Nov. 11, 1969 E. R. BUDZ 3,477,197

DEVICE FOR MONITORING THE OPERATION OF A JAR CAPPING MACHINE

Filed Nov. 6, 1967 2 Sheets-Sheet 1

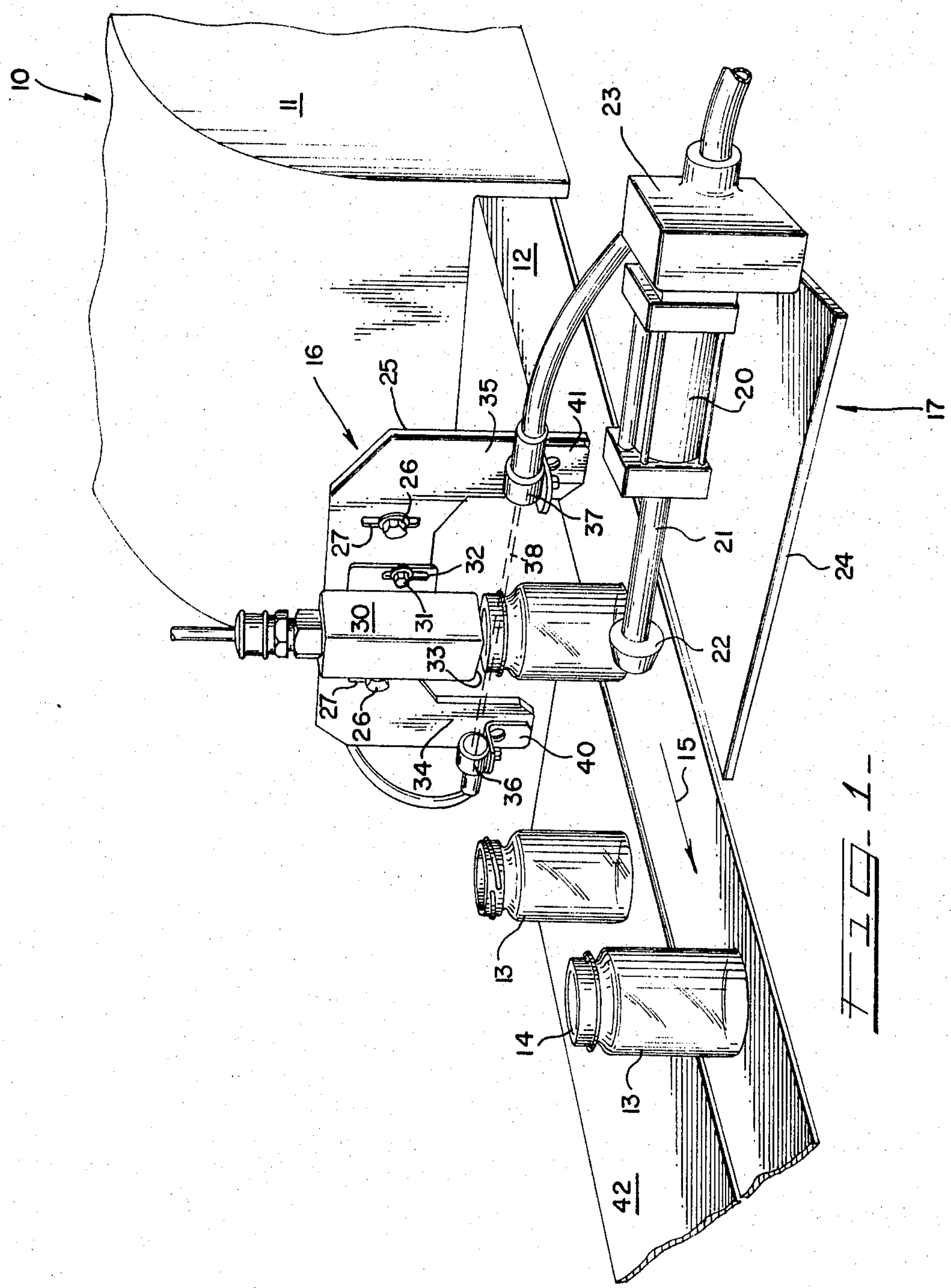

FIG. 1

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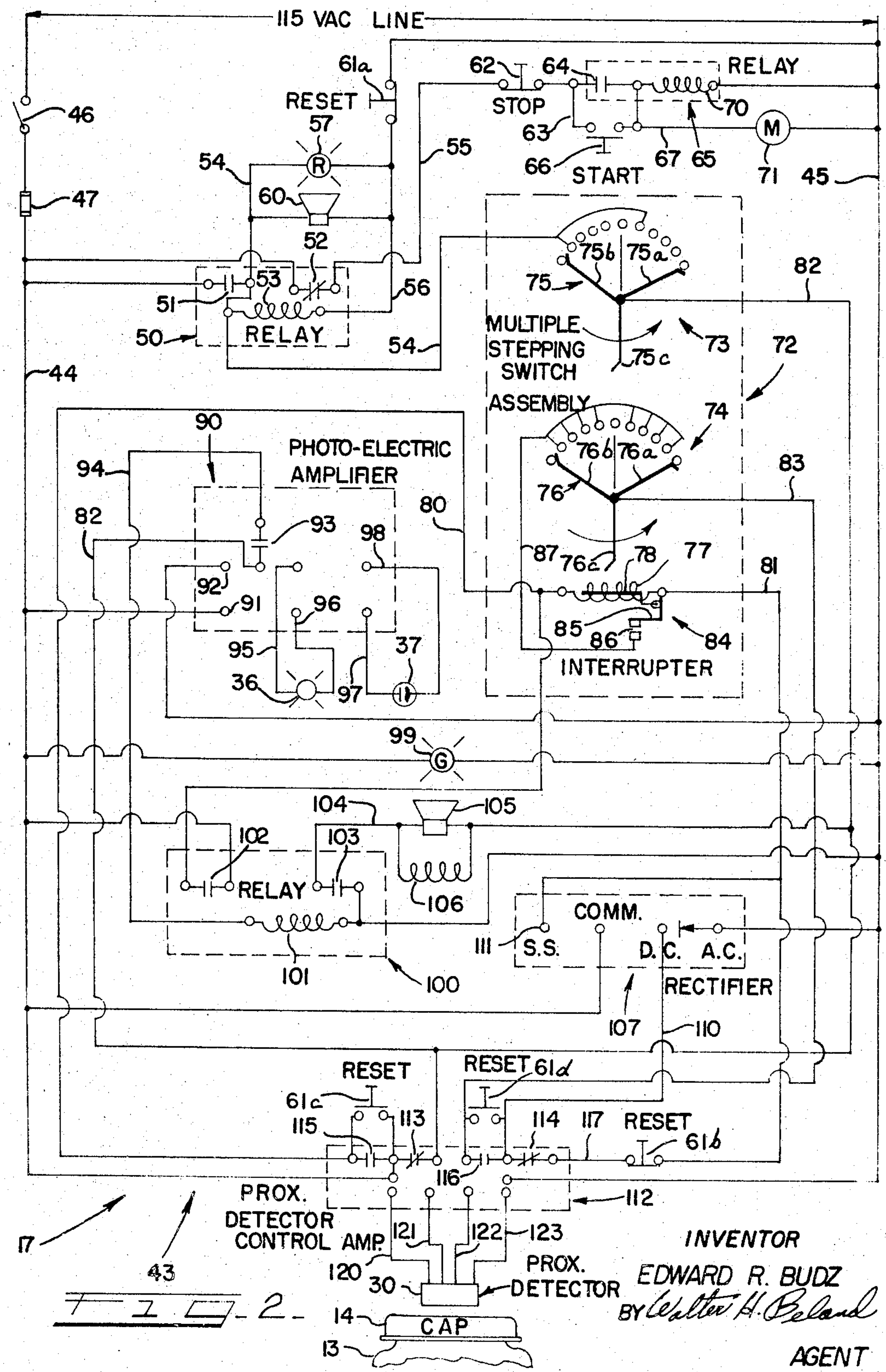

FIG. 2

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DEVICE FOR MONITORING THE OPERATION OF A JAR CAPPING MACHINE

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U.S. Cl. 53—53 7 Claims

ABSTRACT OF THE DISCLOSURE

A device for monitoring the operation of a capping machine which applies caps to containers, such as jars, including a proximity detector positioned above the conveyor belt carrying capped jars in single file out of the capping machine, for detecting the presence of the metal caps. A light source directs a beam of light across the path of the jars to a photocell; the interruption of the beam being used to indicate the detection of a jar. When the light beam is interrupted by a jar, and, a cap is not detected on the jar by the proximity detector, a jar ejecting air cylinder is caused to be operated to push the detected uncapped jar from the line. Occasionally occurring uncapped jars are thus automatically removed from the conveyor belt with the operation of the capping machine continuing. However, if a predetermined number of uncapped jars in succession, such as, for example, four, are detected, indicating that the capping machine is malfunctioning, it is caused to be shut down and a signal horn operated.

BACKGROUND OF THE INVENTION

Field of the invention

The invention is in the general field of capping containers such as jars for such products as apple sauce, olives, fruit preserves and baby food. Such jars are almost universally made of glass and the caps of tin-plated steel or aluminum. The caps may be of the type that are turned on and off of the container mouth or pressed on and pried off; both types of caps being used extensively.

