

- [54] **APPARATUS FOR AND METHOD OF INSPECTING CONTAINER MEANS**
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abandoned.
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356/237, 250/223 B
[51] Int. Cl. **B07c 5/342**
[58] Field of Search **209/111.7, 111.6,**
209/73, 74, 75, 82; 356/237; 250/223

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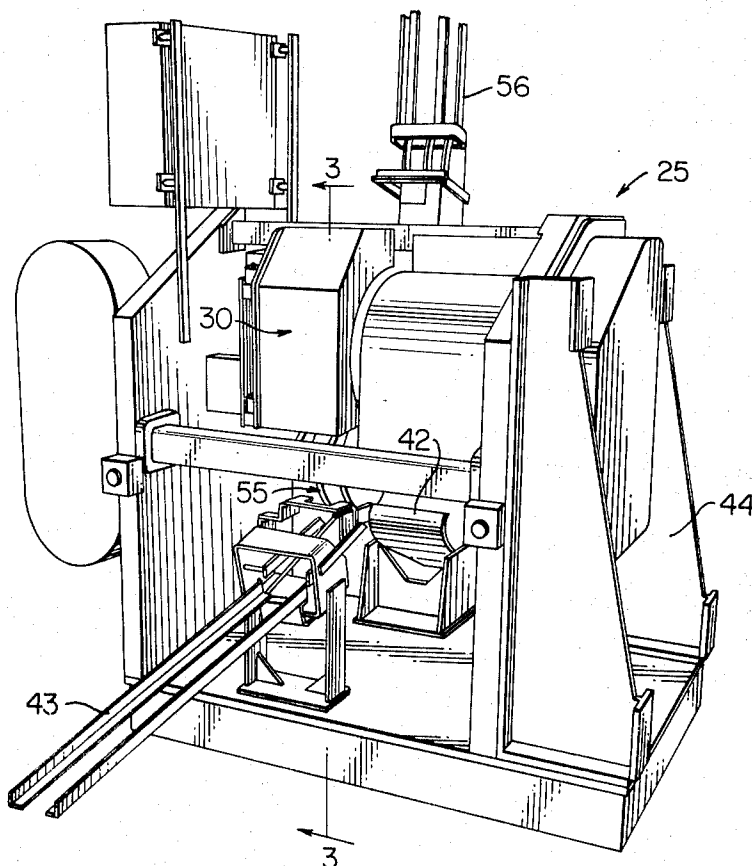
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[57]

ABSTRACT

An apparatus for and method of inspecting wall means of containers utilizing a light-emitting device, a photo-sensitive device and a high speed rotatable carrier for serially moving each of the containers between such devices to enable any opening in the walls of the containers to be detected by light passing therethrough to energize the photosensitive device which in turn actuates a mechanism to reject the particular defective container.

42 Claims, 19 Drawing Figures



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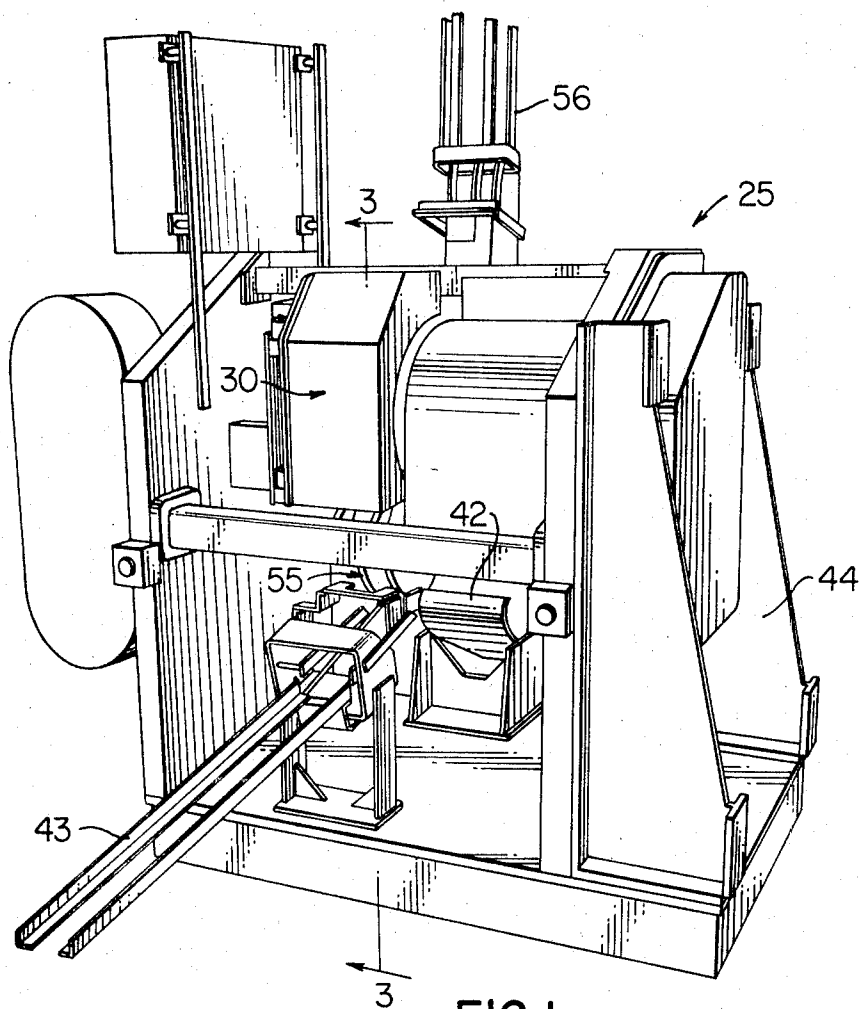


FIG. 1

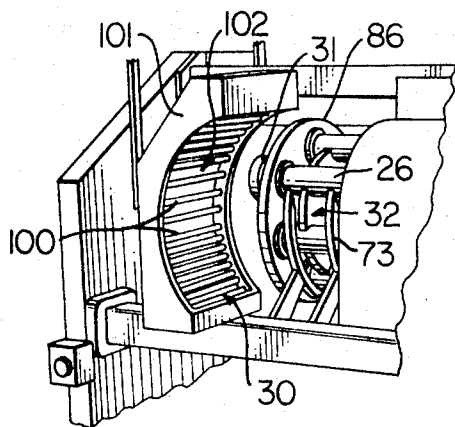


FIG. 2

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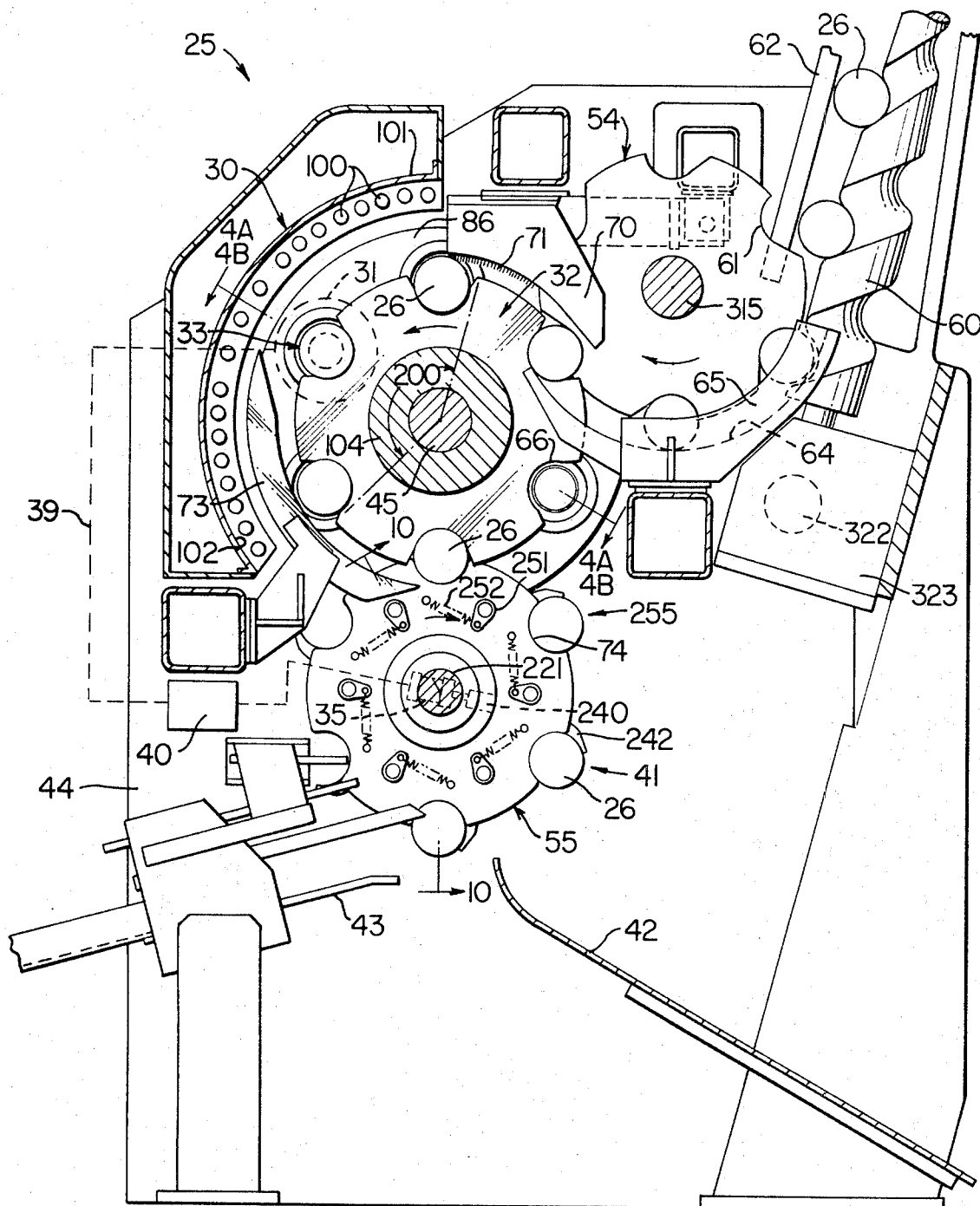


FIG. 3

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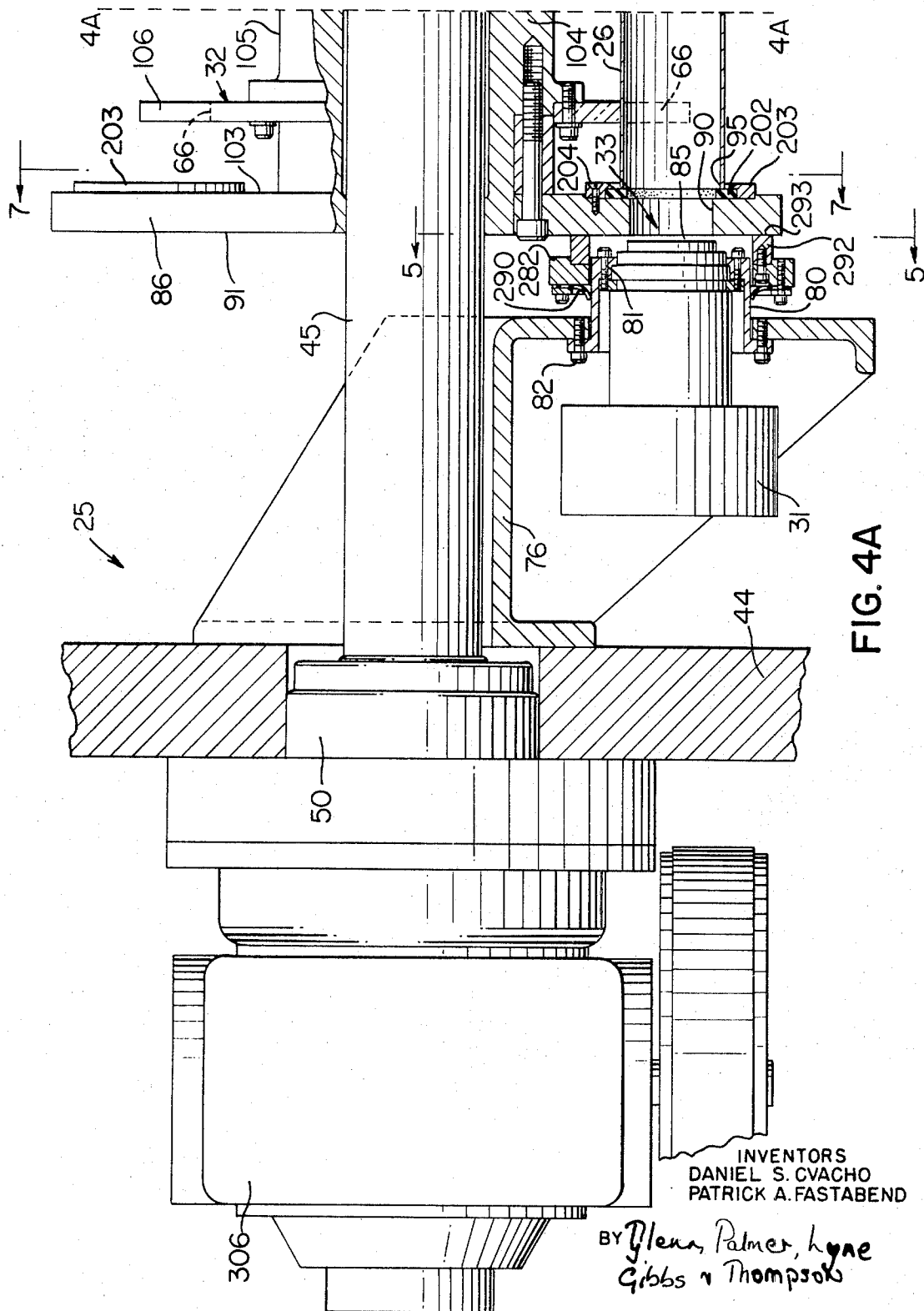


