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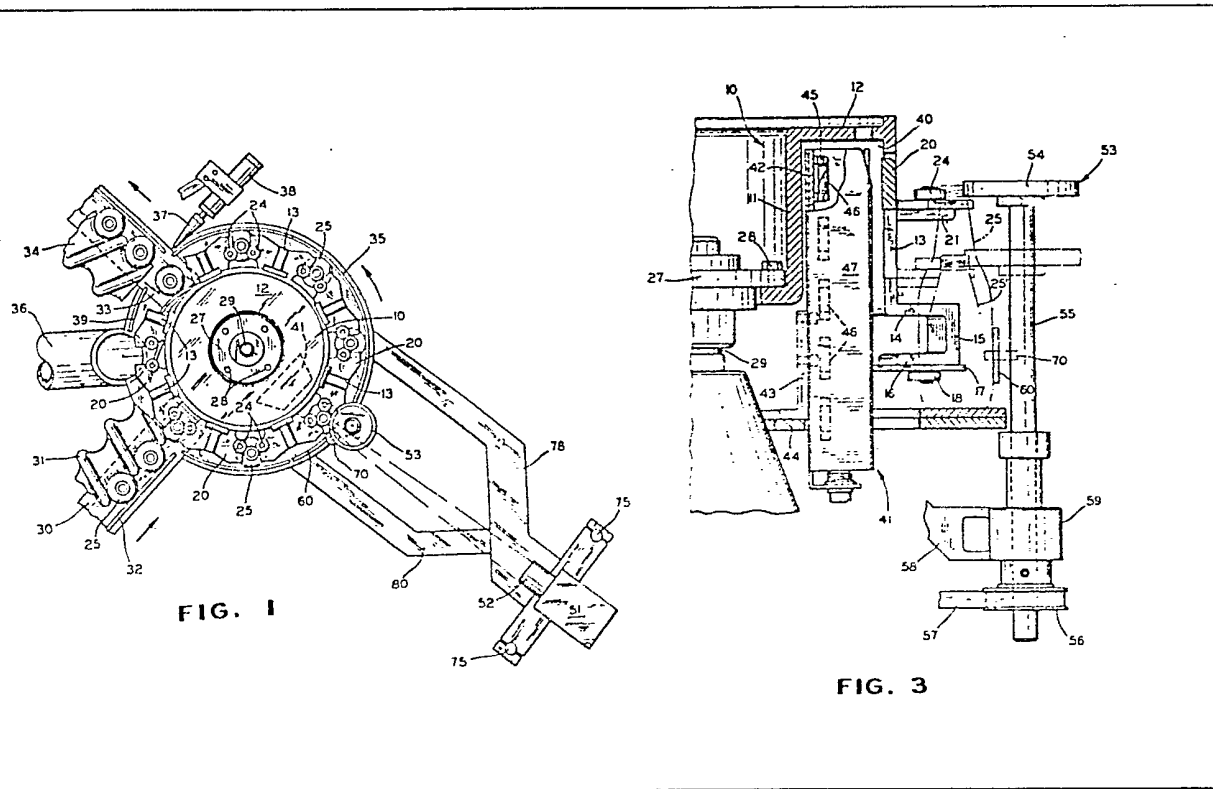
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(54) Rotary conveyor in a glass
container sidewall defect detection
system

(57) Apparatus for inspecting glass
containers in which an indexing
starwheel (10) moves a plurality of
containers (25) in series through a
plurality of stations where the
containers are physically and optically
examined, the containers 25
being held against rollers 18, 24
carried by arms 13 depending the
peripheral portion 12 of the starwheel
10, and each container being rotated
about its vertical axis by engagement
of the top thereof with a driven wheel
(53) at one of the stations. The

container, as it is rotated, is viewed by
a camera (51) whose lens focuses the
sidewall image of the bottle onto a
vertical, linear array of light sensitive
pick-ups in the camera. The camera is
supported relative to the bottle
handling system for adjustment up
and down, back and forth and
sideways so as to have the flexibility
of viewing different size bottles.

Rotating worm means (31, 34) move
the bottles into and out of the
handling system and serve as means
to time the bottle movements. A
mechanism (81) at the exit position
assists the bottles out of the starwheel
(10). At the station where the sidewall
of the bottles is to be inspected, a light
source (41) in the form of a tall
housing is positioned in a vertical,
annular recess of the starwheel. The
light source is composed of three
columns of five lamps (46) with the
outer columns being lit when viewing
flint bottles and the centre column is
additionally lit when amber bottles are
being viewed. The circuit for the lamps
is provided with a means to detect
the presence of burned out bulbs.



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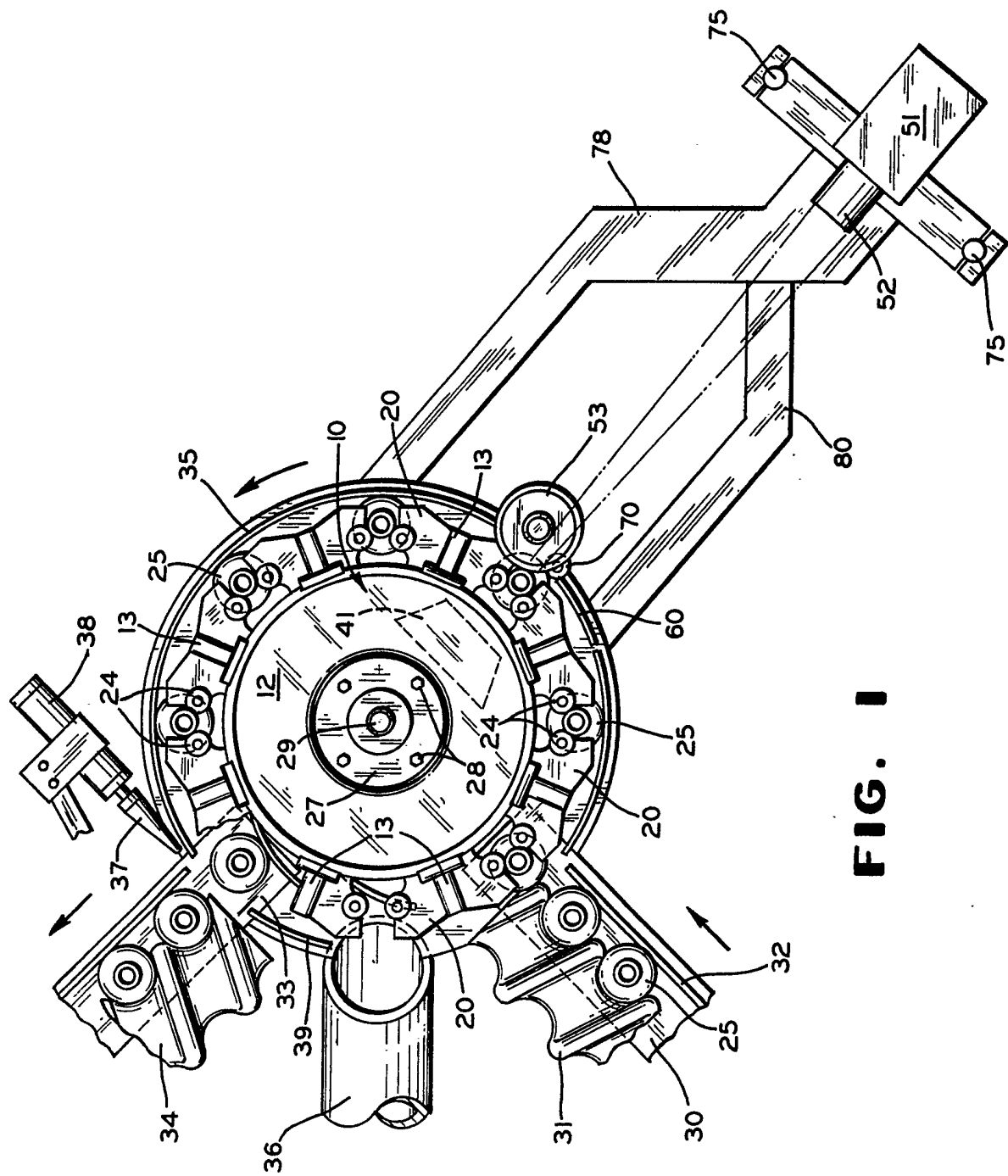
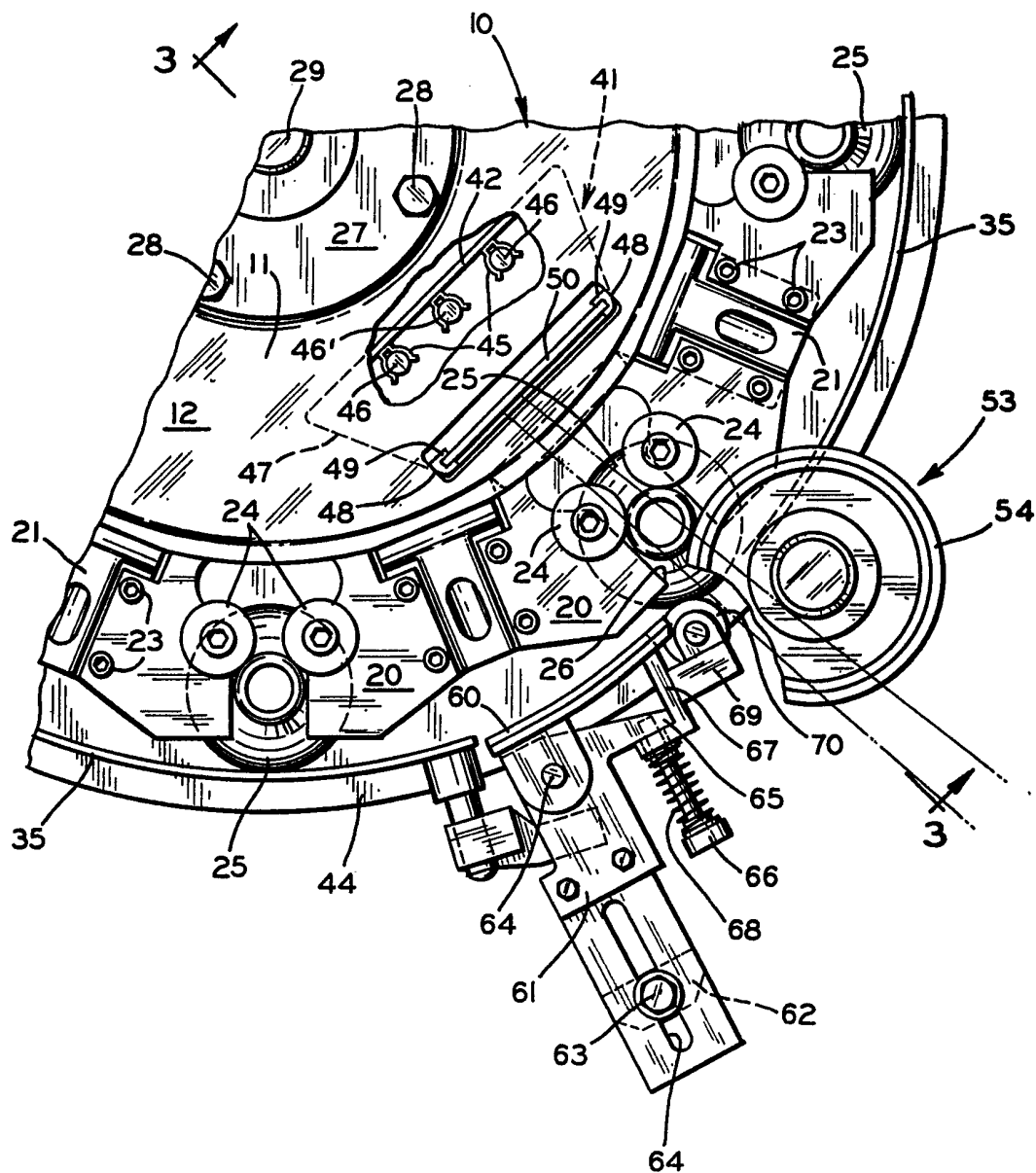


FIG. 1

**FIG. 2**

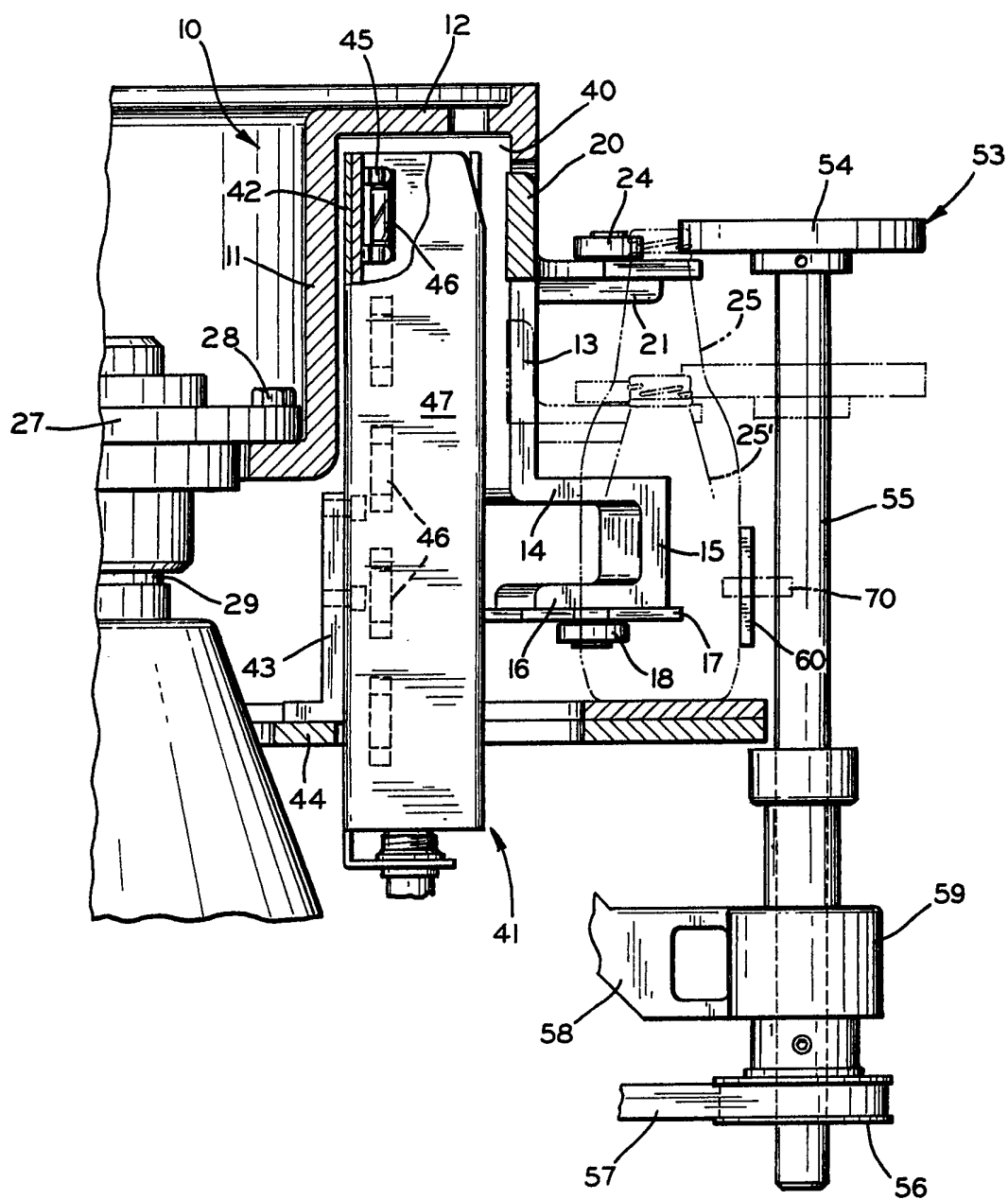
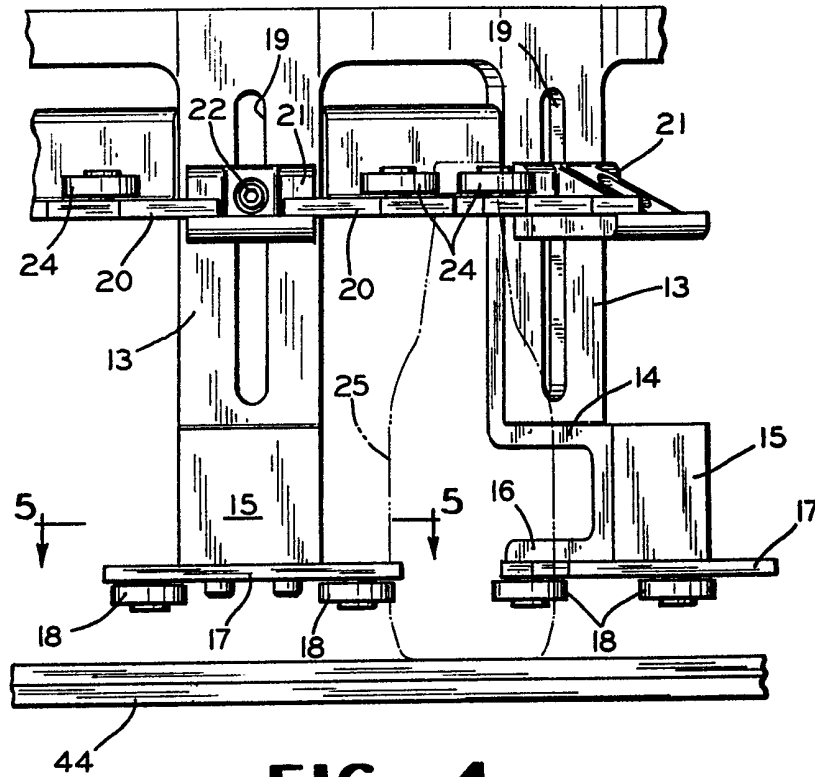
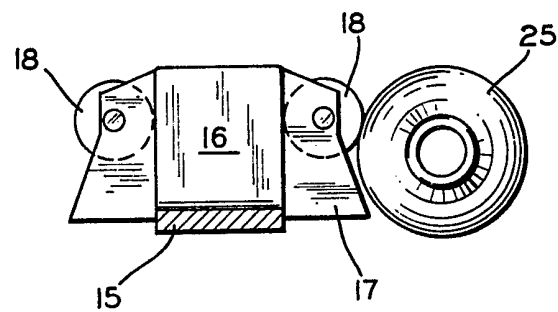