Modern day filling and capping production lines for such containers operate at a rate of many hundreds of containers per minute. The general practice is for the containers to leave the capping machine in spaced apart single file processional order on a relatively high speed endless type belt-conveyor. In such a high speed jar capping operation, if, for any reason, the capping machine malfunctions so as not to apply caps to the jars passing therethrough; before the machine operator becomes aware of the situation, it is possible for hundreds of uncapped jars to be delivered from the capping machine before the capping machine is shut down. Such uncapped jars must be identified and removed from the production line which is a time consuming nuisance. Even in a jar capping line that is functioning normally; occasionally a jar or two, or even perhaps three in succession, will be discharged from the capping machine without a closure cap or closure caps thereon. It is important that any such infrequently occurring uncapped jars be removed from the production line which is usually done by a human inspector stationed at a point down-stream of the capping machine.

The invention eliminates the necessity of the capping machine operator being externally vigilant at the output end of the capping machine and permits him to perform other duties. To accomplish this, the invention provides a monitoring device which inspects each container

leaving the capping machine to determine if it is capped. Any container found by inspection to be uncapped is automatically ejected from the production line. If a predetermined number, such as, for example, four successive containers are determined to be uncapped; indicating that the capping machine is malfunctioning; the capping machine will be automatically shut down and the operator warned by means of a horn, a light, or both, that the capping machine is in need of attention.

