Feb. 20, 1973 H. E. SCRIBNER 3,717,248

DIFFERENTIAL PRESSURE BOTTLE CROWN INSPECTOR EMPLOYING FLUDIC CONTROL SYSTEM

Filed Dec. 10, 1971 3 Sheets-Sheet 1

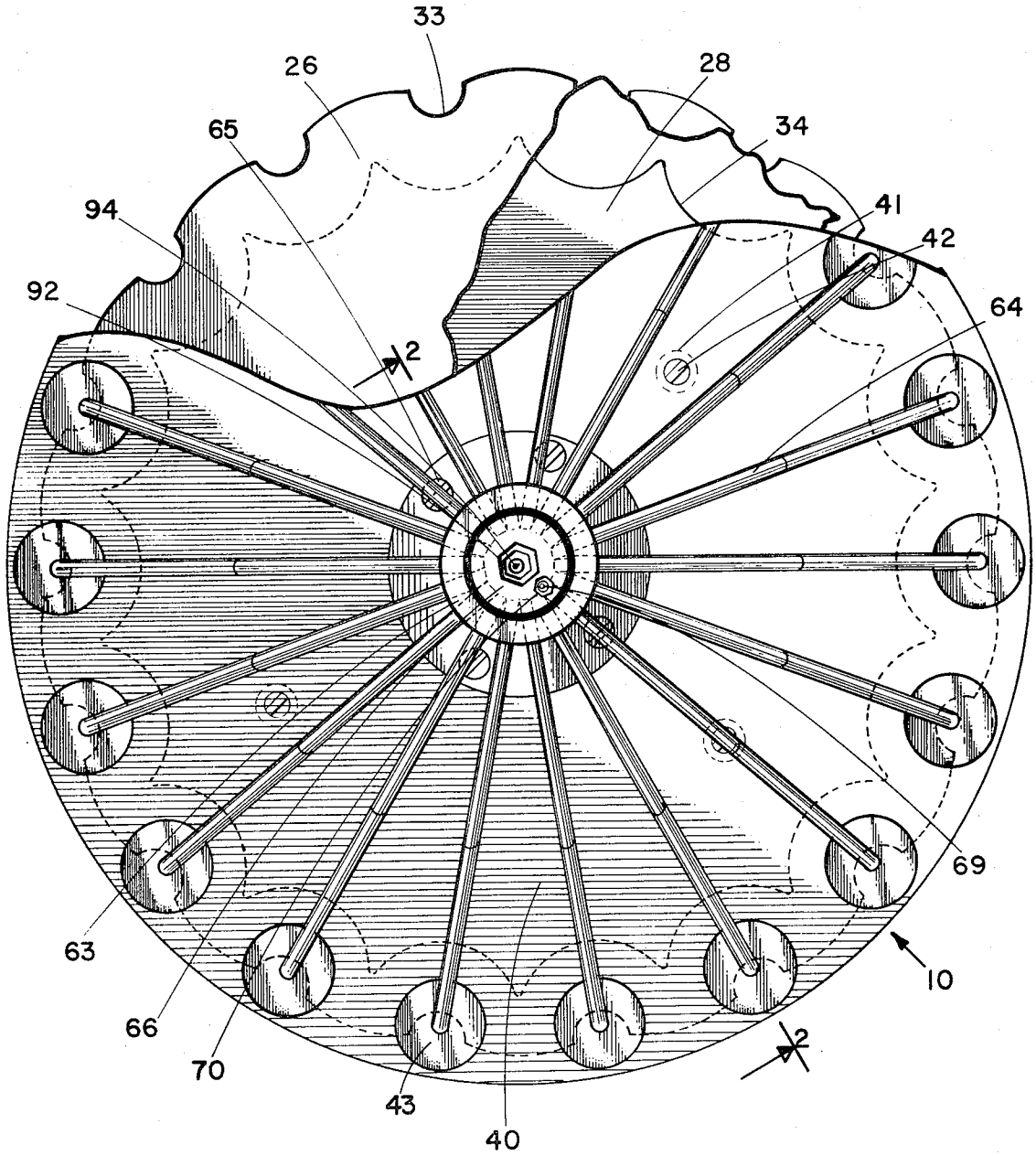


Fig. 1.

