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(54) Title: A QUALITY CONTROL SYSTEM FOR SEMI-FINISHED GLASS PRODUCTS

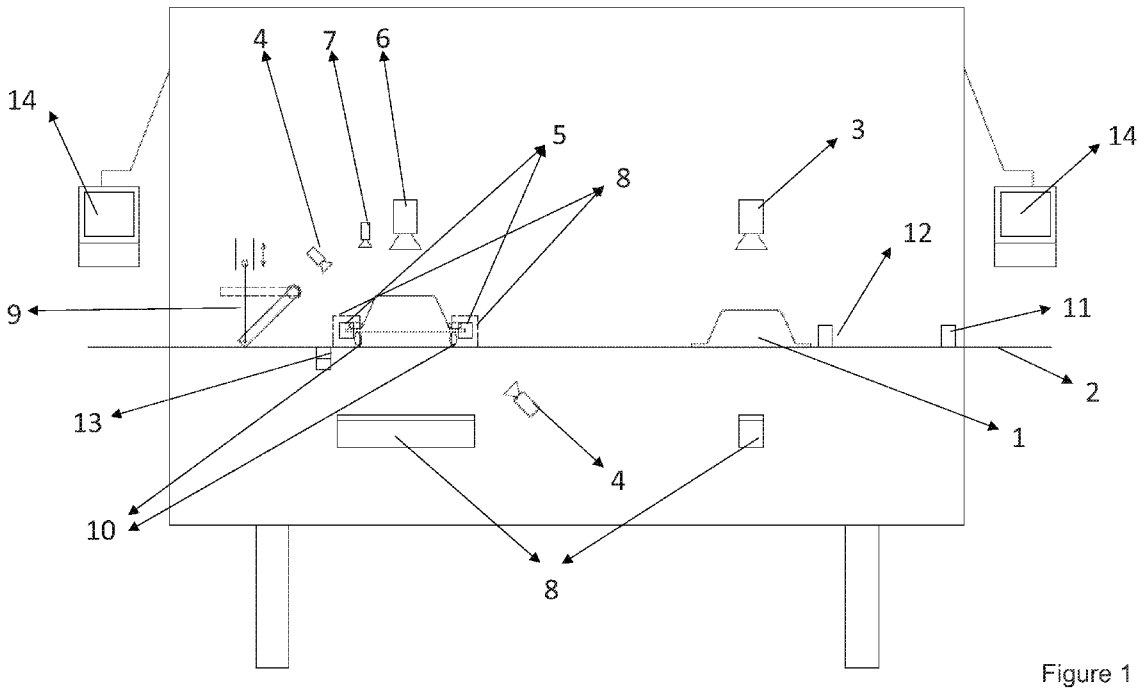

Figure 1

(57) Abstract: The present invention relates to an automated quality control system developed for inspection semi-finished glass products such as washing machine door glasses or industrial glass containers made of soda-lime or borosilicate glass in a press against manufacturing defects.

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DESCRIPTION

A QUALITY CONTROL SYSTEM FOR SEMI-FINISHED GLASS PRODUCTS

Field of the Invention

The present invention relates to an automated quality control system developed for inspection semi-finished glass products such as washing machine door glasses or industrial glass containers made of soda-lime and borosilicate glasses in a press against manufacturing defects.

Background of the Invention (Prior Art)

In the quality control methods employed in the state of the art, the semi-finished glass products such as washing machine door glasses or industrial glass containers (container ware) made of soda-lime or borosilicate glass in a press are sorted according to defects at the end of the cooling process completely by manual inspection and human eye, wherein the quality control process takes place depending on the decision made by the operator by interpreting certain quality control criteria based on experience.

This manual method of the prior art causes varying interpretations from one operator to another, and thus delivery of the defective products to the user depending on the perspective of the operator due to the fact that said glass products are sorted according to defects completely by manual inspection and human eye.

In this method, a proper quality control is significantly dependent on the competence and eyesight of the operator; and the inability to observe defects depending on the quantity of light in the environment where quality control is performed and on the viewpoint of the operator to the product presents an important problem in terms of quality control.