Description of the prior art

Prior art devices have been developed which are capable of detecting and removing uncapped jars being conveyed out of the capping machine. Such devices, however, do not have the capability of fully monitoring the capping machine and shutting it down as soon as it becomes apparent that it is malfunctioning. When such devices are employed; if the capping machine is malfunctioning and is not capping any of the jars; all of the uncapped jars emanating from the machine will be ejected from the take-away conveyor and the machine will continue to deliver uncapped jars. Even though it is possible with such devices to warn the operator by means of a flashing light or the sounding of a horn that the capping machine is malfunctioning, by the time the machine operator reacts, a great number of uncapped jars may have been produced.

Statistical studies have indicated that a properly functioning capping machine may occasionally turn out an uncapped container or perhaps even several uncapped containers in succession. However, when a capping machine turns out a predetermined number, such as, for example, four uncapped containers in succession, it is highly probable that the capping machine is malfunctioning and will continue to turn out uncapped containers. The device of the invention represents an improvement over the prior art in that it is effective to shut down the capping machine upon the passage of a statistically determined number of successive uncapped jars therefrom.

SUMMARY OF THE INVENTION

The main object of the invention is to provide an apparatus for monitoring the operation of a machine which applies closure caps to containers, such as jars, and delivers the capped containers on a conveyor, comprising: a testing station adjacent said conveyor which includes means for detecting the presence of a cap on each container arriving at said testing station and means for detecting the presence of each container; control means responsive to signals from said cap detecting means and said container detecting means, said control means including counting means for registering the detection of uncapped containers, and means operated by said counting means for shutting down the capping machine upon the registering of a predetermined number of uncapped containers in succession by said counting means.

A more specific object is to additionally provide means at the testing station for ejecting detected uncapped containers from said conveyor with said control means additionally including means for operating said means for ejecting uncapped containers to cause the ejection of an uncapped container upon receiving signals from said cap detecting means and said container detecting means that said uncapped container is present at said testing station.

A still further object is to include in the control means, means for automatically resetting said counting means to a start position after the passage of a single container or unbroken succession of containers having no cap or caps thereon, but less than the predetermined number necessary to cause the counter operated means to be operated, said resetting means being actuated by a capped container arriving at the testing station before the set predetermined number of successive uncapped containers have been counted off.

Other and more specific objects will become apparent upon reaching an understanding of the operation of the preferred embodiment to be described.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a fragmentary perspective view of the discharge end of a capping machine showing containers leaving the capping machine and passing through the testing station of the monitoring device of the invention and also showing the means for ejecting uncapped jars from the container conveyor; and

FIGURE 2 is a wiring diagram showing the electrical circuitry of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGURE 1 of the drawings, the capping machine is referred to generally by the numeral **10**. Only a fragmentary portion of the capping head of the capping machine **10** and a portion of the jar conveyor thereof are illustrated and are respectively indicated by the numerals **11** and **12**. Jars **13** are conveyed in spaced apart single file order from the capping machine **10** on the jar conveyor **12** which may, as illustrated, be an endless belt type.

Jars **13** are priorly filled with product after which they are delivered in single file to the capping machine **10** wherein a cap **14**, which is usually made of either tin plated steel or aluminum, is applied to each successive jar.

As the jars leave the capping machine in the direction of the arrow **15** they pass through a testing station generally indicated at **16** of the monitoring apparatus of the invention generally indicated at **17**. Monitoring apparatus **17** includes means for ejecting uncapped jars from the conveyor **12** which may be in the form of the illustrated air cylinder **20**.

Air cylinder **20** includes a reciprocating piston rod **21** that is provided with an enlarged rubber jar contacting head **22** at its outer end. Air cylinder **20** also includes an integral electrically operated air-flow control valve **23** for controlling the reciprocating movement of the piston rod **21**. Air cylinder **20** and associated air-flow control valve **23** are completely conventional and may be purchased as a unit from many well known suppliers.

A mounting plate **24** is fixedly positioned in a conventional manner on a frame member (not shown) of the capping machine adjacent the conveyor **12**. Air cylinder **20** is mounted in a conventional manner such as by means of threaded fasteners on the mounting plate **24**.

Testing station **16** comprises a mounting plate **25** of generally inverted U-shape. Mounting plate **25** is adjustably fastened to the capping head **11** such as by means of threaded fasteners **26** passing through elongated adjusting slots **27**.

A proximity detector **30** is adjustably mounted above the path of travel of the jars **13** on the mounting plate **25** by means of threaded fasteners **31** and adjusting slots **32** of which only one of each is illustrated; a like threaded fastener and adjusting slot being hidden from view behind the proximity detector **30**.

The proximity detector **30** is of a type capable of detecting the presence of a metallic object positioned adjacent a detecting face **33** thereof, without contact being necessary between the detecting face and the object being detected.

Mounted on oppositely downwardly extending legs **34** and **35** of the mounting plate **25** is respectively a light source **36** and a photoelectric cell **37**. The light source **36** is mounted on a bracket **40** which in turn is fastened to the mounting plate leg **34**, such as by means of threaded fasteners. In a similar manner, the photo-electric cell **37** is mounted on an angle bracket **41** attached to the leg **35**. When the light source **36** is energized it directs a light beam **38** transversely across the belt **12** to the photo-electric cell **37**.

