May 7, 1957 G. P. STOUT 2,791,730

CLOSURE DETECTION APPARATUS

Filed June 25, 1953 2 Sheets-Sheet 1

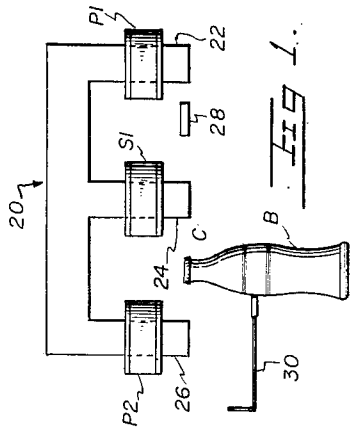


Fig. 1.

Fig. 3.

INVENTOR.
George Philip Stout
BY
Jewett, Mead, Browne & Schuyler, ATTYS.

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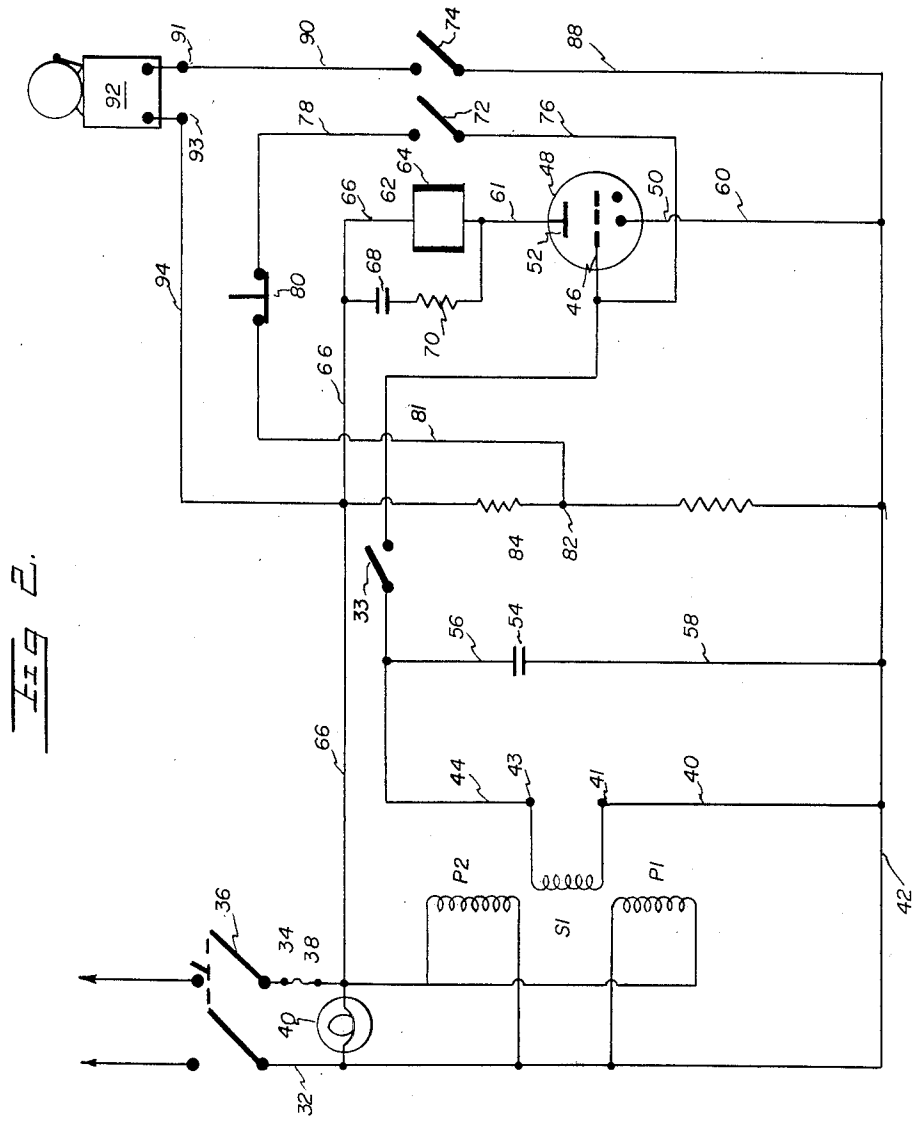


Fig. 2.

INVENTOR.
George Philip Stout
BY
Jewett, Mead, Browne & Schuyler, ATTYS.