FIG. 4A

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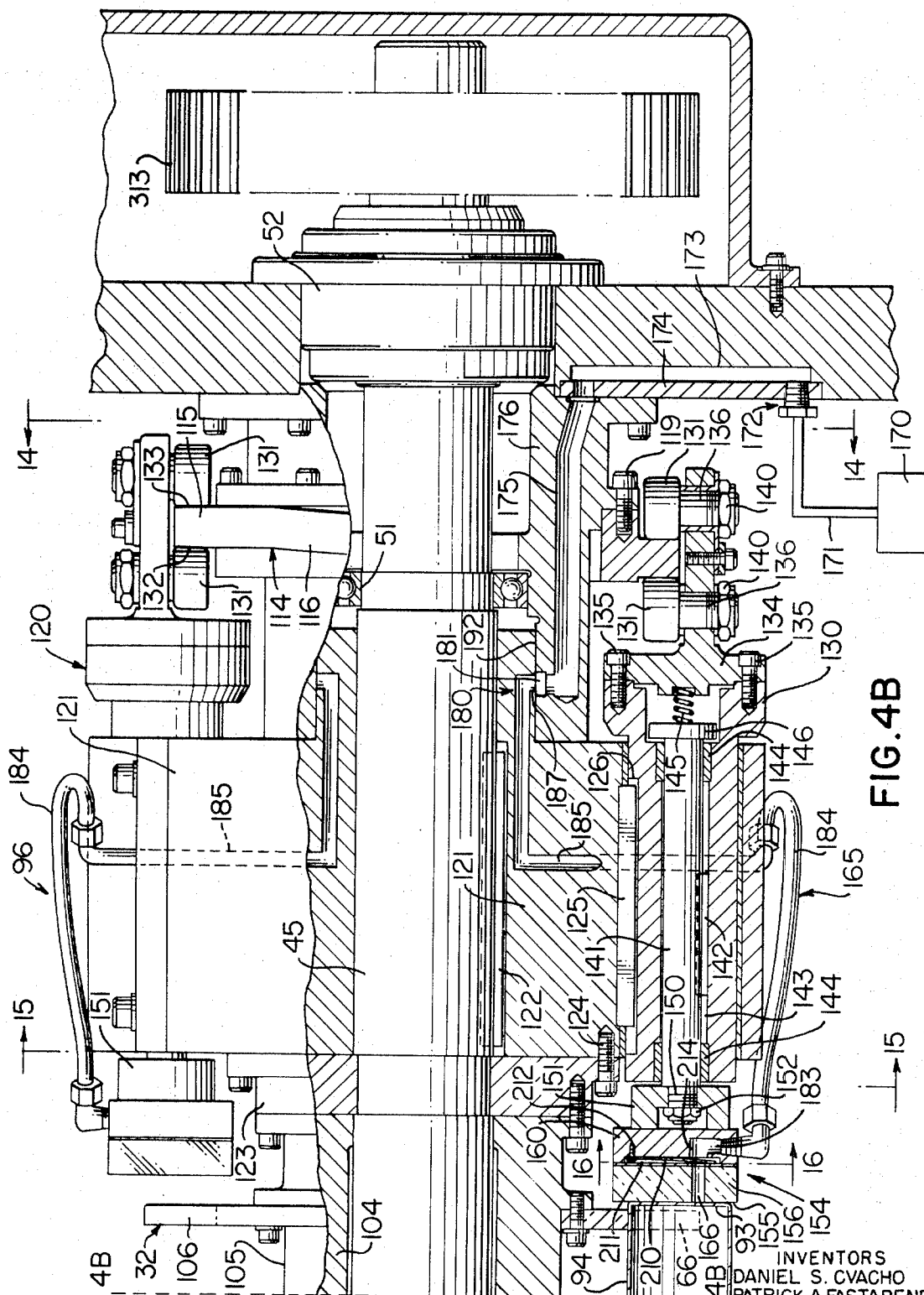


FIG. 4B

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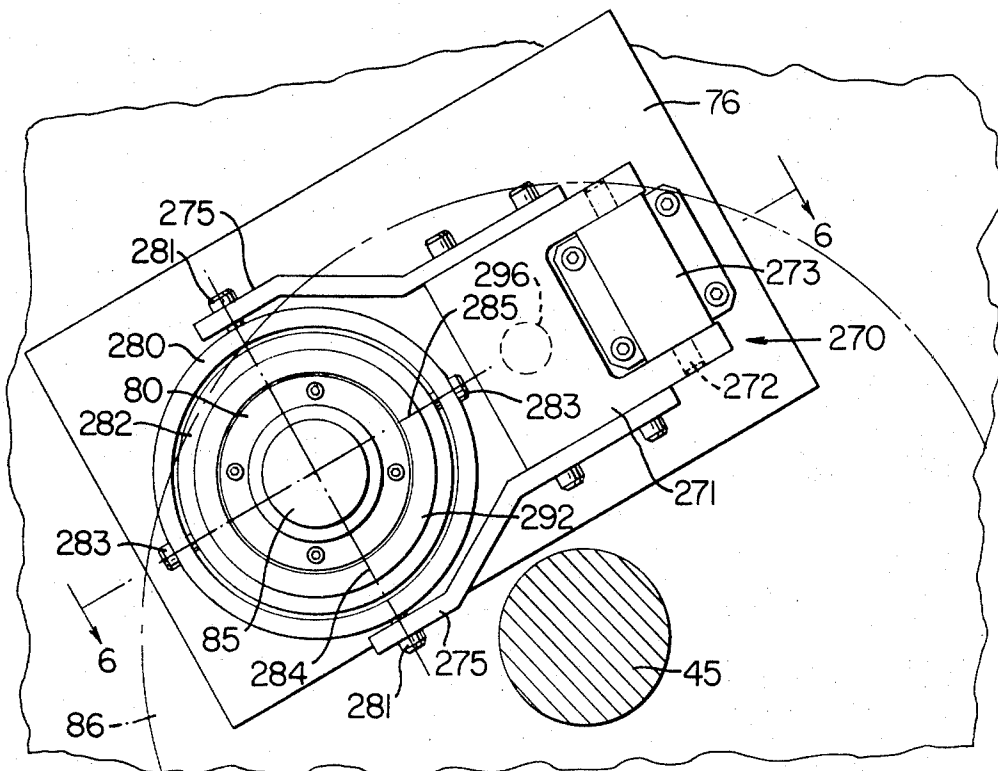


FIG. 5

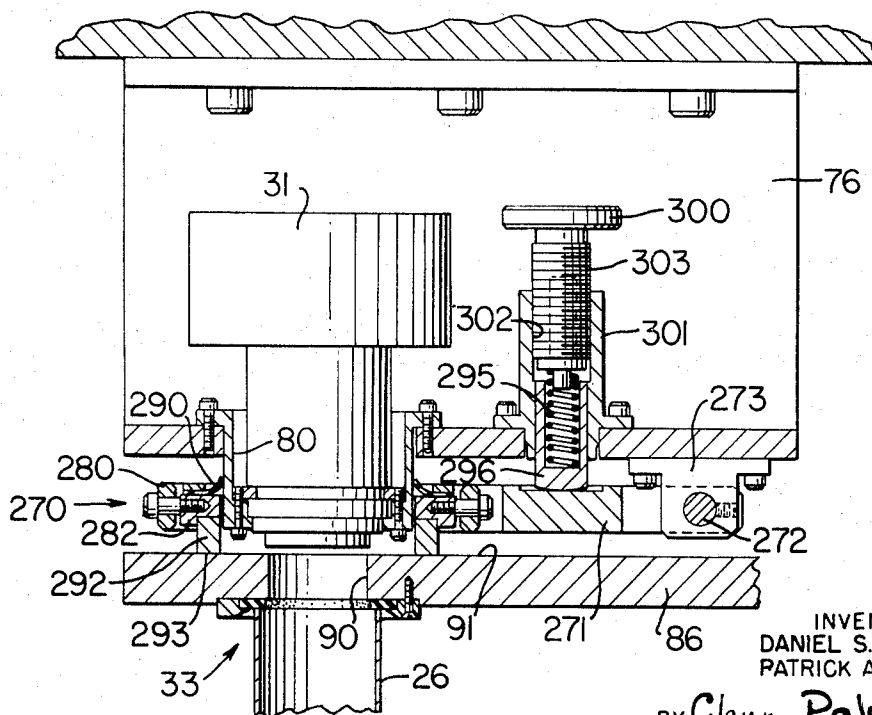
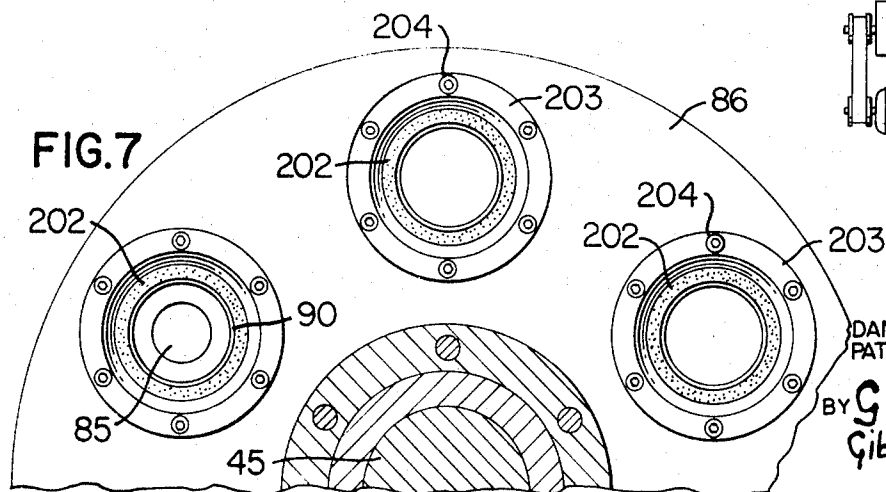
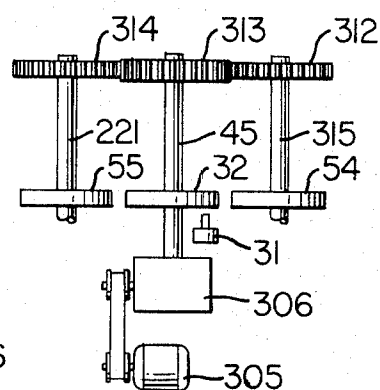
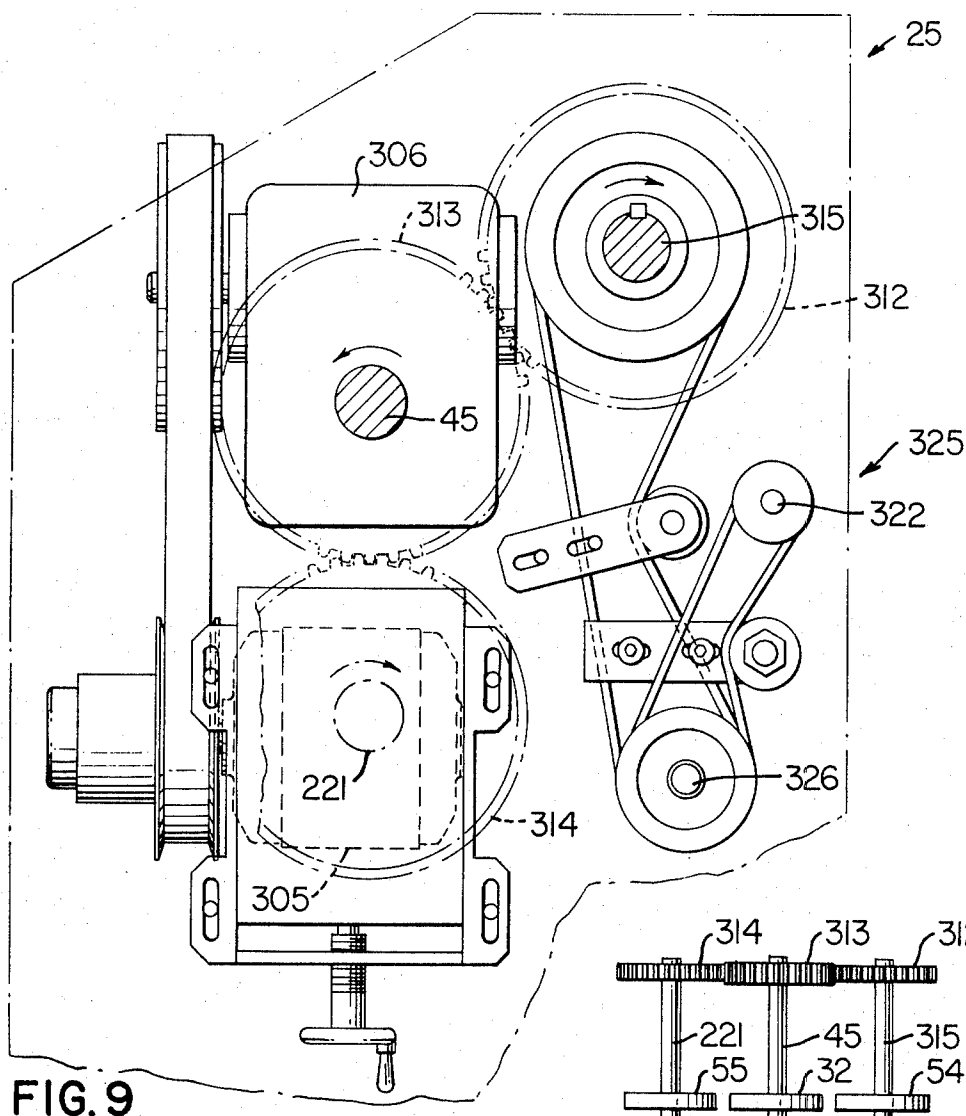