A table or platform **42**, which is disposed in the plane of the illustrated portion of the conveyor belt **12**, is fixedly positioned closely adjacent the conveyor belt, such as, for example, on a frame member (not shown) of the machine **10**. Platform **42** receives uncapped jars **13**, ejected from the conveyor **12** by operation of the air cylinder **20**, as will be later explained in detail.

Referring to FIGURE 2 of the drawings, it will be seen that the control circuitry of the invention, generally indicated at **43**, is energized by means of ordinary 115 volt A.C. line conductor networks **44** and **45**. The control circuitry is energized and de-energized as desired through a switch **46** in the conductor network **44**, which also may have a fuse **47** to prevent damage to the circuitry through an overload.

A dual contact relay generally indicated at **50** has a set of normally open contacts **51** and a set of normally closed contacts **52**. Contacts **51** and **52** are operated by the solenoid coil **53**. Branches of the line conductor network **44** connect to the contacts **51** and **52**. The opposite side of contacts **51** is connected to a conductor network **54** while the opposite side of the contacts **52** is connected to a conductor **55**.

One side of solenoid coil **53** connects into the conductor network **54** while the other side is connected to a conductor network **56**.

Connected in parallel between the conductor networks **54** and **56** is a red indicating light **57** and a horn **60**.

Conductor network **56** is in electrical communication with the line conductor network **45** through a normally closed push-button reset switch *61a*. The conductor **55** connects into one side of a push-button stop switch **62**; the other side of the switch **62** connecting into a conductor network **63**.

One branch of the conductor network **63** is connected to a normally open set of contacts **64** of a relay generally indicated at **65**. Another branch of the conductor network **63** is connected to one side of a normally open push-button start switch **66**; the other side of the switch **66** being connected to a conductor network **67**.

One branch of the conductor network **67** connects to one side of a solenoid coil **70** of the relay **65** while another branch is connected to one side of the capping machine drive motor **71**. The opposite sides of the solenoid coil **70** and motor **71** are connected to the line conductor network **45**.

Control circuitry **43** includes a multiple stepping switch assembly indicated generally at **72**. Stepping switch assembly **72** includes two stepping switches, one being indicated generally at **73**, and the other at **74**. The stepping switch **73** which is used as a counter includes a three-armed rotor **75**, while stepping switch **74** which is used to reset the counter **73** includes a similar rotor **76**. Rotors **75** and **76** are mounted on a common shaft for stepwise rotation in unison in a counter-clockwise direction due to the energization and de-energization of a solenoid; the coil of which is indicated at **77** and movable armature at **78**. One side of coil **77** is connected to a conductor network **80**, while the other side is connected to a conductor network **81**. Rotor **75** is connected to a conductor network **82** while rotor **76** is connected to a conductor network **83**. An interrupter generally designated **84** includes a movable arm **85** operated by the armature **78** and a set of contacts **86**. One of the contacts is attached to the arm **85** while the other connects into a conductor network **87**.

Stepping switch **74** has a set of contacts totalling 11 which is swept in counter-clockwise sequence by the arms ***76a***, ***76b*** and ***76c*** of the rotor **76**. Counting off from the first contact to the eleventh in a counter-clockwise direction it will be observed that the second, third, fourth, fifth, seventh, eighth, nine and tenth contacts of the stepping switch **74** are in electrical communication with the conductor network **87**. The first, sixth and eleventh or last contact are inactive.

Switch **73**, being similar to switch **74**, also has 11 contacts sequentially swept in a counter-clockwise direction by the arms **75**_a_, **75**_b_ and **75**_c_ of the rotor **75**. Counting in a counter-clockwise direction it will be seen that the 5th and 10th contacts are connected to the conductor network **54**; the remaining contacts being inactive contacts.

A photo-electric amplifier indicated generally at **90** is energized through terminals **91** and **92** thereof, which respectively connect into line conductor networks **44** and **45** for energization thereby. Amplifier **90** includes a set of normally open contacts **93** one side of which connects into the conductor network **82** while the other side connects to a conductor **94**.

The light source **36** receives electrical energy from amplifier **90** via conductors **95** and **96**. Photo-electric cell **37** is in electrical communication with the amplifier **90** through the conductors **97** and **98**.

A green indicating light **99** is connected across the line conductor networks **44** and **45** for energization thereby.

A relay generally indicated at **100** is actuated by a solenoid coil **101**. One side of solenoid coil **101** is connected to the conductor **94** while the other side connects into the conductor network **45**. Relay **100** includes a pair of normally open contacts **102** and **103**. Contacts **102** connect across conductor networks **44** and **80** while contacts **103** connect across conductor networks **45** and **104**.

A signal horn **105** connects across conductor networks **82** and **104** as does a coil **106** of a solenoid which operates the air-flow control valve **23**.

A rectifier unit generally indicated at **107** is energized by branch conductors of the conductor networks **44**, **45** and provides D.C. electricity in a conductor network **110**. Rectifier unit **107** includes a spark suppressing terminal **111** to which a branch of conductor network **81** is fastened.

A proximity detector control amplifier generally designated **112** has a pair of normally closed contacts **113** and **114** and a pair of normally open contacts **115** and **116**. The control amplifier **112** is energized by the line conductor networks **44** and **45**.

One side of contacts **113** connects into the conductor network **82** while the other side connects into line conductor network **44**. Conductor network **110** connects to one side of contacts **114** while the other side of contacts **114** is connected to a conductor **117**. Conductor **117** connects to one side of a normally closed push-button reset switch **61**_b_, the other side of which connects into the conductor network **81**.