United States Patent Office

2,791,730

Patented May 7, 1957

2,791,730

CLOSURE DETECTION APPARATUS

George Philip Stout, Baltimore, Md., assignor to Aeronca Manufacturing Corporation, Middletown, Ohio, a corporation of Ohio

Application June 25, 1953, Serial No. 364,159

4 Claims. (Cl. 317—142)

This invention relates to apparatus for detecting the presence of closures on containers and, more particularly, to an apparatus for testing containers such as beverage bottles to automatically determine that a capping or crowning machine has functioned properly to cap each container passing therethrough.

In the beverage industry, bottle capping machines are used to automatically place caps or crowns on bottles, the bottles being conducted to and from the automatic capping machines by means of a conveyor. Occasionally, a bottle fails to receive a cap due to a defective cap or due to a transient failure of the cap supply to the capping machine. At other times, the cap supply chute may become jammed with the result that all bottles passing through the capping machine remain upcapped until the condition is rectified. In the case where a single bottle fails to receive a cap, it is desirable that a signal or alarm be actuated so that an operator may remove the single uncapped bottle from the conveyor system. In the case of more serious difficulty, where a number of bottles are uncapped, it is desirable that a signal or alarm be actuated and also that the bottling machine be shut down automatically until the condition causing the succession of capless bottles is corrected.

In my United States Patent No. 2,587,664, issued March 4, 1952, I disclose an arrangement for detecting the presence of capless bottles, for sounding an alarm where a single capless bottle is detected, and for additionally shutting down the bottling machine when the presence of more than one capless bottle is detected.

In the invention disclosed in my aforementioned patent, the iron content of a crown cap is utilized to affect the magnetic flux between the poles of a sensing transformer in such manner as to produce an output voltage of the transformer which is balanced against a positive grid biasing potential to maintain an electron tube in non-conducting condition. On the other hand, a capless bottle passing adjacent the poles of the transformer causes the output voltage of the transformer to be substantially zero so that the positively biased electron tube becomes conducting and actuates a control relay. The sensing transformer which is used in the arrangement of my aforementioned patent is E-shaped, the mouth of the bottle passing between the middle leg of the E and one of the outer legs so that a path of less reluctance is provided between the middle core leg and the outer core leg through which the bottle passes than between the middle core leg and the other outer leg.

In my aforementioned patent there is also disclosed an arrangement for discriminating between a single capless bottle and more than one capless bottle. In accordance with this arrangement a second relay controlling electron tube is switched into circuit with the sensing unit in such manner that a second successive capless bottle will actuate the second electron tube to shut down the bottling machine.

It is an object of this invention to provide a sensing arrangement for use with crown detectors which is an

improvement over the arrangement disclosed in my Patent 2,587,664.

It is a further object of my invention to provide a sensing unit for crown detectors operating upon the magnetic detection principle of my Patent 2,587,664 but in which the presence of a capped bottle causes a balanced condition of the sensing transformer rather than an unbalanced condition.

It is another object of my invention to provide an improved arrangement for discriminating between a single capless bottle and a succession of capless bottles.

It is still another object of my invention to provide a crown detector arrangement which does not require delicate electrical adjustments, which is highly sensitive, in which the electron tube sensitivity is not critical, and in which a minimum number of components are used.

In accordance with these objectives, this invention provides a crown detector having a magnetic sensing unit which is in general similar to that described in my aforementioned Patent No. 2,587,664, but in which a capped bottle is magnetically balanced by a magnetic slug. Due to the provision of the magnetic slug which balances the crown cap, the sensing transformer produces substantially no output voltage in the presence of a capped bottle, but has an unbalanced magnetic condition in the presence of an uncapped bottle due to the face that the magnetic slug is not balanced by a corresponding magnetic cap. The latter condition causes the sensing transformer to produce an output voltage which is applied to a relay controlling electron tube in such manner as to sound an alarm. In my preferred circuit arrangement, I provide an arrangement for discriminating between a single capless bottle and a succession of capless bottles. In this preferred circuit arrangement, a timing device is also started in operation at the time the electron tube is rendered conductive by the first capless bottle, the timing device being arranged in such manner as to open the circuit of the bottle capping machine if a second capless bottle passes the sensing unit within a predetermined interval of time.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and use, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a front elevation view of a bottle passing through the sensing device of my invention;

Fig. 2 is a wiring diagram of one embodiment of my crown detecting arrangement which does not discriminate between a single capless bottle and a succession of capless bottles; and

Fig. 3 is a circuit diagram of a crown detector arrangement having a discriminating circuit to detect the presence of more than one successive capless bottle.