FIG. 3

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**FIG. 4****FIG. 5**

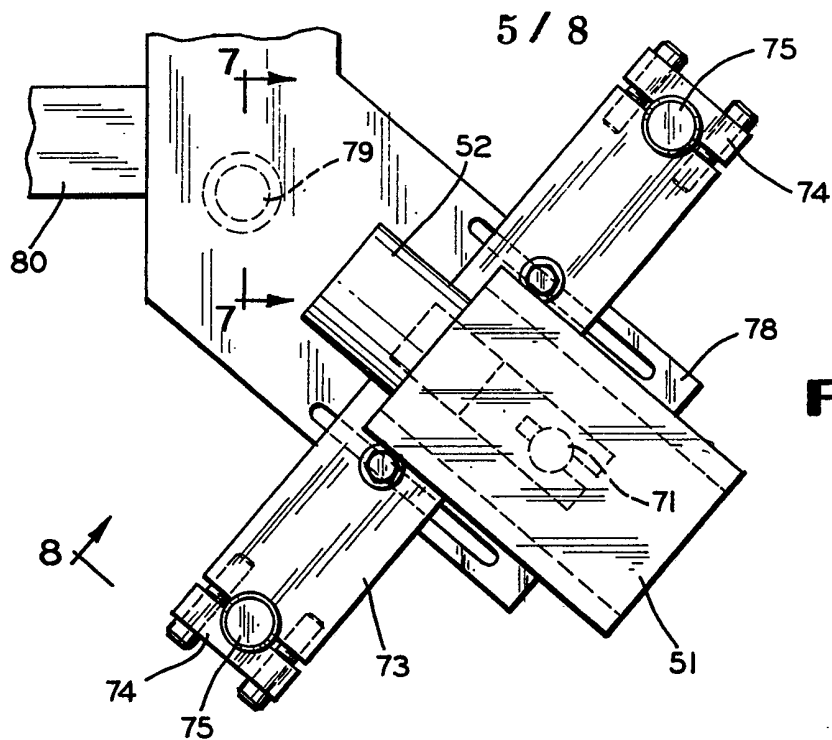


FIG. 6

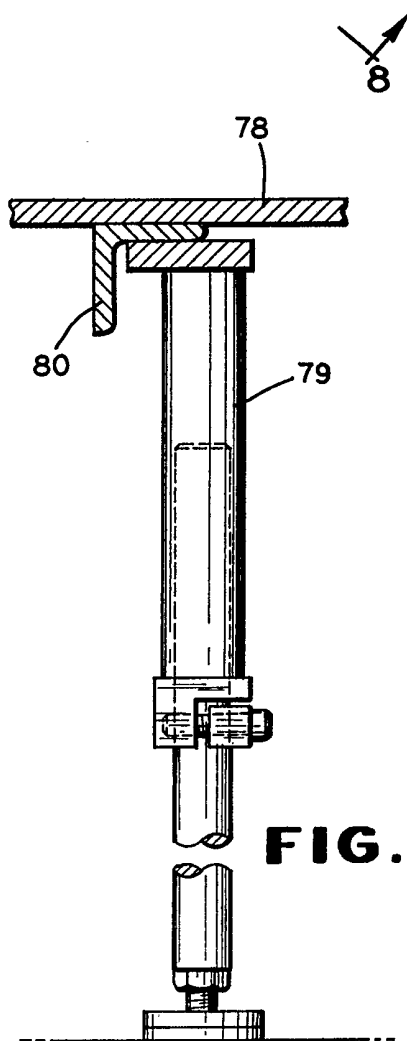


FIG. 7

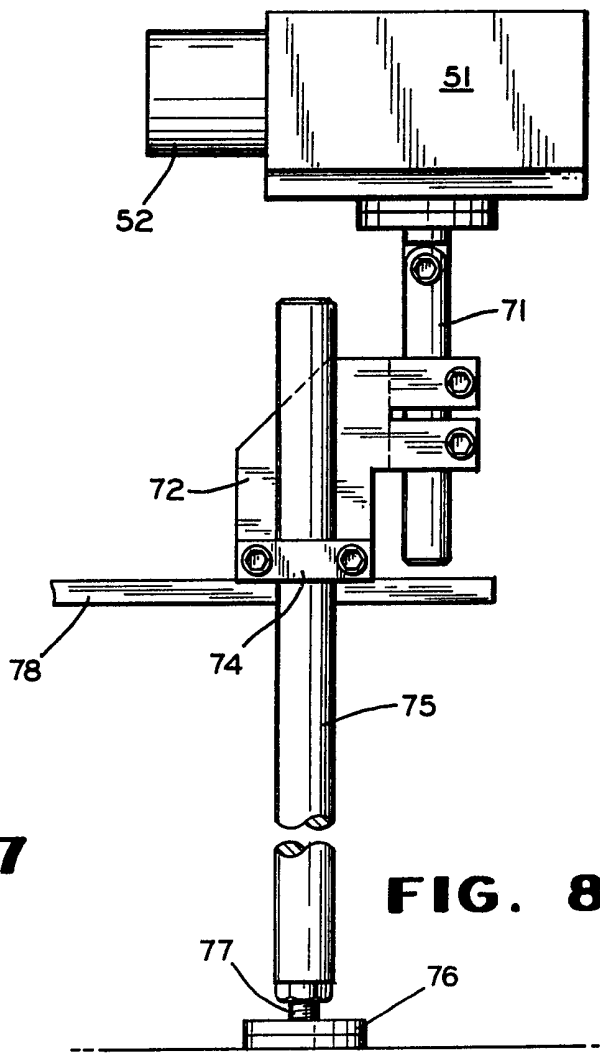


FIG. 8

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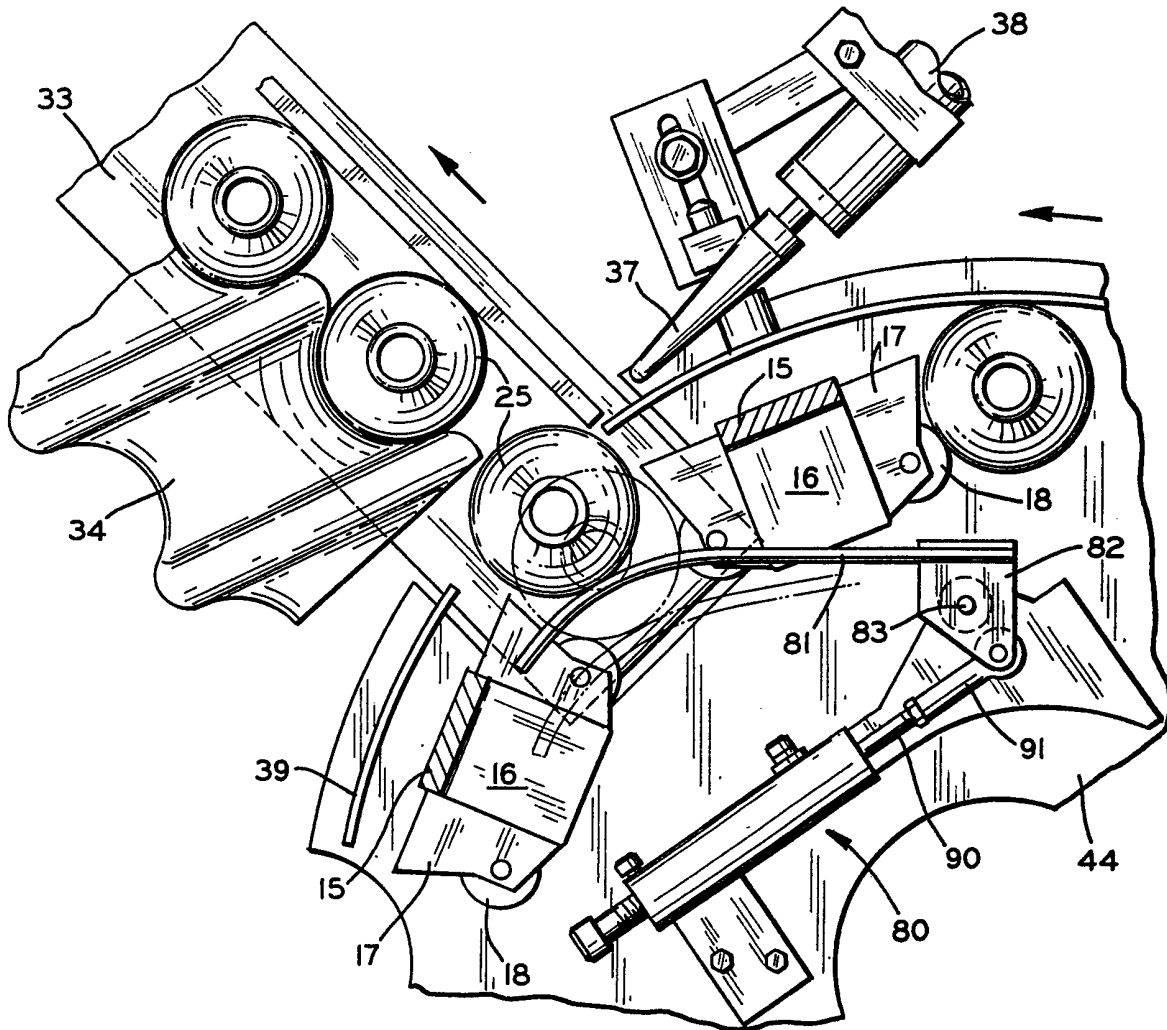