FIG. 6

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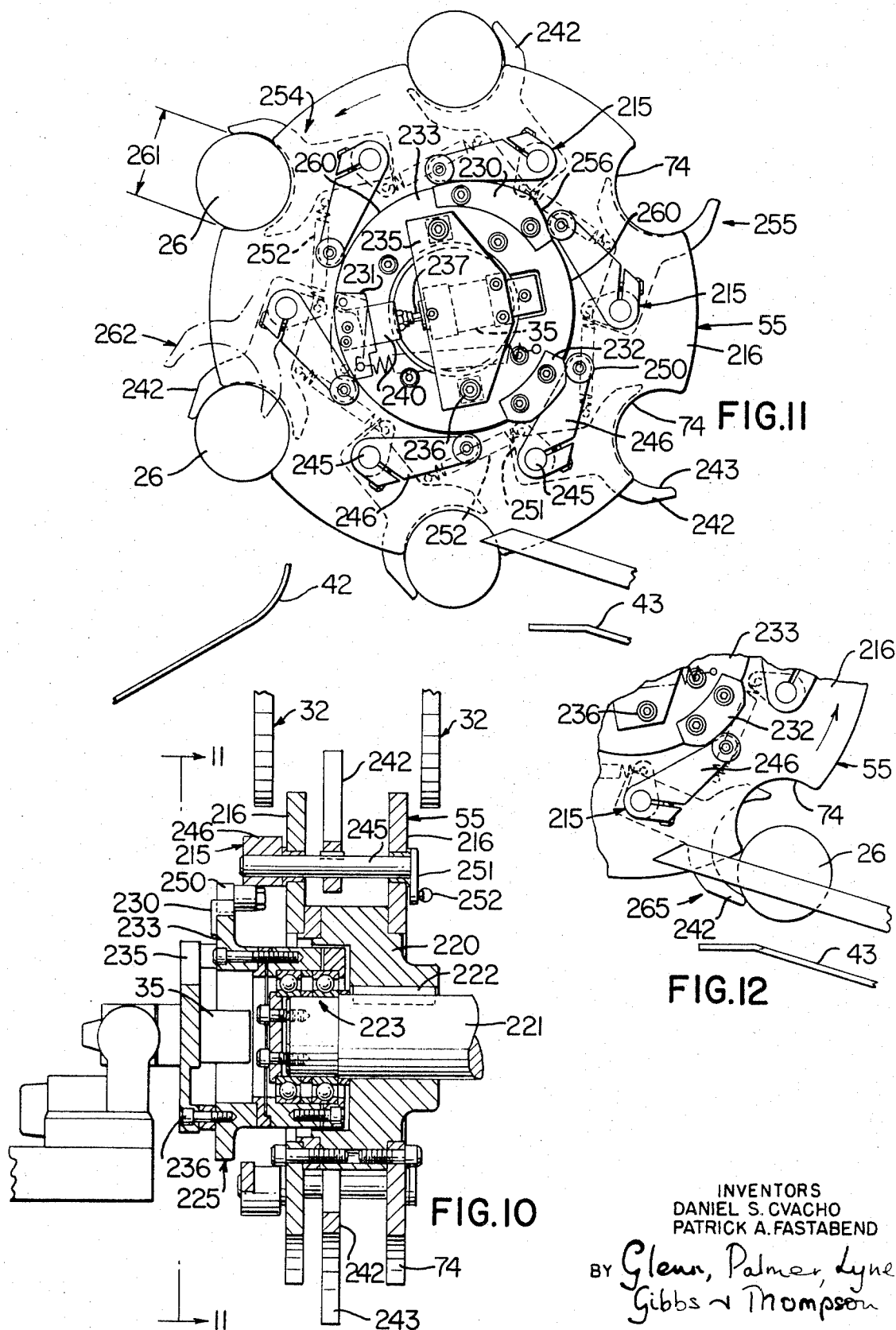
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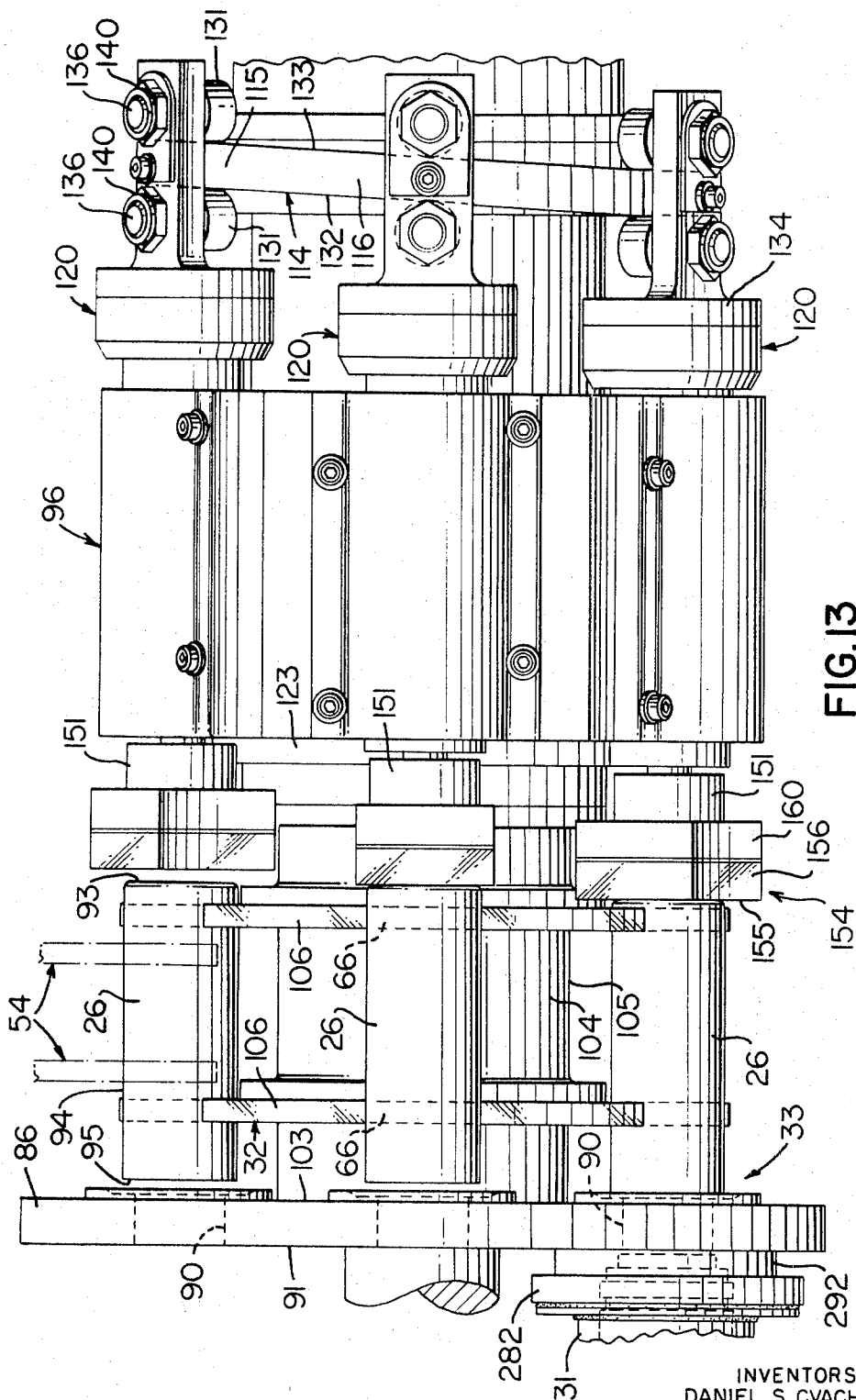


FIG. 13

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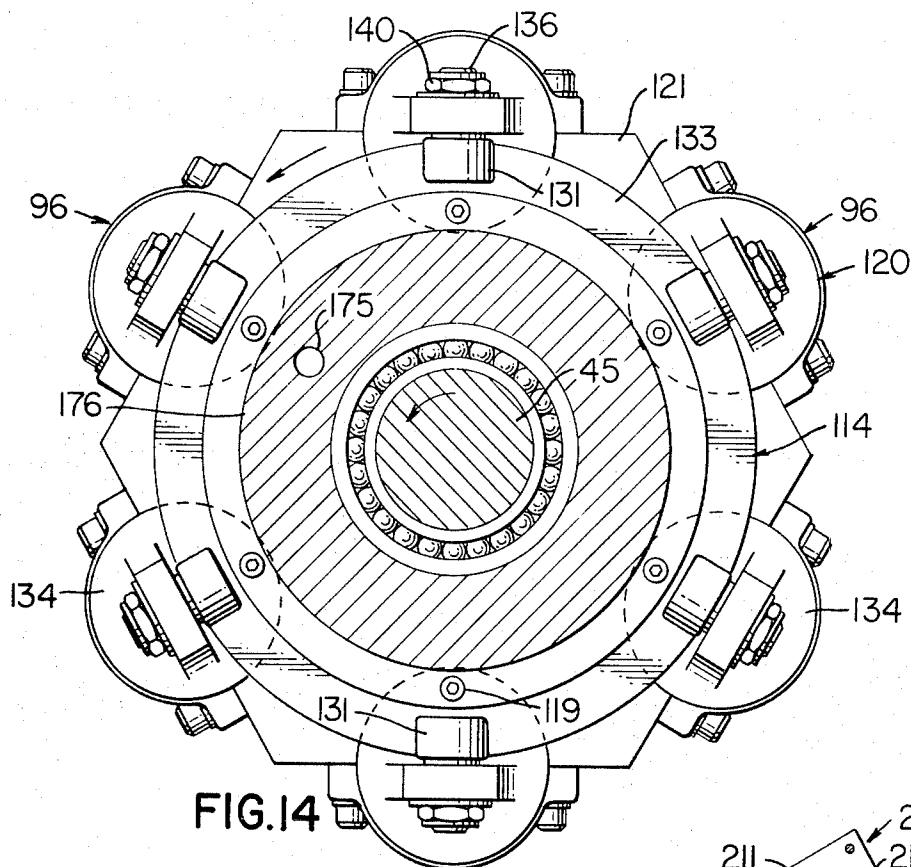


