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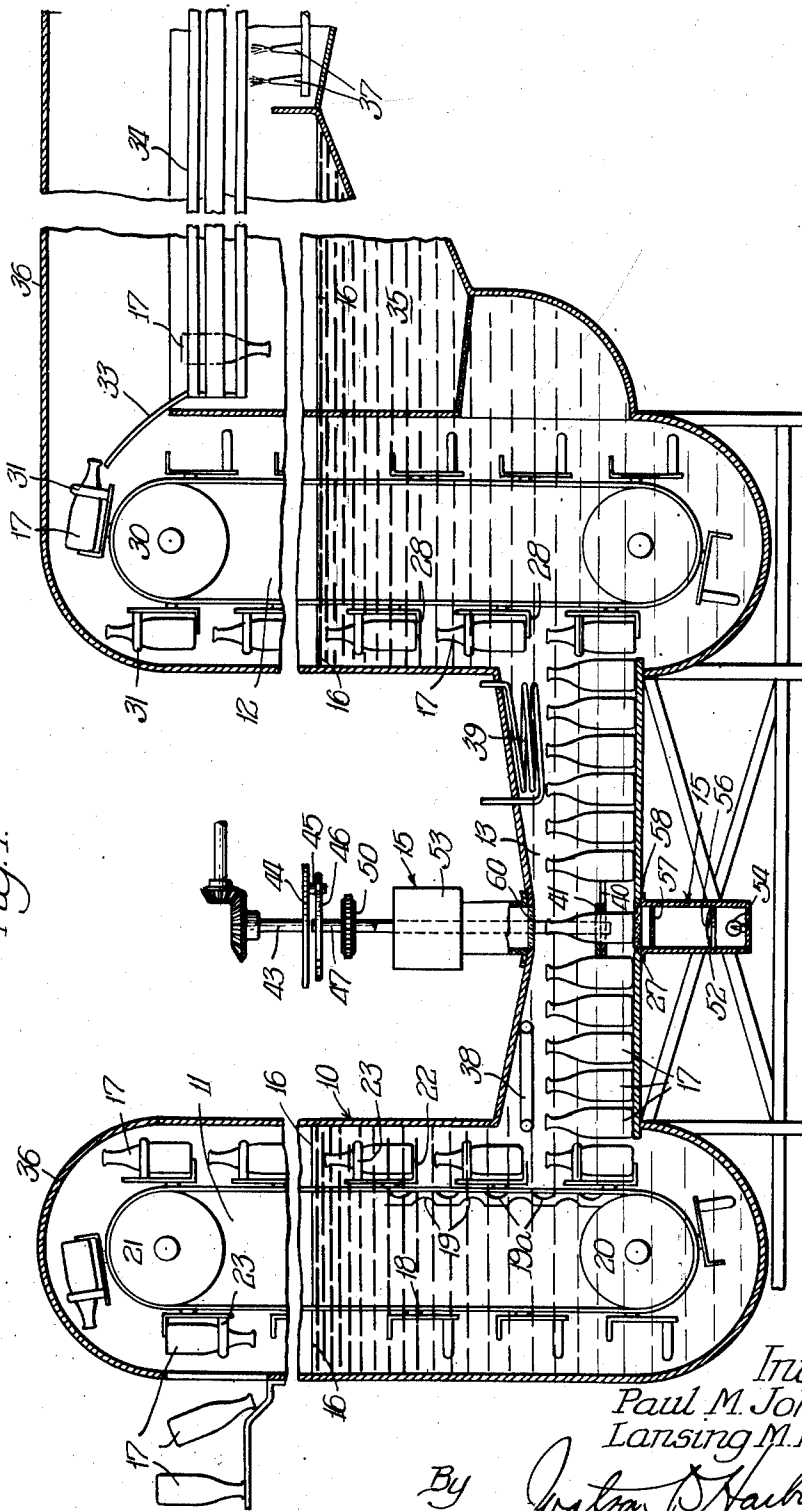
P. M. JOHNSON ET AL
APPARATUS FOR DETECTING THE PRESENCE OF FOREIGN
BODIES IN TRANSPARENT CONTAINERS

2,593,311

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2 SHEETS—SHEET 1

Fig. 1.