In order to overcome these technical problems in the state of the art, the quality control process needs to be standardized by performing said process using automated systems instead of manual inspection and human eye.

One of the systems used in the state of the art with a view to overcome these technical problems is the Patent Application No. US5729340. Said invention discloses

performing the inspection and recording by means of cameras via transmitting a diffused beam of light for detecting the flaws in glass bottles. Thus, the flaws on the bottles can be detected from different directions.

Another exemplary document is the Patent Application No. DE3611536. Said invention discloses at least one camera and illumination apparatus for testing glass objects which are distanced at certain intervals, for use as a testing device in order to test transparent objects, in particular glass bottles, for automatically detecting manufacturing faults. The transparent objects arranged on a linear plane are scanned by at least one or more cameras and the faults thereon are detected.

Summary and Objects of the Invention

The quality control system according to the invention consists of 7 cameras, 4 fixed light sources and 1 movable light source, and two separate control sections, wherein the defect inspection criteria can be adjusted and the quality control assessment can be stably performed over these criteria. Thus, different interpretations of the quality control criteria on the same product are prevented.

The sufficient lighting is ensured using one or more fixed and movable light sources within the system and images are taken from the angles in which the measurement is desired to be made using one or more cameras. This, in turn, inspection quality control errors resulting from the quantity of light and the viewpoint to the product.

The newly developed system allows sorting the defective products at the rate of 100%.

It is aimed by developing the quality control system according to the invention to:

- Ensure the standardization of the quality control criteria and an assessment complying with the standards,
- Eliminate the dependency on the manual control performed by humans,
- Perform the assessment under sufficient light and from a fixed viewpoint to the product,
- Perform dimensional measurements,

- Shorten the process time by means of the automated quality control process, and
- Observe the defects along with their sizes and to perform statistical evaluation regarding the defects by recording.

Description of the Drawings

The drawings for a better understanding of the quality control system developed with the present invention and the explanations related thereto are given below.

Fig. 1: Schematic view of the quality control system along the tunnel.

Description of the Part References

The parts and components which are shown in the drawings illustrating the quality control system developed with the present invention for a better understanding of the invention are enumerated individually and the reference numbers corresponding thereto are presented below.

1. Semi-finished glass product

2. Conveyor

3. Upper surface camera

4. Side surface camera

5. Camera with telesentric lens

6. Bottom surface camera

7. Auxiliary camera

8. Fixed light source

9. Movable light source

10. Lifting and rotating wheel

11. Entry photocell

12. Trigger photocell

13. Capacitive proximity sensor

14. Computer system

Detailed Description of the Invention

The semi-finished glass products (1) such as washing machine door glasses or industrial glass containers made of soda-lime or borosilicate glass are fed to the annealing lehrs or tempering units through the automatic line subsequent to being formed in press machines at the hot end. The door glasses exiting the annealing lehrs or tempering units are transferred to the quality control system according to the invention over the conveyor (2) in a single row.

The quality control system according to the invention operates as a defect inspection system consisting of at least 7 cameras (3, 4, 5, 6 and 7), at least 4 fixed light sources (8), at least 1 movable light source (9), in two separate control sections.

In the first control section, as in the state of the art, the upper surface of the semi-finished glass product (1) is inspected by at least one upper surface camera (3). The entry of the product (1) to the quality control system is determined by at least one entry photocell (11) disposed in the entry of the system and this product (1) is monitored until it gets out of the system.

The fixed light source (8) and the upper surface camera (3) are activated by the signals coming from the trigger photocell (12) used within the system.

The images recorded by the cameras (3, 4, 5, 6 and 7) are processed by the control algorithm depending on the speed of the conveyor (2) belt and the image of the semi-finished glass product (1) is formed in the computer system (14). These recorded images are processed in the computer system (14) in the quality control system. It is possible with these processed images to detect the defects on the semi-finished glass product (1) which are formed during or after the manufacturing process by way of the difference in the contrast. If there is any defect on the semi-finished glass product (1), the system stores the defective product in its memory to be rejected at the exit of the machine.