Referring now to the drawings, and more particularly to Fig. 1, the sensing unit comprises an E-shaped magnetic core generally indicated at 20 having three winding legs 22, 24, and 26. A pair of parallel connected primary windings P1 and P2 are positioned on the outside legs 22 and 26, respectively, and a secondary winding S1 is positioned on the middle leg 24 of the core. The outer leg 26, on which primary winding P2 is positioned, is not connected to one end of middle leg 24, the space between these two legs providing a passage through which the crown or cap C of the bottle B may pass. The outer leg 22 on which the primary winding P1 is positioned is unconnected to one end of leg 24 but a slug 28 of magnetic material is positioned in the space between the disconnected ends of legs 22 and 24. The slug 28 is so positioned and its magnetic properties are such that it pro-

vides a magnetic path of the same reluctance between the ends of legs 22 and 24 as is provided by the cap C between the ends of legs 24 and 26. A feeler arm 30 is positioned in the path of the bottles B as they reach the location shown in Fig. 1 between the legs 24 and 26 of the transformer core 20. Feeler arm 30 actuates a switch 33 in such manner as to connect the output voltage of transformer secondary S1 to the control grid of a relay controlling electron tube, as will be described hereinafter.

Referring now to Fig. 2, the sensing unit and control system are connected to a source of alternating current energy through conductors 32 and 34 which are in series with a suitable double-pole single-throw switch means 36 and a fuse 38. A pilot light 40 may be connected across conductors 32 and 34 to indicate that the system is energized. Primary coils P1 and P2 of the transformer 20 are connected in parallel across the power lines 32 and 34, but are so connected that corresponding ends of primaries P1 and P2 are connected to opposite power lines.

Terminal 41 of the secondary S1 is connected through conductor 40 to conductor 42 which is at the same potential as power line 32. Terminal 43 of the secondary S1 is connected through conductor 44 in series with switch 33, actuated by bottle feeler arm 30, to the grid 46 of a three element gaseous tube 48 having a cathode 50 and an anode 52. A capacitor 54 is connected in parallel with the secondary S1 through conductor 56 which is connected to conductor 44 and through conductor 58 which is connected to conductor 42. The capacitance of capacitor 54 is so adjusted with respect to the inductance of secondary S1 as to produce resonance at the operating frequency of secondary S1, thereby producing a maximum voltage output of the secondary S1.

The cathode 50 of tube 48 is connected to conductor 42 by means of conductor 60. The anode or plate 52 of tube 48 is connected by conductor 61 to one terminal of the coil 64 of a relay generally indicated at 62, the other side of coil 64 being connected by conductor 66 to power line 34. In order to quiet the operation of the relay 62, a capacitance 68 in series with a resistance 70 is connected in parallel with the relay coil 64.

Coil 64 of relay 62 controls two normally open contacts 72 and 74 which are respectively in a sealing-in circuit for tube 48 and in the circuit of alarm bell 92. Contact 72 is connected by conductor 76 directly to the grid 46 of tube 48. The other side of contact 72 is connected by conductor 78 to one side of normally closed reset switch 80, the other side of which is connected through conductor 81 to point 82 on a resistance potentiometer 84 which is connected between conductors 66 and 42 and, therefore, is across power lines 34 and 32.

One side of relay-operated contact 74 is connected through conductor 88 to conductor 42, the other side of contact 74 being connected through conductor 90 to terminal 91 of an alarm bell 92, the other terminal 93 of bell 92 being connected through conductor 94 to conductor 66 and thus to power line 34.

The operation of the crown detector arrangement shown in the circuit of Fig. 2 will now be described. When a capped bottle passes between legs 24 and 26 of the sensing transformer 20, it actuates arm 30 to close switch 33 to complete a circuit from terminal 43 of the secondary S1, through conductor 44 in series with switch 33 to the grid 46 of tube 48. The magnetic material in the cap of the capped bottle is the magnetic equivalent of the magnetic slug 28 between the legs 22 and 24 of the transformer 20. Hence, the magnetic flux linkage between primary coil P1 on magnetic core leg 22 and the secondary coil S1 is the same in magnitude but opposite in direction to the magnetic flux linkage between primary coil P2 on leg 26 and secondary coil S1. Because of the flux linkages of the respective primary coils P1 and P2 with the secondary coil S1 are of equal and opposite magnitude, substantially zero voltage is induced in the secondary coil S1. Hence, no voltage is applied from secondary S1 to the grid 46 of tube 48, and grid 46 remains at substantially the same potential as the cathode 50. Tube 48 therefore remains non-conducting and relay 62 remains unenergized since there is no conduction through the plate or anode circuit of tube 48. Contacts 72 and 74 remain open and the alarm bell 92 is not actuated.

