Dec. 14, 1965 D. F. UECKER 3,223,414

PINFALL DETECTION MEANS

Filed May 31, 1962 2 Sheets-Sheet 1

Fig. 1

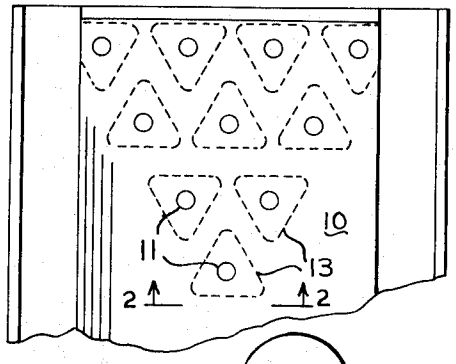


Fig. 4

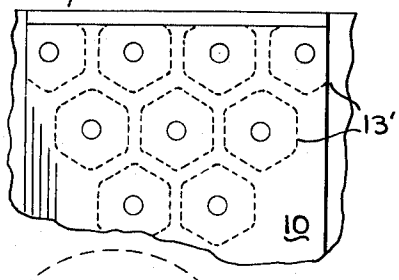
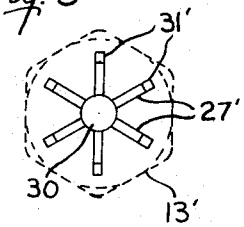


Fig. 5



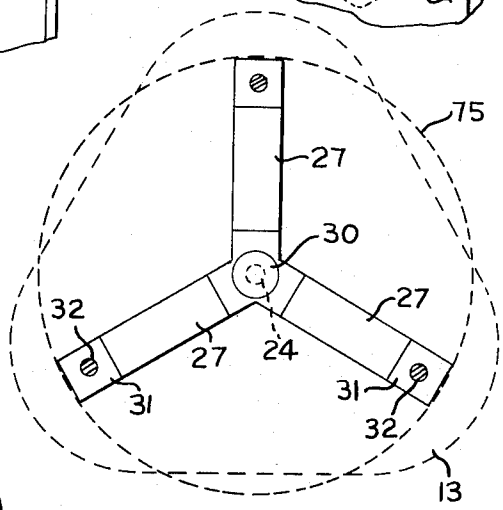


Fig. 3

Fig. 2

INVENTOR.
DONALD F. UECKER
BY Hofgren, Brady, Wegner, Allen & Stellman
ATTYS.