FIG. 9

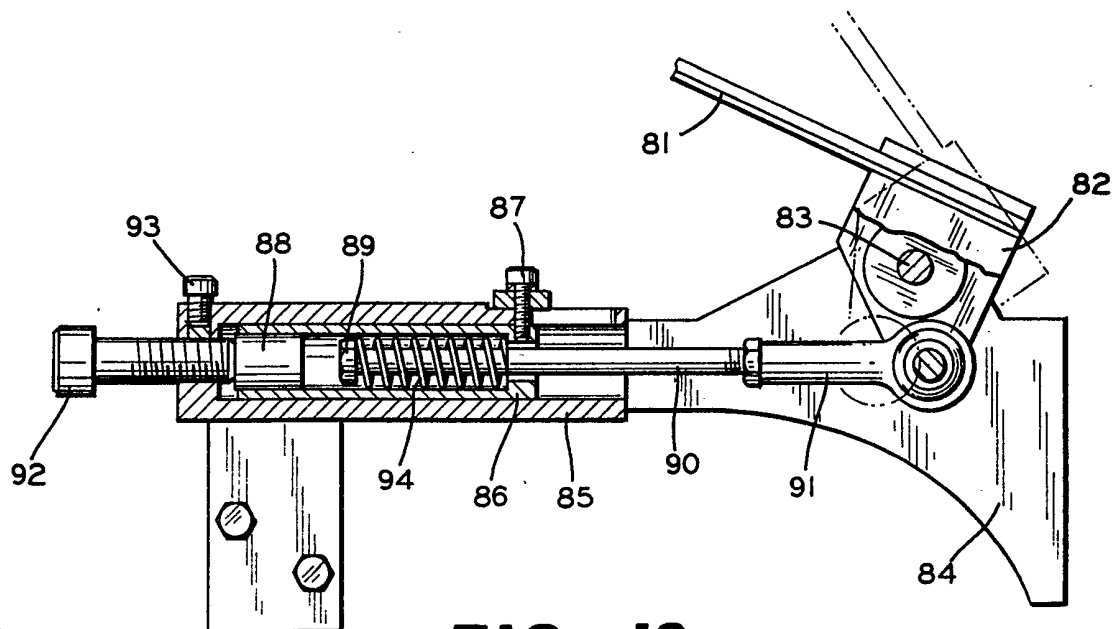
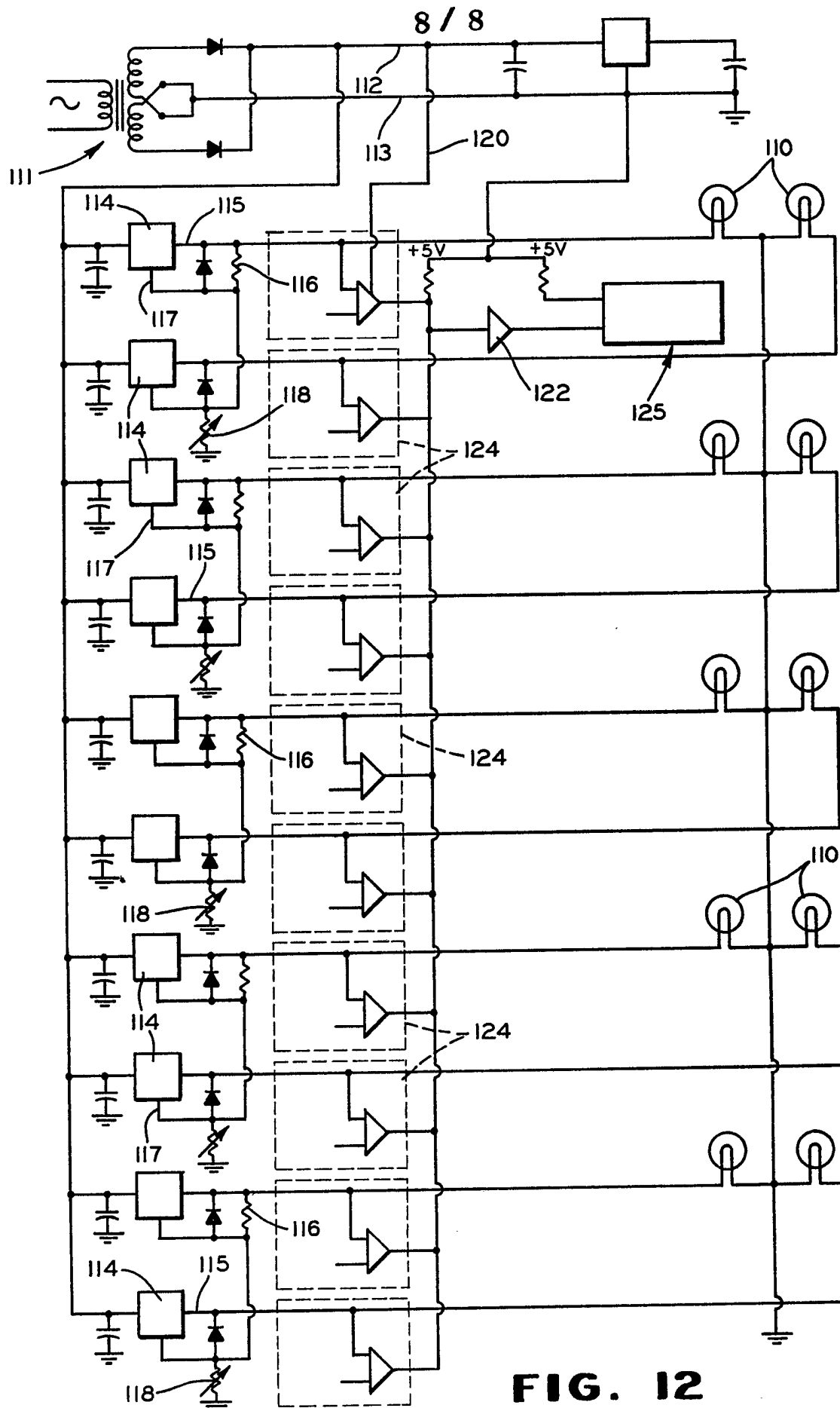


FIG. 10



SPECIFICATION

Glass container sidewall defect detection system

The present invention relates to apparatus for handling glass containers, and in particular to apparatus for optical inspection of the sidewalls of glass containers.

