

Dec. 10, 1963

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3,113,774

FOUL DETECTING AND SIGNALLING MECHANISM

Filed May 18, 1960

2 Sheets-Sheet 1

FIG. 1

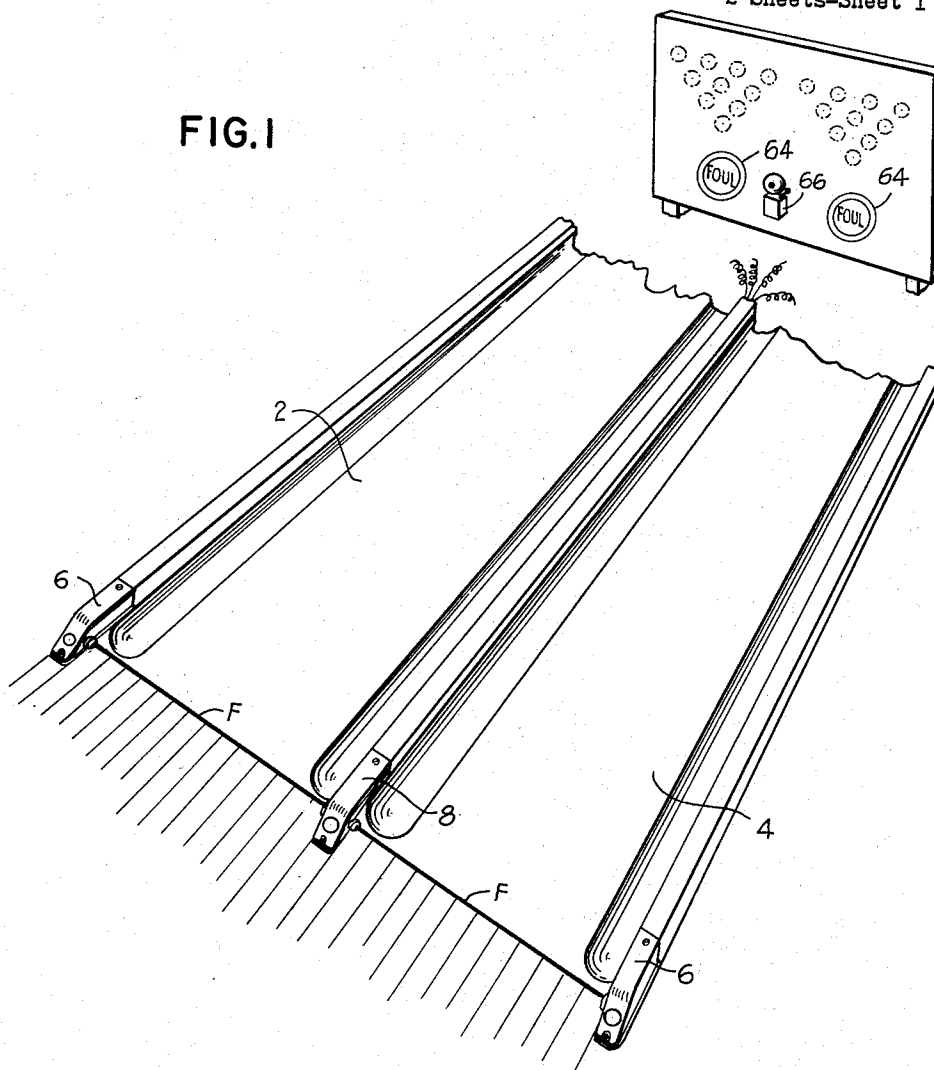
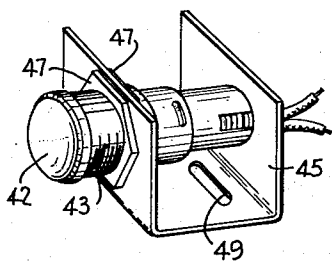