FIG. 14

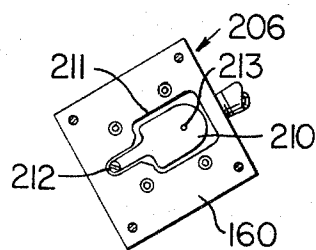


FIG. 16

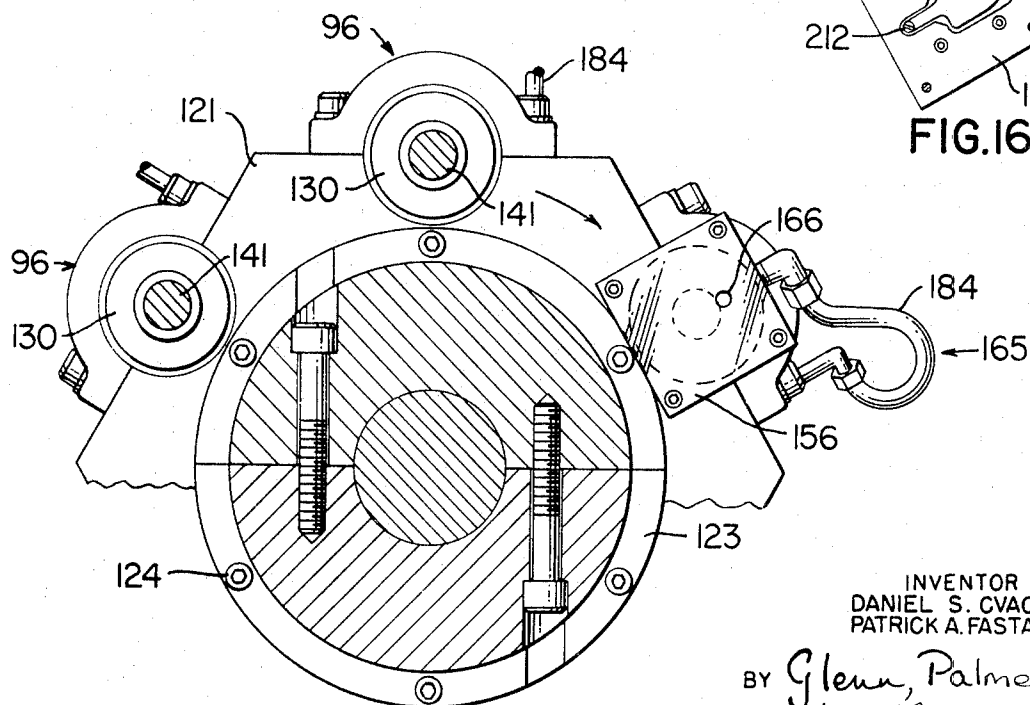
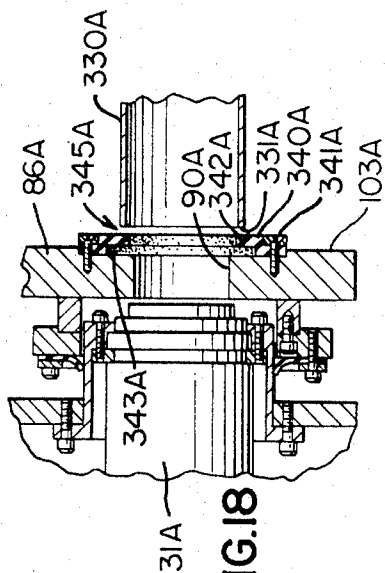
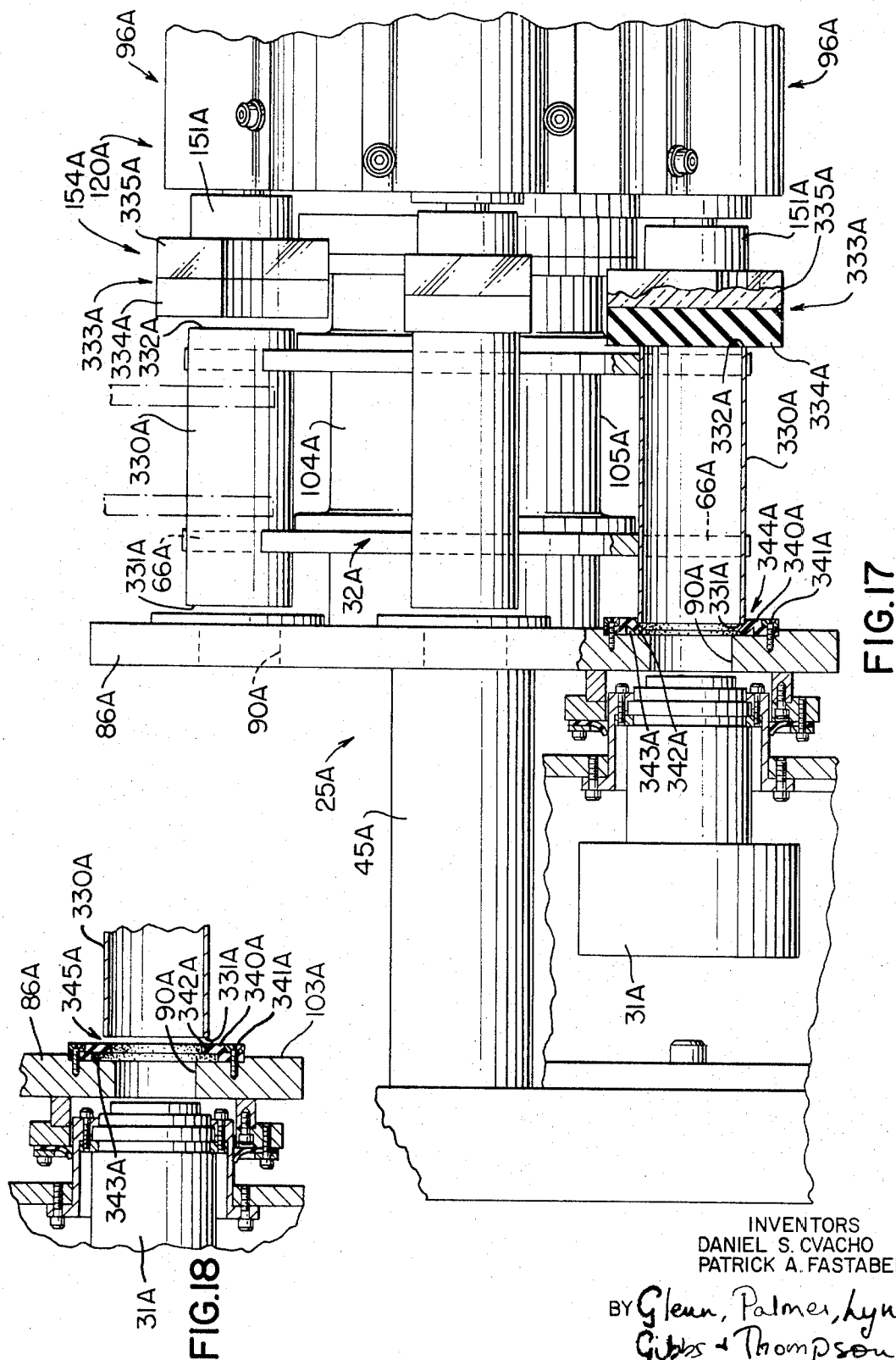


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APPARATUS FOR AND METHOD OF INSPECTING CONTAINER MEANS

This application is a continuation of Ser. No. 774,776, filed Nov. 12, 1968, now abandoned.

BACKGROUND OF THE INVENTION

Can bodies and the like may require inspection in the course of manufacture to determine whether there are openings through the walls or cracked edges around the open ends which might render the cans unacceptable for containing a fluid product. It has long been conventional to use compressed air to check the fluid-retention ability of can bodies. A recent development in the art is the use of light to detect wall openings and edge cracks in can bodies.

SUMMARY

The present invention provides improved apparatus and method for successful handling of can bodies and the like as they are passed through a light inspection station. Very small openings or edge cracks can be detected and unacceptable units rejected as a long series of can bodies are passed through the apparatus at high speeds (such as several hundred units per minute) in the course of normal plant operations.

Other details, uses, and advantages of this invention will become apparent as the following description of the embodiments thereof presented in the accompanying drawings proceeds.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate present exemplary embodiments of this invention, in which

FIG. 1 is a perspective view illustrating one exemplary embodiment of the apparatus of this invention which is particularly adapted for inspecting the wall means of containers such as metal cans to determine the presence of any small openings in such wall means and which utilizes a light-emitting device to emit light which is used as the inspection medium for inspecting the containers at high speed;

FIG. 2 is a fragmentary perspective view particularly illustrating a plurality of electric lights comprising the light-emitting device of the apparatus of FIG. 1 mounted on a hinged support therefor adjacent a rotatable carrier comprising such apparatus;

FIG. 3 is a view taken essentially on the line 3—3 of FIG. 1 and also schematically illustrating associated electrical circuitry used in association with the illustrated mechanical components to provide a complete system for automatically inspecting the wall means of the containers for small openings therein;

FIGS. 4A and 4B illustrate a view taken on the line 4A & B — 4A & B of FIG. 3 upon aligning FIGS. 4A and 4B along their respective break lines 4A—4A and 4B—4B;

FIG. 5 is a view taken on the line 5—5 of FIG. 4A;

FIG. 6 is a view with parts in section and parts broken away taken essentially on the line 6—6 of FIG. 5;

FIG. 7 is a fragmentary view taken essentially on the line 7—7 of FIG. 4A;

FIG. 8 is a schematic view of the drive system for the apparatus of FIG. 1 and particularly illustrating the drive motor, main gear box, and associated gears and shafts;

FIG. 9 is a fragmentary view in elevation with parts in section and parts broken away particularly illustrating

ing the relative positions of the various components of the drive system for the apparatus of FIG. 1;

FIG. 10 is a view with parts in section and parts broken away taken essentially on the line 10—10 of FIG. 3;

FIG. 11 is a view taken on the line 11—11 of FIG. 10;

FIG. 12 is a view particularly illustrating the manner in which an acceptable can is discharged from the apparatus of FIG. 1 through the use of a unique linkage system;

FIG. 13 is an enlarged view with parts in section and parts broken away particularly illustrating the action of a plurality of cam roller assemblies and an associated cam plate in moving each can into an inspection position at the inspection station after receiving each can from an infeed star wheel comprising the apparatus of FIG. 1;

FIG. 14 is a view taken on the line 14—14 of FIG. 4B;

FIG. 15 is a view taken on the line 15—15 of FIG. 4B;

FIG. 16 is a view taken on the line 16—16 of FIG. 4B;

FIG. 17 is a view similar to FIG. 13 and particularly illustrating another exemplary embodiment of this invention which utilizes the normal resilient character of a grommet provided at the inspection station to axially move an associated container which is open at both ends away from the inspection station; and

FIG. 18 is a fragmentary sectional view particularly illustrating the grommet of FIG. 17 in its undeflected position with the container moved away therefrom;

DESCRIPTION OF ILLUSTRATED EMBODIMENTS

Reference is now made to FIGS. 1—3 of the drawings wherein an exemplary machine or apparatus of this invention is illustrated and designated generally by the reference numeral 25. The inspection apparatus 25 is particularly adapted to inspect hollow containers such as metal can bodies 26 in mass production quantities in excess of 600 containers per minute to determine the presence of small openings in the wall means or walls of such containers and with great reliability. The apparatus and method of this invention utilizes radiant energy in the form of light as an inspection medium and the light may be of any desired wave length which may or may not be visible to the human eye.

The apparatus 25 comprises a suitable light-emitting device designated generally by the reference numeral 30, a photosensitive device in the form of a photoelectric device 31, and a rotatable carrier 32 for serially moving each of the containers 26 between the light-emitting device 30 and the photoelectric device 31 enabling an opening in the wall means or walls of each container to be detected by the light passing through such opening at an inspection station 33 and energizing the photoelectric device 31. A suitable mechanism shown in this example of the invention as an electric solenoid 35 is provided and cooperates with suitable linkages to be subsequently described in details to reject each container 26 which has an opening in its wall means as determined by the photoelectric device 31. An air cylinder may be substituted for the electric solenoid 35 without departing from the scope of this invention.

The photoelectric device 31 is electrically connected in a known manner by a line 39 to an electrical apparatus 40 such as a shift register which receives a signal from the photoelectric device 31 at the inspection sta-

tion 33 and suitably stores such signal in a memory bank of known construction comprising the apparatus 40 to provide actuation of the solenoid 35 after four additional containers have been inspected and at a station which will be referred to as a rejection station 41 so that each unacceptable container, i.e., one having an opening in its wall means, will be ejected from the apparatus 25 into a chute 42 and conveyed away from the apparatus 25. Each acceptable container 26 is moved by the apparatus 25 beyond the rejection station 41 and is ejected into a downwardly inclined chute 43 which is utilized to convey each acceptable container 26 away from the inspection apparatus 25 for subsequent processing, as desired.

The apparatus 25 has a supporting frame 44 which may be suitably fixed in position on an associated supporting structure such as a rigid floor and has a central shaft 45 which has the rotatable carrier or main star wheel 32 suitably fixed thereto for rotation therewith. The central shaft 45 is rotatably supported on the supporting frame 44 by a plurality of spaced antifriction bearings 50, 51 and 52, see FIGS. 4A and 4B.

The exemplary apparatus 25 is comprised of a plurality of three cooperating star wheels comprising the previously mentioned main or central star wheel 32 carried by the central shaft 45, an infeed star wheel 54, and a cooperating discharge or outfeed star wheel 55. The infeed star wheel 54 and outfeed star wheel 55 assure that cans are moved into and out of the central star wheel 32 respectively in a positive, efficient, and non-slipping manner thereby assuring that the inspection of containers is achieved in a precision and reliable manner at the inspection station 33 while handling large quantities in excess of 600 containers 26 per minute.

The containers 26 to be inspected may be conveyed to the apparatus 25 by a suitable gravity chute 56, see FIG. 1, and the cans 26 are positively removed from the chute 56 by a screw conveyor 60 and moved into position on supporting cradles 61 of the infeed star wheel 54 at correctly spaced intervals to enable high speed pickup by the star wheel 54. The infeed system for the apparatus 25 has suitable guides 62 cooperating with the screw conveyor 60 to assure movement of the containers 26 in a controlled manner.

The infeed star wheel 54 has a lower arcuate guide 64 and cooperating side guides 65 which assure that the containers 26 are moved in an unobstructed manner by the infeed star wheel 54 on the cradles 66 of the main rotatable carrier or star wheel 32. The apparatus 25 also has an arcuate guide 70 fixed to the supporting frame 44 to help position the containers 26 in their associated cradles 66 of the main star wheel 32. The guide 70 has a brush-like portion or brush 71 which engages the outer periphery of each container 26 and gently seats each container 26 in its associated cradle once the outer periphery of a particular container engages the brush 71. The brush 71 is effective in essentially moving each container substantially radially inwardly toward the center of the star wheel 32. Another guide 73 is provided downstream of the inspection station 33 and is particularly adapted to engage the outer lower periphery of each container 26 as it leaves the inspection station 33 and is introduced into the discharge star wheel 55. The guide 73 has an arcuate configuration particularly adapted to assure smooth entry of the containers 26 from the infeed star wheel 32 into associated cradles 74 of the discharge star wheel 55.

The guides 64, 65, and 73 comprising the apparatus 25 may have outer surfaces made of a suitable antifriction material to assure easy unobstructed movement of the containers 26 through the inspection apparatus 25. Further, the outer surfaces of the above-mentioned guides are made of suitable materials to assure that the containers 26 coming in contact therewith will not be scratched, damaged, or otherwise marred during the movement of such containers at high speed through the inspection apparatus 25.

As seen particularly in FIG. 4A of the drawings the photoelectric device 31 is mounted at a fixed location on the supporting frame 44 by a bracket 76 and is adapted to receive light solely from the interior of each container 26 and in a manner to be subsequently described. The photoelectric device 31 is fixed to a tubular member of sleeve 80 by a plurality of bolts 81 and the sleeve is in turn fixed to the bracket 76 by a plurality of threaded bolts 82.

The photoelectric device 31 has a light-receiving aperture 85 which is suitably arranged at a fixed position defining the previously mentioned inspection station 33. The photoelectric device 31 is shielded from light from all sources except the interior of each container 26 as it moves into inspection position at the inspection station 33 and the unique means in which the light-receiving aperture 85 is shielded from unwanted light will be described in more detail subsequently.

As previously mentioned the rotatable star wheel 32 has a plurality of cradles 66 which are adapted to carry associated containers 26 therein. The star wheel 32 also has an opaque plate 86, see FIGS. 4A and 13, defining one side thereof and the plate 86 has a plurality of windows 90 provided therein corresponding in number to the plurality of cradles 66 and each window 90 is arranged adjacent an associated cradle 66.