One side of contacts **115** connects to the conductor network **80** while the other side connects into the line conductor network **44**. A push-button normally open reset switch **61**_c_ is also connected across the contacts **115**. One side of contacts **116** is connected into the conductor network **83**, while the other side is connected to the conductor network **110**. A normally open push-button reset switch **61**_d_ is connected across the contacts **116**. Push-button reset switch **61**_a_, **61**_b_, **61**_c_ and **61**_d_ are part of a gang reset switch for operation in unison whenever it is desired to reset the control circuitry **43**.

Proximity sensor **30** is connected into the control amplifier **112** by a set of conductors **120**, **121**, **122** and **123**.

OPERATION

In order to begin operation, the switch **46** (FIGURE 2) is first closed with the effect that the green light **99** immediately goes on to indicate that the circuitry **43** is now energized.

Next, the push-button start switch **66** is closed. This completes a circuit from the line conductor network **44** through the normally closed contacts **52** of the relay **50**, through the conductor **55**, stop switch **62**, conductor network **63**, start switch **66**, conductor network **67**, and capping machine drive motor **71** to line conductor network **45**. With the closing of the start switch **66**, electrical energy also flows through the switch **66**, conductor network **67**, solenoid coil **70** and conductor network **45**. This current flow energizes the solenoid coil **70** causing the normally open contacts **64** of the relay **65** to be closed. Upon release of the start switch **66** the motor **71** will continue to operate through the now closed contacts **64**.

With reference to FIGURE 1, the energizing of the motor **71** is effective to start the conveyor **12** moving in the direction of the arrow **15** to convey jars being capped in the capping machine **10**, therefrom, as illustrated.

As a jar having a cap thereon is moved by the jar conveyor **12** into the testing station **16**, the presence of the cap **14** on the jar will be detected by the proximity detector **30** slightly in advance of the light beam **38** from the light source **36** being broken by the passage of the capped jar therethrough. Such a capped jar will pass along undisturbed.

However, when an uncapped jar moves into the testing station **16**, the absence of the cap will first be detected by the proximity detector **30**, and immediately subsequent, the beam **38** will be broken, effecting the operation of the air cylinder **20** to knock the uncapped jar from the conveyor **12** onto the platform **42**. This is accomplished by the piston rod **21** being extended from the air cylinder **20** causing the rubber jar contacting head **22** to strike the side of the jar with sufficient force to propel the jar onto the platform **42**.

Prior to the starting operation; if there is a change in the height of the jars being run; it will be necessary to in unison reposition the height of the proximity detector **30**, light source **36** and photo-electric cell **37**, by loosening the threaded fasteners **26**. Regardless of jar size, however, the arrangement of the components at the testing station should be such that the jar cap will be detected prior to the breaking of the beam **38**.

As long as only occasional uncapped jars are detected, up to a maximum of three in succession, the capping machine **10** will continue to operate as just explained with the uncapped jars being removed from the conveyor **12**. However, should the passage of four uncapped jars in succession through the testing station be detected, indicating that the capping machine **10** is malfunctioning, it will be automatically shut down by the stopping of motor **71**. The machine operator will be advised that the machine has been shut down by the lighting of the red indicating light **57** and the operation of the horn **60** which will continue until the machine operator pushes the ganged reset push-button switch which includes the individual switches **61**_a_, **61**_b_, **61**_c_ and **61**_d_.

In order to fully understand the operation of the invention, assume first that a capped jar is moving from the capping machine into the testing station **16**. The proximity detector **30** will be positioned sufficiently close vertically to the cap so that the cap will be detected as it passes thereunder. The detection of the cap has the immediate effect of repositioning all of the contacts **113** through **116** of the proximity detector control amplifier **112**. Normally open contacts **115** and **116** will now be closed while normally closed contacts **113** and **114** will be open.

Very shortly after the detection of the cap, the light beam **38** will be broken by either the side of the jar or by the skirt of the cap **14** depending upon the elevation at which the light beam is set with respect to the passing jars. The interruption of the light beam causes the normally open contacts **93** of the photo-electric amplifier **90** to momentarily close and open again while the cap **14** is still under the proximity detector **30**. At the time the contacts **93** are closed the contacts **113** are open; thus, there will not be a completed circuit from conductor network **44** through the contacts **113**, conductor network **82**, closed contacts **93**, conductor **94** and solenoid coil **101** to conductor network **45**. Due to the coil **101** not being energized the contacts **102** and **103** remain open so that nothing further occurs in the circuitry **43** and the capped jar passes through the testing station and stays on the conveyor **12**.

Now, assuming that an uncapped jar is arriving at the testing station **16**, the contacts **113** through **116** of the proximity detector control amplifier 112 will remain in their normal positions as illustrated in FIGURE 2 due to the absence of a metal cap beneath the proximity detector 30. The light beam 38 will be interrupted as before by a portion of the jar side-wall or mouth defining rim. The breaking of the beam immediately causes the contacts 93 to close momentarily.