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Fig. 7

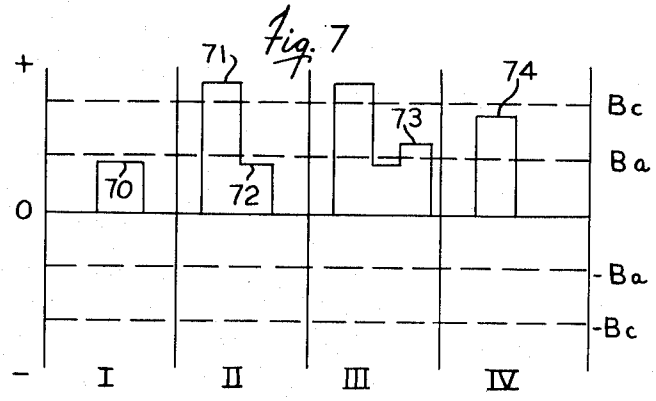


Fig. 6

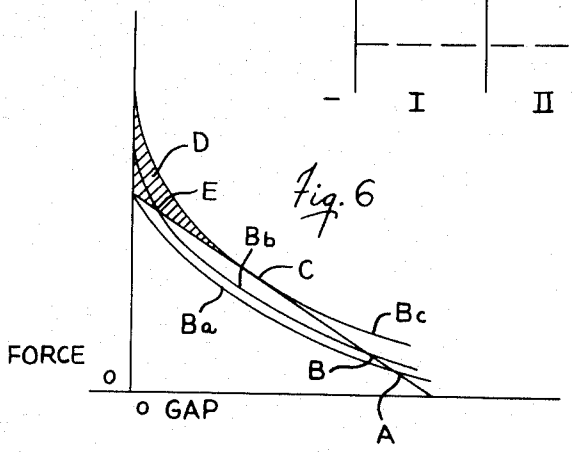
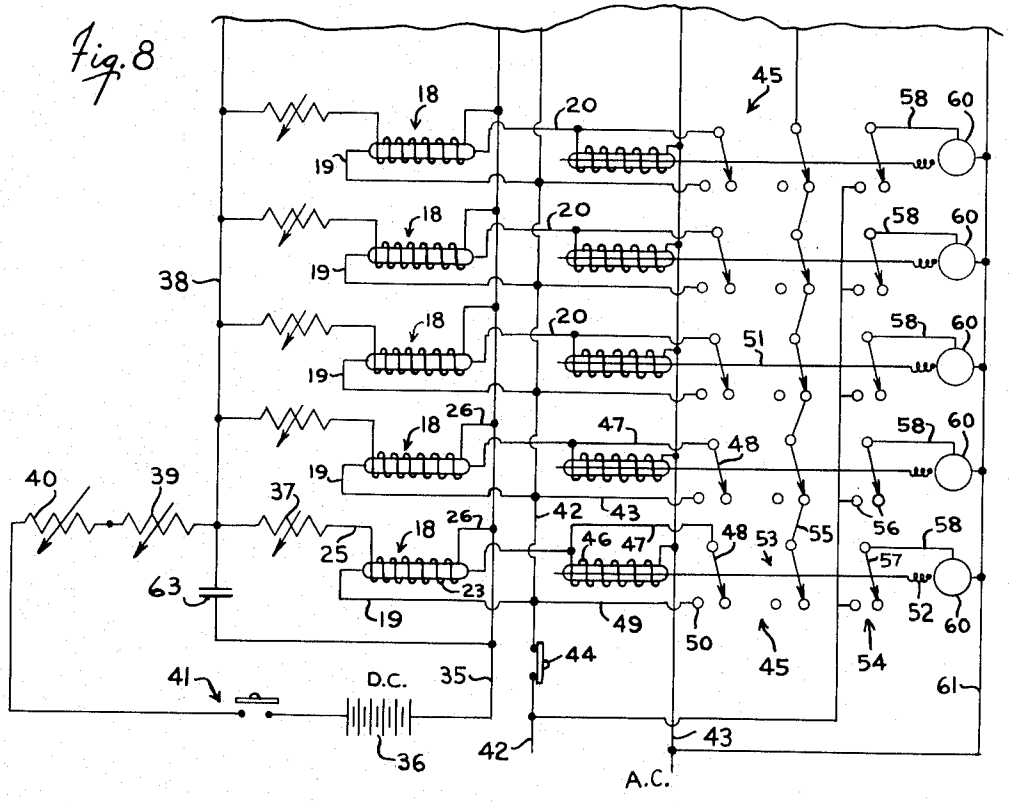


Fig. 8



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PINFALL DETECTION MEANS

Donald F. Uecker, Spring Lake, Mich., assignor to Brunswick Corporation, a corporation of Delaware

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10 Claims. (Cl. 273—52)

This invention relates to new and useful improvements in bowling pin detecting systems.

More particularly, the invention relates to bowling pin detection systems and devices for determining whether a bowling pin is standing on a bowling lane bed on a pin spot or within a predetermined area surrounding the pin spot.

It is the general object of the invention to provide a new and improved detecting system for bowling pins.

Another object is to provide a detecting means for use in detecting pins having magnets therein and, more particularly, for use in detecting standing pins having vertically positioned magnets at the lower end of their central axes.

A further object is to provide such detecting devices with so-called reed type switches or relays, with means for normally biasing the reed switch to increase its sensitivity and with additional means for extending the area within which pins may be detected.

