft **36** to either of the pins **46** or **50** with respect to its associated wire.

What I claim as new and desire to protect by Letters Patent is:

1. A device for detecting and indicating relative movement between a pair of elements, said device comprising:

(a) an elongated flexible strand extending between and attached at its respectively opposite ends to said elements, said strand being of greater length than the distance between said elements and having an intermediate portion thereof offset laterally from a straight line connecting its ends,

(b) a signal device, and

(c) actuator means for said signal device comprising a disc disposed intermediate the ends of said strand and carried for rotation on a horizontal axis transverse to the plane established by the lateral offset of said strand, a finger projecting from said disc parallel to but eccentrically offset from the axis thereof, and engaging said strand, an arm affixed to and projecting radially from said disc, the weight of said arm biasing said disc rotatively to maintain said finger against said strand, and means operable by rotative movement of said arm in either direction to actuate said signal device.

2. A device as recited in claim **1** wherein said signal device is electrically operated and has an operating electric circuit including a normally-open, tilt-responsive switch, said switch being carried by said arm and constituting the means operable by rotative movement of said arm in either direction to actuate said signal device.

3. A device as recited in claim **1** with the addition of means for adjusting the angularity between said arm and said finger, relative to the axis of said disc.

4. A device as recited in claim **1** including a pair of said strands extending generally angularly to each other and each connected at its respectively opposite ends to a pair of elements, a pair of said discs mounted coaxially for independent rotation, a pair of said fingers carried respectively by said discs and each engaging one of said strands, and a pair of arms each attached to and extending radially from one of said discs, said arm normally being substantially parallel, and wherein said means operable to actuate said signal device is carried by both of said arms and is responsive to the movement of said arms into non-parallel relationship.

5. A device as recited in claim **4** wherein said last named means comprises a normally-open, tilt-responsive electric switch normally extending horizontally between said arms parallel to the axis of said discs, and pivoted to said arms on axes radial to said disc axis, said switch being operable to close on tilting thereof in either direction from its normal horizontal postiion.

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U.S. Cl. X.R.

200—61.93, 152; 340—274, 276