In the operation of apparatus for the inspection of glass containers, it is assumed that automatic inspection may be made better than manual or visual inspection by operators. This invention relates to an apparatus for inspecting glassware and in particular to apparatus for inspecting the sidewall of hollow glass containers for defects which are of an optically distinguishable character. As might be expected, in the manufacture of blown hollow glass containers it sometimes happens that the sidewall of the container, that is that portion of the container below the finish or neck of the bottle and above the curved heel and bottom of the bottle, has defects which would affect the performance of the container in service. It is important that every blown glass container have its sidewall, among other portions of the container, inspected for defects and it would be a great advantage if these containers could be inspected at high speeds with a high degree of reliability so that when a container passes the inspection, it would be positively free of defects in the sidewall thereof.

In the past, there have been inspection devices which would inspect containers for defects in the finish portion such as "line-over-finishes", "checks" (both vertical and horizontal), "seeds" and "blisters". Further, there have been bottom and heel check detectors which operate on the principle of optical reflectance or refraction. Furthermore, there have been inspection devices which inspected the containers to ensure that their height is correct, that the finish of the bottle is free of "dips and warps" and that the finish of the container not be cocked or out of alignment with the general central vertical axis of the container. Such an inspection apparatus may be found by reference to U.S. Patent 3,313,409 issued to J. R. Johnson and assigned to the Assignee of the present application.

The disclosure of this U.S. Patent 3,313,409 is incorporated herein by reference thereto. A reading of this patent will indicate that there are four inspection stations in the inspection device which are labelled II, III, IV and V. While the present disclosure is directed specifically to the inspection of the sidewall area of a glass container, the invention should be considered in its broader sense as a system for inspecting at any one of the stations as depicted in the above-referred-to Johnson patent.

In the present disclosure, only one station of the inspection machine is disclosed in detail, inasmuch as this is the station in which the containers are to be inspected for sidewall defects by the system of the invention. While the Johnson patent is dealing with what would appear to be

fairly small size containers, the general principle of operation of the device is one which would readily lend itself to the handling of a plurality of larger size containers through a series of inspection stations by having the ware brought to the machine with the turret or head then being indexed through approximately a 45° angle of rotation. This indexing motion carries the containers in the present invention through five inspection positions with a first position in advance of the first inspection station being in alignment with a conveyor that brings the bottles into the machine followed by five inspection positions and then followed by an exit position. Intermediate the exit position and the entrance position is what is termed a "reject position" or zone where bottles which have been sensed as defective by the apparatus, are retained in the apparatus so as to be cleared from the apparatus turret at this intermediate position. At this position, a cullet bin or other defective container disposal chute may be positioned. Frequently, these bottles which are rejected are returned, by a suitable conveying system, to the forming area where the forming operator may examine the container and in this way determine what might be an appropriate change to the process or to the machine being used to correct any ongoing or long-term defect which is being produced. As in many manufacturing processes, defects sometimes crop up without any apparent reason, while in other instances a defect may appear and continue to appear through a period of production. These types of recurring defects are those which the present invention is most capable of determining and alerting the operators to the situation. Furthermore, any glass container which is made with any kind of a structural defect which might affect its performance in the market place is gauged, inspected and discarded when such a defect is detected, no matter for what reason the defect may have been produced.

It will be noted that the starwheel or indexing mechanism head of the prior art shown in the above-mentioned U.S. Patent 3,313,409 consists generally of a pair of flat plates having notches formed in the periphery thereof within which containers to be inspected are serially placed. The starwheel of the present invention is considerably modified and improved for the purpose of handling containers in such a manner that they may be successfully inspected by illumination of the sidewall of the container to its full height. This is something which has not been easily achievable in prior devices where multiple inspections are being made. It has also been the practice in the past to move containers down a conveyor and, in effect, use a pair of TV cameras looking at the bottle at two angles in an effort to determine whether or not a container is of an acceptable appearance or shape. One serious drawback with such a device has been the inability to completely examine 360° of the container sidewall without distortion being injected into the system due to the fact that the edges of the container produce optical refractance

and reflectance aberrations in the images viewed by the cameras.

With the foregoing in view, it is an object of the present invention to provide apparatus which is

- 5 capable of moving glass containers through a series of inspection positions where various types of inspection may be carried out, with one of the positions being the location of a novel optical sidewall inspection device. Such sidewall
10 inspection device comprises a source of illumination which will cover substantially the full height of the container and illuminate a vertical section of the sidewall from behind. Further, the source of illumination is variable in its intensity to provide greater illumination for containers that are
15 formed of coloured glass such as "amber", and to vary the intensity of the light at selected areas of the bottle depending on the shapes thereof. In addition, the source is comprised of a plurality of
20 individual lamps with means connected thereto for indicating when any lamp is burned out.

- The illuminated sidewall is viewed by a camera that is mounted outboard of the handling system. The camera is composed of a linear array of
25 photosensitive devices onto which the illuminated image of the sidewall section is focused, with the array being scanned electronically and with the outputs being processed by microprocessor.

- It is a further object of the invention to provide
30 a container handling system capable of high speed operation and smooth handling of containers into and out of the indexing head or starwheel. The invention further consists of an improved starwheel construction which will permit rotation
35 of a container at the sidewall inspection station without blocking the view of the camera and a novel mechanism to assist the movement of the containers out of the starwheel at the exit position.

- 40 Other and further objects will be apparent from the following detailed description taken in conjunction with the accompanying drawings.

- Apparatus for inspecting the sidewall of transparent containers for optically detectable
45 defects by having the container moved into an inspection position and rotated about its vertical axis. At the inspection position is located a stationary light source of sufficient height to illuminate substantially the full height of the
50 container being inspected. The means for handling and rotating the container is such that it does not block the back illumination of the container by the light source which is formed of a plurality of lamps behind a diffusing plate. A camera with a vertical,
55 linear array of light-responsive pickups is positioned so that it may view the illuminated vertical portion of the back-lighted front wall of the container being rotated and means are provided for monitoring the intensity of the light
60 source and for handling a series of containers into and out of the inspection position.

The present invention will now be described further, by way of example only, with reference to the accompanying drawings, in which:—

- 65 Fig. 1 is a top plan view of the apparatus of the

invention;

Fig. 2 is a plan view of the inspection station of Fig. 1 on an enlarged scale;

- 70 Fig. 3 is a cross-sectional view taken at line 3—3 of Fig. 2;

Fig. 4 is a side elevational view of a portion of the container supporting hub of the invention;

Fig. 5 is a view taken at line 5—5 of Fig. 4;

- 75 Fig. 6 is a plan view of the camera and support of Fig. 1 on an enlarged scale;

Fig. 7 is a cross-sectional view taken at line 7—7 of Fig. 6;

Fig. 8 is a side elevational view taken at 8—8 of Fig. 7;

- 80 Fig. 9 is a plan view of the exit station of the apparatus of Fig. 1 on an enlarged scale;

Fig. 10 is an enlarged view, partly in section, of the ejector actuator shown in Fig. 9;

- 85 Fig. 11 is a schematic circuit diagram for the illuminating means of the invention; and

Fig. 12 is a schematic circuit diagram for an alternative embodiment of the illuminating means of the invention.

- 90 The various aspects of the invention will be described in detail with an overall view being given in a general bottle handling section followed by a sidewall inspection section which will include a detailed description of a container-illuminating system. Further, the container exit position of the
95 starwheel will be disclosed in light of the mechanism shown in the drawings.