The momentary closing of the contacts 93 results in the momentary completion of a circuit from the line conductor network 44 through the closed contacts 113, conductor network 82, momentarily closed contacts 93, conductor 94 and coil 101 of relay 100 to line conductor network 45. The coil 101 is thus momentarily energized with the result that the contacts 102 and 103 of relay 100 are caused to momentarily close. The momentary closing of contacts 103 creates a circuit from line conductor network 45, closed contacts 103, conductor 104, horn 105, solenoid coil 106, conductor network 82 and closed contacts 113 to line conductor network 44. This results in the momentary sounding of the horn 105. It also results in the operation of the air cylinder 20 due to the energizing of the coil 106 of the air-flow control valve 23 which controls the operation of the air cylinder 20. As a result of the operation of the air cylinder 20, the detected uncapped jar is knocked off the conveyor belt 12 by the enlarged rubber jar contacting head 22.

The momentary closing of relay contacts 102 creates a circuit from line conductor network 44, momentarily closed contacts 102, conductor network 80, solenoid coil 77, conductor network 81, closed reset switch *61b*, conductor 117, closed contacts 114 and conductor 110 connecting into the rectifier unit 107. Since conductor 110 is a direct current conductor, direct current will momentarily be caused to flow through the solenoid coil 77 while the relay contacts 102 are closed and the flow of current to the coil 77 will cease immediately upon the contacts 102 opening. This momentary energizing of the relay coil 77 results in the rotors 75 and 76 of the multiple stepping switch assembly 72 being indexed in unison in a counterclockwise direction so that the arms thereof *75a* and *76a* in contact with the first contact on the right hand side of the stepping switches 73 and 74 will move up one step to register the detection of the uncapped jar so that they will now be in contact with the second switch contact. The rotors 75 and 76 will remain in contact with the second contact of stepping switches 73 and 74 until the passage of the next jar into the testing station 16.

Assuming that a second uncapped jar now arrives directly after the first uncapped jar at the detecting station 16, the contacts 113 through 116 of the proximity detector control amplifier 112 will remain as before in their normal positions as shown in FIGURE 2 and the normally open contacts 93 of photo-electric amplifier 90 will again be caused to momentarily close and be opened again when the jar breaks the light beam 38 as just priorly explained. The circuitry energized will be the same as for the first uncapped jar, resulting in the sounding of the horn 105 and the removal of the second detected jar from the conveyor 12. Coil 77 of the multiple stepping switch assembly 72 will be momentarily energized as previously explained with the result that the three-armed rotors 75 and 76 will move counter-clockwise so that the arms thereof *75a* and *76a* in contact with the second contact of respective stepping switches 73 and 74 will now be moved into engagement with the third contacts to register the detection of the second successive uncapped jar.

The passage of a third successive uncapped jar will result in the arms *75a* and *76a* being moved into contact with the fourth contact of the respective stepping switches in the same manner.

The arrival of a fourth successive uncapped jar at the testing station, however; which is an indication that there is something wrong with the operation of the capping machine 10, will result in the shutting down of the capping machine due to the connection of the conductor network 54 to the fifth contact of the stepping switch 73.

The arrival of the fourth uncapped jar at the testing station 16 results in the movement of the arms *75a* and *76a* of the rotors 75 and 76 into contact with the fifth contact of the stepping switches 73 and 74, respectively. When the arm *75a* comes into contact with the fifth contact, a circuit is created from line conductor network 45 through closed reset switch *61a*, conductor network 56, solenoid coil 53 of relay 50, conductor network 54, arm *75a*, conductor network 82 and contacts 113 to line conductor network 44.

The completion of this circuit results in the energizing of the solenoid coil 53 causing the contacts 51 and 52 of the relay 50 to respectively close and open. The closing of the contacts 51 causes the solenoid coil 53 to remain energized through a circuit formed therethrough from the line conductor network 45 to the line conductor network 44 even though a following jar having a cap thereon passes under the proximity detector 30 which would cause the contacts 113 to open to break the previously explained circuit through the solenoid coil 53. By means of the closing of contacts 51, the relay 50 will remain energized regardless of the passage of subsequently properly capped jars out of the capping machine 10.

The closing of contacts 51 also creates a circuit from line conductor network 45 through reset switch *61a*, the red light bulb 57 and horn 60 through conductor network 54 and closed contacts 51 to line conductor network 44. This circuit turns on the red indicating light 57 and horn 60. They will remain on until the push-button reset switch *61a* is operated to break the completed circuit.

The opening of the contacts 52 effects the breaking of the circuit from line conductor network 44 through the push-button stop switch 62, closed contacts 64, solenoid coil 70 and also motor 71 to the line conductor network 45. This results in the motor 71 stopping and thus shutting down the capping machine. The de-energization of the solenoid coil 70 of relay 65 also results in the contacts 64 returning to their normal open position so that the closing of the now open contacts 52 by the operation of the reset switch *61a* will not be effective to start up the motor 71 since the relay contacts 64 and the start switch 66 through which electrical paths through the motor 71 may be formed are both open.

Upon being advised of the shutting down of the capping machine by the continuous sounding of the horn 60 and the turning on of the red indicating light 57, the machine operator would first operate the ganged reset switch with the result that switches *61a* and *61b* would be caused to momentarily open, while switches *61c* and *61d* would be caused to be momentarily closed.

The opening of switch *61a* is effective to turn off the light 57 and horn 60 and also de-energize the relay 50 so that the contacts 51 and 52 return to their respective normally open and normally closed positions. The turning off of the horn 60 permits the machine operator to rectify the difficulty with the capping machine 10 in silence, after which he can restart the machine 10 by momentarily pushing the start switch 66 to close it, creating a completed circuit again through the motor 71 and solenoid coil 70 of the relay 65. This energizes the solenoid coil 70 resulting in the closing of the contacts 64 of the relay 65 through which the circuit to the motor 71 is maintained upon the releases of the push-button start switch 66 by the operator.