If, however, a capless bottle passes between the legs 24 and 26 of the sensing transformer 20, causing bottle feeler arm 30 to close switch 33 to connect secondary S1 to the grid circuit, alarm bell 92 will begin to sound and will continue to sound until reset switch 80 is manually operated to open the circuit of grid 46. The sequence of events started by the presence of a capless bottle will now be described. In the absence of a capped bottle, an air gap is present between legs 24 and 26 of sensing transformer 20. Since there is no magnetic crown or cap to counterbalance the magnetic slug 28, the primary winding P1 has a much greater flux linkage with the secondary winding S1 than has primary winding P2. Therefore, a voltage of considerable magnitude is induced in secondary winding S2, this voltage being so related to the polarity of the voltage applied to the anode 52 when anode 52 is positive that the grid 46 has a sufficiently high positive potential applied to it from secondary S1 to cause the gaseous tube 48 to fire. Firing of tube 48 causes conduction through the plate or anode circuit of the tube and energizes relay coil 64, causing contacts 72 and 74 to close. Closing of contact 72 completes the sealing-in circuit for tube 48 which maintains the tube conducting even after the capless bottle has passed out of contact with bottle feeler arm 30, which controls closing of switch 33 between secondary S1 and grid 46. This sealing-in circuit connects grid 46 through conductor 76, contact 72, conductor 78, normally closed reset switch 80 and conductor 81 to point 82 on the potentiometer 84, a point having a sufficiently positive potential when anode 52 is positive to maintain the tube 48 conducting.

Closure of contact 74 by the relay 62 completes a circuit to the alarm bell from power line 32, through conductor 42, through conductor 88 and contact 74, through conductor 90 to terminal 91 of alarm bell 92, from terminal 93 of the alarm bell through conductors 94 and 66 to power line 34. Upon completion of the circuit just described, the alarm bell 92 sounds and indicates to an operator that a capless bottle has passed through the sensing unit. In the circuit shown, tube 48 remains conducting until an operator opens the reset switch 80 to open the sealing-in circuit for the grid 46. Opening of switch 80 removes the positive potential applied from potentiometer 84 to grid 46 and causes the tube to become non-conducting. When tube 48 again becomes non-conducting, relay coil 64 becomes deenergized, causing the opening of contacts 72 and 74, and causing the bell or alarm 92 to stop ringing. Obviously, if it should be desired to utilize the circuit shown in Fig. 2 to stop the operation of the bottling machine in addition to ringing the alarm bell 92, the leads 90 and 94 which are connected to alarm bell 92 could also be connected by a suitable relay means into the circuit of the bottling machine in such manner as to stop the operation of the bottling machine.

There is shown in Fig. 3 a circuit arrangement which discriminates between a single uncapped bottle and more than one uncapped bottle in such manner that a single uncapped bottle results in the sounding of an alarm while a second uncapped bottle immediately following upon the first uncapped bottle actuates the circuit in such manner as to shut down the bottling machine. This circuit arrangement uses exactly the same sensing transformer 20 as is shown in Fig. 1. However, to avoid confusion, the transformer coils utilized in the arrangement of Fig. 2 will be referred to as P1', P2' and S1', these coils having the same respective physical relationships to each other and to the magnetic core as the coils P1, P2 and S1 of Figs. 1 and 2.

Referring now to Fig. 3, conductors 32' and 34' are

connected to a source of alternating current power through a switch 36'. Neon lamp or pilot light 39' may be connected across conductors 32' and 34' to indicate when these conductors are energized.

Primary coils P1' and P2' are connected across power lines 32' and 34' in parallel with each other by means of conductors 95 and 97 with corresponding terminals of the respective primary coils being connected to opposite power lines. Terminal 99 of secondary winding S1' is connected by conductors 103 and 95 to power line 32'. Terminal 101 of the secondary S1' is connected by conductor 105 to grid 46' of tube 48'. A capacitor 54' is positioned in parallel with secondary coil S1' across terminals 99 and 101. Capacitor 54' has a capacitance of such value as to produce resonance between the capacitor 54' and the inductance of coil S1' at the operating frequency of the circuit. A resistance 98, which may be of the magnitude of 100,000 ohms, is connected in series with conductor 44' between terminal 101 of the parallel combination of secondary S1' and grid 46'. This resistance serves to limit the grid current in such manner that the circuit is not sensitive to individual tubes. In order to connect the output of secondary S1' to the grid 46' of tube 48' when a bottle is present, a contact 33' operated by bottle feeler arm 30 is adapted to be moved out of bridging connection across a pair of contacts 107 and 109 which are respectively connected to the terminals 99 and 101 of secondary winding S1. When terminals 107 and 109 are bridged by contact 33', the parallel combination of secondary coil S1' and capacitor 54' is shorted out. When contact 33' is removed from bridging relation with respect to terminals 107 and 109, any output voltage of secondary S1' is applied to the grid 46' of tube 48' through conductor 105. The arrangement of contact 33' just described whereby contact 33' normally shorts out secondary S1' but is opened upon the passage of a bottle to connect the output of secondary S1' to the grid 46' is an alternative to the wiring arrangement of contact 33 shown in the circuit diagram of Fig. 2. Contacts 33 of Fig. 2 and 33' of Fig. 3 can be connected in either one of the alternative arrangements shown.