As previously mentioned the photoelectric device 31 has its light-receiving aperture 85 mounted at a fixed position which in essence defines the inspection station 33. The photoelectric device 31 is mounted adjacent the exterior surface 91 of the plate 86 and as the star wheel 32 is rotated each of the windows 90 registers momentarily with the light-receiving aperture 85 at the inspection station 33 and such momentary registration comprises what will be referred to as an inspection interval. The inspection interval in each application may be varied and depends upon the speed at which the star wheel 32 is rotated and hence the speed at which the entire apparatus 25 is operated and such speed may be adjusted as desired.

As seen in FIG. 13 of the drawings each of the containers 26 has wall means comprised of a bottom wall 93 and a tubular side wall 94 adjoining the bottom wall 93 and terminating in a rim 95. Urging means designated generally by the reference numeral 96 is provided for urging each of the containers 26 axially along its cradle 66 until the rim 95 of each tubular side wall is urged against the plate 86 and surrounding an associated window 90, at the inspection station 33, to provide a light-proof seal between each tubular side wall 94 and the plate 86. The urging means 96 will be described in detail subsequently; however, it will be appreciated that the light-emitting device 30 floods the exterior of the wall means, comprised of tubular side wall 94 and bottom wall 93, with light during the inspection interval so that light passes from the exterior to the interior of each container 26 which has an opening in its wall

means, through an associated window 90 in plate 86, and through the light-receiving aperture 85 of the photoelectric device 31 to energize the photoelectric device and provide a signal to the electrical apparatus 40 previously described whereupon the particular container 26 which has an opening therein and hence is unacceptable will be removed, i.e., ejected, from the apparatus 25. The ejection of each unacceptable container takes place at the rejection station 41 by the solenoid 35 being energized after a suitable delay as imposed by the electrical apparatus 40 whereby the unacceptable can 26 is discharged from the discharge star wheel 55 into the discharge chute 42.

The light-emitting device 30 comprises a plurality of spaced electric fluorescent lights 100 which are mounted on a support 101 which is supported in a hinged manner adjacent the inspection station 33 so that the lights 100 are arranged inwardly of the interior surface 103 of the opaque plate 86, see FIGS. 2 and 3. The hinged support 101 has an arcuate reflective interior surface 102 defining an arcuate path which corresponds to and has a slightly larger radius than the path defined by the outer surface of the containers 26 during movement of such containers past the inspection station 33. The lights 100 of this example of the invention are mounted substantially an equal distance from the reflective interior surface 102 and extend over a roughly semicylindrical arc having an arcuate length of roughly 120°. Thus, it is seen that optimum lighting is provided on opposite sides of each container 26 as it is moved into inspection position at the inspection station 33.

The star wheel 32 has a hub portion 104, the outer surface 105 of which is made of a reflective material such as a highly polished metal, see FIG. 13. Further, the interior surface 103 of the opaque plate 86 is also a highly reflective surface such as a highly polished metal surface.

Each of the cradles 66 of the star wheel 32 is made of a transparent material such as a high strength transparent plastic, and in this example of the invention, the cradles are defined by suitable cutouts of roughly semicircular peripheral outline in a pair of cooperating spaced annular plates 106. The highly reflective interior surface 103 and the reflective outer surface 105 of the hub 104 assure that light provided from the electric lights 100 effectively floods the entire exterior of the wall means of each container 26 while the container is at the inspection station 33 and during the inspection interval. In particular, the lights 100 are preferably kept on at all times so that it is merely necessary to rotate the star wheel 32 to move each container 26 into inspection position at the inspection station 33 and light is automatically flooded entirely therearound enabling the high speed inspection to be carried out by the photoelectric device 31 sensing any light that may pass through an opening in the wall means of a particular container 26 being inspected to actuate the rejection means comprising rejection solenoid 35 at the rejection station 41 after a suitable time delay has been imposed by the electrical apparatus 40.

As previously mentioned, urging means designated generally by the reference numeral 96 is provided for urging each container axially along its cradle 66 until a rim 95 of the tubular side wall 94 is urged against the plate 86 in surrounding relation around an associated window 90 during the inspection interval to provide a

lightproof seal between the tubular wall 94 of each container 26 and the plate 86. As seen particularly in FIGS. 4B, 13 and 14 of the drawings, the urging means 96 comprises a cam plate 114 which is fixed to the supporting frame 44 by a plurality of bolts 119. The cam plate 114 of the exemplary apparatus 25 has an annular configuration comprised of a main portion 115 arranged substantially in one plane and an effective cam section 116. The effective cam section 116 has a central closely controlled portion arranged more closely adjacent the inspection station 33 which provides a controlled camming action during the inspection interval and has smooth transition sections at opposite ends thereof providing smooth movement out of and into the main portion 115.

The urging means 96 also comprises a plurality of cam roller assemblies 120 which are carried by the central shaft 45 and are rotatable simultaneously with the star wheel 32. Each of the cam roller assemblies 120 is arranged in axial alignment with an associated cradle 66 so that each assembly 120 may engage an associated container 26 carried in an aligned cradle 66 and move such container axially along its cradle 66 toward and against the opaque plate 86 and with the rim 95 of the particular container 26 in surrounding relation around an associated window 90.

Each cam roller assembly 120 is carried by a support 121 which is keyed to the shaft 45 by a key 122 and an annular plate 123 is fastened to support 121 by a plurality of bolts 124. The key 122 prevents the support 121 from rotating relative to the shaft 45. Another key 125 is also provided and is received within an elongated keyway 126 in an outer structural member 130 of each assembly 120 and the keyway 126 is substantially longer than the key 125 whereby the keyway 126 is effective in preventing rotation of an associated assembly 120 relative to the support 121, and hence the central shaft 45, while the key 125 and keyway 126 are constructed and arranged to allow axial movement of each assembly 120 relative to the central shaft 45 and toward and away from the inspection station 33. The amount of axial movement that may be provided is determined by the difference in length between the key 125 and the keyway 126 in a direction parallel to the axis of the shaft 45.

Each roller assembly 120 has a pair of cooperating cam rollers 131 adjacent the rear end thereof and the cam rollers engage opposed surfaces 132 and 133 of the cam plate 114 to control the axial movement of each assembly 120. A support bracket 134 comprises the rear end portion of each roller assembly 120 and the bracket 134 is fixed to the main structural portion 130 of each assembly 120 by a plurality of bolts 135. Each of the cam rollers 131 is carried on a shaft 136 which has a threaded outer end and a threaded nut 140 is threaded on the threaded end of each shaft 136 after extending such shaft through a cooperating opening provided in the rear end portion of the support bracket 134 to thereby rotatably support the cam rollers 131 in position.

Each cam roller assembly 120 has a rod 141 which is keyed to the outer member 130 by a key 142 to prevent rotation of such rod 141 relative to its member 130 and member 130 has an inner slot 143 which is adapted to receive the key 142 and allow axial sliding movement of the rod 141. A pair of sleeve bearings 144 supports opposite ends of the rod 141 and allows axial

movement of such rod relative to the housing 130. A compression spring 145 is provided and acts between an inner head portion 146 of the rod 144 and the bracket 134 to normally yieldingly urge the rod 141 outwardly toward an associated cradle 66.

The rod 141 has a threaded forward portion 150 which is inserted through an associated opening in a supporting member 151 and a nut 152 is used to fasten the member 151 to the rod 141. Each cam roller assembly 120 has a forward portion designated generally by the reference numeral 154 and which will be described in more detail subsequently and the forward portion 154 has an outer surface 155 which is adapted to engage the bottom wall 93 of an associated container 26 to urge the particular container axially along its cradle 66 in a precise and positive manner as determined by the configuration of the cam plate 114.

The compression spring 145 of each assembly 120 is used, in effect, as an override mechanism to compensate for containers 26 having different heights, i.e., axial lengths, within predetermined tolerance limits and thereby assure that the associated cam roller assembly 120 does not damage an associated container 26 which is of excessive length by pushing too hard thereagainst. Similarly, if a container 26 is shorter than usual the fully extended compression spring 145 has an overall extended length which assures even a shorter container 26 will have its rim 95 urged against the plate 86 in a lightproof manner with the fixed movement provided by the cover plate 114.

As previously indicated each cam roller assembly 120 has a forward portion 154 the outer surface 155 of which is adapted to engage and urge its associated container 26 axially along its cradle 66. The forward portion 154 comprises a transparent member 156, i.e., a member made of a transparent material such as a clear plastic, having surface 155 defining its outer surface. The transparent member 156 allows light from the light-emitting source 30 to also flood the bottom wall 93 simultaneously with flooding of the tubular side wall 94 and thereby assure that the entire wall means of a particular container 26 are exposed to light so that any opening, irrespective of whether it is in the bottom wall 93 or the side wall 94, will allow light to pass there-through and be detected by the photoelectric device 31 in the manner previously described.

The forward portion 154 of each assembly 120 comprising the urging means 96 has a structural member 160 suitably fixed to the forward end of the supporting member 151 and to assure minimum interference with the light passing through the transparent member 156 the rear surface of transparent member 156 is adhesively fastened to the forward portion of the structural member 160 utilizing a suitable adhesive means.

The apparatus 25 also has positioning means tending to position each of the containers 26 axially along its associated cradle 66 so that the rim 95 is moved away from the plate 86 following the inspection interval to thereby assure that a particular container 26 which has been urged toward and against the plate 86 is not held thereagainst during transfer of the particular container 26 from the central star wheel 32 to the discharge star wheel 55. The positioning means of the exemplary apparatus 25 is particularly illustrated in FIG. 4B of the drawings and comprises a vacuum device associating with each cam roller assembly 120 and each vacuum

device is designated generally by the reference numeral 165.

Each vacuum device comprises a vacuum passage 166 extending through an associated transparent member 156 and exiting the exterior surface 155 of such member so that the inlet of the passage 166 is effective in partially evacuating the air from the space between the transparent member 156 and the bottom wall 93 of an associated container 26 to hold the associated container in position firmly against the transparent member 156. Thus, with the vacuum device in operation each container 26 is effectively held against the transparent member 156 and its axial position is controlled precisely by the cam plate 114 and an associated cam roller assembly 120.

As seen in FIG. 4B, each vacuum device 165 is suitably connected, as will now be described, to a suitable vacuum source such as a vacuum pump 170 which has a vacuum line 171 connected to the vacuum pump 170 and threadedly connected to supporting frame 44 as indicated at 172. An internal vacuum passage 173 is provided in the supporting frame by a suitable cutout therein and by a plate 174 which is suitably fixed in position in a fluid-tight manner against the supporting frame 44. The passage 173 has a passage 175 interconnected thereto which extends through a fixed structural member 176 and terminates in an annular groove 181 at a fixed location 180.

Each telescoping assembly 165 has its vacuum passage 166 in fluid flow communication with another passage 183 provided in the member 160 and an external line 184 extends from the passage 183 and communicates with an internal passage 185 which has an open end portion 187 exiting the member 121. As the end portion 187 of each internal passage 185 registers with the annular groove 181 the passage 166 is directly connected with the vacuum pump 170 whereby a vacuum is provided in the passage 166 in a known manner. It will be appreciated that the member 121 has a plurality of internal passages 185 each discharging at an associated end portion 187 and member 121 rotates while member 176 is a fixed member whereby a fluid-tight face seal is provided along the line indicated at 192 between the members 176 and 121.

The annular groove 181 provided in the member 176 extends circumferentially around such member for an arcuate length indicated at 200 in FIG. 3 and defined essentially by the total arcuate distance over which roughly three cradles 66 extend. A vacuum is applied over the arcuate length 200 and for approximately the same distance on each side of the inspection station 33 and it will be appreciated that the rim 95 of a particular container 26 is rapidly moved away from the opaque plate 86 by the cam plate 114 once the particular container has been inspected at the inspection station 33. Thus, each cam roller assembly 120 controls the axial portion of its associated container in a positive manner over the angular distance indicated at 200.

As seen particularly in FIG. 7 the apparatus 25 has a plurality of gaskets 202 corresponding in number to the plurality of cradles 66 and each of the gaskets is fixed in position by an annular ring 203 which is bolted to the plate 86 by a plurality of bolts 204. The fixed annular gaskets 200, in effect, define a portion of the plate 86 and surround an associated window 90 and each gasket 202 is adapted to be engaged by a rim 95 of an associated tubular wall of a container 26. Each

gasket 202 is made of an opaque material such as a rubber-like material and is adapted to be engaged by a rim 95 to provide a lightproof seal of optimum quality even with minor defects in an associated rim 95 once the associated rim is urged thereagainst.

As seen particularly in FIGS. 4B, 15, and 16 of the drawings each vacuum device 165 has what will be referred to as a vacuum saver assembly designated generally by the reference numeral 206 in FIG. 16 and the vacuum saver assembly comprises a substantially flexible paddle-shaped member 210 which is supported in a recess 211 provided in the member 160 and at a single point by a screw 212.

The member 210 has an orifice 213 of controlled area provided therein and the member 210 is adapted to be aligned over a circular opening 214 provided in the member 160. The vacuum-saving function is achieved by the member 210 being pulled tightly against the opening 214 in the event a container 26 is not present in its associated cradle 66 so that the maximum vacuum flow that can be applied in controlled and determined by the size of the orifice 213. In the event that a container 26 is present the size of the orifice 213 is sufficient to assure that the particular container 26 will be held in position by the vacuum device 165.