- With particular attention to Fig. 1, there is shown, in plan view, a bottle inspection system for handling containers through a series of potential
100 inspection positions and for determining the optical characteristics of the sidewall region of glass containers specifically at one position. Generally, the apparatus of Fig. 1 and the inspection system thereof is of a similar character to that described in Patent No. 3,313,409, and consists of a starwheel, generally designated 10,
105 in Figs. 1 to 3. The starwheel 10, in effect, is formed of a generally cylindrical hub 11 having a radially outwardly, extending portion 12 to which are integrally formed downwardly extending arms 13 at spaced intervals about the periphery of the horizontally extending portion 12 of the hub 11. The downwardly extending arms 13, adjacent
110 their lowermost portion, are provided with horizontally extending ledges 14 which extend outwardly to a radial extent at which point there is connected a downwardly extending arm extension 15. The downwardly extending extension 15 in turn has an inwardly extending
115 horizontal ledge 16 formed thereto. The inwardly extending ledges 16 on the arms 13, of which there are 8 in the present apparatus, serve as mounts for plates 17 which are attached to the lower surface thereof. Each plate 17 extends
120 horizontally outward from the sides of the ledge 16 to which it is attached and each plate carries a pair of bottle-engaging rollers 18, as best shown in Fig. 5. The downwardly extending arms 13 are provided with a vertically elongated slot 19,
125 therein, the slot 19 serving as an adjustable

mounting means for bifurcated plates 20. The plates 20 actually extend between adjacent arms 13. Each arm is provided with an angle bracket 21 which may be adjustably clamped to the arm 13 by suitable fasteners such as bolt 22 as shown in Fig. 4. The bolt 22 will extend through the vertical slot 19 and have a nut or other suitable threaded member on its opposite end. Loosening of the bolt 22 would permit vertical adjustment of the bracket 21 relative to the arm 13.

As previously stated, the bracket 21 serves as a mounting platform for the bifurcated plates 20. It should be understood that each plate 20 is connected to a bracket 21 carried by adjacent arms. The mounting of the plate 20 to the bracket 21 may be by way of bolts 23, as shown in Fig. 2. Each plate 20 carries a pair of rollers 24. The rollers 24 are adapted to engage the "finish" or threaded neck portion of a glass container 25. The container 25 is shown in phantom line in Figs. 3 and 4 and in full line in Figs. 1 and 2. It should be pointed out that the plates 20 have a cut-out portion in the centre thereof when looking in plan view with the forward portion, designated 26, being of a size such that the neck of a bottle will fit in the gap formed thereby, while the cut-out portion closest to the hub 11 is cut out to a greater degree and greater height for the purpose of permitting illumination of the bottle as will be later explained. Toward the rear portion of the cut-out 26 are mounted the two neck-engaging rollers 24. As can be seen in Fig. 2, the rollers 24 are equidistant from a plane passing through the centre of the container positioned at the station shown in Fig. 2.

The hub 11 of the starwheel 10 is connected to a circular plate 27 by bolts 28. The circular plate 27 in turn is fastened to the upper end of a drive shaft 29. The drive shaft 29 is connected to a suitable indexing drive which will turn the drive shaft and the hub or starwheel connected thereto through a 45° angle of rotation during each indexing movement thereof.

With reference to Fig. 1, containers 25 are brought to the inspection device in an upright position on a conveyor 30. The conveyor 30 is moving in the direction of the arrow adjacent thereto and containers 25, as they approach the inspection device or the starwheel 10, are engaged by a screw 31. The screw 31 will be rotated at a preselected speed in a clockwise direction thus effecting the advancing movement of the containers 25 toward the centre axis of the starwheel 10. The containers are confined to the threads of the screw by a guide rail 32. The timing of the screw is such that a container is brought into and becomes engaged by the starwheel 10 and the rollers 24 and 18 which are positioned at each station of the starwheel at predetermined intervals. Indexing of the starwheel will carry the container which has been positioned in the confines of "pocket" of the starwheel to the next adjacent position by indexing of the starwheel in a counter-clockwise direction. In this fashion, containers are, one by one, moved through a

series of five inspection stations, only one of which is of specific concern in the present invention and which is illustrated in greater detail in Figs. 2 and 3. The starwheel 10, it should be noted, handles the containers through the series of five inspection stations and when the containers arrive at the location of an exit conveyor 33, the containers will be assisted in leaving the pocket of the starwheel so as to become engaged by a screw 34 which is being rotated in a counter-clockwise direction to effect removal of the containers from the starwheel. Again the screw 34 is driven at a slightly greater velocity than the velocity of the conveyor 33. While the threads on the screw 34 are shown as symmetrical, they need not be of a regular pitch, but may have a greater separation distance as the screw becomes farther removed from the location of the starwheel 10. This is sometimes preferred when clearing the inspection device and for spacing containers on the exit conveyor.

It should be noted that the containers, as they are moved through the plurality of inspection stations, which are five in number between the entrance conveyor 30 and the exit conveyor 33, are held within the confines of the pockets in the starwheel by side-engaging rails 35 that are at a height which will render the containers fairly stable as they are moved laterally. Rails 35 are interrupted, obviously, at the entrance conveyor and at the exit conveyor so that the bottles may enter and exit from the starwheel. Furthermore, the rail 35 is not present at a portion of the distance between the exit conveyor and the entrance conveyor, since this is the zone where defective containers may be rejected by being positioned into a chute 36. In the event, during any of the inspections that may be carried out at the five stations where the containers are indexed to and between a defective bottle is determined to be present, a plunger 37 will be positioned by a cylinder 38 connected thereto to move into position to prevent the defective container from leaving the starwheel during that period when the starwheel is stationary and positioned in alignment with the exit conveyor 33. It can be seen that upon indexing of the starwheel with the container still retained adjacent the exit position by the plunger 37, that the starwheel will carry the defective container to the area of the disposal chute 36 and thus be discarded from the line of ware being inspected. Immediately after initial indexing movement of the starwheel has been sufficient to carry the defective container into engagement with the portion 39 of the guard rail, the plunger 37 will be retracted by the cylinder 38.

With specific reference now to Figs. 2 and 3, a detailed description of the sidewall inspection system will be given.

The configuration of the starwheel is such that an annular, upstanding, recess 40 is provided therein which serves as the location for an illuminating means generally designated 41. The illuminating means comprises a generally flat, vertically positioned panel 42 bolted to an angle

bracket 43. The angle bracket 43 is supported from a horizontal, generally circular table 44. The panel 42 carries a plurality of fuse clips 45 in an array of three vertical columns with five individual clip pairs in each column. Each clip supports a lamp 46. The lamp 46 is a tubular bulb within which a vertically positioned filament is carried. These lamps are commercially available from General Electric and designated Style T-3, Lamp

211-2.

As can best be seen from Fig. 2, the lamps are positioned within a generally trapezoidally-shaped housing having sidewalls 47. The sidewalls 47, at their forward ends 48, are provided with vertical channels 49 within which a light-diffusing plate 50 is positioned in overlying relationship to all of the fifteen lamps. An opening is provided in the portion 12 of the starwheel 10 to provide access to the diffuser plate from above, to permit elevation of the diffusing plate, when desired, for the purpose of replacing lamps which may burn out during the operation of the device.

It should be noted that the illuminating means 41 extends below the table 44 such that the lowermost lamps will provide full height illumination to the front side of a container positioned as shown in phantom line in Fig. 3. With the lights as shown in Fig. 3, the full height of the container 25 will be back-lighted and, in particular, the lower portion of the bottle will be lighted. A vertical strip that is lighted is viewable by a camera 51 mounted opposite the illuminating means. The camera 51, as shown in Fig. 1, has a lens contained within a housing 52. The area of view of the portion of the bottle being inspected is schematically shown by dot-dash lines extending from the lens 52 to the area of the container in Fig. 1. The same pair of dot-dash lines also indicate the area of view of the front portion of the bottle in Fig. 2. It would be pointed out that the camera lens focuses that portion of the front portion of the sidewall of the container that is within its view onto a vertical linear array of pickups within the camera 51. The details of the camera and the electronic processing of the signals resulting from scanning the pickups in the camera is the subject of U.S. Application Serial Number of common Assignee with this application.

The vertical array of lamps used to inspect the sidewall characteristics of flint or clear glass containers is provided by the two outer columns of lamps 46 only. By providing a plurality of lamps, the forward wall of the container, which is that portion of the container being viewed by the camera, will have a relatively constant intensity of illumination over its total height and the width of the portion being viewed. In order to ensure that the entire container sidewall is inspected, it is necessary that the container be rotated about its vertical axis through at least 360° of rotation. Rotation of the container about its axis is accomplished by a wheel 53 which has a frictional surface 54, such as a rubber tread. The wheel is positioned in engagement with the neck of a

container when the container is at the location shown in Figs. 2 and 3. The wheel 54 is mounted on the upper end of a vertical shaft 55. The lower end of the shaft 55, as viewed in Fig. 3, carries a pulley 56 which is driven by a belt 57 in engagement therewith. The means for driving the belt may take the form of an electric motor (not shown). A bracket 58 which carries a bearing 59 serves to support the shaft 55 for rotation about its vertical axis. It should be noted that the shaft 55 and the wheel 53 are biased in the direction of the axis of the bottle in a yielding manner such that when indexing of the starwheel 10 takes place, the neck of the container may pass from engagement with the wheel 53 without undue stress placed thereon. However, it is necessary that the surface of the wheel engage the container neck with sufficient force so as to assure rotation of the container about its vertical axis.