The defective or non-defective glass product (1) having undergone the first control section is transferred to the second control section by the conveyor (2). The position of the glass product (1) is sensed by the at least one capacitive proximity sensor (13) arranged in this section, and thus the cameras (4, 5, 6 and 7) and the movable light source (9) are triggered. When the glass product (1) assumes the desired position, it is held, lifted, and rotated 360 degrees by means of at least one lifting and rotating wheel (10). The rotating angle and speed of the wheel (10) is adjustable and said rotating wheels (10) are made of

an engineering plastic material. The wheel positions may be adjusted in accordance with different diameters and the quality control of the products having different diameters can also be performed within the system. Hence, it becomes possible to perform 360-degree visual inspection of the door glass (1). In the meantime, the at least 3 fixed light sources (8) and at least 1 movable light source (9) along with the at least two side surface cameras (4), at least two telecentric cameras (5), at least one bottom surface camera (6), and at least one auxiliary camera (7) are activated and start to take images. The conveyor (2) line arranged in the second section of the quality control system stops while the glass product (1) is being lifted and rotated by the lifting and rotating wheel (10). The glass product (1) may also be viewed from the lower portion by means of the side surface camera (4), which is one of the components of the two-section conveyor (2) line. The movable light source (9) which is located right opposite the camera (4) serves for illuminating. However, the light source (9) here must be movable. This is because the movable light source (9) assumes the suitable position and provides the required lighting while the semi-finished glass product (1) is being rotated. When the rotating operation is finished and the glass product (1) is being advanced by operating the conveyor (2) line, the light source (9) is raised and positioned such that it will not interfere with the movement of the glass product (1) in order to ensure that the movable light source (9) and the glass product (1) does not collide.

Due to the nature of the semi-finished glass product (1), the side surfaces are inspected by two side surface cameras (4) and the defective or defect-free images are recorded by the computer system (14). In addition to these, the auxiliary camera (7) which controls the so-called blue cracks, which are very fine cracks indistinguishable to the eye, scans the flange portion throughout the rotation of the glass product (1) and records images.

Moreover, the diameter of the glass product (1), the wall thickness in the flange portion and other dimensional measurements are performed and transferred to the system by at least two cameras with telesentric lenses (5) scanning the lateral surfaces of the glass product (1). To that end, telecentric lenses are used in the cameras (5) facing the glass product (1) in a way to view the walls thereof at both sides, perpendicular to the conveyor (2) axis. While the visual inspection system is being adjusted according to the product (1), the distance between both cameras with telesentric lenses (5) is adjusted and the distance information is manually recorded in the system via the screen. While performing diameter measurement, on the other hand, the cameras (5) provided thereon with telecentric lenses record 30 images each during 360-degree rotation of the glass product (1). The images are processed by the computer system and the outer wall dimensions of the product (1) are

determined by way of the difference in the contrast, and then measuring the average of the dimensions. Thus, the diameter information at the desired height is found by adding the value in the images to the distance between the cameras with telesentric lenses (5). The thus obtained value is compared to the required value, thereby detecting the defects. Other dimensional measurements are also determined by recording and processing the images by means of the those cameras (5).

The images recorded by all of the cameras (3, 4, 5, 6 and 7) are processed by the computer system (14) and the defects on the products resulting from the glass, occurring during or after the manufacture as well as the dimensional defects are detected, and then the defective glass products (1) are stored in the system memory to be rejected at the exit of the machine.

At the exit of the machine, the defective glass products (1) are rejected while the non-defective glass products (1) are delivered to the packaging section by way of conveyors (2). The fact that the process in which the defective glass products (1) are rejected or the non-defective products (1) are sent to the packaging section is conducted accurately by the machine is ensured by monitoring the product (1) entering the machine until the exit of the machine.

