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3,170,689

FOUL DETECTING SYSTEM WITH TRANSISTOR OUTPUT SWITCH

Filed April 27, 1962

2 Sheets-Sheet 1

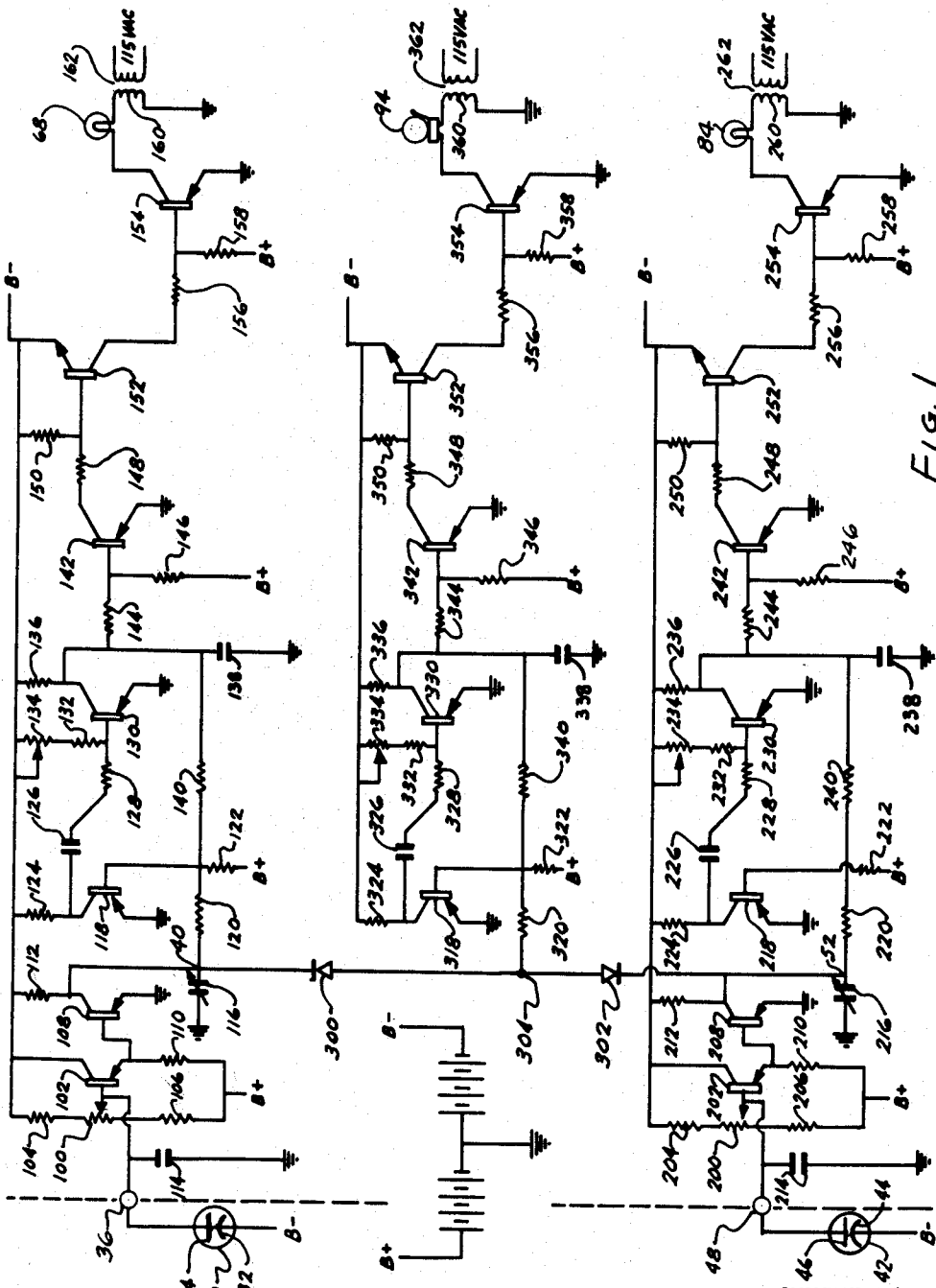


FIG. 1

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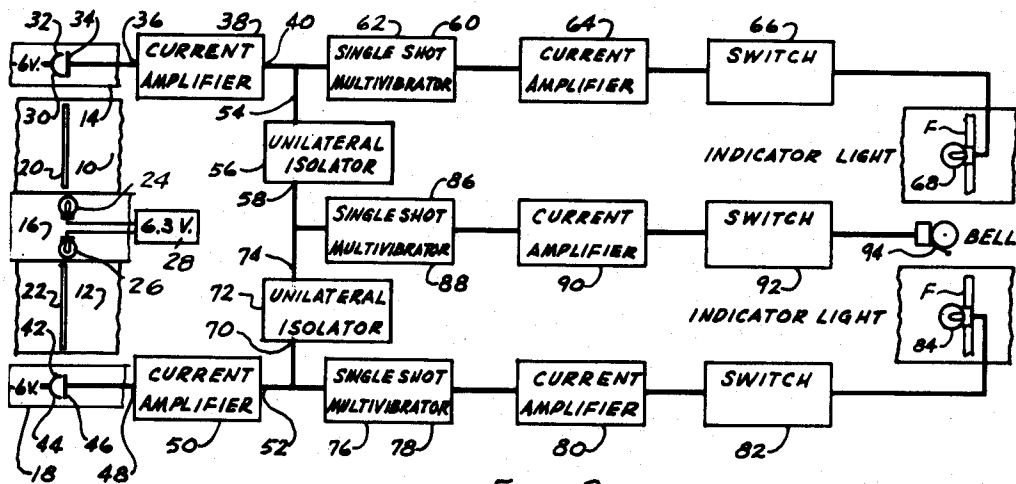


FIG. 2

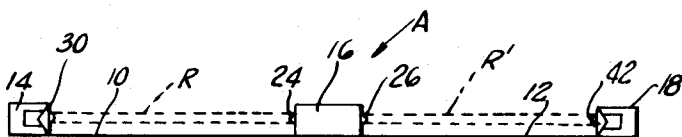


FIG. 3

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3,170,689

FOUL DETECTING SYSTEM WITH TRANSISTOR OUTPUT SWITCH

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3 Claims. (Cl. 273—50)

This invention relates in general to foul detection systems for use in bowling alleys and the like, and more particularly to foul detection systems in which all controls are electronic and electronically operated.

At the present time, foul detection systems as used in bowling alleys are composed of a combination of electrical and mechanical devices, including relays, gears, motors, mechanically-operated switches and the like. Because of the large number of moving parts associated therewith, this equipment inherently requires repeated maintenance in order to be kept in satisfactory operating condition, which said maintenance results in unusually high cost to the owners and operators of such equipment.

It is the primary object of the present invention to provide a foul detection system which, except for a sound producer, is purely electronic in structure and operation and which employs no other moving parts.

It is also an object of the present invention to provide a foul detection system of the type described in which the said system can electronically distinguish between the passage of a bowling ball or the like over a foul line and the passage of a human foot over the said foul line.

With the above and other objects in view, which will become apparent upon reading the following description, our invention resides in the novel features of form, construction, arrangement and combination of parts presently described and pointed out in the claims.

In the accompanying drawings:

FIGURE 1 is a schematic block diagram of an embodiment of our invention as used in a pair of adjacent bowling lanes;

FIGURE 2 is an electrical schematic diagram thereof;

FIGURE 3 is an end view of a typical pair of bowling lanes showing the position of the beams with respect to the floor and the rails.

Referring now in more detail and by reference character to the drawings, which illustrate a preferred embodiment of the present invention, A designates a bowling alley comprising a pair of adjacent bowling lanes 10, 12, defined by spaced parallel gutter rails 14, 16, 18, and respectively provided with regulation foul lines 20, 22, the crossing of which will cause that particular bowler to forfeit his score for that particular throw.