It should be noted that as the containers are moved around from station to station, their bottoms slide on a stationary surface supported by the table 44. To ensure that the bottle, when it is rotated about its vertical axis, is maintained within the confines of the pockets of the starwheel and in the position to be viewed by the camera 51, the side rail 35 is interrupted just in advance of the position where the sidewall inspection is being carried out. An auxiliary portion 60 (see Fig. 2) of the side rail is pivotally mounted to a bracket 61 which in turn is adjustably mounted to a fixed member 62 by a bolt 63 extending through a horizontal slot 64 in the bracket 61. The rail portion 60 is mounted to the bracket 61 by a vertical pivot pin 64. The bracket 61 also carries a stationary ear 65 into which a bolt 66 is threaded. The rail portion 60, at its end opposite the end where the pivot 64 is provided, carries a right angle tab 67 with a portion that overlies the ear 65. The tab 67 has a hole formed adjacent its end and the bolt 66 extends therethrough with clearance from the tab 67. A compression spring 68 extends between the head of the bolt 66 and the tab 67 to, in effect, bias the tab and the one end portion 60 of the side rail into the position shown in Fig. 2. A block 69 is mounted to the side of the tab 67. The outer end of the block 69 carries a roller 70. The roller 70 is therefore biased by the spring 68 through the tab 67 and engages the sidewall of the container being inspected at the position shown in Figs. 1 and 2. In this way, the container is held at the side near its centre of gravity in engagement with the rollers 18.

It should be noted that in Fig. 3, a second dot-dash line configuration is shown for a container with the position of the angle bracket 21, steadying roller 24 and drive wheel 53 moved down to accommodate a shorter container designated 25'. For example, the bottle 25 would represent a 12oz. beverage bottle such as a beer bottle, while 25' would represent a stubby or short beer or soft drink bottle. While the rollers 70 and rail section 60 are shown in Fig. 3, it should be understood that these are merely shown for purpose of reference, since they normally would

not be visible in this view when considering the section line 3—3 designated on Fig. 2.

The camera 51, as can be seen with reference to Figs. 6—8, is supported on a vertical post 71,

- 5 with the connection between the camera and the post being such that the camera mount may be tilted in a vertical plane relative to the vertical axis of the post 71. The post 71 is clamped in a bracket 72 and thereby can be vertically adjusted or rotated relative to the bracket 72. The lower portion of the bracket 72 takes the form of a horizontal plate 73. The plate 73 carries a pair of clamping blocks 74 at opposed ends thereof, which blocks, when threadably clamped at the ends of the plate 73, will grip a pair of posts 75. The posts 75, at their lower ends, are provided with feet 76 which may be vertically adjusted by threaded screws 77. It should be understood that the feet 76 rest upon the floor and through the adjustments shown, provide support for the camera at its position spaced from the starwheel 10. The plate 73 is also adjustably carried by a plate 78 that extends to and may connect with the main support for the table 44 of the starwheel supporting mechanism.

The plate 78, as viewed in Fig. 7, may be vertically adjusted by adjustment of a support column 79. A second angle bracket 80 is shown extending from the underside of plate 78 and it too may be connected to a stationary portion of the starwheel supporting mechanism.

One aspect of the present invention which has led to the design of the starwheel with the arm extension 15 and two horizontal ledges 14 and 16 so as to provide an outwardly extending area, is the provision at the exit position for an improved bottle exit assisting mechanism, generally designated 80, and shown in detail in Figs. 9 and 10.

Fig. 9 shows the operative position of the assist mechanism and Fig. 10 shows the internal detail of the spring-retaining and biasing means for the assist mechanism. The assist mechanism takes the form of a bent, bottle-engaging member 81.

- 45 Member 81 may be formed of a material which has a non-abrasive surface, yet has a high wear-resistance, for example, a Micarta member formed in the configuration shown and being generally an elongated, rectangular arm. At one end, the member 81 is unrestrained, while at its opposite end it is fixed to a pivoted crank 82. The crank 82 is pivotally supported for rotation about the axis of a pin 83. The pin 83 is supported by a plate 84 which in turn is fixed to the table 44. The plate 84 also supports a cylindrical housing 85 within which a sleeve 86 is coaxially positioned. The sleeve 86 may be adjustably positioned relative to the cylindrical housing 85 by loosening of a threaded bolt 87. The sleeve 86 at one end thereof is provided with a plug 88 which serves as a stop lock against which a head 89 of a rod 90 may engage. The rod 90 is threadably connected to a crank arm 91 which in turn is pivotally connected to the crank 82. A threaded bolt 92 which may be turned in or out of the housing 85

adjustably limits the position of the plug and sleeve 86 within the housing 85. It should be understood that the bolt 87 would be loosened during this adjustment and tightened after the adjustment has been made. A set screw 93 in the cylinder 85 is provided to maintain the adjusted position of the bolt 92, once the position has been selected.

- It should be pointed out that with regard to Fig. 9, the member 81, in full line, is shown as being slightly turned in a clockwise direction with respect to the dotted line position illustrated in Fig. 9. The dotted position of the arm in Fig. 10 would correspond to the position of the member 81, were the rod head 89 in actual engagement with the plug 88.

- Before a container comes into position at the exit area of the mechanism, shown in Fig. 9, a spring 94 in the sleeve 86 will maintain the head 89 in engagement with the plug 88 and the member 81 will be at its farthest clockwise position with respect to its pivot. As a container is moved into the exit position shown in Fig. 9, the member 81 will first assume the dotted line position, since the container will be biased against the member and the spring 94 will be compressed to a greater extent than that viewed in Fig. 10. Once the container at the exit station is free to move out toward the screw 34, the spring 94 will come into play and assist the container in its exiting movement. However, if the container has been judged or found to have a defect by the gauging and inspection equipment, the plunger 37 will have moved into position to block the exit of the container on the conveyor 33. In this event, the spring 94 will be held in a compressed position and the member 81 will be held in the dotted line position shown in Fig. 9 where it will remain in engagement with the container while it is shifted by indexing the starwheel. The container is held in the starwheel by the rail portion 39. When the bottle has cleared the rail portion 39, it will be discarded by either being pushed from the table 44 or positioned over a cut-out provided in the table, as shown in Fig. 1, with the cut-out overlying the cullet chute 36.

- As previously indicated, when the apparatus is being used to check the sidewall of flint or clear containers, only the outer two columns of lamps are illuminated. With this in view, reference may be had to the schematic wiring diagram illustrated in Fig. 11 wherein a source of alternating current is shown connected to a transformer 95. Transformer 95 has a dual secondary with grounded centre taps and provides, through rectifiers 96, a source of D.C. voltage for the lamps 46. The outputs from the rectifiers 96 are combined in a lead 97 which is connected in parallel to one side of the lamps 46 which are in the two outer columns of five lamps each. The other side of these lamps are connected to comparators 98 by leads 99. It should be understood that all of the lamps 46 are individually current sensed through separate comparators 98. The comparators are supplied in

groups of four in a unit which is supplied with power, schematically shown as lead 107, 107' connected to the comparators that are in circuit with the outer two rows of lamps 46. In addition, when it is desirable to use the present inspection system for viewing the sidewall of amber bottles, where it is required to have a more intense illumination, a switch 100 may be moved downward by hand to connect the power supply through a second lead 101 which is connected to the input of the centre set or column of lamps designated 46'.

All of the lamps 46' are connected at their other sides to comparators 98 of identical characteristic to those connected to lamps 46. The comparators that are in circuit with lamps 46' are supplied with power through lead 108 which is connected to the second lead 101. Thus the power to the centre row of lights and their comparators is controlled by switch 100. A bias voltage provided in line 102 will feed a bias voltage into each of the comparators through an equalizing circuit so as to provide a biased voltage which is compared with the voltage output of the lamps. When the lamps are functioning, there will be no output from the comparators 98. The resistors 109 between the lamps and ground serve as current sensors to the lamps. When a lamp is burned out, no current flows and, therefore, no voltage is developed across the sensor resistor to provide indication of fault. When a lamp malfunctions or burns out, then an output will be sensed from the comparators 98, which output is connected by a lead 103 through a field effect transistor 104 to a suitable indicator or enunciator 105. The field effect transistor 104 is of the V-MOS type having very fast and very powerful response capable of carrying quite a bit of power and is also of fairly low resistance. When the centre column of lamps is illuminated by moving the switch 100, a lamp 106 will light, providing a visual indication that the system is ready to inspect the sidewall of amber coloured bottles or containers.