The cathode 50' of tube 48' is connected by means of conductor 69' to the conductor 42' which is connected to power line 32'. The anode 52' of tube 48' is connected to power line 34' by conductor 66' in series with the coil 64' of a relay generally indicated at 62' which controls a normally open contact 72' and a normally closed contact 74'. To quiet the operation of relay coil 64', a capacitance 68' in series with a resistance 70' is placed in parallel with the relay coil 64'. One side of relay contact 72' is connected by conductor 100 to one side of a coil 104 of a relay generally indicated at 102, the other side of coil 104 being connected to conductor 42'. The other side of relay contact 72' is connected to conductor 66' and thence to power line 34'. Normally closed contact 74' is connected across leads 138 and 140 in the control circuit of the bottling machine, to control the shutdown of the bottling machine as will be described in more detail hereinafter.

Relay 102 controls two normally open contacts 106 and 108, both of which are closed by energization of coil 104. Contact 106 provides a sealing-in circuit for coil 104 after the capless bottle has passed beyond the sensing transformer. The circuit connections of contact 106 will be described in connection with the description of timing device 104. Contact 108 controls the circuits of a timing device 114 and of an alarm bell 92'. One side of contact 108 is connected by conductor 110 to conductor 42' which is in turn connected to power line 32'. The other side of contact 108 is connected to conductor 112 to a parallel circuit consisting of the timing device generally indicated at 114 and an alarm bell generally indicated at 92'. The motor 118 of the timing device 114 is connected to relay-operated contact 108 through conductors 112 and 120 in series with a manually operable switch 122. Switch 122 may be moved to either "manual" position in which the timing motor 118 is not energized or into an "auto" position in which the timing motor is connected to conductors 120 and 112. The other side of the motor 118 of the timing device 114 is connected through conductor 124 to conductor 66' which, in turn, is connected to the power line 34'.

Terminal 91' of alarm bell 92' is connected to relay-operated contact 108 through conductors 112 and 126, terminal 93' of the alarm bell being connected to conductor 66' and thence to power line 34.

The timing device 114 controls two normally closed contacts 128 and 130. Contact 128 is in the sealing-in circuit of relay coil 104 and bridges terminals 129 and 131. Terminal 129 is connected by conductor 135 to one side of contact 106, operated by relay 102. The other side of contact 106 is connected at point 101 to conductor 100 which leads to relay coil 104. Terminal 131 is connected by conductor 132 to terminal 133 of reset switch 134, terminal 136 of the reset switch being connected to conductor 66' and thence to power line 34'.

The normally closed contact 130 which is controlled by timing device 114 normaly bridges terminals 137 and 139 which are respectively connected to conductors 138 and 140 in the control circuit of the bottling machine.

The bottling machine M is controlled through a control box A which is connected by power lines 142, 144 and 146 to a source of three-phase alternating current power. Three control conductors 138, 140 and 148 which are connected to suitable control relay devices within control box A emerge from the control box to permit external control of the starting and stopping of the bottling machine. A normally open "start" button 150 is provided which, by bridging conductors 140 and 148, controls the starting of the bottling machine. A normally closed "stop" button is connected in series with control conductors 138 and 140, so that, if stop button 152 is opened, the bottling machine is shut down. Normally closed contact 130, controlled by timing motor 114 and normally closed contact 74', controlled by relay coil 64', are in parallel with each other across conductors 138 and 140 in such manner that if either contact 130 or 74' is closed, conductors 138 and 140 are in series with each other through normally closed "stop" button 152. However, if both contacts 74' and 130 are open at the same time, the series connection between conductors 138 and 140 is broken, causing the bottling machine to shut down.

The timing device 114 is so adjusted that the bridging contact 130 is timed to open a short time after the relay 62' has become deenergized due to the passage of the first capless bottle beyond the sensing transformer 20 and has reclosed, by its deenergization, contact 74'. The timing device 114 is so adjusted that contact 130 will be open by the time a second bottle has arrived at the sensing station so that if the second bottle is capless and energizes relay 62', contact 74' will be opened while contact 130 is open to thereby open the series connection between conductors 138 and 140, causing the bottling machine to shut down.