Other objects and advantages will become readily apparent from the following detailed description, taken in connection with the accompanying drawings, in which:

FIG. 1 is a fragmentary plan view of the pin supporting portion of a bowling lane bed with a preferred form of the invention installed thereon;

FIG. 2 is an enlarged fragmentary vertical view along line 2—2 of FIG. 1, showing a preferred form of the invention;

FIG. 3 is a horizontal view along line 3—3 of FIG. 2;

FIG. 4 is a view similar to FIG. 1, with a modified form of the invention installed on a bowling lane bed;

FIG. 5 is a view similar to FIG. 3, but on a reduced scale, of the modified form of the invention;

FIGS. 6 and 7 are graphs; and

FIG. 8 is a wiring diagram of a portion of a detecting system including indicating lights.

While there is illustrated and described herein a preferred form of the invention together with a modification thereof, they are shown with the understanding that they are for the purpose of disclosing the principles of the invention and are not to limit the invention to the particular forms. The scope of the invention will be pointed out in the appended claims.

As shown in the drawings, **10** represents the pin supporting end of the bed of a bowling lane, and has the customary ten pin spots **11** for locating pins **12** as shown in FIG. 2. The somewhat triangular areas **13** indicate approximately the areas in which standing pins will be detected by the form of the invention illustrated in FIGS. 1 to 3.

The invention is directed to a system for detecting and indicating the presence or absence of pins in the ten areas **13** adjacent the ten pin spots **11** when the pins are provided with magnets **15**, and detecting devices **16** under the pin spots **11** are sensitive to the magnet **15** in a standing pin **12** but not to a fallen pin or the absence of a pin. The bowling pin **12** is shown with an axially positioned cylindrical bar magnet **15** having its lower end approximately flush with the pin base **17**.

In FIGS. 1 to 3 the detecting device **16** is shown as comprising a reed switch **18** positioned below and coaxially of the pin spot **11**. Leads **19** and **20** connect with the reed switch contacts **21** and **22** respectively, and a biasing coil **23** surrounding the envelope **24** of the switch

has leads **25** and **26** at its ends. The arrangement of such switches in a circuit will be described hereinafter.

In order to extend the sensitive area of the detecting device, the invention contemplates the provision of a magnetically conductive means or structure intermediate the switch **18** and the pin spot **11**. In FIGS. 2 and 3 such means is in the form of a spider having iron pole pieces or members **27** extending upwardly and outwardly from an integrally formed central plate **30** located immediately above the upper end of the switch and below an associated pin spot. The upper ends of the pole pieces are provided with integral horizontal portions **31** to facilitate attachment to the underside of the bed **10** by screws **32**. A detecting device of this form is sensitive to pins standing within a substantial area around a pin spot, as for example the triangular area **13** in FIG. 3, when the magnet **15** in the pin is positioned vertically therein and with its lower end exposed, and the associated reed switch **18** is located coaxially of the pin spot and provided with a biasing coil.

In the modified form illustrated in FIGS. 4 and 5, the magnetically conductive means is shown as comprising a central iron plate **30** and six outwardly and upwardly extending integral pole pieces or members **27'** having attaching portions **31'**. With this form of metal spider the sensitive area of the detection device is more in the nature of the hexagons **13'**.

Considering a two-pole magnet such as **15**, of length L, the magnetic field is most intense between the poles along the magnetic axis, but if the magnet were inserted completely into a bowling pin, such field might be inaccessible for detection purposes. The field strength diminishes generally at all points more remote, but that field lying generally outside the ends of the magnet diminishes more slowly than that transverse to the magnetic axis, and at a distance from the magnet greater than L the endwise field is the stronger, being twice as strong at distances much greater than L.

It follows that a preferred magnet embodiment consists of a cylindrical bar magnet whose magnetic axis coincides with the longitudinal pin axis and one of whose ends is flush or nearly so with the pin base. With this arrangement, the field generally downward from a standing pin is as intense as possible and that from a lying pin is relatively weaker and at right angles. Also, there are no azimuth effects resulting from turning a standing pin on its longitudinal axis, as might happen after several settings by the usual pinsetter machine.

It is preferable to use Alnico V for the magnetic material in the pin as it is among the most energetic materials available. Its magnetic characteristics require that, for its most efficient functioning, its length be about four times its diameter. It has been found that such a magnet ⅜" in diameter by 1½" long in a tenpin is adequate to operate the detection system, and that this size can be accommodated in the hole in a pin base as customarily supplied by the trade, without additional machining and at low cost.