Mounted on the rail 16 and respectively presented to the complementary rails 14, 18, in alignment with the foul lines 20, 22, respectively, are conventional light beam projectors 24, 26, which are conventionally coupled to a source of electrical power 28 and which project beams R and R', respectively, across the lanes 10, 12, above the foul lines 20, 22, respectively. Mounted in the rail 14 in alignment with the foul line 20 and the beam projector 24, is a photocell 30 provided with a cathode 32 which is connected to a source of negative potential designated as B— and a plate 34 which is connected to the input terminal 36 of a current amplifier 38, also provided with an output terminal 40; similarly mounted in the rail 18 and in alignment with the foul line 22 and the beam projector 26 is a photocell 42 including a cathode 44 connected to B—, and a plate 46 which is connected to the input terminal 48 of a current amplifier 50, also having an output terminal 52. Connected to the output terminal 40 of the current amplifier 38 are the input terminal 54 of a unilateral isolator 56 having

also an output terminal 58 and an indicator light igniting circuit 60 comprising a single-shot multi-vibrator network 62, a current amplifier 64, and an electronic switch 66, and an indicator light 68, all connected to each other in series in that order, the indicator light 68 being conventionally mounted in alignment with the lane 10 in a fascia board F above the lanes 10, 12.

Similarly connected to the output terminal 52 of the current amplifier 50 is the input terminal 70 of a unilateral isolator 72, also having an output terminal 74, and an indicator light igniting network 76 comprising a single-shot multi-vibrator network 78, a current amplifier 80, and an electronic switch 82, and an indicator light 84, all connected in series respectively from the output terminal 52 of the current amplifier 50.

The output terminals 58, 74, of the unilateral isolators 56, 72, respectively, are connected together and to a bell ringing circuit 86 comprising a single-shot multi-vibrator network 88, a current amplifier 90, and an electronic switch 92, and a bell 94, all connected in series.

The current amplifier 38 includes a potentiometer 100, the tap of which is electrically connected to the base of a transistor 102 and the input terminal 36. One end of the potentiometer 100 is connected through a resistor 104 to B— and the other end of the potentiometer 100 is connected through a resistor 106 to a source of positive potential designated as B+. The collector of the transistor 102 is directly connected to B— and the emitter of the transistor 102 is connected to the base of a second transistor 108 and through a resistor 110 to B+. The emitter of the transistor 108 is connected to a source of zero potential, or ground, and the collector thereof is connected to the output terminal 40 of the current amplifier 38 and through a resistor 112 to B—.

Connected to the input terminal 36 of the current amplifier 38 is a capacitor 114, one plate of which is connected to ground. Connected to the output terminal 40 of the current amplifier 38 is a variable capacitor 116, also having one of its plates connected to ground.

Connected to the output terminal 40 of the current amplifier 38 is the single-shot multi-vibrator 62 comprising a transistor 118 having a base which is connected to the output terminal 40 through a resistor 120 and which is also connected to B+ through a resistor 122. The emitter of the transistor 118 is grounded and the collector is connected to B— through a resistor 124. Also connected to the collector of the transistor 118 through a capacitor 126 and a resistor 128 is the base of a transistor 130, which said base is also connected to B— through a resistor 132 in series with a potentiometer 134 having a tap which is also connected to B—. The emitter of the transistor 130 is connected to ground and the collector is connected to B— through a resistor 136, to ground through a capacitor 138, and to the base of the transistor 118 through a resistor 140.

The current amplifier 64 comprises a transistor 142, the base of which is connected to the collector of the transistor 130 through a resistor 144 and to B+ through a resistor 146. The emitter of the transistor 142 is grounded and the collector of the transistor 142 is connected to B— through two resistors, 148, 150, connected to each other in series.