The above described circuit is the power circuit for the preferred lamp system.

A second embodiment of a circuit for supplying power to a modified lamp system is shown in Fig. 12. In this embodiment, only ten lamps 110 are utilized as the backlighting arrangement for the bottle being inspected. The ten lamps are physically arranged in two vertical rows of five lamps. With reference to Fig. 12, a source of alternating current is connected to a transformer 111 whose output is connected through rectifiers to input leads 112 and 113. Lead 112 is connected to ten three-terminal positive voltage regulators 114, there being a regulator 114 in the power supply to each of the lamps 110. The pair of regulators 114 which are connected to the upper two lamps are connected as a pair by the output lead 115 of the first one being connected through a resistor 116 to the adjustment terminal 117 of the regulators. The adjustment at the terminal 117 is effected through the

potentiometer 118 connected thereto to ground. Each of the pairs of lamps that are at the same height are similarly adjusted as multiple pairs and thus the intensity of pairs of lamps may be effected by the hand adjustment, selectively of any one of the five potentiometers 118.

The output lead 115 from each regulator is connected to a comparator 119 which is the same as is shown and described with respect to Fig. 11 and designated 98. The comparators 119 are again in groups of four with the power thereto being derived through lead 120 connected to lead 112. The comparators are shown within enclosures designated 121, it being understood that there are ten of these similar circuits all connected in parallel to the input or "OR" gate 122. The gate 122 may be a field effect transistor as described in connection with Fig. 11. However, it should be recognized that a bias voltage, derived from a voltage regulator 123, is connected through lead 124 to a faulty lamp indicator 125 in a similar manner as described in connection with Fig. 11. Thus the output at "OR" gate will provide a signal to the indicator.

90 CLAIMS

1. Apparatus for handling glass containers in spaced apart series into an inspection position in front of an illuminating means with an uninterrupted view of the container from the side thereof opposite the illuminating means and with means to rotate the container while the container is so positioned comprising a generally cylindrical hub, said hub having a horizontally extending periphery which is at a height greater than the height of a container to be inspected; indexing means connected to said hub for indexing the hub about its vertical axis; a plurality of spaced-apart, downwardly extending arms connected to the periphery of said hub, said arms being of a length sufficient to extend below the centre of gravity of a container positioned adjacent thereto; container-engaging rollers mounted on said arms at, at least two vertically spaced points, the uppermost rollers being at the finish of the container; a peripherally spaced guide rail system extending around said hub adapted to engage containers and maintain them in contact with the rollers; and container rotation means at one of the inspection stations for engaging the finish of the container at said station for rotating the container positioned thereat about its central vertical axis.

2. Apparatus as claimed in claim 1 wherein said hub has a plurality of said arms at spaced intervals about the periphery thereof; transport means at one radial location for advancing containers into an area between adjacent arms; removal means at a circumferentially spaced second radial location for moving containers away from between adjacent arms; and means at said second location for assisting the movement of containers out from between said arms in a radial direction.

3. Apparatus as claimed in claim 2 wherein said means for assisting containers out from between said arms comprises a pivoted arm extending into

the path of the container movement into said second location; spring-biasing means connected to said arm for maintaining a force on said arm; and adjustable means limiting the extent of movement of said arm.

4. Apparatus as claimed in claim 1 wherein said downwardly extending arms are formed with a horizontally-extending portion adjacent to which the lower set of rollers are mounted.

5. Apparatus as claimed in claim 4 wherein said horizontally extending portion of said arm has a further, lower, inwardly extending portion joined together by a downward extending portion thereby forming a recess in each arm.

6. Apparatus as claimed in claim 4 or 5, further including first conveyor means for bringing containers into position in contact with said rollers at a loading position, second conveyor means extending generally radially outward from the periphery of said cylindrical hub for moving containers that have been inspected out of said handling system, and means at said second conveyor location for engaging containers at their sidewall and assisting their movement onto said second conveyor.

7. Apparatus as claimed in claim 4, 5 or 6, further including a container engaging outfeed worm extending along the side of said second conveyor, means for rotating said worm in a direction to move containers away from said hub, and said side-engaging means moving containers into position on said second conveyor to be engaged by said outfeed worm.

8. Apparatus as claimed in claim 6, wherein said means at said second conveyor location for engaging containers is positioned at the height of within the area of said recess in said arm.

9. Apparatus for inspecting the sidewall of transparent containers for optical defects wherein the containers are moved into an inspection station and rotated about their vertical axis, comprising a light source of sufficient height to illuminate substantially the full height of the containers, said light source being formed of a plurality of light bulbs positioned behind a light diffusing plate, said plate and bulbs being held stationary during an inspection; a camera having a vertical, linear array of light pick-ups; means positioning said camera at a predetermined distance from a container at said inspection station, said camera having a lens therein which is focused on the front wall of the container at the inspection station and being positioned at approximately the diametrically opposed side of said container from said light source whereby the container sidewall nearest the camera is illuminated throughout its full height by a source of diffused light of substantially constant intensity.

10. Apparatus for inspecting the sidewall of glass containers, wherein the containers are presented at an inspection station, in series, comprising: means at said station for rotating the container about its central, vertical axis; a diffuse light source positioned at one side of said station, said diffuse light source comprising an elongated

lamp holder of a vertical height greater than that of the containers to be inspected, said source extending below the bottom of the sidewall so as to illuminate the opposed sidewall of the container at the inspection station; a camera mounted adjacent said inspection station; lens means on said camera focused on the illuminated sidewall of the container, said camera having a linear, vertical array of photo detectors which are scanned while the containers are rotated; and means connected to said camera for processing the signals from said photo detectors.

11. Apparatus as claimed in claim 10 wherein said diffuse light source comprises an array of individual lamps, a diffuser panel overlying said lamps and means connected to said lamps for varying the light output thereof, whereby the sensitivity of said camera output may be varied by varying the intensity of illumination at various points on the container.

12. A light source for illuminating a transparent glass article for optical inspection purposes comprising: a vertical support plate having a height greater than the height of the portion of the glass article to be illuminated; a plurality of lamp holders evenly spaced over the face of said plate; spaced-apart sidewalls extending outwardly from said plate; a first vertically extending member at the forward edge of one of said sidewalls; a second vertically extending member at the forward edge of the other sidewall, said first and second members being formed with vertically extending grooves therein in facing relationship; and a light diffusing panel positioned in said grooves extending the full height of said support plate.

13. A light source as claimed in claim 12, further including circuit means connected to said lamps for varying the intensity thereof.

14. A light source as claimed in claim 13 wherein said circuit means comprises switch means for connecting the input voltage to selective groups of individual lamps of said plurality of lamps whereby the intensity of said source may be selectively varied.

15. A light source as claimed in any of claims 12 to 14 wherein said lamp holders are in rows and columns.

16. A light source as claimed in claim 15 wherein said lamp holders are in five vertically spaced rows and three horizontally spaced columns.

17. A light as claimed in claim 15 or 16 wherein each said light holder is comprised of a pair of bifurcated clips and said light bulbs are cylindrical bulbs with elongated filaments.

18. In apparatus for inspecting glass containers for sidewall defects, where a light source is positioned to illuminate a container sidewall as the container is rotated and a linear array of light-sensitive pick-ups are positioned to view the illuminated sidewall, the improvement in the light source comprising: a vertical support plate having a height greater than the height of a container to be inspected; a plurality of columns and rows of

light sources mounted on said plate; a pair of outwardly extending sidewalls connected to the vertical sides of said plate; an elongated, transparent light diffusing plate; means at the
5 forward edges of said sidewalls for supporting said light diffusing plate in overlying relationship to said light sources, said lights being of such an intensity in relation to said diffusing plate so that they do not present any significant deviation in
10 light intensity across the width or height of said diffusing plate.

19. Apparatus as claimed in claim 18, wherein said light source is comprised of three vertical

columns of five individual lamps each.

15 20. Apparatus as claimed in claim 18 or 19 further including circuit means connected to said lamps, said circuit means comprising parallel circuit means for energizing the two outside columns of said lamps and switch means for
20 selectively energizing the middle row of lamps when necessary to increase the intensity of the light passing through the container.

21. Apparatus constructed and arranged and adapted to operate substantially as hereinbefore
25 described with reference to and as illustrated in the accompanying drawings.