Other magnetic materials might also be used provided the material can be conveniently fitted into the pin and will produce sufficient energy.

A reed switch such as **18** consists generally of two thin, permeable, conductive reeds **21** and **22** whose adjacent ends overlap in the longitudinal direction with a slight gap in the transverse direction. The outer reed ends connect into an electric circuit, for which the gap constitutes a normally open circuit. Such constructions are commercially available, and are attractive because of their low cost, freedom from pivot joints, and their hermetically sealed, inert gas atmosphere for contact protection.

They are, therefore, a preferred construction although functionally similar constructions might also be used.

If such a switch is placed in a magnetic field with its longitudinal axis more or less in the direction of the field, the relatively high permeability of the reeds causes a local increase in field strength and the appearance of magnetic poles at the cantilevered ends of the reeds. The magnetic poles cause the reed ends to be attracted to each other, as is well known, with a force that increases rapidly as the gap is closed. At some field strength the magnetic attraction is sufficient to overcome the stiffness of the reeds and the gap closes rapidly and completely. These relations are depicted in FIG. 6. The magnetic forces resulting from three different intensities of magnetic field are shown as curved lines B*a*, B*b* and B*c*. In the case of the low field intensity B*a*, the magnetic force can deflect the reeds only to point A, short of closure. At an intermediate field of strength B*b*, the reeds would partially close to point B. At a particular higher field intensity B*c*, the magnetic curve would become tangent to the spring constant line at C and the gap would close completely with surplus energy as shown by the area D and a residual force producing contact pressure. As the fields were reduced, the contacts would remain closed, as at E, until no excess force or energy were available, at which time the contacts would spring apart again. This snap action is highly desirable to prevent contact burning and to provide shock and vibration resistance. It can be made as slight or pronounced as desired by varying the stiffness of the reeds and the magnetic proportions.

These relations lead to the conditions shown in FIG. 7 for a particular switch. Line B*c* indicates the field strength required to close the switch, i.e., the upper line of FIG. 6. B*a* indicates the drop out field, i.e., the lower line of FIG. 6. By providing a bias field associated with the subdeck equipment, the switch can be put in the intermediate condition B of FIG. 6 before the flux from the pin is applied. By adding sufficient bias field to move point B very close to point C, only a slight incremental field from the pin is required to operate the reed switch. The reed switches are insensitive to field polarity and would operate as well at —B*c* and —B*a*, but if the pin magnets are all inserted with a given polarity, only one direction need be considered.

Generally, it is not desirable that the detection system be equally sensitive at all times. The mechanical shock and vibration of pinfall suggest that the detection system be activated after each ball is thrown only after the pins have assumed essentially rest position, and the fact that the pinsetter may subsequently re-spot or sweep the standing pins suggests that the results of the interrogation be stored in a memory such as a bank of holding relays.

Four different bias examples are indicated in FIG. 7. In Example I, a bias **70** slightly less than B*a* is applied, with the result that the operating pin field is reduced from B*c* to little more than B*c*—B*a*. In Example II, the switch is closed by a bias pulse **71** greater than B*c*, subsequently the bias is reduced to **72** just under B*a*, and only if a standing pin contributes a field to equal B*a* will the switch remain closed. This approach has the shortcoming that during the second interval the switch has little surplus energy and may be of high resistance. Accordingly, in Example III the bias **73** is increased to a value between B*c* and B*a* for readout. My preferred method is shown in Example IV, in which the bias pulse **74** approaches B*c*. It has the advantage of requiring no more pin field than in Examples II or III, results in low resistance, vibration-resistant contact, and can be completed in a shorter interval with simpler bias switch gear.

The above assumes that the bias field and the pin magnet field are cooperative in their effect on the reed switch; although there is no operational advantage to be gained, the polarity of the bias field might be chosen to oppose the pin magnet field and increased so as to be slightly greater than B*c* or B*a* as the case may be. In such case, closure of the reed switch would signify a fallen pin and vice versa.