As stated before, the capping machine was caused to be shut down when the rotor arm *75a* reached the fifth contact of the stepping switch 73. Before operation can again commence it will be necessary for the rotor arm *75a* to move counter-clockwise to the next or sixth contact of the stepping switch 73. This is accomplished by the making and breaking of circuits due to the substantially simultaneous closing of reset switches *61c* and *61d* and opening of reset switch 61*b*. Direct current is now applied from the conductor 110 through momentarily closed switch 61*d* into the conductor network 83, rotor arm 76*a*, the number 5 contact of reset stepping switch 74 into conductor network 87, through closed contacts 86 of interrupter 84, through the solenoid coil 77, into conductor network 80 and then through the momentarily closed reset switch 61*c* into the line conductor network 44. The movable arm 85 of the interrupter is associated with the movable armature 78 of the solenoid coil 77 in a manner that when the solenoid coil is energized the contacts 86 will be caused to open and when the solenoid coil is de-energized contacts 86 will be caused to close. Shortly after the solenoid coil is energized as just explained, the contacts will be caused to open with the result that the solenoid coil 77 is de-energized. As the solenoid coil 77 is energized, the moving of the armature 78 of the solenoid effects the counter-clockwise rotation of the rotors 75 and 76 so as to position the contact arms 75*a* and 76*a* on the sixth contact of the stepping switches. As will be observed, the sixth contact of stepping switch 74 has no electrical connection, therefore, the solenoid 77 will not be again re-energized through the arm 76*a* and conductor network 87 through the now closed contacts 86, resulting in the arms 75*a* and 76*a* remaining in contact with the sixth contact of respective stepping switches 73 and 74. The first and sixth contacts of the stepping switches 73 and 74 are starting positions. That is to say, at the start of operations, one of the arms of the rotors 75 and 76 will be in contact with either the first or sixth contact of the respective stepping switches 73 and 74.

With the circuitry 43 now reset as just explained and upon the starting of the motor 71 by pressing the start button switch 66, capped jars will again begin moving out of the capping machine 10 and into the testing station 16. As long as properly capped jars are being turned out of the machine 10, the rotor arms 75*a* and 76*a* will remain in contact with the sixth contact of switches 73 and 74. However, if the capping machine malfunctions such that four uncapped jars in succession are detected at the testing station 16 the rotors 75 and 76 will be caused to step in a counter-clockwise direction as previously explained until the arms 75*a* and 76*a* arrive at the tenth contacts of the respective switches 73 and 74. As will be observed, the sixth through ninth contacts of stepping switch 73 are electrically inactive, but the tenth contact is connected into the conductor network 54. Therefore, when the arm 75*a* comes into contact with the tenth contact, the capping machine is caused to be shut down in the manner previously explained as a result of the arm 75*a* coming into contact with the fifth contact of the stepping switch 73. Now when the circuitry is reset to again commence operations, the arms 75*a* and 76*a* will move in unison to the last or eleventh contact of their associated stepping switches and the arms 75*c* and 76*c* will move into contact with the first contact of the respective switches putting the arms 75*c* and 76*c* in a starting position.

Whenever a single uncapped jar or a maximum of three uncapped jars in succession pass through the testing station, the control circuitry 43 through reset stepping switch 74 and associated interrupter 84 automatically resets the stepping switches 73 and 74 to the next starting position upon the passage of a following capped jar. That is to say, if the arms 75*a* and 76*a* are on the first contact of the switches 73 and 74 as illustrated in FIGURE 2 they will be caused to move up to the second contact of the respective switches upon the detection of a first uncapped jar. Now, if a capped jar follows the uncapped jar into the testing station 16, the stepping switches 73 and 74 will automatically be caused to rapidly index in a counter-clockwise direction until the arms 75*a* and 76*a* are at the second starting position in contact with the sixth contact of the respective switches 73 and 74. This rapid indexing is accomplished with such rapidity that it is completed before the arrival of the next jar at the testing station.

In order to understand this rapid indexing of the stepping switches 73 and 74 to the second starting position it will be assumed that the arms 75*a* and 76*a* are resting on the second switch contacts as a result of the detection of an uncapped jar. Now it will be assumed that the next succeeding jar is a properly capped jar. When this jar arrives under the proximity detector 30 it will result in all of the normally open and normally closed contacts of the proximity detector control amplifier 112 being reversed so as to be just the reverse of that shown in FIGURE 2. When the jar breaks the light beam 38, the contacts 93 of photo-electric amplifier 90 will momentarily be caused to close. The closing of the contacts 93, however, will not result in energizing the solenoid coil 101 due to the contacts 113 being open through which solenoid coil 101 is energized. The closing of the contacts 93 will thus not result in the closing of the contacts 102 and 103. Because the contacts 102 and 103 remain open the solenoid coil 77, horn 105 and solenoid coil 106 cannot be respectively energized therethrough. The stepping switches 73 and 74 will thus not be indexed as a result of the closing of the contacts 93.