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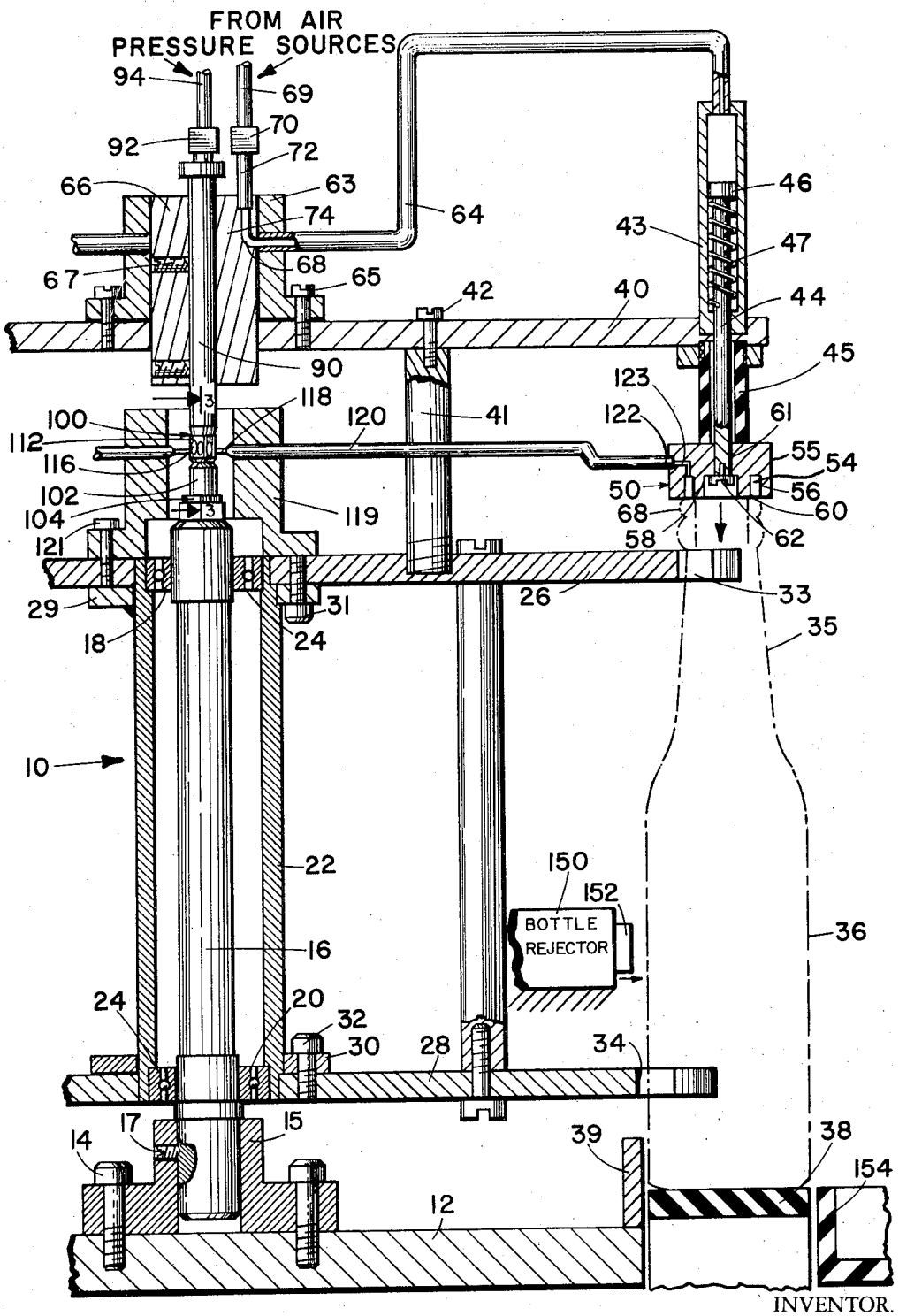


Fig. 2.