With a ⅜ x 1½ Alnico V magnet, the reed switch mounted vertically with its upper tip about 5" below the playing surface, and bias conditions as in Example IV above, it is possible to detect a standing pin over about a generally circular area of 3½" radius. The sensitive area is preferably extended by using a magnetic means extending from the region of the switch toward the playing surface. In the preferred embodiment as shown in FIGS. 2 and 3, and with the bias adjusted so that a fallen pin does not close the switch, a sensitive area about as shown at **13**, with a 6" extreme radius has been obtained. The 5" radius of the pole pieces, circularly arranged as represented at **75**, the 5" depth of the switch below playing surface, and the number, exact angle, or cross sectional area of the pole pieces are not critical.

Preferably the switch and its associated bias coil are supported from the spider plate **30** by a coil spring **33** for convenience as well as its vibration isolation action.

FIGURE 8 is a fragment of a circuit diagram showing a pin detecting and indicating system embodying a plurality of reed switches **18** provided with biasing coils **23**. The coil leads **26** are all connected to a live wire **35** extending from one terminal of a 12 volt D.C. source **36**. The coil leads **25** are connected to individual adjustable trim bias resistors **37**, the other ends of which are connected to a common line **38** which in turn is connected to the other side of D.C. source **36** through an adjustable fine bias resistor **39**, an adjustable coarse bias resistor **40** and a manaully operable switch device **41**.

Lines **42** and **43** represent a source of A.C. controllable by a normally closed switch **44** in line **42**. Leads **19** from the reed switches connect with line **42**. Relays **45** are provided, one for each pin spot on the bed, however, only five are shown in the fragmentary diagram of FIG. 6. These relays have coils **46**, the left-hand ends of which are connected to the reed switch leads **20** and by leads **47** to relay-operated, normally open switch members **48** which, when closed, act to complete holding circuits which include wires **49** extending from switch contacts **50** to the line **42**. Armatures for the relays include rods **51** which are connected to operate the switch members **48** to engage the contacts **50** when the relays are energized, the rods normally being returned to the positions shown by springs **52**.

Each relay includes additional switches **53** and **54**. The switches **53** are connected in series by wires **55** and may be used in a circuit to indicate "strikes and spares." Switches **54** have contacts **56** also connected to wires **49** and have switch members **57** connected by wires **58** to one terminal of indicating lights **60** which have their other terminals connected by a wire **61** to line **43**. This arrangement results in the indication by illumination of lights **60** of the reed switches which are closed and cause energization of corresponding relays **45**.

A capacitor may be utilized as at **63** to limit the rate of current increase in biasing coils **23**, thereby to avoid shock excitation and consequent vibration of reeds **21** and **22**.

Thus it has been shown how a relatively simple and inexpensive pin detecting mechanism having small magnets in the base of the pins and reed switches positioned below the pins and sensitive to the presence of the magnets in the pin operates through a circuit to indicate standing bowling pins. Also, further improvements such as a magnetic means between the magnets and the reed switches, and electrical bias on these switches have been described to provide a more effective and useful detecting system. Further a relatively simple circuit, as shown, has been devised to provide for the biasing of the reed switches to permit a small magnetic field caused by the presence of a standing bowling pin to actuate the detection means and

to use the signals for indicating pinfall or for other purposes.

I claim:

1. A detector for a bowling pin containing a vertical permanent magnet comprising: a bowling alley having a pin spot thereon, a magnetically actuated reed switch located vertically beneath said bowling alley pin spot and in an upright position, a metal structure located beneath and around said spot and effective to produce conducting paths for magnetic forces from such a pin standing on or near said spot to the switch, said structure comprising a plurality of metal members extending radially outwardly and upwardly from an integral joining member located immediately above the switch, and means forming a magnetic bias on said switch operable when energized to partially close it.

2. A detector for a bowling pin containing a vertical permanent magnet comprising: a bowling alley having a pin spot thereon, a magnetically actuated reed switch located vertically beneath said bowling alley pin spot and in an upright position, a metal structure located beneath and around said spot and effective to produce conducting paths for magnetic forces from such a pin standing on or near said spot to the switch, and means forming a magnetic bias on said switch operable when energized to partially close it.