The discharge star wheel 55 is of unique construction and assures reliable and efficient high speed transfer of containers 26 into the discharge chute 42 if the containers are found unacceptable and into chute 43 if the containers are acceptable. The discharge star wheel 55 has a plurality of cradles 74, as previously mentioned, and has a plurality of linkage assemblies 215 each designated generally by the reference numeral 215 and each associating with and, in effect, defining a portion of an associated cradle means or cradle 74, see FIGS. 10-12.

The star wheel 55 has a pair of annular members 216 suitably fixed to a support 220 which is keyed to a shaft 221 by a key 222 whereby the star wheel 55 and particularly plates 216 defining the cradles 74 are rotated simultaneously with the shaft 221. An antifriction roller bearing 223 is provided to enable free rotation of shaft 221 and star wheel 55 relative to a fixed support assembly which is designated generally by the reference numeral 225. The fixed support assembly 225 carries a pair of fixed cam members 230 and 232 and a movable cam member 231 and the cam members 230-232 control the action of the linkage assemblies 215 in a manner to be subsequently described.

The cam members 230 and 232 are fixed to a support member or plate 233 which is carried by the fixed support assembly 225. The previously mentioned electrical solenoid 35 (which serves as an actuator for actuating the assemblies 215) is carried by a support plate 235 fixed by bolts 236 to the plate 233. The solenoid 35 has a telescoping rod 237 which in turn is fastened to a bracket 240 which is operatively connected to the cam member 231 and the solenoid operates to pivot one end of cam member 231 about a pivot pin operatively associating with the opposite end of cam member 231.

Each linkage assembly 215 is comprised of a yoke-shaped member 242 having an arcuate outer end 243 which helps define the supporting surface means of an associated cradle means or cradle 74 of the discharge star wheel 55. The inner end of each member 242 is fixed to a pin 245 that is rotatably supported by the

members 216 and an elongated arm 246 is also provided and fixed to the pin 245. The arm 246 rotatably carries a cam roller 250 at its terminal outer end and another comparatively short arm 251 is fixed to the pin 245 and has a compression spring 252 which acts between the outer end of arm 251 and the member 216 to normally yieldingly urge the terminal end of the arm 246 and its cam roller 250 radially inwardly toward the center of the discharge wheel 55 and against a substantially cylindrical cam surface 260 so that the arcuate outer end 243 of yoke-shaped member 242 normally normally in the position illustrated at 254 in FIG. 11. Thus, the position of each yoke-shaped member 242 and in particular the position of its outer end 243 is controlled by the position of an associated cam roller 250 as the discharge wheel 55 is rotated by its shaft 221.

The operation of the discharge wheel 55 will be readily understood by viewing FIGS. 3, and 10-12 of the drawings. It should also be noted that the discharge wheel 55 is viewed in one direction in FIG. 3 of the drawings whereby clockwise rotation is illustrated and is viewed in an opposite direction in FIGS. 11 and 12 whereby counterclockwise is illustrated.

As the discharge wheel 55 approaches the position at which a container 26 is to be transferred from the main star wheel 32 onto the discharge wheel 55 the particular cradle and linkage assembly 215 is essentially in the position illustrated at 255 in FIGS. 3 and 11. Continued rotation of the star wheel 55 moves an associated cam roller 250 over the crest 256 of cam member 230 whereupon the outer portion 243 of the yoke member 242 is pivoted outwardly its greatest amount to a position of maximum opening to define the point of transfer of an associated container 26 from the star wheel 32 to the star wheel 55. Continued movement of the discharge wheel 55 past the cam member 230 causes the particular cam roller 250 to again move against the substantially cylindrical cam surface 260 whereupon an overcenter condition is created wherein the effective cradle 74 has a width indicated at 261 which is substantially smaller than the diameter of an associated container whereby the container 26 is firmly held in position with high speed rotation of the discharge wheel 55 yet without the need of firmly clamping or gripping the container which could cause marring thereof.

If a particular container 26 approaching the rejection station 41 is defective in that it has an opening in its wall means the electrical apparatus 40 will provide a suitable signal to the solenoid 35 after a suitable time delay and in the manner previously described whereby the solenoid pushes the cam member 231 outwardly from its solid line position to the dotted line position illustrated at 262. The cam member 231 pivots the yoke-like member 242 to the dotted line position 262 and the particular defective container 26 is discharged into the discharge chute 42.

However, if the particular container or cam 26 is acceptable a signal will not be provided to the solenoid 35 and as the discharge wheel 55 continues to rotate the acceptable container 26 will be ejected into the discharge chute 43 by the cam roller 250 engaging the cam member 232 causing the yoke-like member 242 to be moved outwardly to the position illustrated at 265 in FIG. 12 whereupon acceptable container 26 is discharged into the chute 43.

Once each linkage assembly 215 moves past the cam member 232 its cam roller 250 is urged against the normal cam surface 260 by its associated spring 252 in preparation for its yoke-shaped member 242 receiving another container from the star wheel 32. Thus, it is seen that a simple assembly is provided for rapidly moving cans from the inspection star wheel 32 to the discharge star wheel 55 while providing means for rapidly discharging unacceptable containers into a reject chute 42 and discharging acceptable containers into the chute 43.

As seen particularly in FIGS. 4A, 5, and 6 of the drawings, the apparatus 25 has suitable means to assure that the photoelectric device 31 is shielded from any extraneous or unwanted light while assuring that light will enter into the light-receiving aperture 85 thereof from the interior of an associated container 26 being inspected at the inspection station 33 and during the inspection interval. In addition, the photoelectric device 31 may be provided with suitable electric circuitry, if desired, to assure that a signal to the electrical apparatus will only be provided to the electrical apparatus 40 during the inspection interval for each container 26.

The means for shielding the photoelectric device 31 comprises a hinged or pivoted sealing assembly designated generally by the reference numeral 270 which has a load carrying member 271 supported by a pivot pin 272 which is carried by a lug 273 fixed to the supporting bracket 76. The sealing assembly 270 has a pair of arms 275 at its outer end which carry a pair of sealing members in a substantially universal or floating manner as will now be described.

The outer portion of the assembly 270 has an outer ring 280 which is pivotally connected to the arms 275 by a pair of pivot pins 281. The assembly 270 has an inner ring 282 which is pivotally connected by a pair of pivot pins 283 to the outer ring 280 whereby the outer end or head of the sealing assembly 270 is pivotally connected about two mutually perpendicular axes designated by the reference numerals 284 and 285.

The inner ring 282 of assembly 270 has its rearward portion provided with a lip seal 290 fixed thereto which engages the outer periphery of the tubular support 80 for the photoelectric device 31 in a lightproof manner. The forward portion of the ring 282 also has another seal in the form of an annular seal 292 suitably fixed thereto and the seal 292 has an outer surface 293 which engages the outer surface 91 of the plate 86 comprising the main star wheel 32. The annular seal 292 provides a lightproof seal between the plate 86 and the light-receiving aperture 85 of a photoelectric 31. 32. The seal 292 may be made of any suitable substantially frictionless material and a fluorocarbon seal has been effectively utilized.

The assembly 270 is urged toward the rotating plate 86 of the star wheel 32 by a compression spring 295 which acts between an axially slidable contact member 296 and the inner end of a threaded adjusting knob 300 which is carried by a support 301 which is fixed to the bracket 76. The fixed support 301 has cooperating internal threads 302 for receiving external threads 303 of the adjusting knob 300. The spring 295 urges the sealing assembly 270 and hence annular seal 292 against the plate 86 and the force with which the assembly is urged is adjusted by the adjusting knob 300. With wear of the fluorocarbon seal, the adjusting knob enables the provision of a lightproof seal between the plate 86 and

the photoelectric device 31 and adjustments are made simply by turning the adjusting knob 300. It will also be appreciated that the universal mounting of the seal 292 assures that even if the plate 86 does not rotate in a true vertical plane a lightproof seal will be maintained.

As illustrated in FIGS. 8 and 9 of the drawings the inspection apparatus 25 is driven by a single drive motor 305 which is operatively connected to a gear box 306 which has a single shaft 45 which drives a plurality of cooperating intermeshing gears 312, 313, and 314 and the gears 312 and 314 drive shafts 315 and 221 respectively. The shafts 315, 45, and 221 are suitably keyed to the infeed star wheel 54, main star wheel 32 and the discharge star wheel 55 respectively whereby simultaneous synchronized rotation of the star wheels and associated component parts are provided by the drive system. Further, a suitable drive connection is provided from the infeed star wheel shaft 315 which rotates a shaft 322 operatively connected to a driving gear box 323 at the lower end of the screw conveyor 60. The gear box 323 drives the screw conveyor from the lower end thereof in synchronization with the infeed star wheel 54.

A belt drive system designated generally by the reference numeral 325 is also provided and driven in a synchronized manner with the starwheels by the motor 305. The drive system 325 drives a shaft 326 which is suitably operatively connected with the apparatus 40 to assure each unacceptable container 26 is rejected at the proper location.

To provide an even better understanding of the apparatus 25, a brief summary will now be presented to highlight the manner in which containers 26 are inspected at high speed. In particular, it will be seen that containers 26 are positively introduced by a screw conveyor 60 into the infeed star wheel 54 and the cans are then transferred to a main star wheel 32. The main star wheel 32 moves each container 26 past an inspection station 33 where a light-emitting device 30 and associated reflective surfaces flood the entire exterior surface of each container with light.

Any opening in the wall means of a particular container 26 will allow light to pass from the exterior of the particular container to the interior thereof. A photoelectric device 31 is provided and operatively associates with the interior of each container 26 so that if the container is defective by having an opening therein the light will pass therethrough and be sensed by the photoelectric device 31 to actuate an associated electric apparatus 40 which in turn actuates a solenoid 35 after a suitable time delay to reject, i.e., eject, the defective container 26 at the rejection station 41 provided in association with the discharge star wheel 55 comprising the apparatus 25. The discharge star wheel 55 has a unique cam linkage system which allows the inspected containers to be removed therefrom at high speed either into the discharge chute 42 or into the chute 43 which receives acceptable containers 26.

Another exemplary embodiment of this invention is illustrated in FIGS. 17 and 18 of the drawings. The apparatus of FIGS. 17 and 18 is very similar to the apparatus 25; therefore, such apparatus will be designated generally by the reference numeral 25A and parts of the apparatus 25A which are very similar to corresponding parts of the apparatus 25 will be designated by the same reference numeral as in the apparatus 25 also followed by the letter designation A and not de-

scribed again. Only those component parts which are substantially different from corresponding parts of the apparatus 25 will be designated by new reference numerals also followed by the letter designation A and described in detail. The detailed description of those parts of the apparatus 25A which carry reference numerals which correspond to similar parts of the apparatus 25 would be the same as in the apparatus 25 and thus will not be repeated.

The apparatus 25A is particularly adapted for automatically inspecting containers 330A having wall means comprised of a tubular wall terminating in a pair of oppositely arranged rims 331A and 332A each defining an open end. The apparatus 25A has urging means 96A also comprised of a plurality of roller assemblies 120A which cooperate with a cam plate substantially identical to the cam plate of the apparatus 25 previously described.

Each container 330A is mounted in its associated cradle 66A with its one rim 331A mounted adjacent an associated window 90A in annular plate 86A and its opposite rim 332A arranged adjacent an associated end sealing means designated generally by the reference numeral 333A. The end sealing means 333A is provided as a part of the forward portion 154A of each associated roller assembly 120A comprising urging means 96A for the apparatus 25A.

Each roller assembly 120A and in particular each forward portion 154A engages the outer edge of a rim 332A of an associated container 330A and urges the particular container axially along its cradle 66A until its rim 331A is urged against the plate 86A in surrounding relation around an associated window 90A to provide a lightproof seal between each tubular container 330A and the plate 86A. The forward portion 154A of each roller assembly of the exemplary apparatus 25A is comprised of an opaque member 334A made of a rubber-like material.

The opaque member 334A is suitably fixed to a transparent member 335A which is in turn suitably fixed to supporting member 151A. The opaque member 334A assures that light does not enter the interior of the container 330A from the rear portion thereof and the transparent member 335A assures that light from the light-emitting device 30A passes through the transparent member 335A and is reflected by the reflective surface 105A of hub portion 104A so that light surrounds the entire outer surface of the container 330A.

Positioning means is provided as a part of the exemplary apparatus 25A and such positioning means is of simple and economical construction. In particular, it will be seen from FIG. 18 that the positioning means comprises a high quality resilient gasket 340A fixed around each window 90A by a plurality of fastening screws 341A. Each gasket 340A has an annular portion 342A spaced by a distance indicated at 343A from the interior surface 103A of the plate 86A. Each cam roller assembly 120A of the urging means 96A normally urges a tubular container 330A toward and against the annular gasket 340A essentially as illustrated at 344A in FIG. 17 whereupon the gasket is deflected as shown.

However, as each roller assembly 120A is moved to its retracted position the resilient character of the gasket 340A effectively urges, actually moves, the associated tubular container 330A away from the gasket 340A whereupon a typical distance indicated by the reference numeral 345A is provided between the annu-

lar plate 86A and an open ended tubular container 330A previously urged against a gasket 340A. Thus, the gasket 340A serves as positioning means moving 330A along its cradle 66A so that it may be picked up by the discharge star wheel in a simple and efficient manner and essentially in the same manner as previously described in connection with the containers 26 inspected by apparatus 25. Thus, it is seen that the apparatus 25A enables the inspection of tubular containers 330A having both ends open and in a rapid and efficient manner.

The inspection apparatus 25 and 25A are especially effective in inspecting containers such as drawn and ironed metal cans, such as aluminum cans, which have bright reflective interior surfaces. However, it will be appreciated that the inspection apparatus and method of this invention is especially useful in inspecting all types of substantially tubular containers irrespective of the character of their inside surfaces inasmuch as the reflective inside surfaces only serve to increase the efficiency of operation.