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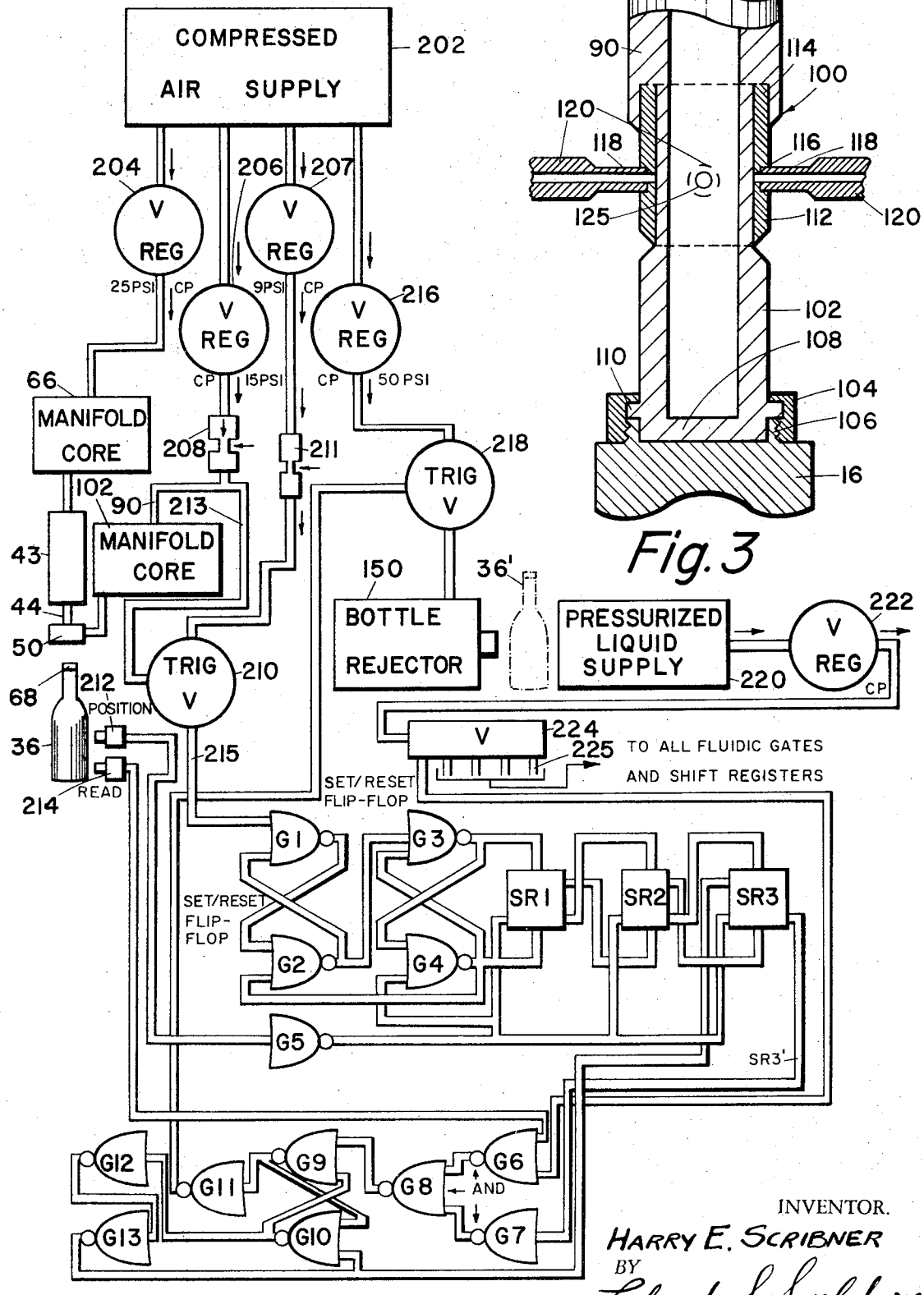


Fig. 4.

Fig. 3

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DIFFERENTIAL PRESSURE BOTTLE CROWN INSPECTOR EMPLOYING FLUIDIC CONTROL SYSTEM

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ABSTRACT OF THE DISCLOSURE

This apparatus inspects the tops of bottles as they move along on a conveyor past an inspection position. Resilient sensor heads carried by air driven cylinders on a rotating plate engage the top of each bottle in turn at the inspection position. The plate is carried by star wheels which engage the side of each bottle in turn at the inspection position. A pressurized source of air applies air under pressure to each sensor head in turn to test the bottle tops for air leakage. A fluidic control system is connected between the pressurized source of air and a bottle rejector to eject a bottle automatically after the bottle leaves the inspection position, if the bottle is defecive and causes air leakage while in the inspection position.

