

Feb. 28, 1961

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2,973,206

BOWLING PIN

Filed Oct. 11, 1956

2 Sheets-Sheet 1

FIG. 1

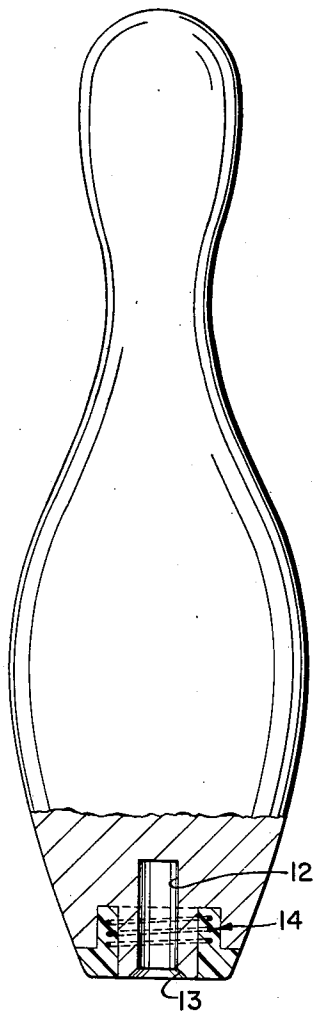


FIG. 2

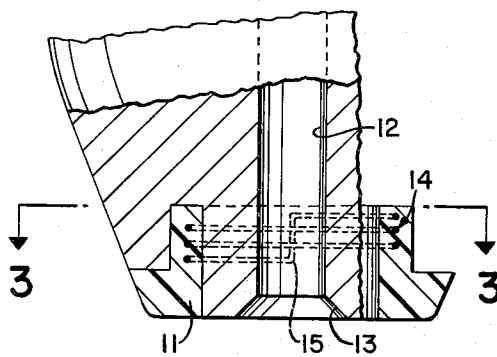
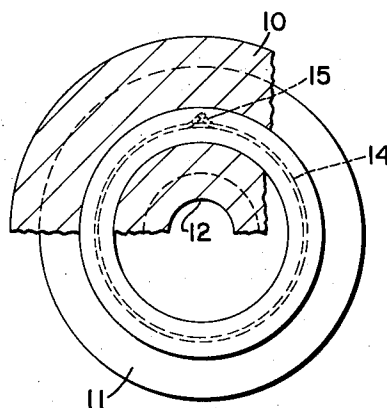


FIG. 3



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FIG. 4

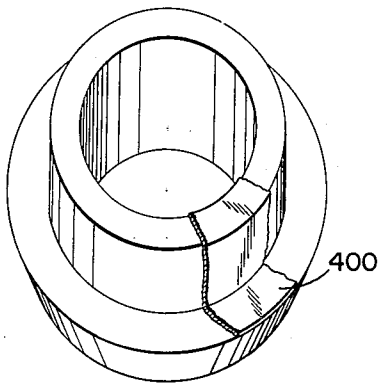


FIG. 5

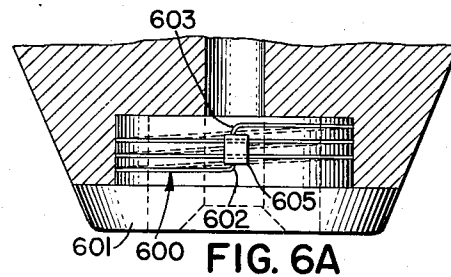
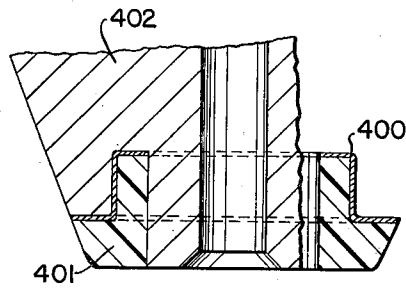


FIG. 6

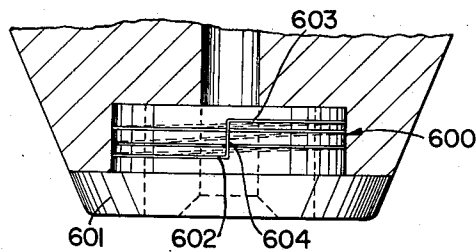
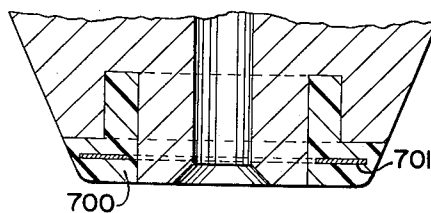


FIG. 7



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2,973,206

## BOWLING PIN

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8 Claims. (Cl. 273—82)

This invention relates to bowling pins having a resonant electrical structure consisting of a ring and/or a coil with or without a series capacitance located at the base of the pin to provide a means for detecting the presence or the wobble of the bowling pin near an electronic or electrical detecting circuit.