While the contacts 130 and 74' are shown in the control circuit of a bottling machine which is operated by an electric motor, obviously contacts 130 and 74' could be used to control the shut down of other apparatus components. For example, contacts 130 and 74' might control, through appropriate solenoid valves, an air operated bottling installation.

A further feature of the circuit shown in Fig. 3 is an arrangement which is intended to prevent false operation of the electron tube 48' and the associated relay devices due to transient overvoltages. Such transient overvoltages are sometimes induced in the windings of the sensing transformer due to electrical faults at the bottling plant where the crown detector is installed. For example, such a transient overvoltage might be caused by a fuse that is not snugly seated in its receptacle which

would cause sparking or sputtering of the electrical circuit in such manner as to cause abrupt changes in voltage of extremely short duration to be impressed on the sensing transformer. Also, a loose wire in the electrical circuit, such as wire held in place by a screw in a fuse box, might produce the same abrupt changes in voltage. Such momentary interruptions of power as might be produced in the manner just described produce an instantaneous high voltage in the electrical windings of the sensing transformer. This overvoltage is generally a high harmonic of the power supply frequency. If such a momentary overvoltage occurs on the upper portion of the positive cycle of applied voltage, the electron tube 48' might become conducting without provocation.

In order to overcome the effect of the transient overvoltages just described, a series resonant circuit comprising an inductance 160 and a capacitance 162 is connected between power lines 32' and 34'. The circuit may be traced as follows: one end of inductance 160 is connected by conductor 164 to conductor 66' and thence to power line 34'. The other side of inductance 160 is connected by conductor 166 to one side of capacitor 162, the other side of the capacitor being connected by conductor 168 to conductor 42', and thence to power line 32'. There is also connected in parallel with the series resonant circuit just described a resistance element 170. One side of resistance element 170 is connected through conductor 172 to conductor 66' and thence to power line 34' while the other side of resistance 170 is connected by conductor 174 to conductor 42' and thence to power line 32'. Inductance 160 may have an inductance of approximately 2.5 millihenries, while capacitor 162 may have a capacitance of approximately 1 microfarad. Resistor 170 may have a resistance of approximately 1500 ohms with a power rating of approximately 10 watts. The series inductance-capacitance is tuned to absorb most of the high harmonic voltages produced by the electrical faults hereinbefore described, while the resistor 170 is intended to absorb transient voltages outside the tuned range of the series inductance-capacitance circuit. While the anti-transient circuit just described has been illustrated in connection with the circuit of Fig. 3, it is obviously equally applicable to the circuit of Fig. 2.

The operation of the circuit of Fig. 3 can be best understood by outlining three different possible situations as follows:

(*A*) A normal capped bottle passes adjacent the sensing unit. (*B*) A single capless bottle passes adjacent the sensing unit. (*C*) Two or more capless bottles follow each other in succession through the sensing unit.

Condition A.—Since the magnetic paths linking primary coils P1' and P2' respectively with the secondary coil S1' are balanced due to the magnetic slug on one side and the equivalent crown or cap on the other side, substantially no voltage is generated in secondary coil S1', due to the fact that the primary coils P1' and P2' are equal and opposite in their magnetic effect on the secondary coil S'. Therefore, when the bottle feeler switch 30 is closed by the presence of the bottle, no positive voltage is applied from secondary S' to the grid 46' of the electron tube 48'. Hence, tube 48' remains nonconducting and the relay 62' is unenergized. Consequently, the alarm bell 92' is not actuated.

Condition B.—A single capless bottle passes between the legs 24 and 26 of the sensing transformer 20, the bottle closing the bottle feeler switch 30 to open the bridging connection of contact 33' across terminals 107 and 109. In this case there is a much greater magnetic linkage between primary coil P1' and secondary coil S1' than between primary coil P2' and secondary coil S1' since the magnetic slug 28 is not balanced by the presence of a bottle cap. A voltage of sufficient magnitude to cause the tube 48' to fire is therefore generated in secondary S1', this voltage being transmitted by conductor 105 to the grid 46' of tube 48'. When tube 48' becomes conducting, relay coil 64' in the anode circuit is energized, causing contact 72' to close, and causing contact 74' across conductors 138 and 140 to open. Closing of contact 72' results in the energization of coil 104 of relay 102 through the following circuit: From power line 34', through conductor 66', through contact 72' and conductor 100 to coil 104, through coil 104 to conductor 42' and thence to power line 32'.