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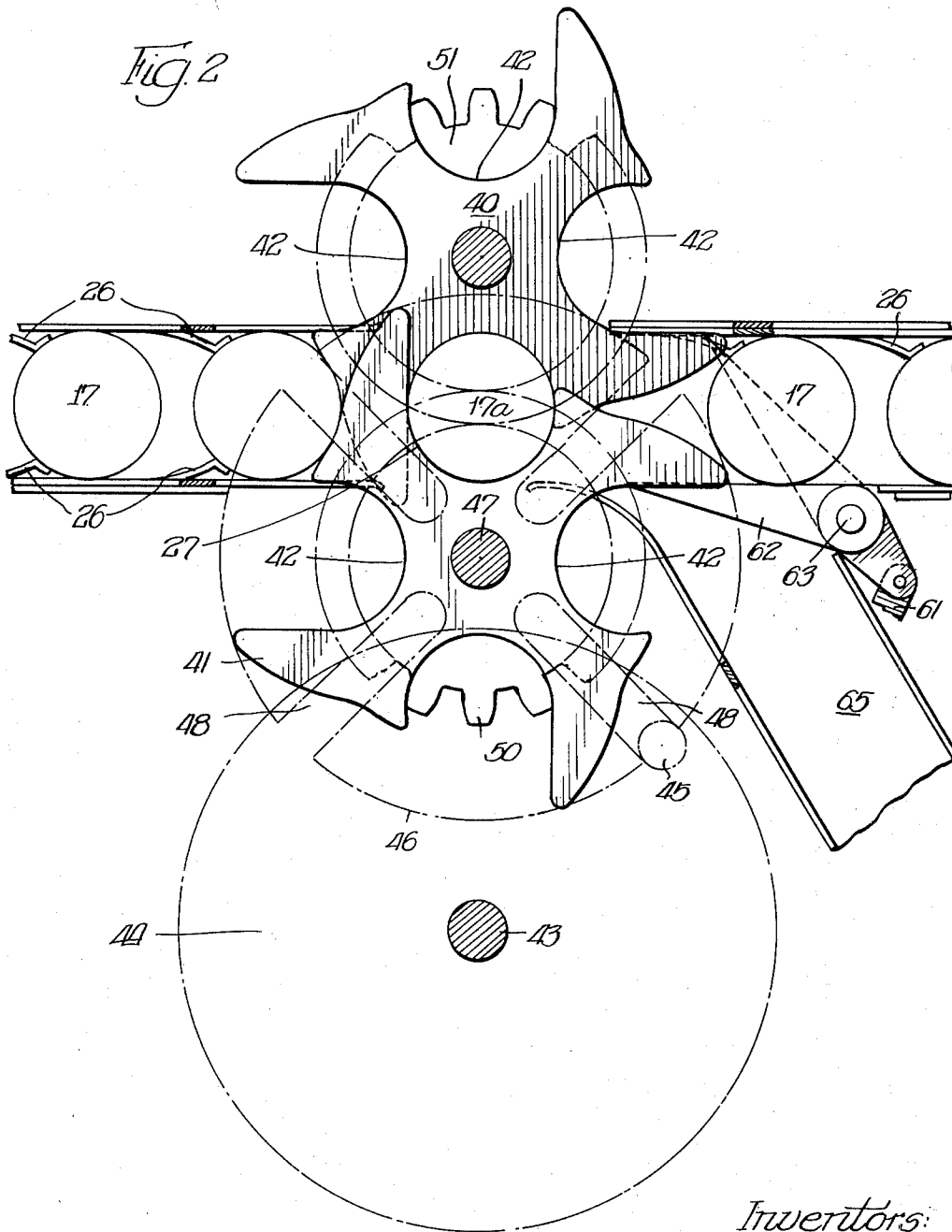
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APPARATUS FOR DETECTING THE PRESENCE OF FOREIGN BODIES IN TRANSPARENT CONTAINERS

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6 Claims. (Cl. 88-14)

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The present invention relates generally to apparatus for detecting the presence of foreign bodies in transparent containers and more particularly to the detection of foreign bodies in beverage bottles.