This invention relates to apparatus adapted to inspect the crown ring, lip or top of a bottle for defects such as cracks, chips, flaws, malformations, irregularities, and the like.

The present invention involves improvements over those described in my prior U.S. Pat. 3,595,065. In my prior patent there is described a bottle inspection apparatus in which a line of bottles moving along a conveyor are inspected automatically and ejected if found defective. Inspection is accomplished by monitoring fluid pressure or vacuum applied to the top of a bottle through a tight fitting resilient sensing head. The sensing heads are carried by cam operated arms which rotate with star wheels engaging the bottles in turn. If fluid pressure applied to the top of a bottle drops beyond a predetermined limit an electrically operated ejection device is actuated to remove the defective container from the moving conveyor.

In the present invention, sensor heads are carried by spring biased piston shafts in air cylinders mounted on a rotatable plate. The air cylinders are connected via valve controlled manifold means to a source of pressurized air for applying the sensor heads in turn automatically to the bottle tops when they reach the inspection position. Another pressurized air source supplies air to the sensor heads via another valve controlled manifold means. An air operated ejector device is located beyond the inspection position to eject a defective bottle after it leaves the inspection position. A fluidic control system is connected between the ejector device and the pressurized air supply supplying air to the sensor heads. The fluidic control system includes an arrangement of fluidic gates and shift registers to sort information indicative of a defective bottle to actuate the ejector device after it leaves inspection position.

It is therefore a principal object of the present invention to provide apparatus for inspecting the tops of bottles by employing air actuated cylinders to apply a resilient sensor head to each bottle in turn.

A further object of the invention is to provide a bottle inspection apparatus as described, with rejector means located beyond an inspection position to reject a defective bottle after it leaves inspection position.

Another object is to provide one air supply source to

supply pressurized air to the air cylinders via one valve operated manifold means and a second air supply source to supply pressurized air to the sensor heads via another valve operated manifold means to test the bottle tops for air leakage.

Another object is to provide fluidic control system in circuit with the second air supply source and bottle rejector means for actuating the same, the fluidic control system containing fluidic information storage means for temporarily storing information as to the condition of each bottle tested and for operating the bottle rejector means when a defective bottle is found.

Other and further features, objects and advantages of the invention will become apparent from the following detailed description taken together with the drawings, wherein:

FIG. 1 is a top plan view of bottle inspection embodying the invention, parts being broken away or omitted.

FIG. 2 is a vertical sectional view taken on line 2—2 of FIG. 1.

FIG. 3 is an enlarged fragmentary sectional view taken on line 3—3 of FIG. 2; and

FIG. 4 is a diagram of an air distribution and fluidic control system which may be employed in the apparatus to effect test of each bottle and rejection of defective bottles.

Referring to the drawings, there is shown apparatus **10** including stationary table or platform **12** on which is secured by bolts **14** a flange bracket **15** having an upright axially vertical post **16** secured to the bracket by a set screw **17**. The post **16** carries upper and lower ball bearing assemblies **18** and **20**. Upper and lower horizontal star wheels **26, 28** are carried by upper and lower flanges **2, 30**, respectively secured to hollow shaft **22** by bolts **31, 32**. Each wheel has a fluted or serrated periphery as best seen in FIG. 1 with indentations **33, 34**. The indentations **33** in the upper wheel are smaller than indentations **34** in the lower wheel and are located further radially outward of the axis of the hollow shaft **22**. Indentations **33** receive the necks **35** of bottles **36**, one of which is indicated by dotted lines in FIG. 2. The bottles are carried on a moving conveyor **38** horizontally in line past the star wheels **26, 28** along lateral guide rail **39**.

An upper horizontal wheel or plate **40** is mounted on spaced vertical posts **41** by screws **42**. The posts are carried by upper star wheel **26**. On plate **40** is secured a multiplicity of axially vertical air cylinders **43**. Each cylinder has an axially movable piston shaft **44** extending through a hole in plate **40** and through an axially vertical spacer sleeve **45** secured to the underside of plate **40**. The shaft has a piston head **46** at its upper end inside the cylinder and moves downwardly against tension in coil spring **47** inside the cylinder.