Connected to the common juncture of the resistors 148, 150, is the base of a transistor 152, the emitter of which is directly connected to B—, and the collector of which is connected to the base of a second transistor 154 through a resistor 156. The base of the transistor 154 is also connected to B+ through a resistor 158. The emitter of the transistor 154 is connected directly to ground, and the collector of the transistor 154 is connected through the indicator light 68 to one terminal of the secondary coil 160 of a step-down transformer 162,

the other terminal of the secondary coil 160 being connected to ground, for purposes presently more fully to appear.

The electrical circuitry for the current amplifier 50 is identical with the electrical circuitry for the current amplifier 38, and similarly the circuitry for indicator igniting networks 60 and 76 are also identical.

The current amplifier 50 includes a potentiometer 200, the tap of which is electrically connected to the base of a transistor 202 and the input terminal 48. One end of the potentiometer 200 is connected through a resistor 204 to B— and the other end of the potentiometer 200 is connected through a resistor 206 to B+. The collector of the transistor 202 is directly connected to B— and the emitter of the transistor 202 is connected to the base of a second transistor 208 and through a resistor 210 to B+. The emitter of the transistor 208 is connected to a source of zero potential, or ground, and the collector thereof is connected to the output terminal 52 of the current amplifier 50 and through a resistor 212 to B—. Connected to the input terminal 48 of the current amplifier 50 is a capacitor 214, one plate of which is connected to ground. Connected to the output terminal 52 of the current amplifier 50 is a variable capacitor 216, one plate of which is connected to ground.

Connected to the output terminal 52 of the current amplifier 50 is the single-shot multi-vibrator 78 comprising a transistor 218 having a base which is connected to the output terminal 40 through a resistor 220 and which is also connected to B+ through a resistor 222. The emitter of the transistor 218 is grounded and the collector is connected to B— through a resistor 224. Also connected to the collector of the transistor 218 through a capacitor 226 and a resistor 228 is the base of a transistor 230, which said base is also connected to B— through a resistor 232 in series with a potentiometer 234 having a tap which is also connected to B—. The emitter of the transistor 230 is connected to ground and the collector is connected to B— through a resistor 236 to ground through a capacitor 238, and to the base of the transistor 218 through a resistor 240.

The current amplifier 80 comprises a transistor 242, the base of which is connected to the collector of the transistor 230 through a resistor 244 and to B+ through a resistor 246. The emitter of the transistor 242 is grounded and the collector of the transistor 242 is connected to B— through two resistors, 248, 250, connected to each other in series.

Connected to the common juncture of the resistors 248, 250 is the base of a transistor 252, the emitter of which is directly connected to B— and the collector of which is connected to the base of a second transistor 254 through a resistor 256. The base of the transistor 254 is also connected to B+ through a resistor 258. The emitter of the transistor 254 is connected directly to ground, and the collector of the transistor 254 is connected through the indicator light 84 to one terminal of the secondary coil 260 of a step-down transformer 262, the other terminal of the secondary coil 260 being connected to ground, for purposes presently more fully to appear.

The unilateral isolators 56, 72, comprise two diodes 300, 302, having a common anode connection 304 in the manner shown in FIGURE 2. Connected to the common anode connection 304 is the bell ringing circuit 86 which, save for the substitution of the bell 96 for the indicator light, 68, is identical in structure and operation to the indicator light igniting network 60.

Connected to the common connection of the anodes of the diodes 300, 302, is the single-shot multi-vibrator network 88 comprising a transistor 318 having a base which is connected to the anode common connection through a resistor 320 and which is also connected to B+ through a resistor 322. The emitter of the transistor 318 is grounded and the collector is connected to B— through a resistor

324. Also connected to the collector of the transistor 318 through a capacitor 326 and a resistor 328 is the base of a transistor 330, which said base is also connected to B— through a resistor 332 in series with a potentiometer 334 having a tap which is also connected to B—. The emitter of the transistor 330 is connected to ground and the collector is connected to B— through a resistor 336 to ground through a capacitor 338, and to the base of the transistor 318 through a resistor 340.