A bowling pin embodying the invention is supported on the alley floor and the floor is provided with a plurality of floor coils. The pin circuit and the floor coil circuits are preferably tuned to an appropriate frequency supplied by an oscillator or other type of source of alternating current. The floor coils or the condenser plates are made of sufficiently large diameter so as to allow for a lateral displacement of the pins from their normal on the spot positions without being knocked down, which occasionally occurs during the game. When such lateral shifting of the pins takes place, it is still necessary to retain appropriate coupling between the pin circuit and the floor coils so as to indicate the presence of such pins on an indicator (not shown) which indicates the presence and absence of the pins after the balls are rolled in the course of a game.

Before proceeding with the description of the pin structures per se, which constitute the object of this invention, it should be stated here that the disclosed pins are suitable for use with pin presence and wobble detecting control systems using either an inductance or capacitance bridge or a control circuit connected to an appropriate oscillator whose output is modulated by a wobbling pin or the amplitude of the control signal is increased when a pin is present and is decreased when the pin is absent. The above change in the amplitude of the output signal will take place if the floor circuit is tuned to the oscillator frequency with the pin absent. The floor circuit then will have the highest impedance when the pin is removed from the spot. It is apparent that the output signal amplitude can be made to increase (the IR drop across an output resistor) when the pin is present and decrease when the pin is absent by tuning the circuit with the pin present.

It is, therefore, an object of this invention to provide bowling pins having an electrical impedance circuit in the base of the bowling pin for producing wobble or presence signals in electrical control circuits inductively or capacitively coupled to such control circuit.

It is also an additional object of this invention to provide a bowling pin having a single turn or a multi-turn coil imbedded in a plastic base of the pin, the coil being tuned to a resonant inductive circuit imbedded in that portion of the floor which supports the pin.

Still another object of this invention is to provide a bowling pin having a plastic base and an inductive or capacitive, or both, circuit mounted on said plastic base, the circuit including a coil and a condenser or only a condenser connected across the coil, the coil and the condenser being tuned to the frequency of the voltage applied through a floor coil or a capacitor connected to a source of alternating current, the floor coil or the capacitor, or

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both, being placed in the floor in concentric relationship with respect to the vertical axis indicating the normal spot position of the pin.

The novel features which are believed to be characteristic of the invention, both to its organization and method of operation, together with the further object and advantages thereof, will be better understood from the following description taken in connection with the accompanying drawings in which the single embodiment of the invention is illustrated here as an example of the invention. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the elements of the invention. Referring to the drawings:

Figures 1 and 2 are vertical side-views of a bowling pin with the base of the pin being shown in section and including a plastic base with a coil imbedded in the plastic base;

Figure 3 is a plan view, taken along line 3—3, Fig. 2, of the plastic base shown in Figs. 1 and 2, and the lower portion of the pin sector;

Figures 4 and 5 are a perspective view and a vertical section view of the pin base having a plastic insert and a ring-shaped, single-twin metallic coil superimposed on the top of the plastic insert;

Figures 6 and 6A are vertical side-views of a pin base, and a base insert, made of an insulating material, and a coil mounted along the outer surface of the base insert;

Figure 7 is a vertical section of a bowling pin base having a plastic insert with an imbedded metallic ring.

Referring to Figs. 1 through 3, they illustrate a bowling pin 10 having a plastic base insert 11 securely attached to the wooden portion of the pin. The wooden portion of the base is provided with a central hollow portion 12 terminating in a cone portion 13 constituting the centering hole and a countersink usually provided in the wooden base portion of the pin in the course of its fabrication on a turning machine or a lathe. This centering hole and countersink are not necessary for proper functioning of the invention, and are indicated in the drawing solely for the purpose of indicating that the invention can be used without modifying the standard construction of the wooden pins. Imbedded in the plastic base insert 11 is a three-turn coil made of copper wire. The three turns are closed, or connected, by means of a cross-bar portion 15. Selection of suitable material for base 11 is governed by the selection of material capable of reducing pin wear to a minimum so as to preserve flatness of the bottom, and verticality of the pin when the pin is set on the alley floor. Moreover, the material should have good electrical insulating and dielectric characteristics, that is, as loss-free a dielectric constant at the frequencies used as it is possible to obtain.

The disclosed pin structures are designed to work with a system which requires the use of sensors in the alley floor which take the form of a coil mounted in the alley floor and a coil, such as coil 14, mounted in the base of the pin. A change in the coefficient of coupling between the two coils provides either a modulated signal or a reduction in the amplitude of the signal appearing across the floor coil when the pin is wobbling or is knocked down, respectively. The magnitude of the useful signal is a function of the frequency used in the detector part of the control circuit, the degree of coupling between the coils, the figure of merit of the coils, whether the circuit is a tuned circuit or untuned, and other known factors influencing the behavior and the sensitivity of the detector circuits of the above type. Insofar as the operating frequency is concerned, the ultra-high (UHF) and the very high (VHF) range is not suitable because of the excessive losses in the surrounding medium at these frequencies. The audio frequencies are equally unsuit-

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able because it would require components of very large dimensions. Therefore, the most suitable, or practicable range is that between 100 kc. and 2 mc. This frequency range at once determines the size of the coils, the feasible number of turns and the size of the wire to be used in the coils. In one specific example, the number of turns in the floor coil was 25 turns of #30 wire, and two turns of #14 wire in the pin coil with a capacitor connected across the floor coil to tune it to 2 mc. The above considerations also determine as to whether the pin coil should or should not have a capacitor. When the operating frequency is sufficiently high, the pin coil itself may have sufficient distributed capacitance so as to tune this coil to the desired frequency. When the operating frequency is relatively low, then a capacitor may be readily connected across the pin coil so as to tune it to the operating frequency. It can be readily shown that the useful signal is proportional to  $K_2 Q_{s2}$ , where K is the coefficient of coupling and  $Q_s$  is the figure of merit of the pin coil. From the above, it follows that coil 14 in Figs. 1-3 or the coil-capacitor combinations shown in Fig. 6A should be tuned to the operating frequency so as to have as high a  $Q_s$  as possible.

Figures 4 and 5 illustrate an additional version of the pin coil construction. A metallic ring 400 is superimposed over a plastic base 401 and the two are fastened by means of set-screws or glue to the pin 402. The single turn coil 400 also may be deposited on the plastic base 401 by using the photo-etching techniques widely used and known in the art of printed circuits. The metallic insert 400 can also act as a capacitance element or as a capacitance inductance element for changing the impedance of the control or detector circuit.

Figures 6 and 6A illustrate the use of the photo-etching technique for depositing a multiturn coil 600 on a plastic base 601. To produce the coil of this type, a metallic layer may be deposited by plating or other means on the cylindrical portion of base 601 and then a coil pattern 600 retained on this layer during the etching step. The two ends 602 and 603 of the coil are then joined together by means of a bridge wire 604. The bridge wire 604 may be also replaced with a capacitor 605 connected in series with the coil, as illustrated in Fig. 6A.

Figure 7 illustrates a plastic base 700 and a single turn coil or a condenser plate 701 imbedded in the base 700. The flat metallic ring 701 may be formed so as to produce a number of concentric, serially connected turns lying in a single plane; the ends of these turns are then connected together by means of a bridge wire, such as wire 604, or condenser 605.

The disclosed bowling pins have the same dynamic characteristics as the pins having no detecting circuit incorporated in the base of the pin. This follows from

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the fact that the mass of the detecting circuit is negligible and it is symmetrically distributed around the axis of the pin, i.e., it is concentric with the pin axis. Accordingly, the detecting circuit will not produce any detrimental or extraneous effects on the scoring of the games.

What is claimed as new is:

1. A bowling pin having a base insert made of electrically insulative material, a multi-turn metallic coil mounted on said base and a capacitor connected in series with said coil.
2. A bowling pin comprising a non-magnetic body, an electrically insulative base attached to the bottom portion of said body, and an impedance circuit constituting an integral part of said base, said impedance circuit including an inductance element and a capacitance element connected in series with each other.
3. A bowling pin comprising a main body, an electrically insulative base attached to said body, and an impedance circuit supported by said base, said circuit including a resistance, an inductive reactance, and a capacitive reactance connected in series with each other.
4. The bowling pin as claimed in claim 3 in which said capacitive reactance is a distributed capacitive reactance.
5. The bowling pin as claimed in claim 3 in which said inductive reactance is a distributed reactance.
6. The bowling pin as claimed in claim 3 in which said inductive reactance is an inductance coil and said capacitive reactance is primarily a lumped capacitance in the form of a capacitor connected across said coil.
7. A bowling pin having an electrically non-conductive base, an electrical component associated therewith, means mounting said component in said base and permanently adhered thereto, said electrical component being operative to adapt said pin to produce a plurality of signals in a pin status detection device, a particular pin signal being representative of a particular pin status, said electrical component including a metallic member comprising a coil mounted in concentric relationship with respect to the longitudinal axis of said pin.
8. The invention as defined in claim 7 wherein said coil has a plurality of turns forming a closed electrical circuit.

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