Beverage bottles are generally made of a transparent glass, although other plastics have come into use in recent years as a substitute for glass. Frequently, these bottles are provided with irregular contours or embossed designs on their outer surfaces to achieve a distinctive appearance or greater strength. Other bottles have markings or permanent labels which may be printed, painted, or glued thereon. Although the invention is described herein as applied to the detection of foreign bodies in beverage bottles, it is not so limited, and its principles may be employed to detect the presence of foreign bodies in other types of transparent containers, wherever high standards of cleanliness must be kept.

One object of this invention is to provide a simple and effective method and apparatus for automatically inspecting either plain bottles, embossed bottles, or bottles having permanent labels thereon for foreign bodies contained therein, preferably just before bottling, and for rejecting bottles which are not found to be clean.

The earlier automatic devices have been unable to operate to fine enough limits to detect minute foreign bodies such as dirt particles or insects because of the tolerances that have to be allowed because of the optical non-uniformity of individual beverage bottles. Consequently, a further object of this invention is to provide an arrangement whereby the irregular contours of the bottles arising either from manufacturing irregularities or embossing are obviated during the inspection.

Another object of this invention is to eliminate the inspection errors resulting from drops of rinsing solution clinging to the bottles by inspecting the bottles while submerged in the rinsing solution and also to thereby eliminate discrepancies arising due to irregularities in bottle contour.

Another object is to immerse the bottles in a liquid having a greater refractive index than air during inspection thereof in order to minimize the degree of refraction caused by the glass.

When colored bottles are to be inspected, difficulty has been incurred because of variations in the color of the bottles. Consequently, another object is to eliminate the effect of color by submerging the bottle in a fluid medium having substantially the same properties of color and light

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absorption as the material of the bottle or to employ mono-chromatic light or other rays of undulating energy and a water-white solution to accomplish a similar result.

5 A further object is to mask the bottle with a medium having the same index refraction and approximately the same transmissivity for rays of a particular wave length as the material of the bottle and testing the medium and bottle for the presence of foreign bodies by passing said ray therethrough and detecting any variations in said ray from a predetermined norm either by eye or ray responsive device.

10 A further object is to inspect bottles in a liquid maintained at a low temperature which aids in the inspection process by virtue of the fact that the refractive index of a liquid is higher at low temperatures and also aids in the bottling process where carbonated beverages are bottled by pre-cooling the bottles just prior to filling so that a higher degree of carbonation may be achieved.

15 Other additional objects and advantages of the invention will present themselves to those familiar with the art on reading the following specification in conjunction with the drawings and the appended claims.

In the drawings:

Fig. 1 is a vertical section showing the preferred embodiment of the apparatus of this invention.

20 Fig. 2 is an enlarged plan view showing a portion of the bottle conveying and rejecting mechanism.

25 For purposes of illustrating the invention, but not in limitation thereof, it is preferred to wash bottles to be filled in the conventional manner including the use of brushes and detergents, spray them, and pass them to a rinsing bath in which they are submerged with their necks up. The bath fills the bottles, and the bottles are then moved into a chamber from which ready access is removed. In this chamber the bath constitutes a medium which has substantially the same index of refraction as the material of which the bodies are made and preferably the same transmissivity to certain rays of undulating energy such as light. This medium wets the exposed bottle surfaces throughout and renders the bottle virtually invisible as a separate or independent body which has little or no refractive or reflective effect on a beam of light.