The current amplifier 90 comprises a transistor 342, the base of which is connected to the collector of the transistor 330 through a resistor 344 and to B+ through a resistor 346. The emitter of the transistor 342 is grounded and the collector of the transistor 342 is connected to B— through two resistors, 348, 350, connected to each other in series.

Connected to the common juncture of the resistors 348, 350, is the base of a transistor 352, the emitter of which is directly connected to B— and the collector of which is connected to the base of a second transistor 354 through a resistor 356. The base of the transistor 354 is also connected to B+ through a resistor 358. The emitter of the transistor 354 is connected directly to ground, and the collector of the transistor 354 is connected through the bell 96 to one terminal of the secondary coil 360 of a step-down transformer 362, the other terminal of the secondary coil 360 being connected to ground, for purposes presently more fully to appear.

By way of illustration, and not of limitation, the following chart discloses component magnitudes which we have found yields an acceptable foul detecting system:

Table A

Resistors:	Magnitude (ohms)
104, 204	1.2 meg.
106, 206	1.2 meg.
110, 210	22K.
112, 212	6.8K.
120, 220, 320	6.8K.
122, 222, 322	27K.
124, 224, 324	560.
128, 228, 328	1K.
132, 232, 332	22K.
136, 236, 336	1.5K.
140, 240, 340	10K.
144, 244, 344	10K.
146, 246, 346	27K.
148, 248, 348	1.5K.
150, 250, 350	6.8K.
156, 256, 356	150.
158, 258, 358	1K.
Potentiometers:	Magnitude
100, 200	0-1 megohm.
134, 234, 334	0-10K.
Transistors:	Type
102, 202	2N 414.
108, 208	2N 414.
118, 218, 318	2N 414.
130, 230, 330	2N 414.
142, 242, 342	2N 414.
152, 252, 352	2N 414.
154, 254, 354	2N 277.
Capacitors:	
114, 214	.03 microf.
116, 216	5-15 microf.
126, 226	500 microf.
326	100 microf.
138, 238, 338	10 microf.
Transformers:	
162, 262, 362	Primary 117 v., Secondary 12 v.
Voltages:	
B+ to ground	6 v.
B— to ground	-6 v.

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It should be here noted that the current amplifiers 38, 50, are each identical, one to the other; the single-shot multi-vibrator networks 62, 78, and 88 are each identical, one to the other; the current amplifiers 64, 80, and 90, are each identical one to the other; the electronic switches 66, 82, and 92, are each identical one to the other; and the indicator lights 68, and 84 and the bell 94 are each respectively connected to the switches 66, 82, and 92, and the secondary coils 160, 260, and 360, of the transformers 162, 262, 362.

In operation, current always flows from B+ to B- through the resistor 106, the potentiometer 100, and the resistor 104; in addition, the current also flows from B+ to B- through the resistors 122, 120, and 112; furthermore, current always flows from B+ to B- through the resistors 122, 140, and 136; also, current flows from B+ to B- through the resistors 146, 144, and 136.

The magnitudes of the resistors 104 and 106 and the potentiometer 100 are selected so that the transistor 102 will always be in conduction. With the light beam R always striking the photocell 30, current will be supplied to the base of the transistor 102 from the photocell 30, and, as long as that beam R is being received by the photocell 30, the voltage at the emitter of the transistor 102 and the base of the transistor 108 is at its least positive value. With the base of the transistor 108 at its least positive value, the transistor 108 is placed in a state of conduction, thereby increasing the voltage drop across resistor 112 and reducing the amount of current that flows through the resistors 122 and 120. With the current through the resistor 122 reduced, the voltage at the base of the transistor 118 becomes positive, the transistor 118 becomes cutoff, and the transistor 130 is biased to saturation through the potentiometer 134 and the resistor 132.

With the transistor 130 in the saturated condition, the voltage at the collector of the transistor 130 is at its most positive voltage, and the current which flows from B+ to B- through the resistors 146 and 144, is substantially reduced, whereby placing the voltage at the base of the transistor 142 at its most positive value, cutting off the transistor 142.

With the transistor 142 in the cutoff condition, no current flows through the resistors 148, 150, and the transistor 152 is also biased to the cutoff condition. Similarly, with the transistor 152 in the cutoff condition, substantially no current flows through the transistor 154.

The capacitor 114 filters random noise from the output of the photocell 30 and prevents such noise from interfering with circuit operation. Similarly, the capacitor 138 is used to prevent random noise from triggering the single-shot multi-vibrator, particularly noise from the B- side of the power supply. The function of the variable capacitor 116 will be discussed in the succeeding paragraphs.

When the beam R is broken, either by the passage of a bowling ball or the foot of a bowler therethrough, and not received by the photocell 30, the voltage at the base of the transistor 102 is made more positive and simultaneously the voltage at the emitter of the transistor 102 and the base of the transistor 108 is also made more positive. The transistor 108 thereby goes into cutoff condition and the voltage at the collector of the transistor 108 becomes substantially more negative due to the substantial reduction in current flow through the resistor 112.

During the operation of the transistor 108, the variable capacitor 116 has its plates at substantially equal potential. Depending on the magnitude of the capacitor 116 and the resistor 112, this condition will remain for a determinable period of time after the beam R has been broken, which said period of time may be varied by varying the magnitude of the capacitor 116. With the magnitudes as disclosed on Table A the charge time for the capacitor 116 is made substantially longer than the

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period of time during which the beam R is broken by the passage of a bowling ball therethrough, a relatively short period of time, and substantially shorter than the period of time during which the beam R would be broken by the passage of a bowler's foot therethrough, a period of time which is of substantial duration. Thus it can be seen that the circuit as disclosed makes the voltage at the collector of the transistor 108 decrease (become more negative) only when the beam R is broken by something that is substantially longer in time duration than the passage of a bowling ball therethrough.

Because the resistors 112 and 120 are each chosen to be substantially less in magnitude than the resistor 122, the reduction in collector voltage of the transistor 108 will cause the voltage at the base of the transistor 118 to become negative, thereby causing the transistor 118 to go into conduction. Prior to conduction of the transistor 118, the capacitor 126 will have developed a charge equal to the voltage magnitude of B- with the plate that is connected to the collector of transistor 118 being the negative of the two plates. When the transistor 118 switches to the conducting state, its positive going collector voltage is coupled through capacitor 126 and resistor 128 to the base of transistor 130, cutting off the operation of transistor 130. In the manner conventional to single-shot multi-vibrators, the transistor 130 will remain in the cutoff state for the period of time required for the capacitor 126 to discharge through the resistors 128, 132, and the potentiometer 134, and the transistor 118 which period of time depends upon the magnitude of the capacitor 126 and the resistors 128, 132, and the potentiometer 134, and not upon the period of time that the beam R has been broken. Therefore, once the beam R is broken for a sufficient length of time for the collector voltage of the transistor 108 to be substantially reduced, the remainder of the circuit operation will not be affected for a finite period of time, notwithstanding that the beam R is reincident on the photocell 30.

As the capacitor 126 discharges through the resistors 128 and 132, and the potentiometer 134, the voltage at the base of the transistor 130 becomes more negative with respect to the emitter thereof, and the amount of current that flows through the transistor 130 again begins to increase to the point of saturation. Negative voltage is transferred back to the base of the transistor 118 from the collector of the transistor 130 through the resistor 140 and holds the transistor 118 in the conducting state until the transistor 130 reapproaches saturation.

However, during the period of time when the voltage at the collector of the transistor 130 is at its most negative values, the base of the transistor 142 achieves a sufficiently negative value to cause the transistor 142 to go into conduction, and the transistor 142 remains in conduction until the current which flows through the resistor 136 from the transistor 130 achieves a sufficient magnitude to bring the voltage at the base of the transistor 142 to zero or positive. While the transistor 142 is in conduction, the base of the transistor 152 is biased into conduction by the current flowing through the resistors 148, 150, from the transistor 142. The conduction of the transistor 152 causes the base of the transistor 154 to go negative in voltage and thereby causes the conduction of the transistor 154. The transistor 154 stays in conduction only so long as the transistors 118, 142, and 152 conduct. This period of conduction required in bowling alleys is nominally 12 seconds selectively determined by the adjustment of the voltage tap on the potentiometer 134, which adjusts the period of time required for the capacitor 126 to discharge as previously explained.

As the transistor 154 is brought into conduction, it will supply whatever current is required to prevent its collector from attaining a negative voltage, thus current will flow from the transistor 154 through the indicator light 68 and the secondary 160 of the transformer 162 during each negative cycle of voltage on the secondary

160, and no current will flow when the voltage on the secondary 160 is positive with respect to ground.

The components numbered 200 through 262 inclusive are respectively identical in operation to the components 100 through 162 inclusive, with the exception that the components numbered 200 through 262 inclusive respond to the receiving and the breaking of a beam of light R' transmitted by the beam projector 26 above the foul line 22 on the lane 12 and received by the photocell 42 in the rail 13. The breaking and receiving of the beam R' by the photocell 42 will cause the components numbered 200 through 262 inclusive to function identically as their correspondingly numbered components, previously described for the lane 10. Thus, normally when the beam R' is received by the photocell 42, the transistors 202, 203, and 230, will be in conduction. When the beam R' is broken for a period of time sufficiently long for the variable capacitor 216 to charge through the resistor 212, the transistor 218 will go into conduction, the capacitor 226 will charge, the transistor 230 will tend towards cutoff, the transistors 242, and 252, will go into conduction, and the transistor 254 will go into conduction during negative half-cycles of voltage across the secondary 260 of the transformer 262. It should be here noted that the diodes 300, 302, prevent a decrease in voltage at one of the output terminals 42, 54, from affecting the voltage at the other terminal.

In operation, the bell ringing circuit 86 functions almost identically to the indicating light networks 60, 76. When both of the beams R, R', are being received respectively by the photocells 30, 42, current flows from B+ to B- along each of the following courses through resistor 322, 320, diode 300 and resistor 112 and through resistor 322, 320, diode 302 and resistor 212. As long as the beams R, R', are undisturbed, the operation of the components numbered 318 through 362 inclusive is identical with the operation of the components numbered 118 through 162 inclusive and the components numbered 218 through 262 inclusive. With both of the beams R, R', on both of lanes 10, 12, being unbroken, the transistor 318 is held in cut-off condition, the transistor 330 has been biased to saturation through the resistor 332 and the potentiometer 334, the transistor 342 is biased to cut-off as the transistor 142 and the transistors 352, 354 are also in cut-off condition as are the transistors 152, 154, respectively. In this condition, no current flows from the transistor 354 through the conventional bell 94, notwithstanding the presence of the voltage on the secondary 360 of the step-down transformer 362.

When either of the light rays R, R', are broken by the passage of a bowler's foot through said beam, depending on which one is broken the transistor 108, or 208, will be cut-off and the voltage at the collector of the particular transistor 108, 208, will decrease. This decrease in voltage will cause the current through the particular diode 300, 302, and through the resistors 322, 320, from B+ to decrease, increasing the voltage at the base of the transistor 318 and placing the transistor 318 into operation, which in turn starts the operation of the single-shot multi-vibrator 88. Once the operation of the single-shot multi-vibrator 88 commences, the components numbered 318 through 362 inclusive operate identically with the components numbered 118 through 162 inclusive and the components numbered 218 through 262 inclusive when they are in operation. It should be observed that the capacitor 326 is sized smaller in magnitude than its counterparts 126, 226, for purposes of reducing the discharge time thereof, and making the bell ringing period substantially shorter in duration than the period during which the indicator lights 68, 84, remain ignited, as is conventional in bowling alleys. It should also be noted that the diodes 300, 302 are so arranged as to isolate the indicator light circuits for their respective lanes. With the diodes 300, 302, connected as shown, operation of the transistor 108 will have no effect whatsoever on the single-shot

multi-vibrator 78 and similarly, operation of the transistor 208 will have no effect whatsoever on the operation of the single-shot multi-vibrator network 62. However, operation of either of the transistors 108, 208, will cause the indicator light igniting network associating with that particular transistor to operate and will simultaneously cause the operation of the bell ringing circuit 86 in parallel therewith.

When the transistor 354 goes into operation and establishes a continuous circuit through the bell 94 and the secondary 360 of the transistor 362 to ground, the transistor 354 behaves in a manner identical to the transistors 154 and 254 when they are in operation in that the transistor 354 will function in such manner as to prevent its collector from going negative. Thus during the negative cycles of the voltage across the secondary 360 of the transformer 362, the transistor 354 will supply substantial current through the bell 94 and will maintain the voltage drop across the bell 94 to a magnitude sufficient to keep the collector of the transistor 354 always positive. This unique and novel method of supplying a power to a bell and an indicator light from a transistor has eliminated the need for large current supply packs and large transistors, and enables power to be furnished using a simple transformer in combination with a transistor.

It should be here noted that in most bowling alleys it is normal for the bell to ring for a period of 3 seconds and the lights to remain on for a period of 12 seconds, thus when the bell indicates that a foul has been committed on one of two alleys, the bowlers have an additional 9 seconds to determine on which alley the foul was committed. The period of time for operation of the bells 94 and the lights 68, 84, may be respectively adjusted by adjusting the setting of the tap on potentiometers 334, 134, and 234, respectively. In addition, the taps on the potentiometers 100, 200, are effective means of providing an ambient light adjustment to compensate for varying amounts and quantities of light present on the photocells 30, 42, respectively.

If it is desired that the system be comprised entirely of solid state devices, a solar cell may be substituted for the photocells 30, 42, in the conventional manner, and a transistorized audio oscillator coupled to a speaker may be substituted for the bell 94.

It should be understood that changes, alterations and modifications in the form, construction, arrangement and combination of parts of the amusement may be made and substituted for those herein shown and described without departing from the major and principle of my invention. For example, although we have disclosed our invention using p-n-p type function transistors for all transistors shown with the exception of transistors 152, 252, and 352, which are n-p-n transistors, n-p-n transistors may be substituted for the p-n-p transistors and p-n-p transistors may be substituted for the n-p-n transistors in the conventional manner.

Having thus described our invention what we claim and desire to secure by Letters Patent is stated in the following claims:

1. A foul detecting and indicating device for use with a bowling lane including a foul line and defined by spaced parallel rails on opposing sides thereof, said device comprising a beam projector operatively mounted on one of said rails and adapted for projecting a beam of light, beam receiving means operatively mounted in the other rail for supplying a signal when a beam of light is received from the beam projector, said beam projector and beam receiving means being in alignment with said foul line, amplifying means adapted for receiving the signal from the beam receiving means and amplifying said signal, triggering means for supplying an actuating signal when the magnitude of the amplified signal is substantially reduced for more than a predetermined period of time, and output means including a transistor which is placed into saturated conduction by the operation of the trigger-

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ing means, a transformer having one winding operatively connected to a source of alternating current power and a second winding connected in series with the terminals of the transistor through which the saturated current flows during conduction, and indicator means operatively connected in series with said second winding and said transistor terminals.

2. A foul detecting and indicating device comprising means for projecting a beam across the foul line of a bowling lane, means for receiving said beam, a transistor operatively connected to a source of power and having a base and a collector and an emitter, a transformer having a primary winding and a secondary winding, indicating means adapted for operating upon application of electrical power thereto, said indicating means and secondary winding being connected in series to the emitter and collector, said primary winding being operatively connected to a source of alternating current electrical power, and triggering means connected to said beam receiving means

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for causing the transistor to go into conduction when a bowler commits a foul by breaking the beam.

3. The device of claim 2 in which the triggering means includes means for retaining the said transistor in conduction for a predetermined period of time.

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