A circuit is completed, however, delivering direct current from the rectifier unit 107 through the conductor 110, closed contacts 116, conductor network 83, rotor arm 76*a*, through the second contact of the reset stepping switch 74, through the conductor network 87, contacts 86, movable arm 85, solenoid coil 77, conductor network 80 and closed contacts 115 to the line conductor network 44. As the solenoid coil 77 becomes energized it is effective to cause the repositioning of the armature 78 which effects the counter-clockwise rotation of the rotors 75 and 76 to the third contact of the respective switches 73 and 75. The repositioning of the armature also operates the interrupter 84 causing the contacts 86 to open. The opening of the contacts 86 results in the breaking of the flow of current through the solenoid coil 77 with the result that the solenoid armature is caused to move to its de-energized position such as by means of a spring associated therewith (not shown) which in turn causes the interrupter contacts 86 to again be closed. Since the rotor arm 76*a* is now in contact with the third contact of the switch 74 which is electrically communicated with the conductor network 87, the coil 77 will again be energized as before through the interrupter 84 resulting in the arm 76*a* being shifted to the fourth contact. Since the fourth contact is also in communication with the conductor network 87, immediately upon the contacts 86 closing again after the coil 77 is de-energized, the coil will again be energized causing the arm 76*a* to be shifted into contact with the fifth contact of switch 74 and immediately thereafter shifted into contact with the sixth or second starting position contact. Since the sixth contact of switch 74 is electrically inactive and not connected into the conductor network 87, there will be no circuit formed through the contacts 86 and solenoid coil 77 as before and the arms 75*a* and 76*a* of respective switches 73 and 74 will remain at the second starting position awaiting the arrival of the next succeeding jar at the testing station.

As thus explained, it will be apparent that during operation of the monitoring apparatus 17, whenever the active arms of the rotors 75 and 76 are in contact with any of the three following switch contacts positioned between the first or second starting positions namely, between the first contact and sixth contact or between the sixth contact and the last contact an immediately following capped jar will cause the rotors to be rapidly indexed to the next starting position.

From the foregoing explanation of the operation of the monitoring device 17 it will be apparent that the main as well as secondary objects of the invention have been fulfilled in that all uncapped jars are removed from the production line and capping operations are stopped upon the detection of a predetermined number of uncapped jars in succession, such as, for example, four, which indicates that the capping machine is not functioning properly and needs attention.

Although the monitoring apparatus **17** may be employed with various types of capping machines it has been successfully used to control a straight-line type of capping machine similar to the machine described in U.S. Patent 2,876,605, issued on Mar. 10, 1956 to Robert K. McElroy and Ray M. Smith entitled "Machine for Applying Rotatable Closure Caps to Containers."

An advantage of the apparatus **17** is that it may be constructed mainly from commercially available components. For example, the multiple stepping switch assembly **72** may be purchased from C. P. Clare and Co., Chicago, Illinois, U.S.A. under catalog designation; Type 210 Spring-Driven Stepping Switch.

Rectifier unit **107** may be purchased from the same source under catalog designation RP8047. This rectifier unit is provided with a built-in spark suppressor to which the conductor network **81** connects at the spark suppression terminal **111** to prevent arcing within the stepping switch assembly **72.**

The photo-electric amplifier **90** with the associated light source **36** and photo-electric cell **37** may be obtained from Photoswitch Division, Electronics Corporation of America, Cambridge, Mass., U.S.A. under catalog designation, Photoswitch Impulse Control Type 23DF3.

The proximity detector control amplifier **112** and associated proximity detector **30**, respectively designated by catalog No. 20FC1 and catalog No. 4FB1 are obtainable from the manufacturer; Microswitch, Freeport, Ill., U.S.A., a division of Honeywell.

The remainder of the relays, horns, lights, etc., are also standard items obtainable from many electrical supply houses.

Although the illustrated embodiment is a preferred form of the invention, various modifications thereof will occur to one becoming familiar with the principles of operation involved. The scope of the invention is therefore not to be construed as being limited to the specific construction details of the illustrated embodiment, but rather, as set forth in the following claims.

I claim:

1. Apparatus for monitoring the operation of a machine which applies closure caps to containers, such as jars, and delivers the capped containers on a conveyor comprising: a testing station adjacent said conveyor which includes means for detecting the presence of a cap on each container arriving at said testing station and means

for detecting the presence of each container; control means responsive to signals from said cap detecting means and said container detecting means, said control means including counting means for registering the detection of uncapped containers; and means operated by said counting means for shutting down the capping machine upon the registering of a predetermined number of uncapped containers in succession by said counting means.

2. Apparatus as set forth in claim **1** further characterized in that said testing station additionally includes means for ejecting detected uncapped containers from said conveyor and said control means additionally includes means for operating said means for ejecting uncapped containers to cause the ejection of an uncapped container upon receiving signals from said cap detecting means and said container detecting means that said uncapped container is present at said testing station.

3. Apparatus as set forth in claim **2** further characterized in that means are provided to reset said counting means to a starting position, operated by signals from said cap detecting means and said container detecting means upon the arrival of a capped container at said detecting station following the detection registration and removal of a single uncapped container or an unbroken series of uncapped containers, said series being at least one less in number than said predetermined number of containers.

4. Apparatus as set forth in claim **3** further characterized in that said means for detecting the presence of a cap comprises a proximity detector.

5. Apparatus as set forth in claim **4** further characterized in that said means for detecting the presence of each container comprises a light source for directing a light beam across said conveyor and a photo-electric cell for receiving said light beam.

6. Apparatus as set forth in claim **5** further characterized in that said counting means comprises a stepping switch.

7. Apparatus as set forth in claim **6** further characterized in that said reset means comprises a stepping switch and an interrupter.

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