30 The bottle in this condition is moved, preferably by step motion, along through the chamber passing between two preferably vertically spaced transparent windows. While present between the windows, parallel rays are passed through

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the body from a ray source to a viewing screen, or an eye, or a detecting device such as a photocell. Transverse rays through the horizontally spaced windows can also be used instead of or in addition to the vertical rays, if desired, but the vertical rays or rays projected axially of the bottle catch foreign particles upon the bottom of the bottle where they are found about 90% of the time. Since the presence of opaque foreign bodies in the bottle decreases the amount of the ray falling on the detector, foreign bodies are detected and the bottles containing them can be rejected.

The preferred embodiment of the rinsing and inspecting apparatus 10 is shown in Fig. 1. The apparatus 10 comprises a pair of elevators 11 and 12, a longitudinal chamber 13 connecting the elevators 11 and 12, a conveying mechanism in the chamber 13, and the detecting apparatus 15 which inspects the bottles as they pass through the chamber 13. The apparatus 10 is filled with the rinsing liquid whose top surface is indicated at 16.

The elevators 11 and 12 are substantially identical in structure, one being employed to lower bottles 17 to the chamber 13 with vibration to jar bubbles loose in the bottles, and the other 12 lifting the bottles 17 out of the chamber 13. In the elevator 11 an endless belt 18 passes over a pair of pulleys or sprockets 20 and 21. The pulley 21 is preferably driven by a motor (not shown) and is synchronized with the rest of the conveying apparatus. The belt 18 carries a number of bottle supporting platforms 22 provided with spring clips 23 which secure the bottles 17 thereto. Bottles 17 are automatically inserted into the elevator 11 at the opening 24 from a conventional conveyor (not shown) and held there by the clips 23 in inverted position. The bottles 17 are rotated to the upright position as they pass over the top of pulley 21 and then are carried downwardly to the level of the chamber 13 filling with liquid during the latter stages of travel as they drop below the liquid level 16. The spring clips 23 serve to prevent the bottles 17 from floating off of the platforms 22 as they descend into the liquid.

When the bottles 17 reach the level of the chamber 13 they are pushed off the platforms 22 by a pair of reciprocating finger-like members 26 similar to those shown in Fig. 2. The reciprocating members 26 are synchronized with the drive for the drum 21 so as to push the bottle 17 off the platform 22 when the platform is level with the bottom of the chamber 13. Additional members 26 serve to move the bottles 17 through the chamber 13, in a step wise fashion, to the inspection station 27 and from the station 27 to the elevator 12.

As they leave the chamber 13, the bottles 17 are lifted upwardly by the elevator 12, being rotated as they pass over the top of the pulley 30 to the inverted position. Clips 31 similar to the clips 23 in the elevator 11 hold the bottles to the platforms 28 until they pass over the top of the pulley 30 and are pulled off of the elevator by the action of a pair of rods 33. After leaving the elevator 12, the bottles 17 slide down the rods 33 into a moving conveyor 34. The conveyor 34 carries the bottles 17 in the inverted position to the filling and capping machine (not shown). Liquid draining out of the bottles 17 is collected in a trough 35 and flows back into the apparatus proper.

Those portions of the apparatus 10 through

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which the bottles 17 pass including the conveyor 34 to the filling machine are enclosed in a dirt-proof housing 36. Thus it is insured that a bottle 17 having passed inspection will not be contaminated during its journey from the inspection station 27 to the filling machine.

The entrance of foreign particles into the bottle after inspection is also discouraged by the fact that the bottles are conveyed in the inverted position from the point of emptying until just prior to filling.

In the event that a liquid which must be completely removed from the bottles 17 prior to filling is employed in the apparatus 10, additional rinsing nozzles 37 may be employed to give the bottles 17 a rinse of pure water during the time they are in the conveyor 34.

In order to prevent the growth of bacteria, molds, etc., in the liquid, it has been found desirable to provide germicidal lamps such as that shown at 38 within the chamber 13.

In the preferred embodiment a refrigerating coil 39 is employed within the chamber 13 to chill the liquid to a low temperature in order to increase the refractive index and to precool the bottles 17. By precooling the bottles 17, a higher degree of carbonation may be achieved if carbonated beverages are to be bottled. Furthermore, germs or bacteria are less likely to grow in cold liquids than warm.