At the lower end of each piston shaft is a sensor head **50**. Each sensor head is made of resilient material such as natural or artificial rubber. A circumferential recess or groove **54** of any suitable configuration is formed in the bottom of each sensor head and is adapted to receive the top of the bottle being inspected. The recess is located radially inward of outer wall **55** defining a flexible lower lip **56**. Concentric inner lip **58** is defined between recess **54** and a central recess **60** communicating with a central passage **61** in the sensor head. Shaft **44** extends through passage **61**. The sensor head is secured to the lower end of shaft **44** by a screw **62**. The flexible lips **56** and **58** can engage on opposite sides of the crown ring **68** at the top end of a bottle **36** to contain the same.

One sensor head **50** at a time is engaged on the top end of an open bottle which arrives at the inspection position defined by that one air cylinder which is disposed over the line of travel of conveyor **38**. The head is moved

downwardly by piston shaft 44 when air under pressure is delivered from manifold collar 63 via one manifold pipe 64. This collar is secured by bolts 65 to upper plate 40. The collar rotates around a stationary manifold core 66 secured by setscrews 67 to a central axially vertical tube 90 carried by post 16. Core 66 has a single radial passage 68 which communicates in turn with each manifold pipe. Pipes 64 are connected to upper ends of the cylinders 43 respectively. An air supply pipe 69 is connected via coupling 70 and fitting 72 to a vertical bore 74 communicating with passage 68. By this arrangement air under pressure is applied to each piston head 46 in turn as each cylinder 43 arrives at inspection position while the plate 40 rotates with the star wheels 26, 28.

Air under pressure is supplied to that one sensor head 50 which is located at the inspection position. Tube 90 is connected via a coupling 92 at its upper end to a pipe 94 which extends from a suitable source of air pressure which is substantially greater than that in pipe 69. The union 100 has a central stationary cylindrical valve core 102 secured by a threaded, flanged coupling ring 104 engaged with threaded nipple 106 on top of post 16; see FIG. 3. The core 102 has a closed bottom end 108. An annular flange 110 of the valve core 102 is engaged under coupling ring 104. A manifold tube 112 surrounds core 102 and is rotatable on the core. The upper end of the tube 112 is rotatably engaged in a groove 114 in union 100. In the manifold tube 112 is a multiplicity of holes 116 in which are engaged narrow ends 118 of flexible pipes 120. Each pipe 120 terminates at a hole 122 in a side of sensor head 50 and communicates with passage 123 opening into recess 54; see FIG. 2. Core 102 has a single radial hole 125 opening into that one pipe 120 which terminates at the sensor head 50 at the inspection position. Cylindrical manifold hub 119 on wheel 26 supports the inner ends 118 of pipes 120 and rotates with pipes 120 and manifold tube 112. Bolts 121 secure hub 119 to star wheel 26.

A defective rejector device 150 is located in the path of movement of tested bottles 36 on a conveyor 38. The rejector device is spaced from the inspection position and is provided with a laterally movable plunger 152 to eject a defective bottle of the belt and into bin 154. This device is operated by air pressure as described below.

In FIG. 200 is shown an air distribution and fluidic control system which may be employed in association with apparatus 10 for actuating the sensor head 50, air cylinder 43, and bottle rejector 150 located at the inspection position of bottle 36. A compressed air supply 202 is connected via regulator valve 204 to manifold core 66. This in turn is connected to air cylinder 43 which drives piston shaft 44 carrying sensor head 50. Another regulator valve 206 connected to the air supply 202 is connected to manifold core 102 via a variable resistance 208. A trigger valve 210 is connected between variable resistance 208 and tube 90 connected to manifold core 102. Regulator valve 207 is connected between air supply 202 and a variable resistance 211 which in turn is connected to trigger valve 210.

Two fluidic sensor devices 212 and 214 are disposed at the inspection position of apparatus 10. Sensor device 212 is actuated to provide a pulse when a bottle 36 is properly positioned at the inspection position for test. Sensor device 214 is actuated to provide a pulse to effect a readout of the bottle condition.

Another regulator valve 216 connected to the air supply 202 is connected via a trigger valve 218 to bottle rejector 150 for actuation when a particular bottle 36' is determined to be defective. A pressurized liquid supply 220 which supplies water, oil or the like is connected via regulator valve 222 to a distributor valve 224. This valve has a multiplicity of outlets 225 connected to all fluidic gates G1–G13 and shift registers SR1–Sr–3 in the fluidic control system.

In operation of apparatus 10 and system 200, one sensor head 50 at a time is applied to the top end of an open bottle 36 which arrives at the inspection position. Air is then applied via manifold core 66 and manifold collar 63 to the air cylinder 43 at the inspection position. Piston 46 is then pressed down along with shaft 44 and applies the resilient sensor head 50 to the top of the bottle being tested. Spring 47 is then compressed. The sensor head will be retracted by expanding spring 47 when the pipe 64 through which air is fed to cylinder 43 is closed off by further rotation of manifold 63. It will be understood that rotation of the star wheels 26, 28 and plate 40 carrying manifolds 119 and 63 will be caused by movement of the bottles on conveyor 38 engaging in identations 33 and 34 of the star wheels. As soon as the sensor head engages on the crown ring 68 of the bottle which has moved into inspection position, air pressure is applied through hole 125 in core 102 and through pipe 120 and recess 54 to the crown ring. The crown rings closes the pressure chamber thus defined by recess 54 and the crown ring. If the crown ring is perfect, the pressure will be maintained in the pressure chamber and in tube 90. If the crown ring is imperfect, plunger 152 is later moved laterally to eject the defective bottle 36', indicated in FIG. 4. The ejected bottle will be thrust off of conveyor 38 into bin 154 or adjacent accumulator.

The manner in which ejection is effected will now be explained with particular reference to FIG. 4. Regulators 204, 206, 207 and 216 may be set to provide different constant pressures for example 25, 15, 9 and 50 pounds per square inch (p.s.i.) respectively as indicated in FIG. 4. Variable resistance 208 should be set so that the pressures applied via branch pipe 213 to trigger valve 210 when a perfect bottle and when a defective bottle are tested, differ by a definite amount, for example at least 0.5 p.s.i. When a bottle 36 being tested is contacted by sensing head 50, the pressure applied to trigger valve 213 will increase if the bottle is good and the valve 210 will be triggered on to apply pressure via resistance 211 to otput 215. If the bottle is defective, the pressure will stay below the critical setting of the valve due to the air leakage at bottle crown 68, and the pressure at output 215 will be zero. The pressure or lack of pressure appearing at output 215 is stored in a Set/Reset Flip-Flop formed by fluidic gates G1 and G2. This information is transferred to and stored in the Set/Reset Flip-Flop formed by gates G3 and G4 when the Read sensor 214 previously closed by the movement of bottle 36 into position is opened by slight movement on conveyor 38 away from the inspection position. When the Read sensor is actuated it applies a reading pulse via fluidic gate G5 to gate G4 and shift registers SR1, SR2 and SR3. As the reading pulse or pressure is turned off, the information stored in gates G3, G4 is transferred to shift register SR1. This information is transferred to shift register SR2 when the next bottle moves into inspection position, and is further transferred to shift register SR3 when a next succeeding bottle is placed in inspection position. When the stored information about the previous bottle reaches the output of shift register SR3 reaches output SR3', it is applied to an AND gate formed by fluidic gates G6, G7 and G8. The AND is activated when Position sensor 212 detects the presence of a new bottle at the inspection position and applies a fluidic pulse to gate G6. The output of the AND gate is fed to unistable, one-shot circuit formed by gates G9, G10, G11, G12 and G13. If the bottle tested was defective an output pulse appears at Gate G11 to operate the trigger valve 218 which passes air pressure via regulator valve 216 to operate bottle rejector 150. If the bottle tested was perfect, no output appears at gate G11 and the bottle rejector 150 remains inactive to permit the perfect bottle to pass by on the conveyor 38.

This operation of the apparatus is continuous. Inspection takes place instantaneously. The moving bottles rotate the wheels 26, 28 and plate 40 carrying the air cylinders 43 and sensor heads 50. If desired, the star wheels with plate 40 can be driven by any suitable means, in-

dependently, or by the conveyor but synchronized with conveyor movement. The apparatus can be made to stop when a defective bottle has been found, although this is not necessary in the apparatus as described. The bottle rejection device **150** is only exemplary to show one way of ejecting defective bottles. Other ways of rejecting defective bottles can be substituted, such as by lifting a defective bottle bodily up off the conveyor belt. Other arrangements of fluidic control and air distribution systems can be substituted.

It will now be apparent that this invention makes it possible to inspect bottles continuously, automatically and reliably. The apparatus is relatively simple in construction and can be installed at existing bottle manufacturing or filling facilities at minimum expense.

While a preferred embodiment of the invention has been described and illustrated, it will be apparent that many other modifications and variations other than those mentioned above, are possible, without departing from the invention.

What is claimed is:

1. An apparatus for inspecting the tops of bottles for flaws, chips, cracks, irregularities and other defects, comprising a rotatable support; means for moving a line of bottles to be tested in turn past an inspection position at said rotatable support; a plurality of air cylinders carried by said support in circumferentially spaced relation thereabout; a plurality of resilient sensor heads carried by the air cylinders respectively, each sensor head having a recess conforming to the top edge of a bottle to seal the same; a first source of pressurized air; first manifold means connected to said source and said air cylinders, said manifold means comprising first valve means arranged to actuate each air cylinder in turn at the inspection position to apply a sensor head to the top edge of a bottle being tested; a second source of pressurized air; and second manifold means connected between said second source and said sensor heads, said second manifold means comprising second valve means arranged to apply air pressure from said second source to only one sensor head at a time at said inspection position.

2. An apparatus as defined in claim **1**, wherein each air cylinder contains a piston driven shaft attached to a sensor head and movable axially out of the cylinder to apply the sensor head to a bottle being tested.

3. An apparatus as defined in claim **2**, wherein each air cylinder further contains a return spring arranged to retract said shaft and attached sensor head when the support means rotates to actuate the first valve means for closing off the air supply to air cylinder leaving the inspection position.

4. Apparatus as defined in claim **1**, further comprising bottle ejector means for ejecting a defective bottle, said ejector means being arranged to respond to loss in pressure of air applied from the second source to a defective bottle to eject the defective bottle from said line after the defective bottle leaves the inspection position.

5. Apparatus as defined in claim **4**, further comprising a fluidic conrol means connected between said second source of pressurized air and said ejector means for actuating the same when the pressure of air applied to a bottle top via a sensor head decreases due to an imperfection of the bottle top.

6. Apparatus as defined in claim **5**, wherein the recess in each sensor head is so shaped that the sensor head grips both internally and externally the open top of a bottle being inspected while pressurized air is applied from said second source to the sensor head for detecting a defect in the shape of the open top of the bottle gripped by the sensor head.

7. Apparatus as defined in claim **6**, wherein said support means comprises a pair of vertically spaced, horizontal, concentric, peripherally serrated wheels mechanically connected together, said wheels having indentations arranged to engage each bottle in turn as it passes the inspection position; and a stationary support at the center of the wheels rotatably carrying the same, so that the wheels turn as the line of bottles advance to engage in the indentation of the wheels.

8. Apparatus as defined in claim **7**, wherein said support means further comprises a horizontal plate carried by the upper one of said wheels, said air cylinders being carried by said plate.

9. Apparatus as defined in claim **8**, wherein said first and second manifold means are mounted on the plate and upper wheel respectively.

10. Apparatus as defined in claim **9**, wherein the first and second valve means each comprises a valve core connected to the first and second sources of pressurized air respectively, each core having a single hole in one side thereof oriented with respect to said inspection position, said first manifold means comprising a manifold member enclosing one valve core, and a plurality of pipes connected respectively between the air cylinders and the manifold member, said second manifold means comprising another manifold member enclosing another valve core, and another plurality of pipes connected respectively between the sensor heads and said other manifold member, whereby pressurized air passes from the first manifold means to the air cylinder located at the inspection position, and whereby pressurized air passes from the second manifold means to the sensor head located at the inspection position.

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