FIG. 2



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2 Sheets-Sheet 2

FIG. 3

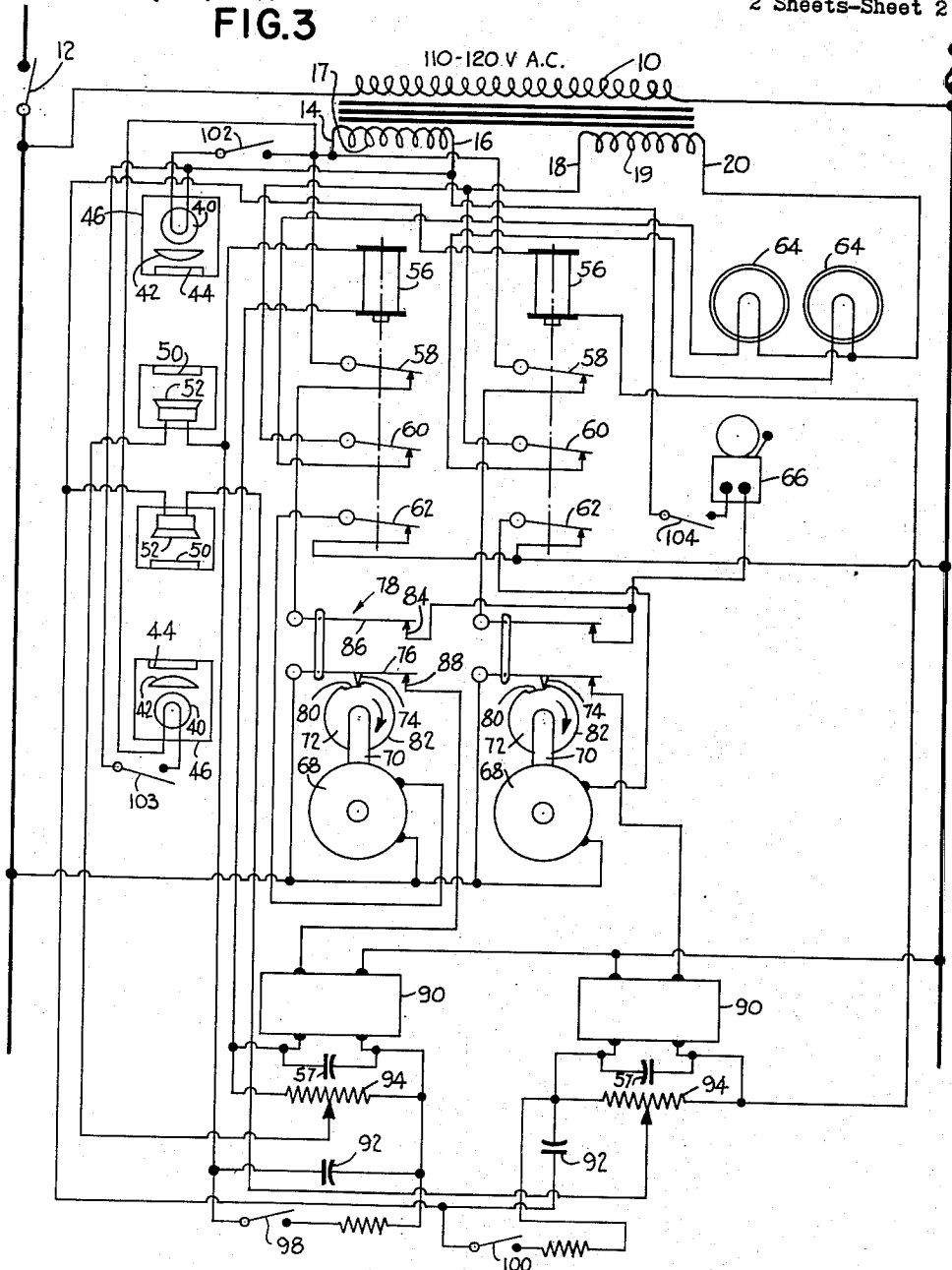
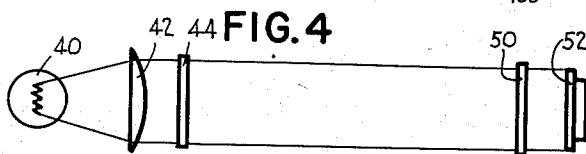