During the time when the bottles 17 are being inspected it is necessary that the bottle 17a undergoing inspection be accurately located with respect to the detection apparatus 15. To accomplish this, a pair of specially shaped wheels 40 and 41 is provided. These wheels 40 and 41 are substantially identical, being mirror images of one another, and each is provided with four recesses 42 in which the bottles 17 are received. The star wheels 40 and 41 are driven in a step-wise fashion, a quarter revolution at a step by the action of a Geneva type drive. The drive comprises a shaft 43 driven at a constant speed and synchronized with the pulleys 21 and 30. A plate 44 attached to this shaft carries an upright pin 45. A driven member in the form of a slotted plate 46 is mounted on another shaft 47 which extends to the star wheel 41.

As the pin 45 enters one of the slots 48 it causes the member 46 to be rotated through a quarter revolution and then leave the slot 48. The member 46 remaining stationary during the other three-quarters of each revolution of the member 44. The star wheel 40 is also driven from the shaft 47 through a pair of spur gears 50 and 51.

Thus the star wheels 40 and 41 are driven in one-quarter revolution steps to convey a bottle 17 into the inspection station 27 and then remain stationary for a period of time three times as long as the time they were in motion before again moving a quarter revolution to the bottle 17 out of the inspection station 27 bringing the next bottle 17 into the station 27. Upon examination of the drawings for Fig. 2, it will be seen that the bottle 17a undergoing inspection is completely surrounded by the recessed portions 42 of the star wheels 40 and 41. This serves not only to hold the bottle 17a, but also to prevent the passage of light rays upwardly except those which pass through the bottle 17a.

A similar type Geneva type drive synchronized with the elevator pulley drive may be employed to cause reciprocation of the finger-like members 26. In some instances it proved desirable to drive the members 26 directly from the

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star wheel drive for these members must be synchronized with the star wheels 40 and 41.

The detection system 15 comprises a light source 52 and a photo-electric cell and amplifier unit 53. The light source 52 which is preferably located beneath the chamber 13 consists of a light bulb 54 and a focusing lens 56 which produce a parallel beam of light.

Where a colorless solution is employed a filter 57 may be used to produce monochromatic light of the desired frequency. A glass plate 58 is mounted in the bottom of the chamber 13 and a similar glass plate 60 is mounted in the top of the chamber 13 at the inspection station 27. The photo-electric cell and amplifier unit 53 is mounted above the glass window 60.

Where a photo-emissive type cell is employed in the unit 53 it has been found desirable to use a lens system similar to that used in the light source 52 in order to concentrate the beam of light on the sensitive surface of the photo cell.

In some instances, however, it has proved desirable to employ a photo-cell having a relatively large sensitive surface such as the copper-copper oxide cell or the selenium cell. When this sort of photo-cell is employed it may be located directly above window 60 and no lens system is required.

The amplifier relay unit used with the cell is conventional, it being adapted to energize a reject solenoid (not shown) in the event that less than a predetermined minimum amount of light falls on the cell.

The reject solenoid (not shown) is connected through a link 61 (Fig. 2) to a reject cam lever 62. This lever 62 is mounted on a pivot 63 so as to swing to either of the two positions shown. When the lever 62 is in the position shown by solid lines, bottles 17 emerging from the inspection station 27 pass on through the apparatus, but when the lever 62 is in the position shown by broken lines the emerging bottles 17 are pushed into a reject chute 65 by the action of the star wheel 41. Thus the photo-electric cell causes the bottles to be rejected as they leave the inspection station if they contain opaque bodies which decrease the incident light thereon below a predetermined value.

The reject chute 65 extends to another elevator (not shown) which lifts the rejected bottles to a station above the liquid level where they may be inspected visually.

In some instances it has proved desirable to employ a conventional memory device and reject bottles after they have been lifted out of the rinsing solution but prior to their being emptied by the action of the elevator 12.

The choice of the liquid to be used in the apparatus 10 is governed by the type of bottles being inspected and the degree of fineness of inspection required.