Energization of coil 104 of relay 102 closes normally open contacts 106 and 108. Closure of contact 106 completes a sealing-in circuit for relay coil 104 as follows: From power line 34', through conductor 66', through the bridging contact 135 of reset switch 134, through conductor 132, through normally closed contact 128 of timing device 114, through relay contact 106 to conductor 100 and thence to the relay coil 104, through coil 104 to conductor 42' and power line 32'. The relay coil 104 then remains energized until contact 128 is opened by the timer 114, or until the bridging contact 135 of reset switch 134 is manually opened. The sealing-in circuit just described is necessary since tube 48' only remains conducting for the very short interval in which the capless bottle is passing through the sensing transformer, this interval being generally less than ½ second. Since relay 64' only remains energized during the period in which tube 48' is conducting, it is necessary to seal in relay 104 for the completion of the cycle of timing device 118, which may be of about 4 seconds' duration.

Contact 130 in the control circuit of the bottling machine is opened by the timer 114 after a time interval which is sufficient to permit the first capless bottle to clear the sensing unit, with resulting deenergization of relay 62' and reclosing of normally closed contact 74'. Thus, for example, the timer 114 may be adjusted to open the contact 130 approximately ½ second after the timing motor has been energized.

Closure of contact 108 completes the energization circuit of timing device 114 through the following circuit: from power line 32' to conductor 42', through conductor 110 to relay contact 108, through contact 110, through conductors 112 and 120, through switch 122 on Automatic position, through conductor 123 to timing motor 118, through motor 118, through conductor 124 to conductor 66' and thence to power line 34'. The timing motor 118 starts to operate.

Energization of relay coil 104 also completes a circuit to the alarm bell 92' which may be traced as follows: from power line 32' to conductor 42', through conductor 110 to contact 108, through contact 108, through conductors 112 and 126 to terminal 91' of alarm bell 92', from terminal 93' of the bell to conductor 66' and thence to power line 34'. Alarm bell 92' then sounds an alarm which continues until relay 104 has been deenergized either by opening of contact 128 after a predetermined interval, such as four seconds, by the timer 114 or by manual opening of the bridging contact 135 of reset switch 134.

The timing device 114 is adjusted to operate for a predetermined time interval, such as four seconds, for example, at the end of which time interval the timer opens contact 128 to unseal the relay coil 104. Deenergization of relay coil 104 results in the opening of contacts 106 and 108. Opening of contact 108 opens the circuit of the alarm bell 92' and also of the motor 118 of timing device 114. Opening of the circuit of motor 118 causes the timing device 114 to reset itself in readiness for another cycle of operation, with contacts 128 and 130 being returned to their normally closed positions.

Condition C.—Assume that after a first capless bottle has passed by the sensing unit and has energized the relay coils 64' and 104 to start the alarm bell 92' ringing and to start the timer 114 in operation, a second capless bottle follows immediately after the first capless bottle. By the time the second successive capless bottle has

arrived at the sensing station, the timing device **114** has already finished timing the short interval, say ½ second, for example, at the end of which contact **130** in the control circuit of the bottling machine is opened. Therefore, contact **130** is already open when the second capless bottle fires the tube **48'** and energizes relay coil **64'** which opens normally closed contact **74'**.

With both contacts **74'** and **130** open at the same time, the series circuit of bottling machine control conductors **138** and **140** is opened and the bottling machine M shuts down. At the end of the four second timing interval of timer **114**, the timer opens contact **128** to unseal relay coil **104**, thereby opening the circuit of the alarm bell **92'** and also opening the circuit of the timing motor **118**. The timing device **114** then resets itself in readiness for another timing cycle and recloses normally closed contacts **128** and **130**.

It can be seen from the foregoing that there is provided in accordance with this invention an improved arrangement for detecting the presence of capless bottles in accordance with which the presence of a cap or closure having a content of magnetic material is balanced by the presence of a magnetic path having the same reluctance as that presented by the presence of the capped bottle or closed container. On the other hand, an uncapped bottle creates an unbalanced magnetic condition in the sensing transformer to thereby provide an output voltage. The voltage output of the sensing transformer produced by the presence of an uncapped bottle causes the firing of a normally non-conducting electron tube. This is an improvement over the arrangement of my prior patent in which the electron tube was normally maintained conducting but was rendered non-conductive by a signal voltage from the sensing transformer. The arrangement of the subject application has the further advantage that delicate electrical adjustments are not required, such as was required particularly in the grid biasing resistor used in the circuit arrangement of my aforementioned patent.

Furthermore, the features of the subject application just described provide a crown detection system of much greater sensitivity than that of my prior patent. The circuit arrangement provided in accordance with this invention to discriminate between a single capless bottle and a succession of capless bottles is also an improvement over the discriminating arrangement of my aforementioned patent since only a single electron tube is required in the discriminating circuit of this application, whereas the discriminating circuit of my aforementioned patent required the use of two electron tubes.

While there have been shown and described particular embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications can be made therein without departing from the invention and, therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as my invention is:

1. Apparatus for testing the mouths of containers to determine the presence of a closure having content of magnetic material comprising a transformer means including a magnetic core positioned to permit passage adjacent thereto of the mouths of containers to be tested for the presence of a closure, electrical winding means positioned on said magnetic core, said magnetic core having a first magnetic flux path adapted to receive the mouths of said containers with their closure means, a second magnetic flux path associated with said windings, said second path having a magnetic reluctance of a predetermined value in proportion to the magnetic reluctance of said first path in the presence of said closure means, said windings being connected to produce an output voltage signal when a closureless container is present in said first magnetic flux path, an electron tube means actuable by said voltage signal, means connecting the output voltage signal of said windings to said electron tube means, a relay device controlled by said electron tube means, a timing means controlled by said relay means, means connecting said electron tube means to said timing means through said relay device whereby a first closureless container initiates operation of said timing means, and means cooperating with said timing means whereby actuation of said electron tube means and said relay device by a second closureless container following said first container within a predetermined time is effective to perform a predetermined operation.

2. Apparatus for testing the mouths of containers to determine the presence of a closure having content of magnetic material comprising a transformer means, electrical windings carried by said transformer means, the magnetic flux path of said windings being adapted to receive the mouth of a container and its closure means, said electrical windings being connected to produce an output voltage signal in the presence of a closureless container, an electron tube means, means for applying said output signal to said electron tube means, a relay device controlled by said electron tube means, a timing device controlled by said relay device, operation of said timing device being initiated through said electron tube means and said relay device upon the presence of a first closureless container, an electrical circuit including contact means controlled by said timing device, said contact means being operated by said timing device after a predetermined period of operation of said timing device, and means controlled by the passage of a second closureless container within a predetermined time interval after the passage of said first container to render effective the operation of said contact means by said timing device whereby said electrical circuit is controlled in a predetermined manner.

3. Apparatus for testing the mouths of containers to determine the presence of a closure applied by a closure applying machine, said closure having content of magnetic material, comprising a transformer means, electrical windings carried by said transformer means, the magnetic flux path of said windings being adapted to receive the mouth of a container and its closure, said windings being connected to produce a predetermined output voltage signal only in the presence of a closureless container, an electron tube means, means for applying said output signal to said electron tube means to render said electron tube means conductive, said tube means remaining conductive only while said closureless container is adjacent said transformer, a first relay device energized by conduction of said electron tube means, said first relay device remaining energized only during conduction of said electron tube means, a control circuit having normally closed first and second contact means, said first and second contact means being in parallel with each other, said first contact means being operated to an open position during energization of said first relay device, said first contact means returning to normally closed position after deenergization of said first relay device, a second relay device energized by the energization of said first relay device, a timing means controlled by said second relay device, operation of said timing means being initiated through said electron tube means and said first and second relay devices upon the presence of a first closureless container, said second contact means being operated by said timing device and timed to open after said first contact means has closed due to deenergization of said first relay means by the passage of said first closureless container beyond said sensing transformer, said second contact means being timed to be open upon reopening of said first contact means within a predetermined time by a second closureless container whereby said first and second contact means are both open at the same time.

4. Apparatus for testing the mouths of containers to determine the presence of a closure having content of magnetic material comprising a transformer means in-

cluding a magnetic core adapted to permit passage adjacent thereto of the mouths of containers to be tested for the presence of a closure, electrical windings positioned on said magnetic core, a first magnetic flux path associated with said windings, a second magnetic flux path associated with said windings, said second path having a magnetic reluctance of a predetermined value in proportion to the magnetic reluctance of said first path in the presence of said closure means, said windings being connected to produce an output voltage signal when a closureless container is present in said first magnetic flux path, an electron tube means actuatable by said output voltage signal, means connecting said output voltage signal to said electron tube means, a timing means controlled by said electron tube means, operation of said timing means being initiated through said electron tube means upon the presence of a first closureless container, a control circuit including contact means, said contact means being controlled by operation of said timing means, and means controlled by the passage of a second closureless container

within a predetermined time interval after the passage of said first container to render effective the control of said contact means by said timing device.

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