3. A detector for a bowling pin containing a vertical permanent magnet comprising: a bowling alley having a bed with a pin spot thereon, a magnetically actuated reed switch located vertically beneath said bowling alley pin spot and in an upright position, and a magnetic structure between the pin spot and the switch effective to enlarge the area on the bed on which such a bowling pin could stand and stil affect the magnetically actuated reed switch.

4. A pin detector for a bowling pin containing a permanent magnet therein with one pole above the other when the pin is standing comprising: a bowling alley having a bed with a pin spot thereon, a reed type switch located in upright position coaxially of said bowling bed pin spot and vertically beneath it, means for producing a bias magnetic field on the switch, and a magnetic structure between the pin spot and switch effective to enlarge the area on the bed on which such a bowling pin could stand and still maintain the switch closed, said structure comprising a portion immediately adjacent the upper end of the switch and portions extending outwardly and upwardly from said first-mentioned portion.

5. A pin detector for a bowling pin containing a permanent magnet therein with one pole above the other when the pin is standing comprising: a bowling alley having a pin spot thereon, a reed type switch located in upright position coaxially of said bowling bed pin spot and vertically beneath it, and means for producing a bias magnetic field on the switch.

6. A pin detector for a bowling pin containing a permanent magnet therein with one pole above the other when the pin is standing comprising: a bowling alley having a pin spot thereon, a magnetically actuated reed type switch located in an upright position coaxially of said bowling pin bed spot and vertically beneath it.

7. A bowling pin detection means for detecting standing pins having magnets therein, comprising: a bowling alley having ten triangularly arranged pin spots thereon; a magnetically operable circuit control device beneath each pin spot responsive to a pin standing thereabove; and a magnetic structure beneath each pin spot around the axis thereof for assisting flux from a standing pin to operate the circuit control device associated therewith; said magnetic structures each defining a polygonal detection area enlarged relative to the pin spot with which it is associated, in which a pin will operate said device, said pin detection areas being oriented relative to each other without overlap and with limited clearances therebetween.

8. In combination with a bowling alley having a plurality of pin spots at positions where pins are set upright on the alley for bowling, a pin detector for detecting the presence or absence of bowling pins on said pin spots and in a predetermined area therearound comprising: a bowling pin for each pin spot, each bowling pin containing a coaxial magnet; a magnetically operable vertically positioned reed switch for each pin spot, each reed switch having an elongate non-magnetic envelope with two aligned overlapping contact reeds therein, said reed switches each being located coaxially of one of said pin spots and vertically spaced beneath the respective pin spot; a metal spider for each pin spot, each spider having a central plate located immediately above the switch associated with the respective pin spot and below said pin spot, and said spiders each including iron pole pieces extending upwardly and outwardly from the central plate thereof to the lower surface of said bowling alley; means forming a magnetic bias on each said switch including a coil surrounding the respective switch envelope and an electric circuit connected to each coil, each circuit providing a current path to its respective coil when the circuit is completed to partially close the respective switch; and an indicating electric circuit for each pin spot, each indicating circuit including one reed switch associated with the respective pin spot, each of said indicating circuits being adapted to be completed when the reed switch therein is closed by the effects of the respective pin magnet.

9. Bowling pin detecting means comprising: a magnetically operable reed switch having an elongate non-magnetic envelope with two aligned overlapping contact reeds therein; a metal spider associated with said reed switch, said spider having a central plate located immediately above the switch with iron pole pieces extending upwardly and outwardly from the central plate to define a pin detection area of triangular configuration; and means for providing a magnetic bias on said switch including a coil surrounding said envelope.

10. Bowling pin detecting means comprising: a magnetically operable reed switch having an elongate non-magnetic envelope with two aligned overlapping contact reeds therein; a metal spider associated with said reed switch, said spider having a central plate located immediately above the switch with iron pole pieces extending upwardly and outwardly from the central plate to define a pin detection area of hexagonal configuration; and means for providing a magnetic bias on said switch including a coil surrounding said envelope.

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DELBERT B. LOWE, *Primary Examiner.*