In most instances it is preferred to employ pure water because of its cheapness and the fact that the bottles need not be re-rinsed after inspection. However, where the bottles are optically non-uniform one with another or when greater accuracy is required, liquids having an index of refraction closer to that of the bottle glass may be required.

The index of refraction of air is substantially unity being 1.000294 while pure water has an index of 1.333. Bottle glass usually has an index of between 1.4 and 1.5. Since the degree of refraction of a ray passing from one medium to another depends on the difference between the indices of the two media, it is obvious that the

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amount of refraction caused by glass in water is far less than that caused by glass in air. Furthermore, the closer the index of the surrounding medium is to that of the glass the less refraction will occur, no refraction at all occurring when the two are equal.

Where the glass of the bottles to be inspected has a relatively high factor of absorption it has been found advantageous to employ a fluid medium having substantially the same absorption characteristics. If the glass is colored, a colored medium may be used or as has been stated a filter may be employed to produce monochromatic light of a wave length which is least affected by the color of the glass.

If the apparatus of this invention is to be used to inspect optically different types of bottles, it has been found desirable to employ two photo-cells and a pair of light sources, one cell being used for inspecting and the other for a standard. The second cell is mounted opposite the second light source and a clean sample bottle corresponding to the batch that is to be run is inserted between, being surrounded by the same fluid medium as the bottles being inspected. The output of the two cells is then impressed on a Wheatstone bridge type circuit which is connected to the amplifier.

Other changes and modifications such as will present themselves to those familiar with the art may be made in the described embodiment without departing from the spirit of this invention whose scope is defined by the following claims.

What is claimed is:

1. A bottle inspecting apparatus comprising a tank, a liquid having an index of refraction of at least 1.333 contained in the tank, a pair of transparent windows in the walls of the tank, means for conveying bottles one by one between said windows, a photoelectric cell adjacent one of said windows, a source of undulating energy adjacent the other of said windows, and means for focusing a beam of said energy through the bottles as they pass by and upon said cell.

2. A bottle inspecting apparatus comprising a tank, a liquid having an index of refraction of at least 1.333 contained in the tank, a pair of transparent windows in the walls of the tank, means for conveying bottles one by one between said windows while submerged, a photoelectric cell adjacent one of said windows, a source of undulating energy adjacent the other of said windows, a lens adjacent said source of energy for forming a beam focused on said cell and passing through the bottle disposed between said windows and the surrounding liquid.

3. A bottle inspecting apparatus comprising a tank, a window in a wall of said tank, means for locating individual bottles adjacent to said window, means for forming a beam of undulating energy and directing same through said bottles as they are located adjacent to said window, a fluid medium in said tank having an index of refraction close to that of the bottles for reducing the refraction of said beam of energy as it passes through said bottles and a photoelectric cell for measuring changes in the intensity of said beam, said cell being disposed proximate to said window.

4. A bottle inspecting apparatus comprising a tank, a body of liquid having an index of refraction of at least 1.333 in said tank, means for conveying bottles through said tank beneath the

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surface of said body of liquid, means for forming a beam of light beneath the surface of the liquid, and a photoelectric cell disposed in the path of the beam of light for measuring the intensity thereof, said beam forming means and said photoelectric cell being so arranged with respect to the conveying means that said bottles pass through said beam on being conveyed through said tank.

5. A bottle inspecting apparatus comprising a tank, a body of liquid in said tank having an index of refraction of at least 1.333, means for forming a beam of light beneath the surface of the liquid, a photo tube disposed in the path of the beam of light for measuring the intensity thereof, and means for conveying bottles through said tank beneath the surface of said body of liquid and through said beam of light.

6. A bottle inspecting apparatus comprising a tank, a quantity of liquid disposed within said tank, said liquid having an index of refraction relatively close to that of bottle glass, a photoelectric device disposed adjacent to a wall of said tank, means for conveying bottles through said tank beneath the normal level of liquid, and means for forming and focusing a beam of light through the liquid and through a bottle undergoing inspection and upon said photoelectric device.

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