The apparatus and method of this invention is particularly effective in inspecting container bodies of all types in large production quantities in excess of 600 cans per minute, as previously mentioned. Further, the type of opening in the wall means of a container is immaterial and will be readily detected irrespective of whether it is in the form of a pin hole, a slit, etc. which might be present in a tubular side wall, a bottom wall, the junction of a bottom wall with a side wall, or at several of such locations.

The inspection apparatus 25 presented earlier in this specification has been shown as inspecting containers or cans 26 made as a single piece construction with a bottom wall and an integral side wall. However, it will be appreciated that the cans 26 may be of any suitable construction and may be comprised of two or more pieces suitably fastened together in a known manner.

The apparatus 25 and 25A is shown in this example as having the central axis of the associated main star wheel 32 and 32A respectively arranged horizontally. However, it will be appreciated that in some applications of this invention it may be preferred to arrange the main star wheel (as well as the other associated star wheels and related components) with its axis arranged substantially vertically whereby gravity may also be effectively utilized to axially position the container bodies being inspected along their associated cradles.

The apparatus and method of this invention is very reliable while providing rapid inspection of 600 or more containers per minute. For example, at these rapid speeds of inspection containers having openings with an effective diameter of 0.002 inch can be inspected and defective ones detected with 100 percent reliability, containers having openings with an effective diameter of 0.0015 can be detected with 99 percent reliability and containers having openings with an effective diameter of 0.001 can be detected with 75 percent reliability.

The photoelectric device 31 may be of any suitable known construction and hence will not be described in detail. Further, it may be desirable in some applications of this invention to provide a suitable connection from the synchronized rotating star wheels (such as by a belt drive system similar to the belt drive system 325) to assure that the photoelectric device 31 will only be activated during each inspection interval. Thus, the photo-

electric device would only be capable of transmitting a signal to the electrical apparatus 40 during such inspection interval. Obviously, a signal would only be transmitted to the apparatus 40 in the event a defective container is present at the inspection station 33 and with a system of this type there would be greater assurance that each signal to the electrical apparatus 40 would be due to a defective container being inspected at the inspection station and not due to extraneous light energizing the photoelectric device 31.

While present exemplary embodiments of this invention, and methods of practicing the same, have been illustrated and described, it will be recognized that this invention may be otherwise variously embodied and practiced within the scope of the following claims.

What is claimed is:

1. An apparatus for automatically inspecting for any opening in wall means of containers, said apparatus comprising, a light-emitting device, a photosensitive device, a rotatable carrier having a plurality of cradles each receiving and supporting the weight of one container therein and each cradle supporting its container so as to allow axial sliding movement of the container along its cradle, said rotatable carrier serially moving each of said containers between said devices with each container held in its associated cradle to allow light from said light-emitting device to pass through any opening in wall means of each container to energize said photosensitive device, shielding means operatively associating with each container and said photosensitive device, urging means for relatively moving each container and said shielding means substantially parallel to the axis of the container and into light-shielding engagement so that said photosensitive device only receives light from said light-emitting device which has passed through an opening in wall means of a container to thereby energize said photosensitive device, and a mechanism operatively connected to and actuated by said photosensitive device to reject each container having an opening in its wall means.

2. An apparatus as set forth in claim 1 in which said rotatable carrier comprises a rotatable wheel-like carrier which is rotatable in a substantially vertical plane.

3. An apparatus as set forth in claim 1 in which said light-emitting device floods one surface of said wall means of each container with light as it is rotated into an inspection position defining an inspection station, and further comprising means supporting said photosensitive device adjacent said inspection station.

4. An apparatus as set forth in claim 1 in which said rotatable carrier comprises a rotatable star wheel having said plurality of cradles and having an opaque plate defining one side thereof with said plate having a plurality of windows provided therein corresponding in number to said plurality of cradles with each window being arranged adjacent an associated cradle, said photosensitive device being mounted adjacent the exterior surface of said plate and having a light-receiving aperture provided therein and arranged at a fixed position defining an inspection station so that each of said windows registers momentarily with said aperture during rotation of said star wheel with said momentary registration comprising an inspection interval, said light-emitting device flooding the exterior of said wall means with light during said inspection interval so that light passes from the exterior to the interior of each container which has an opening in its wall means through

an associated window and through said aperture to energize said photosensitive device.

5. An apparatus for automatically inspecting for any opening in wall means of containers, said apparatus comprising, a light-emitting device, a photosensitive device, a rotatable carrier having a plurality of cradles each receiving and carrying one container therein, said rotatable carrier serially moving each of said containers between said device with each container held in its associated cradle to allow light from said light-emitting device to pass through any opening in wall means of each container to energize said photosensitive device, and a mechanism operatively connected to and actuated by said photosensitive device to reject each container having an opening in its wall means, said rotatable carrier comprising a rotatable star wheel having said plurality of cradles and having an opaque plate defining one side thereof with said plate having a plurality of windows provided therein corresponding in number to said plurality of cradles, each of said windows comprising an open passage in said plate and each window being arranged adjacent an associated cradle, said photosensitive device being mounted adjacent the exterior surface of said plate and having a light-receiving aperture provided therein and arranged at a fixed position defining an inspection station so that each of said windows registers momentarily with said aperture during rotation of said star wheel with said momentary registration comprising an inspection interval, said light-emitting device flooding the exterior of said wall means with light during said inspection interval so that light passes from the exterior to the interior of each container which has an opening in its wall means through an associated window and through said aperture to energize said photosensitive device.

6. An apparatus for automatically inspecting wall means of containers, said apparatus comprising, a light-emitting device, a photosensitive device, a rotatable carrier for serially moving each of said containers between said devices enabling any opening in wall means of each container to be detected by light passing there-through and energizing said photosensitive device, and a mechanism actuated by said photosensitive device to reject each container having an opening in its wall means, said rotatable carrier having a plurality of cradles each suitable for carrying one container, said rotatable carrier comprising a rotatable star wheel having said plurality of cradles and having an opaque plate defining one side thereof with said plate having a plurality of windows provided therein corresponding in number to said plurality of cradles with each window being arranged adjacent an associated cradle, said photosensitive device being mounted adjacent the exterior surface of said plate and having a light-receiving aperture provided therein and arranged at a fixed position defining an inspection station so that each of said windows registers momentarily with said aperture during rotation of said star wheel with said momentary registration comprising an inspection interval, said light-emitting device flooding the exterior of said wall means with light during said inspection interval so that light passes from the exterior to the interior of each container which has an opening in its wall means through an associated window and through said aperture to energize said photosensitive device, said star wheel having a hub portion provided with an outer reflective surface and each cradle is made of a transparent material, said reflective

surface and transparent material assuring that light from said light-emitting device effectively floods the entire exterior of said wall means during said inspection interval.

7. An apparatus for automatically inspecting wall means of containers, said apparatus comprising, a light-emitting device, a photosensitive device, a rotatable carrier for serially moving each of said containers between said devices enabling any opening in wall means of each container to be detected by light passing through and energizing said photosensitive device, and a mechanism actuated by said photosensitive device to reject each container having an opening in its wall means, said rotatable carrier having a plurality of cradles each suitable for carrying one container, said rotatable carrier comprising a rotatable star wheel having said plurality of cradles and having an opaque plate defining one side thereof with said plate having a plurality of windows provided therein corresponding in number to said plurality of cradles with each window being arranged adjacent an associated cradle, said photosensitive device being mounted adjacent the exterior surface of said plate and having a light-receiving aperture provided therein and arranged at a fixed position defining an inspection station so that each of said windows registers momentarily with said aperture during rotation of said star wheel with said momentary registration comprising an inspection interval, said light-emitting device flooding the exterior of said wall means with light during said inspection interval so that light passes from the exterior to the interior of each container which has an opening in its wall means through an associated window and through said aperture to energize said photosensitive device, said light-emitting device being mounted at a position adjacent said light-receiving aperture of said photosensitive device, said star wheel having a hub portion provided with an outer reflective surface made of polished metal with each cradle being made of a transparent material, said reflective surface and transparent material assuring light from said light-emitting device effectively floods the entire exterior of the wall means of each container during said inspection interval.

8. An apparatus for automatically inspecting wall means of containers, said apparatus comprising, a light-emitting device, a photosensitive device, a rotatable carrier for serially moving each of said containers between said devices enabling any opening in wall means of each container to be detected by light passing through and energizing said photosensitive device, and a mechanism actuated by said photosensitive device to reject each container having an opening in its wall means, said rotatable carrier having a plurality of cradles each suitable for carrying one container, said rotatable carrier comprising a rotatable star wheel having said plurality of cradles and having an opaque plate defining one side thereof with said plate having a plurality of windows provided therein corresponding in number to said plurality of cradles with each window being arranged adjacent an associated cradle, said photosensitive device being mounted adjacent the exterior surface of said plate and having a light-receiving aperture provided therein and arranged at a fixed position defining an inspection station so that each of said windows registers momentarily with said aperture during rotation of said star wheel with said momentary registration comprising an inspection interval, said light-emitting device

flooding the exterior of said wall means with light during said inspection interval so that light passes from the exterior to the interior of each container which has an opening in its wall means through an associated window and through said aperture to energize said photosensitive device, said light-emitting device comprising a plurality of spaced lights mounted on a hinged support which is supported adjacent said inspection station inwardly of the interior surface of said plate.

9. An apparatus as set forth in claim 8 wherein said plurality of lights are mounted adjacent the interior surface of said hinged support in an arcuate path with said arcuate path corresponding to and having a slightly larger radius than the path defined by the outer surface of said containers during movement thereof past said inspection station.

10. An apparatus for automatically inspecting wall means of containers, said apparatus comprising, a light-emitting device, a photosensitive device, a rotatable carrier for serially moving each of said containers between said devices enabling any opening in wall means of each container to be detected by light passing through and energizing said photosensitive device, and a mechanism actuated by said photosensitive device to reject each container having an opening in its wall means, said rotatable carrier having a plurality of cradles each suitable for carrying one container, said rotatable carrier comprising a rotatable star wheel having said plurality of cradles and having an opaque plate defining one side thereof with said plate having a plurality of windows provided therein corresponding in number to said plurality of cradles with each window being arranged adjacent an associated cradle, said photosensitive device being mounted adjacent the exterior surface of said plate and having a light-receiving aperture provided therein and arranged at a fixed position defining an inspection station so that each of said windows registers momentarily with said aperture during rotation of said star wheel with said momentary registration comprising an inspection interval, said light-emitting device flooding the exterior of said wall means with light during said inspection interval so that light passes from the exterior to the interior of each container which has an opening in its wall means through an associated window and through said aperture to energize said photosensitive device, and said apparatus further comprising a support mounted in a hinged manner adjacent said inspection station, said support having an arcuate reflective interior surface defining an arcuate path corresponding to and having a slightly larger radius than the path defined by the outer surface of said containers during movement thereof past said inspection station, said light-emitting device comprising a plurality of spaced lights each being mounted on said support substantially equidistant from said arcuate interior surface and being arranged inwardly of the interior surface of said plate with said lights in their normal light-emitting position, said star wheel having a hub portion and the outer surface of said plate defined as reflective surfaces and having each cradle made of a transparent material, said reflective surfaces and transparent material assuring that light from said plurality of lights effectively floods the entire exterior of the wall means of each container during said inspection interval.

11. An apparatus for automatically inspecting wall means of containers, said apparatus comprising, a light-emitting device, a photosensitive device, a rotatable

carrier for serially moving each of said containers between said devices enabling any opening in wall means of each container to be detected by light passing there-through and energizing said photosensitive device, and a mechanism actuated by said photosensitive device to reject each container having an opening in its wall means, said rotatable carrier having a plurality of cradles each suitable for carrying one container, said rotatable carrier comprising a rotatable star wheel having said plurality of cradles and having an opaque plate defining one side thereof with said plate having a plurality of windows provided therein corresponding in number to said plurality of cradles with each window being arranged adjacent an associated cradle, said photosensitive device being mounted adjacent the exterior surface of said plate and having a light-receiving aperture provided therein and arranged at a fixed position defining an inspection station so that each of said windows registers momentarily with said aperture during rotation of said star wheel with said momentary registration comprising an inspection interval, said light-emitting device flooding the exterior of said wall means with light during said inspection interval so that light passes from the exterior to the interior of each container which has an opening in its wall means through an associated window and through said aperture to energize said photosensitive device, said wall means of each container comprising a tubular wall terminating in a rim with each container being supported by its associated cradle with its rim arranged adjacent an associated window, each of said windows comprising an open passage in said plate, and said apparatus further comprising means urging each of said containers axially along its cradle until a rim of its tubular wall is urged against said plate in surrounding relation around an associated window and during said inspection interval to provide a lightproof seal between each tubular wall and said plate.

12. An apparatus as set forth in claim 10 and further comprising a plurality of gaskets corresponding in number to said plurality of cradles, each of said gaskets being fixed in position to define a portion of said plate surrounding an associated window and each gasket being adapted to be engaged by a rim of an associated tubular wall of a container to provide a lightproof seal of optimum quality even with minor defects in an associated rim urged thereagainst.

13. An apparatus as set forth in claim 11 in which said urging means comprises a fixed cam plate and a plurality of cam roller assemblies corresponding in number to said plurality of cradles and being rotatable simultaneously with said star wheel, each of said assemblies being arranged in axial alignment with an associated cradle and having cooperating cam rollers adjacent the rear end thereof engaging said cam plate and also having a forward portion adapted to engage and urge its associated container axially along its cradle.