FIG. 4



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1

3,113,774 FOUL DETECTING AND SIGNALLING MECHANISM

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Filed May 18, 1960, Ser. No. 29,833

5 Claims. (Cl. 273—50)

This invention relates to detecting and signalling apparatus, and more particularly to improvements in foul detecting and signalling mechanism useful in connection with declaring infractions of the rules of games, such as bowling, where if a bowler moves past a foul line in rolling his ball, he is penalized as prescribed by the rules of the game of bowling.

The invention relates to improvements in foul detecting and signalling devices of the type in which there is provided a light beam directed from a source of light at one side of a bowling alley across the foul line to a photocell at the opposite side of the alley. Whenever a foul is made, as for example, when the foot of a bowler moves through the beam and breaks it, as he rolls a ball at bowling pins standing at the far end of the alley, the result caused by the breaking of the beam energizes the circuit controlled by the photocell and operates mechanism which indicates the occurrence of the foul. This may be a bell or a signal light, or both. Obviously, when the bell rings and/or the signal light glows, there is no doubt that a foul has been made. This automatic declaration of a foul eliminates discussions arising from the personal views of a player and possible oversights or miscalling of fouls by a foul judge and contributes materially to the orderly play of the game.

The increased power level at which a system constructed in accordance with my invention operates makes the effect of lead capacitance practically negligible, and the installation thereof in operative relationship with a bowling alley is therefore markedly less critical than in installations heretofore available. Furthermore, the light source which I employ provides photo-lens type of focusing and a separate aiming device which in turn reduces the possibility of error in installation and also provides simpler maintenance and less adjustment. The fact that the complete control unit is contained within the light source housing permits the direct reading of the photocell output while the unit is being focused and therefore more precise focusing. My invention makes it possible to operate the photocell itself well within the limits of its capabilities in a manner not heretofore possible in mechanisms of this type wherein it was necessary that the photocell operate at its maximum output. It will be seen, therefore, that in a detecting and signalling apparatus embodying my invention, due to the extended photocell life longer satisfactory use is possible with a minimum of repairs and replacement.

It is an object of my invention to provide a mechanism which is simple in construction, sensitive in operation and one which meets all requirements for a successful foul detecting and signalling device.

Furthermore, I have found that by projecting a beam of light from a given light source to a point removed therefrom and then through a red filter directly onto a photocell, I provide a detecting and signalling system which not only is highly sensitive, but one which is virtually unaffected by ambient light, thereby achieving results which heretofore have not been obtainable with known devices.

It is accordingly a further object of my invention to provide a novel foul detecting and signalling system which includes means for projecting a light beam across the foul line of a bowling alley, through a red filter located

2

adjacent a photocell and onto the surface thereof, and wherein the system is virtually unaffected by ambient light.

The invention also includes means for projecting a light beam emitted from a source of light and through a red filter at one end of a bowling alley foul line and through another red filter located proximate a photocell mounted adjacent the other end of the foul line and is focused upon the photocell, and wherein due to the construction employed masking and shielding of the photocell against ambient light is unnecessary.

The invention also is characterized by the provision of a foul detecting and signalling apparatus of the type embodying a photocell and operating electrical circuit and wherein, due to the novel characteristics of the system, satisfactory operation is obtained without the use of an amplifying circuit in order to properly actuate the operating control circuit.

The invention is further characterized by the provision of a novel foul detecting and signalling apparatus capable of selective use with one or more bowling alleys and wherein time delay means capable of being adjusted to operate over a widely selected range of operation is provided in order to control the operation of the foul detecting and signalling mechanism such that the mere passage of a bowling ball through the detecting beam of light will not actuate the system.

The invention further consists in the provision of novel timing mechanism for controlling the operation of the foul detecting and signalling apparatus and for effecting the selective controlled actuation of audible and/or visible foul detecting and signalling means for predetermined time intervals in response to the occurrence of a foul on one or more bowling alleys, as the case may be.

Other objects and advantages of my invention will be apparent from the following detailed description of a preferred embodiment thereof, reference being made to the accompanying drawings which form a part of this specification and in which like characters of reference indicate the same or like parts:

FIGURE 1 is a perspective view showing two side-by-side bowling alleys provided with detecting and signalling apparatus embodying my invention.

FIGURE 2 is a perspective view showing a preferred form of light beam projecting device.

FIGURE 3 is a wiring diagram disclosing an electrical system suitable for use in performing the operative functions of my invention.

FIGURE 4 is a diagram showing the manner in which the light beam is transmitted to the photocell.

Referring to the drawings which disclose a preferred embodiment of the invention, the detecting and signalling apparatus disclosed can be used with a single alley or with a plurality of alleys, as desired, selective means being provided for effecting such use. As disclosed in FIGURE 1, the invention is shown operatively associated with two side-by-side alleys 2 and 4. The apparatus includes a visible signal, such as foul lights 64, one being provided for each alley, and an audible signal 66, such as a conventional bell, common to both alleys. The components connected in the electrical control circuit are mounted in the housing enclosing unit 8.

Photocell units and light beam projecting units 6 and 8, respectively, as shown in FIGURE 1, replace the ends of the division guards of alleys 2 and 4, respectively, at the foul lines F, although these units may be mounted in any other manner as long as the light beam is projected properly transversely across foul lines F. Units 6 contain photocells 52, each of which receives a beam of light from a lamp 40 mounted in its respective light source 46.

The beam of light projected from lamp 40 to photocell 52 is directed across and above foul line F a suitable dis-

tance such that when a foul is made, as when the foot of a bowler breaks the beam of light, the detecting and signalling apparatus is actuated, and the occurrence of the foul is made known substantially immediately, visibly and/or audibly.

Referring to FIGURES 2 and 4, which disclose a preferred form of light beam projecting means, light from lamp 40 is projected through a plano-convex lens 42, and red filter 44 to red filter 50 and onto the surface of photocell 52. Because of the construction disclosed and the virtual insensitivity of the system embodying my invention to ambient light, I have found that it is unnecessary to mask or shield photocells 52.

The photocells used in the system disclosed are solid state devices. Cell 52 illustrated herein is a cadmium sulfide photo-conductive type, such as the RCA #7163 photocell. This cell is red sensitive, has excellent output characteristics, and also is capable of operating a relatively inexpensive sensitive relay directly without amplification, thus contributing to a simple, low cost, and efficient construction. Furthermore, as far as aging characteristics of the cell are concerned, it represents an increase in cell resistance which is uniform and therefore the ratio of the light resistance to the dark resistance remains substantially the same for given light conditions.

In the description, and as shown in FIGURE 3, any voltages and currents indicated are exemplary, since other voltages and currents could be used with suitable changes in elements forming a part of the circuit. In FIGURE 3, power such as 110-120 volts, 60 cycle A.C. current is supplied to the primary winding of transformer 10 through switch 12. Transformer 10 has two secondary windings. Winding 17 through leads 14 and 16 supplies a suitable potential for operation of the audible signal 66 and light source lamps 40. The other secondary winding 19 has leads 18 and 20 which supply a suitable potential for the operation of the visible signal lights 64.

The control chassis for the two alleys 2 and 4 has two sets of the above-mentioned components and one common power supply. As described in more detail hereinafter, both sets of components can be operated simultaneously or severally in accordance with the play on two or on only a single alley. The operation of the control unit of the detecting and signalling apparatus is as follows:

When power is applied by closing switch 12, light source lamps 40 are energized through transformer 10 and leads 14 and 16 from its secondary winding 17. Light from lamps 40 passes through a suitable lens, such as plano-convex lens 42, and then through a red filter 44. I have found that a red filter ranging between cherry and ruby red and of good optical clarity gives satisfactory results. Lamp 40, lens 42 and filter 44 are mounted in housing 46 comprising light source unit 8 adjacent one end of foul lines F (FIGURE 1).

Referring to FIGURE 2, it will be seen that lens 42 is carried in a tube 43 threadably adjustably mounted in support bracket 45. By merely loosening lock nuts 47 tube 43 can be turned, as desired, in order to focus lens 42 relative to photocell 52 at the other end of foul line F. An elongated slot 49 in bracket 45 permits its adjustable attachment to housing 46, and thereby insures more accurate positioning of each light source within unit 8 relative to its respective photocell 52. Filters 50 through which the beams are projected onto photocell 52 may be the same color as filter 44, but function to virtually eliminate the effect of ambient light. The use of red filter 44 may be considered to be optional, since I have found that very satisfactory results are obtained by the use of red filter 50 only located adjacent photocell 52, as shown in FIGURES 3 and 4.

Each photocell 52 is connected in the operating circuit shown in FIGURE 3 to the coil of relay 56. As long as a beam of light falling on a photocell remains unbroken, each relay 56 remains energized, and its contacts 58, 60 and 62 remain open. At this time visible

foul signal lights 64, and audible signal or bell 66 are incapacitated.

Since there are two sets of components comprising foul detecting and signalling units, with the exception of the audible signal which is common to the two side-by-side alleys 2, 4, in the further description only one is described.

When a foul is made, say on alley 2, as by the foot of a bowler moving across this alley's foul line F, and although the time interval may be relatively short, it is sufficient to effect the release of relay 56, and closing of its contacts 58, 60 and 62. This action causes a circuit to be made through now closed contact 62 which starts motor 68. Shaft 70 of motor 68 carries a cam 72 which is tracked by a cam follower 74 mounted on contact arm 76 of a double pole switch 78. Cam 72 is provided with a low portion 80 and a high portion 82. As cam 72 rotates in response to the operation of motor 68, cam follower 74 first travels on low portion 80 of cam 72. This causes a circuit to be made through now closed contact 58, and contact 84 to bell 66 which rings until cam follower 75 rides onto the high portion 82 of cam 72, and contacts 84 and 88 are opened. A suitable bell operating period is about two seconds.

It will be noted that when a foul is made there is a simultaneous operation of the both the associated signal lamp 64, and bell 66. However, as described above bell 66 stops ringing after a relatively short period, i.e., when contact 84 opens due to cam follower 74 riding off cam portion 80. Lamp 64, which is energized by the completion of a circuit through closed contact 60, remains in that state until relay 56 is again energized.

When switch 78 opens, contact 88 also opens and power is removed from rectifier 90, which may be of any suitable type, such as a selenium rectifier bridge. This operation in turn completely discharges capacitor 92 and the circuit through photocell 52.

As shown in FIGURE 3, relays 56 are energized by the charging of their respective capacitors 92. They remain energized through their respective photocells 52 and the circuit including their respective potentiometers 94. As noted above, photocells 52 used in this circuit are of the cadmium sulfide type which are known as photo-resistive or photo-conductive cells. These cells have the characteristics of having a resistance value which is inversely proportional to the amount of light falling on the cell. Consequently, when the beam of light from a source 8 to its respective photocell 52 is interrupted the resistance of cell 52 will rise and current through it will drop, which tends to reduce the current through the coil of relay 56. However, the rise in resistance of a photocell 52 will also raise the voltage across it and therefore across its respective capacitor 92. This increase in voltage across capacitor 92 requires additional charging thereof, which charging current must pass through the coil of relay 56, thereby tending to maintain this coil energized until capacitor 92 has reached its new steady state condition. Capacitor 57 is a filter capacitor which provides a more uniform direct current supply.

Potentiometer 94 is so adjusted that the additional charging time of its respective capacitor 92 corresponds to the time required for a bowled ball to pass through the light beam. By means of this adjustment of potentiometer 94 compensation can be made for any changes in the operating characteristics of a photocell 52, such as may be caused by aging. When the light beam across foul line F is broken for a period of time longer than that required for a bowled ball to pass therethrough, such as when a bowler commits a foul, the current through the coil of relay 56 is reduced to a value which is insufficient to maintain relay 56 in its energized condition and therefore relay contacts 58, 60, and 62, which were held open while relay 56 was energized, now close and assume the condition shown in FIGURE 3.

When a foul is made, as previously stated, relay 56

5

will drop out. Since at this time capacitor 92 is fully charged, relay 56 cannot be re-energized by the charging of capacitor 92. Also, since potentiometer 94 is so adjusted that when the light beam directed across foul line F is received on the surface of photocell 52, the current through photocell 52 is sufficient to maintain relay 56 in an energized condition, yet insufficient to re-energize it once it has been de-energized. Therefore, even though an uninterrupted light beam is restored upon the surface of photocell 52 relay 56 is not re-energized until capacitor 92 is discharged.

Referring to FIGURE 3, it will be noted that power is provided to rectifier 90 by means of a circuit through contact 88 when cam follower 74 of switch 78 is running on low portion 80 of cam 72. When cam follower 74 rides onto high portion 82 of cam 72 switch 78 is opened, breaking the circuit through contact 88 and power to rectifier 90 is interrupted, at which time capacitor 92 discharges through photocell 52 and potentiometer 94. After one complete revolution of shaft 70, or when cam follower 74 rides off high portion 82 onto low portion 80 of cam 72, contacts 84 and 88 return to their normally closed positions as shown in FIGURE 3. At this time relay 56 is again energized through the recharging of capacitor 92. When relay 56 is energized the normally closed contacts 58, 60 and 62 are moved to their open position thereby removing the signals to bell 66, lights 64 are de-energized and motor 68 is stopped. The unit is then completely reset pending the occurrence of the next foul.

When a foul detecting and signalling apparatus having an operating circuit such as shown in FIGURE 3 is to be used in conjunction with two alleys simultaneously switches 102 and 103 are closed and switches 98 and 100 are open. Thus fouls are detected on both of the side-by-side alleys 2 and 4 and lamps 64 are lighted, depending on which alley a foul is made. If it is desired that bell 66 also operate then switch 104 is also closed. If it should be desired to detect and signal fouls made only on alley 2, then switch 103 is opened and switches 100 and 104 are closed. Under such conditions the light 40 which is incapacitated by opening switch 103 and the relay 56 associated with alley 4 will be de-energized at all times, thereby eliminating the possibility of lighting light 64 serving alley 4, and bell 66 will not be energized. By similar suitable movements of switches 98, 100, 102, 103 and 104 fouls can be detected and signalled only on alley 4.

It will be seen that the invention comprises an extremely simple, yet sensitive and accurate apparatus for detecting and signalling fouls. Furthermore, an apparatus constructed in accordance with the invention can be produced at low cost and installed with alleys which may or may not be provided with automatic pinspotting machines. In alleys which are provided with pinspotting machines connections can be made quite readily with such machines so that the detection of a foul will coordinate with the operation of the machine to remove and respot pins in accordance with the rules of the game.

What I claim is:

1. An automatic foul detecting and signalling device for use with a bowling alley comprising a visible signal and audible signal, a source of light at one end of the foul line of a bowling alley for projecting a beam of light across said alley above said foul line, a photocell mounted at the opposite end of said foul line positioned to receive said beam of light and a red filter mounted proximate said photocell and in the path of travel of said light beam to said photocell whereby said filter removes all but red light and a beam of red light only is received on said photocell and substantially all ambient light is excluded from said photocell; control mechanism connected in said circuit and operative in response to the breaking of said beam of light to said filter for actuating said audible and said visible signals, said control mechanism including a

6

relay having an operating coil and a plurality of contacts, one of said contacts being connected in a subcircuit for actuating said visible signal and another of said contacts being connected in a subcircuit for actuating said audible signal; an electrical circuit including said photocell and comprising additionally a capacitor and a source of D.C. potential; said relay, capacitor, and source of D.C. potential being so connected that said source of D.C. potential is adapted to cause said capacitor to charge and said relay is adapted to be energized by said charging current of said capacitor; said photocell having a low resistance and being adapted to pass a relatively high current when illuminated by said beam of light, and having a high resistance and being adapted to pass a relatively low current when not illuminated by said beam of light, said relay being so connected to said photocell that when energized it will be maintained in an energized state by said relatively high current drawn by said photocell when illuminated by said beam of light but will not be so maintained by said relatively low current drawn by said photocell when not illuminated by said beam of light, and that when deenergized it will not be energized by said relatively high current drawn by said photocell when illuminated by said beam of light.

2. The invention defined in claim 1, including timing means in said circuit operative in response to the detection of a foul for incapacitating said audible signal without affecting the continued operation of said visible signal, said timing means including a motor, a cam on the shaft of said motor, a contact operated by said relay when deenergized to complete a circuit through said motor, and wherein said cam is provided with a portion which incapacitates said audible signal, means for maintaining said visible signal in operation subsequent to the incapacitation of said audible signal, and means operative subsequent to the incapacitation of said audible signal for substantially discharging said capacitor.

3. The invention defined in claim 1 wherein said photocell is connected between said source of D.C. potential and said capacitor and controls the potential to which said capacitor charges, with said capacitor charging to a higher potential when said photocell is not illuminated by said beam of light and correspondingly has a relatively high resistance, than it does when said photocell is illuminated by said beam of light and has a correspondingly low resistance, the additional charging current drawn by said capacitor in charging from said lower potential to said higher potential being adapted to maintain said relay in an energized state, whereby when said photocell changes from a relatively high current state to a relatively low current state upon interruption of said beam of light, the current drawn by said capacitor in charging to said higher potential maintains said relay in its energized condition for a predetermined period of time, with said predetermined period of time being sufficient to prevent the deenergization of said relay during the period of time normally required for a bowling ball to pass through said beam of light.

4. A foul detecting and signalling device for use with a bowling alley comprising a visible signal, an audible signal, a source of light at one end of the foul line of said alley for projecting a beam of light across said foul line, a photocell mounted at the other end of said foul line and positioned to receive said beam of light, and control mechanism for operating said signals, said control mechanism including a source of D.C. potential, a capacitor, and a relay adapted to actuate said signals when deenergized; said relay, capacitor, and source of D.C. potential being so connected that said source is adapted to cause said capacitor to charge and said relay is adapted to be energized by said charging current of said capacitor; said photocell having a low resistance and being adapted to pass a relatively high current when illuminated by said beam of light, and having a high resistance and being adapted to pass a relatively low current when not illumi-

7

nated by said beam of light; said relay being so connected to said photocell that it will be maintained in an energized state by said relatively high current drawn by said photocell when illuminated by said beam of light, but will not be so maintained by said relatively low current drawn by said photocell when not illuminated by said beam of light and that when deenergized it will not be energized by said relatively high current drawn by said photocell when illuminated by said beam of light; means to terminate the energization of said signals at predetermined times after their initiation, and means for substantially discharging said capacitor prior to the termination of the last of said signals, whereby upon the termination of the energization of both said signals, said capacitor is conditioned to be recharged by the reception of said beam of light by said photocell, thereby resetting said device.

5. The invention defined in claim 4 having means to prevent the deenergization of said relay for a sufficient period of time subsequent to the cessation of flow of said

8

relatively high current through said photocell to allow the passage of a bowling ball through said beam of light; said means comprising interconnection of said photocell, said capacitor, said relay and said source of D.C. potential so that when said resistance of said photocell changes from said relatively low value to said relatively high value, the potential to which said capacitor is charged is increased, with the additional current drawn by said capacitor in charging to said increased potential passing through said relay and being sufficient to maintain said relay in its energized state for said predetermined period of time.

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