CLAIMS

1. A quality control system developed as a supplementary system to the quality control systems in which the semi-finished glass product (1) made of soda-lime or borosilicate glass are transferred to the annealing lehrs or tempering units through the automatic line subsequent to being formed in the press machines at the hot end, and then being transferred by the conveyor (2) in a single row for upper surface and side surface inspection, characterized in comprising:

   - A two-section conveyor (2) by which the defective or non-defective glass product (1) having undergone the first control section is carried along the line,
   - At least one capacitive proximity sensor (13) which senses the position of the semi-finished glass product (1) and at the same time triggers the cameras (4, 5, 6 and 7) and the movable light source (9),
   - At least one lifting and rotating wheel (10) which holds, lifts, and rotates the product (1) 360 degrees when the semi-finished glass product (1) assumes the desired position and the rotating angle and rotating speed of which can be adjusted,
   - At least 3 fixed light sources (8) and at least 1 movable light source (9) for lighting the semi-finished glass product (1),
   - At least 6 cameras (4, 5, 6 and 7) for taking the images of the semi-finished glass product (1), and
   - At least one computer system (14) by which the images recorded by the cameras (4, 5, 6 and 7) are stored in the memory and processed, and also the glass product (1) is monitored along the quality control system.

2. The quality control system according to Claim 1, characterized in that the semi-finished glass product (1) is an industrial glass container or a washing machine door glass.

3. The quality control system according to Claim 1, characterized in that the lifting and rotating wheel (10) is made of an engineering plastic material.

4. The quality control system according to Claim 1, characterized in that the lifting and rotating wheels (10) are configured such that their positions may be adjusted to different diameters.

5. A method for operating the quality control system, characterized in that it comprises the process steps of:

- Transferring the defective or non-defective glass product (1) having undergone the first control section to the second control section by means of the two-section conveyor (2),
- Sensing the position of the glass product (1) by means of the at least one capacitive proximity sensor (13) arranged in this section,
- Stopping the conveyor (2) line when the semi-finished glass product (1) assumes the desired position and holding, lifting, and rotating the glass product (1) 360 degrees by means of at least one lifting and rotating wheel (10),
- In the meantime, starting to take images by at least 3 fixed light sources (8) and at least 1 movable light source (9) along with at least 6 cameras (4, 5, 6 and 7) having been activated,
- Viewing the glass product (1) from the lower portion as well by means of the side surface camera (4), which is one of the components of the two-section conveyor (2) line,
- Making the movable light source (9) which is arranged right opposite side surface camera (4) to assume the suitable position for lighting and providing the required illumination while the semi-finished glass product (1) is being rotated,
- Scanning the lateral surfaces of the product (1), determining the diameter of the glass product (1), the wall thickness in the flange and performing other dimensional measurements, and then transferring the defective and defect-free images to the computer system by the cameras (5) with telecentric lenses facing the glass product (1) in a way to view the walls thereof at both sides, perpendicular to the conveyor (2) axis,
- In addition to these, scanning the flange portion throughout the rotation of the product (1) and recording the images by the auxiliary camera (7) which controls the so-called blue cracks, which are very fine cracks indistinguishable to the eye,
- Thus, obtaining the diameter information at the desired height by adding the value in the images to the distance between the cameras (5),

- Comparing the thus obtained value to the required value, thereby detecting the defects,
- Determining other dimensional measurements as well by recording and processing the images by means of the cameras with telesentric lenses (5),
- Thus, performing 360-degree visual inspection of the glass product (1),
- Once the rotating operation is finished and the glass product (1) is being advanced by operating the conveyor (2) line, raising the light source (9) and positioning it such that it will not interfere with the movement of the product (1) in order to ensure that the movable light source (9) and the product (1) does not collide,
- Processing the images by the computer system and determining the outer wall dimensions of the product (1) by way of the difference in the contrast, and then measuring the average of the dimensions,
- Processing the images recorded by all of the cameras (4, 5, 6, 6 and 7) by the computer system and detecting the defects on the products resulting from the glass, occurring during or after the manufacture as well as the dimensional defects, and then storing the defective semi-finished glass products (1) in the system memory to be rejected at the exit of the machine,
- Rejection the defective products (1) at the exit of the machine,
- Delivering the non-defective products (1) to the packaging section by the conveyors (2), and
- Monitoring the product (1) entering the machine until the exit of the machine in order to ensure that the process in which the defective glass products (1) are rejected and the non-defective products (1) are sent to the packaging section is conducted accurately by the machine.

6. The method for operating the quality control system according to Claim 5, characterized in that the distance between both telecentric cameras (5) is also adjusted and the distance information is manually recorded in the system via the screen while the quality control system is being adjusted according to the product (1).

7. The method for operating the quality control system according to Claim 5, characterized in that the cameras (5) provided thereon with telecentric lenses record 30 images each

during a 360-degree rotation of the product (1) while performing diameter measurement.

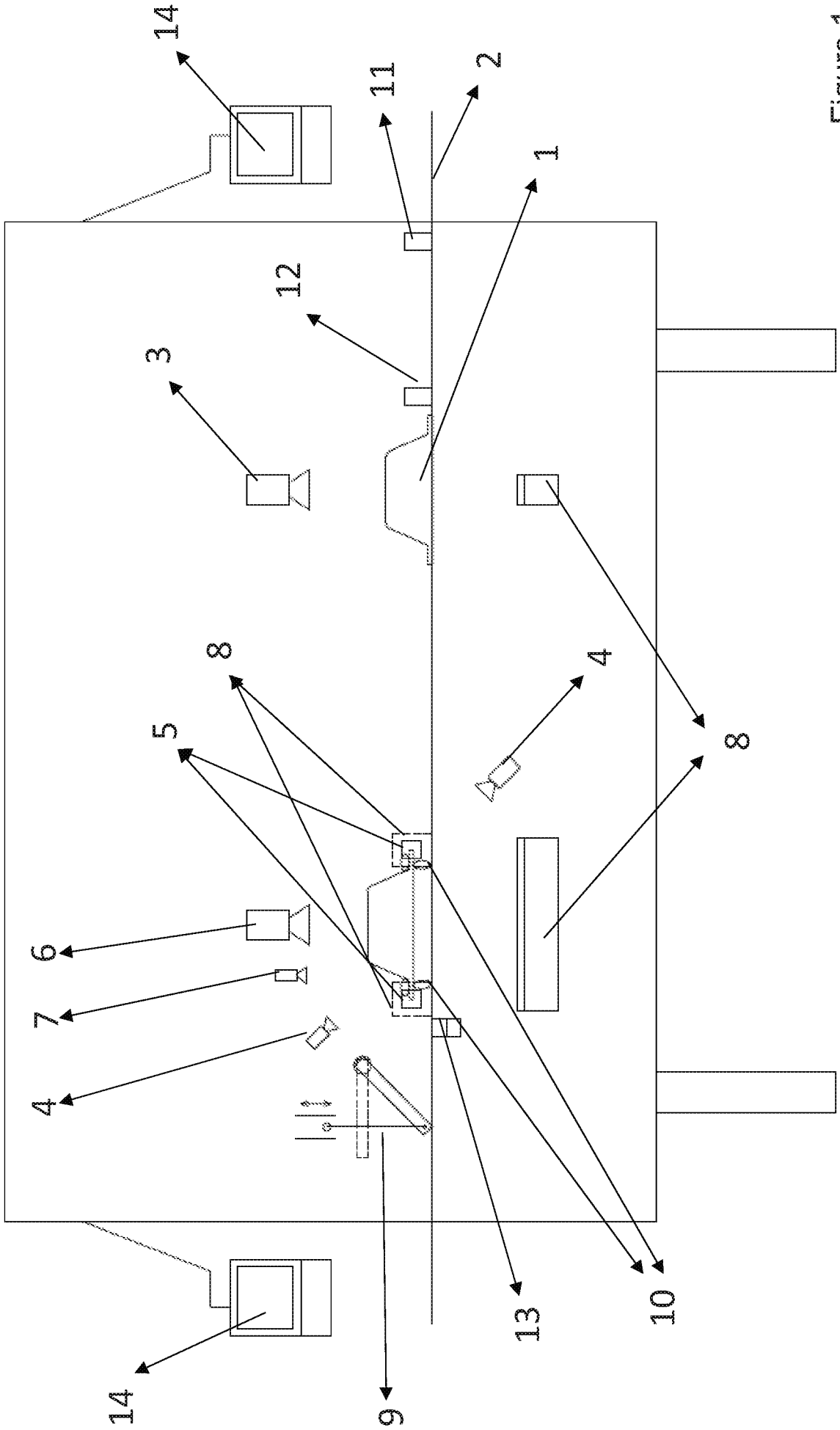

Figure 1