14. An apparatus for automatically inspecting wall means of containers, said apparatus comprising, a light-emitting device, a photosensitive device, a rotatable carrier for serially moving each of said containers between said devices enabling any opening in wall means of each container to be detected by light passing there-through and energizing said photosensitive device, and a mechanism actuated by said photosensitive device to reject each container having an opening in its wall means, said rotatable carrier having a plurality of cradles each suitable for carrying one container, said ro-

tatable carrier comprising a rotatable star wheel having said plurality of cradles and having an opaque plate defining one side thereof with said plate having a plurality of windows provided therein corresponding in number to said plurality of cradles with each window being arranged adjacent an associated cradle, said photosensitive device being mounted adjacent the exterior surface of said plate and having a light-receiving aperture provided therein and arranged at a fixed position defining an inspection station so that each of said windows registers momentarily with said aperture during rotation of said star wheel with said momentary registration comprising an inspection interval, said light-emitting device flooding the exterior of said wall means with light during said inspection interval so that light passes from the exterior to the interior of each container which has an opening in its wall means through an associated window and through said aperture to energize said photosensitive device, said wall means of each container comprising a bottom wall and a tubular side wall adjoining said bottom wall and terminating in a rim, each of said containers being mounted in its associated cradle with its rim arranged adjacent its associated window, and said apparatus further comprising means urging each of said containers axially along its cradle until the rim of each tubular side wall is urged against said plate and surrounding an associated window to provide a lightproof seal between each tubular side wall and said plate.

15. An apparatus as set forth in claim 14 and further comprising positioning means tending to position each of said containers axially along its associated cradle so that said rim is moved away from said plate following said inspection interval.

16. An apparatus as set forth in claim 14 in which said urging means comprises a transparent member adapted to engage the bottom wall of each container and allow light from said light-emitting device to also flood said bottom wall simultaneously with the flooding of said tubular side wall to enable detection of any opening in said bottom wall.

17. An apparatus as set forth in claim 14 in which said urging means comprises a fixed cam plate and a plurality of cam roller assemblies corresponding in number to said plurality of cradles and being rotatable simultaneously with said star wheel, each of said assemblies being arranged in axial alignment with an associated cradle and having cooperating cam rollers adjacent the rear end thereof engaging said cam plate and having a transparent forward member adapted to engage and urge its associated container axially along its cradle, and said transparent member allowing light from said light-emitting device to also flood said bottom wall simultaneously with the flooding of said tubular side wall to enable detection of any opening in said bottom wall.

18. An apparatus as set forth in claim 16 and further comprising positioning means tending to position each of said containers axially along its associated cradle so that the rim of each container is moved away from said plate following said inspection interval.

19. An apparatus as set forth in claim 18 in which said positioning means comprises a plurality of vacuum devices each associating with an associated cam roller assembly, each vacuum device comprising a vacuum passage extending through each associated transparent member with the inlet of said vacuum passage being

adapted to partially evacuate the air from the space between the associated transparent member and the bottom wall of an associated container to hold such associated container against the transparent member.

20. An apparatus for automatically inspecting wall means of containers, said apparatus comprising, a light-emitting device, a photosensitive device, a rotatable carrier for serially moving each of said containers between said devices enabling any opening in wall means of each container to be detected by light passing there-through and energizing said photosensitive device, and a mechanism actuated by said photosensitive device to reject each container having an opening in its wall means, said rotatable carrier having a plurality of cradles each suitable for carrying one container, said rotatable carrier comprising a rotatable star wheel having said plurality of cradles and having an opaque plate defining one side thereof with said plate having a plurality of windows provided therein corresponding in number to said plurality of cradles with each window being arranged adjacent an associated cradle, said photosensitive device being mounted adjacent the exterior surface of said plate and having a light-receiving aperture provided therein and arranged at a fixed position defining an inspection station so that each of said windows registers momentarily with said aperture during rotation of said star wheel with said momentary registration comprising an inspection interval, said light-emitting device flooding the exterior of said wall means with light during said inspection interval so that light passes from the exterior to the interior of each container which has an opening in its wall means through an associated window and through said aperture to energize said photosensitive device, said wall means of each of said containers comprising a tubular wall terminating in a pair of oppositely arranged rims each defining an open end, each open-ended container being mounted in its associated cradle with one of its rims arranged adjacent its associated window and its opposite rim arranged adjacent associated end sealing means, and said apparatus further comprising means urging the end sealing means in a lightproof manner against said opposite rim of each associated container while urging the associated container axially along its cradle until its one rim is urged against said plate surrounding an associated window and during said inspection interval to provide a lightproof seal between each tubular wall and said plate.

21. An apparatus as set forth in claim 20 in which said urging means comprises a fixed cam plate and a plurality of cam roller assemblies corresponding in number to said plurality of cradles and being rotatable simultaneously with said star wheel, each assembly being arranged in axial alignment with an associated cradle and each assembly having cooperating cam rollers adjacent the rear end thereof engaging said cam plate and having an opaque forward portion adapted to engage and urge its associated container axially along its cradle, and the opaque forward portion of each assembly defining said end sealing means.

22. An apparatus as set forth in claim 21 in which each assembly further comprises a transparent member fixed rearwardly of each opaque forward portion, said transparent member allowing light from said light-emitting device to pass therethrough and be reflected by reflective surfaces of said star wheel to assure light surrounds the entire outer surface of each associated open-ended container.

23. An apparatus as set forth in claim 20 and further comprising positioning means tending to position each of said containers axially along its associated cradle so that said one rim is moved away from said plate following said inspection interval.

24. An apparatus as set forth in claim 23 in which said positioning means comprises a plurality of resilient annular members each arranged surrounding an associated window in said plate, each resilient member being deflected toward said inspection station by said urging means urging an associated container thereagainst and each resilient member utilizing its inherent resiliency to axially move an associated container away from said plate upon retraction of said urging means following said inspection interval.

25. An apparatus as set forth in claim 1 in which said rotatable carrier comprises a rotatable wheel-like carrier which is rotatable in a substantially vertical plane, and each of said cradles is arranged adjacent the periphery of said carrier so that it supports an associated container horizontally.

26. An apparatus for automatically inspecting wall means of containers, said apparatus comprising, a light-emitting device, a photosensitive device, a rotatable carrier for serially moving each of said containers between said devices enabling any opening in wall means of each container to be detected by light passing there-through and energizing said photosensitive device, and a mechanism actuated by said photosensitive device to reject each container having an opening in its wall means, said rotatable carrier having a plurality of cradles each suitable for carrying one container, said rotatable carrier comprising a rotatable star wheel having said plurality of cradles and having an opaque plate defining one side thereof with said plate having a plurality of windows provided therein corresponding in number to said plurality of cradles with each window being arranged adjacent an associated cradle, said photosensitive device being mounted adjacent the exterior surface of said plate and having a light-receiving aperture provided therein and arranged at a fixed position defining an inspection station so that each of said windows registers momentarily with said aperture during rotation of said star wheel with said momentary registration comprising an inspection interval, said light-emitting device flooding the exterior of said wall means with light during said inspection interval so that light passes from the exterior to the interior of each container which has an opening in its wall means through an associated window and through said aperture to energize said photosensitive device, said photosensitive device being mounted at a fixed position outwardly of said opaque plate and further comprising shielding means cooperating between exterior surface means of said photosensitive device adjoining said light-receiving aperture and the exterior surface of said plate during rotation thereof, said shielding means assuring unwanted light is kept away from said light-receiving aperture of said photosensitive device, said shielding means comprising a pivotally mounted assembly having a swinging end portion and a lightproof seal at one end of said swinging end portion which is adapted to engage said exterior surface means of said photosensitive device in surrounding relation around said light-receiving aperture and having another lightproof seal provided at the opposite end of said swinging end portion which is yield-

ingly held against the outer surface of said opaque plate during rotation thereof.

27. An apparatus as set forth in claim 26 in which said lightproof seal fixed to said opposite end of said assembly comprises an annular seal made of a plastic anti-friction material.

28. An apparatus as set forth in claim 27 in which said swinging end portion of said pivotally mounted assembly has a head portion which is universally mounted for movement in a plurality of directions to assure that a lightproof seal is provided between said outer surface of said opaque plate and said photosensitive device under conditions where the plate does not rotate in a true vertical plane.

29. An apparatus as set forth in claim 28 and further comprising urging means for urging said head portion and its associated annular seal against said plate.

30. An apparatus as set forth in claim 29 and further comprising adjusting means for adjusting the position of said outer head portion and the force exerted by said urging means to hold said annular seal against the outer surface of said plate to provide a lightproof seal and compensate for wear in said annular seal.

31. An apparatus for automatically inspecting for any opening in wall means of containers, said apparatus comprising a light-emitting device, a photosensitive device, a main rotatable star wheel having a plurality of container-carrying cradles each receiving and carrying one container therein, said main star wheel serially moving each of said containers between said devices with each container held in its associated cradle to allow light from said light-emitting device to pass through any opening in wall means of each container to energize said photosensitive device, a discharge star wheel having a plurality of cradle means adapted to receive inspected containers from said container-carrying cradles of said main star wheel, a plurality of linkage assemblies corresponding in number to said plurality of cradle means and each linkage assembly being supported adjacent an associated cradle means, and an actuator operatively associating with said linkage assemblies and energized by said photosensitive device to reject each container having an opening in its wall means.

32. An apparatus as set forth in claim 31 in which each linkage assembly comprises a yoke-shaped member having an arcuate outer end which helps comprise supporting surface means of an associated cradle means comprising said discharge star wheel.

33. An apparatus as set forth in claim 32 and further comprising first fixed cam means, yielding means for normally yieldingly holding a portion of each linkage assembly against said first cam means, and second fixed cam means for moving each linkage assembly and hence each yoke-shaped member to a position of maximum opening to enable easy entry of a container from the main star wheel into an associated cradle means whereupon said yielding means returns said portion of said assembly against said first cam means causing the associated yoke-shaped member to be pivoted so the width at the entrance of the associated cradle means is substantially smaller than the diameter of an associated container whereby such container is firmly held in position with high speed rotation of said discharge star wheel while maintaining the outside surface means thereof substantially intact and in an undamaged condition.

34. An apparatus as set forth in claim 33 and further comprising movable cam means attached to said actuator, said movable cam means being moved by said actuator upon determining that a defective container is present in the associated cradle means to thereby override said yielding means and move said portion of the associated linkage assembly outwardly to provide a maximum width opening at the entrance of the associated cradle means to eject the unacceptable container from said discharge star wheel.

35. An apparatus as set forth in claim 33 and further comprising a third fixed cam means arranged downstream of said movable cam means and adapted to engage said portion of each assembly and move the associated yoke-shaped member to an open position and thereby discharge each acceptable container remaining in an associated cradle means of said discharge star wheel.

36. A method of inspecting wall means of containers at high speed comprising the steps of, placing a light-emitting device at a fixed position, placing a photosensitive device at a fixed position spaced from the fixed position of said light-emitting device to define an inspection station, supporting a plurality of containers to be inspected on a rotatable carrier having a plurality of cradles each receiving and supporting the weight of one container therein and each cradle supporting its container so as to allow axial sliding movement of the container along its cradle, rotating said carrier to serially move each of said containers between said devices with each container held in its associated cradle to allow light from said light-emitting device to pass through any opening in wall means of each container to energize said photosensitive device, and relatively moving each container and associated shielding means substantially parallel to the axis of the container and into light-shielding engagement using associated urging means so that at said inspection station said photosensitive device only receives light from said light-emitting device which has passed through an opening in wall means of a container to thereby energize said photosensitive device.

37. A method as set forth in claim 36 in which said step of rotating said carrier comprises rotating said carrier in a continuous nonindexing manner, thus facilitating high speed movement of the containers through the inspection station.

38. A method of inspecting wall means of containers at high speed comprising the steps of, placing a light-emitting device at a fixed position, placing a photosensitive device at a fixed position spaced from the fixed position of said light-emitting device to define an inspection station, supporting a plurality of containers to be inspected on a rotatable carrier having a plurality of cradles each receiving and carrying one container therein, rotating said carrier to serially move each of said containers between said devices with each container held in its associated cradle to allow light from said light-emitting device to pass through any opening in wall means of each container to energize said photosensitive device, and transferring said containers from said first-named rotatable carrier to a second rotatable carrier while continuously rotating said carriers at high speed, and mechanically ejecting each unacceptable container having an opening in its wall means from said second rotatable carrier and at an associated container rejection station.

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39. A method as set forth in claim 38 in which said step of supporting said plurality of containers on said first-named rotatable carrier comprises the step of supporting said containers so that light from said light-emitting device floods only the exterior thereof and must pass through any opening in wall means in each container to the interior thereof to energize said photo-sensitive device.

40. A method as set forth in claim 38 comprising the further steps of placing reflecting surface means on said first-named rotatable carrier in position to reflect light from said light-emitting device, said light being reflected by said surface means toward the exterior sur-

face of each container during inspection thereof at said station, thereby adding the reflecting light from said light-emitting device to its direct light for illumination of the entire exterior surface of each container.

41. A method as set forth in claim 36 in which said supporting step comprises supporting each container in a cradle of a wheel-like carrier which is rotatable in a substantially vertical plane.

42. An apparatus as set forth in claim 1 in which each of said cradles provides the sole support for its associated container.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,750,877

DATED : August 7, 1973

INVENTOR(S) : Daniel S. Cvacho, Patrick A. Fastabend

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Page 1 the name "Dvacho" should be --Cvacho--

Column 15, lines 22-24, delete "and each cradle supporting
its container so as to allow axial sliding
movement of the container along its cradle"

Signed and Sealed this

Eleventh Day of January 1977

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks