INSPECTION EQUIPMENT FOR SUPPLIED CASES WITH EMPTY BOTTLES

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In the paper some aspects of the input control of a production beverage line are discussed. An analysis of the input control of the production line for beverage industry is performed. Based on the analysis an inspector for supplied cases with empty bottles is proposed. The inspector is realized as an independent unit in the production line. It has not control functions and it is used only for counting the input cases and the available bottles in them. The collected information is used as for statistics as well as for diagnostics of the next devices in the production line. The proposed inspector together with other existing inspectors is organized as a part of an information system for automated production beverage line.

Keywords: microprocessor system, beverage industry, production line

1. INTRODUCTION

The systems for quality control occupy an important place in the automated discreet systems [1, 2]. The quality systems [3, 4, 5, 6] (so-called inspectors) are characterized with high complexity and high speed of data processing.

The inspectors are created as a part of the given machine or as an independent unit in the production line. In the first case, the microcontroller of the inspector takes the control functions of the machine. The machine is completed with actuators and sensors, which are used for inspection functions. In the second case, the inspectors are created as an independent unit in the production line and special equipment is developed for them.

The inspector may be decomposed into several processes (fig. 1).

1. Identification – some defined object's parameters are evaluated.
2. Take the solution – on the basis of the valuation, the object is classified.
3. Control the object – on the basis of the taken solution the appropriated actions over the object are done.

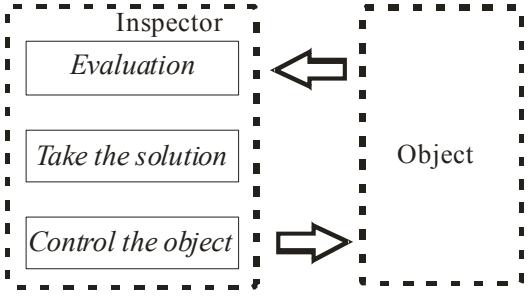

Fig. 1. Structure of the inspector.

Besides, the inspectors in the structure of the information system allow accomplishing early diagnostics and evaluation the work of the previous or the next devices in the production line [4]. In addition, a series of the other important production parameters, such as: common production, reason of idle time and so on, may be evaluated.

In the present paper the inspector for supplied cases with empty bottles is proposed. It has no control functions, and it is used only for counting the input cases and available bottles in them. The collected information is used for statistics and diagnostics of the next device in the production line.

2. PROPOSED SOLUTION

The cinematic scheme of the production line, which includes the inspector for supplied cases with empty bottles, is shown on fig. 2. It consists of a feeding conveyor, and a mother conveyor. Two sensors of light barrier type (marked as S1 and S2) are used to detect the position of the case. The first sensor S1 controls the position, when the case has entered under the scanning device. The second sensor reacts, when the case is in the mother conveyor. If S8 is activated for time larger than the time given, choking has occurred in the technological line. In this case the inspector device stops the motor of the feeding conveyor and activates the alarm signal.

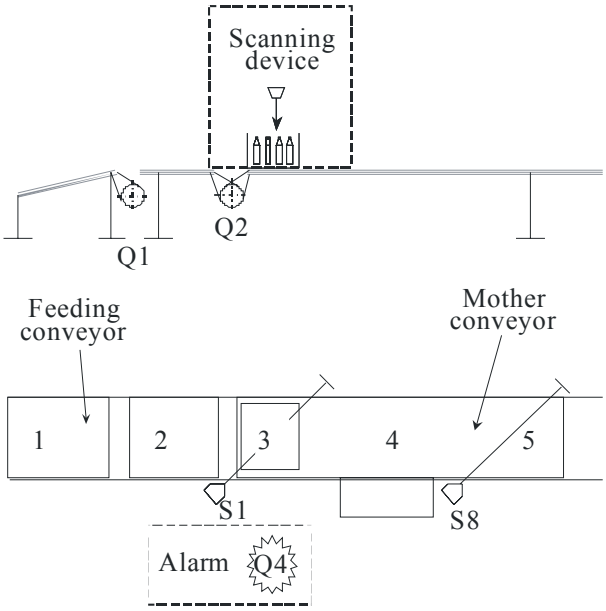

Fig. 2. Cinematic scheme.

The inductive sensors are used to detect the empty bottles in the case (fig. 3). Each of them is supplied with a steel plate, which is pressed to the sensor from a passing bottle. The number of the inductive sensors is 8.

Besides the case analysis, the inspector must execute some other functions, related to the work of the production line. These functions are divided in several

different tasks:

– Task, which analyses the case;
– Task, which processes start and stop buttons;
– Task, which controls the feeding conveyor;
– Task, which services the communication via industrial network.

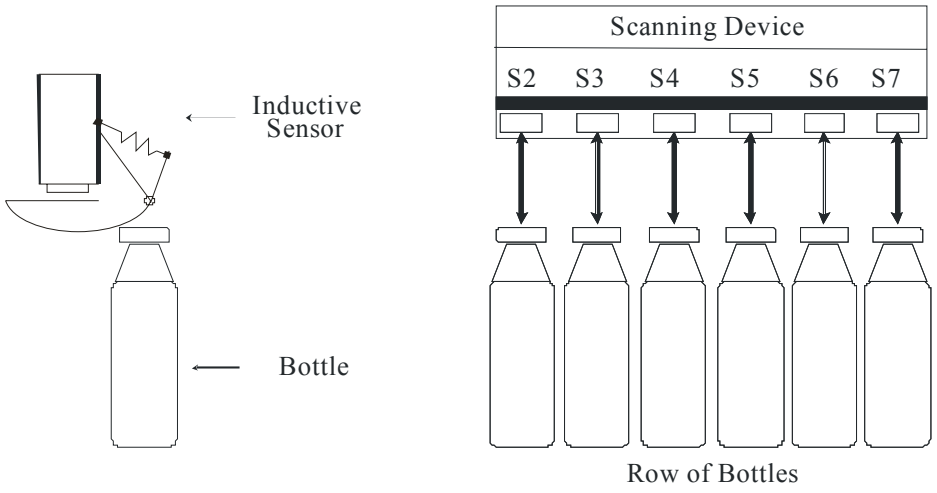

Fig. 3. Scanning device.

All tasks are performed sequentially. The state machine of the task, which analyses the case, is shown on fig. 4.

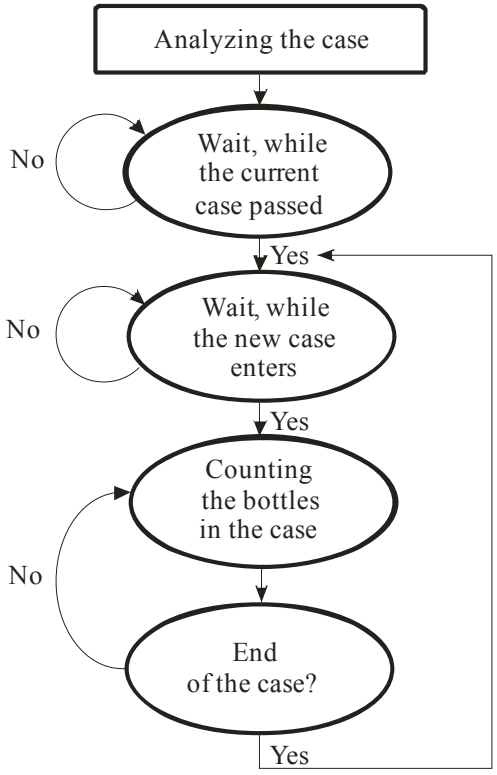

Fig. 4. State machine of the inspection task.

3. ALGORITHM

For control of the inspector for supplied cases with empty bottles, the following algorithm is developed.

1. Waiting, until the case enters under the scanning device. The case enters, when all inductive sensors are activated from the front edge of the case.

2. The following deactivation of the all-inductive sensors indicates that the front edge of the case has passed.

3. After this the bottles in the case are counted. Each active signal from some of the inductive sensors indicates that there is a bottle.

4. Waiting, until the case leaves the scanning field. The light sensor S1 indicates this state.

5. The protected time interval is started. In this time all signals from the inductive sensors are ignored. The protection time is the minimum time interval before the next case arrives.

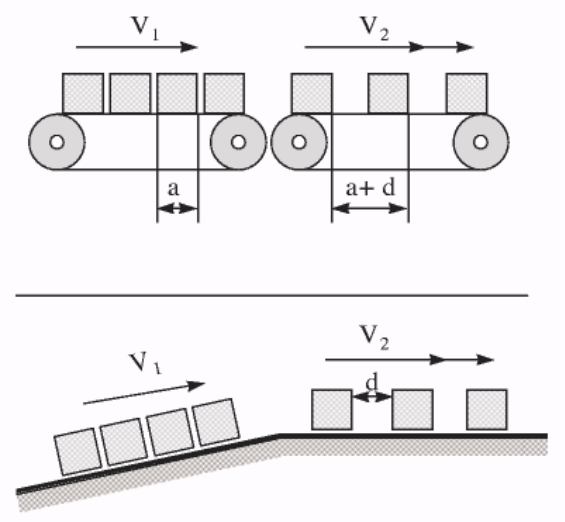

Fig. 5. The feeding and the mother conveyor

The protection time between two cases is calculated theoretically, and after this it is experimentally proved (fig. 5). The speed of the case movement along the feeding and the mother conveyor is different. The increasing of the case's speed through the mother conveyor is used to obtain the distance between the cases. The relation between the speeds is connected with the distance between the cases and the length of the case:

$$\begin{vmatrix} a = V_1.t \\ a + d = V_2.t \end{vmatrix}, \qquad (1)$$

where a is the length of the case, d is the distance between the cases.

The distance between the cases is calculated:

$$d = a\left(\frac{V_2 - V_1}{V_1}\right). \quad (2)$$

The time delay τ is $\tau = d / V_2$, i.e.

$$\tau = a\left(\frac{V_2 - V_1}{V_1 . V_2}\right) \quad (3)$$

4. EXPERIMENTAL RESULTS

The inspection equipment uses programmable microprocessor based controller created for this purpose, shown in fig. 4 and fig. 5.

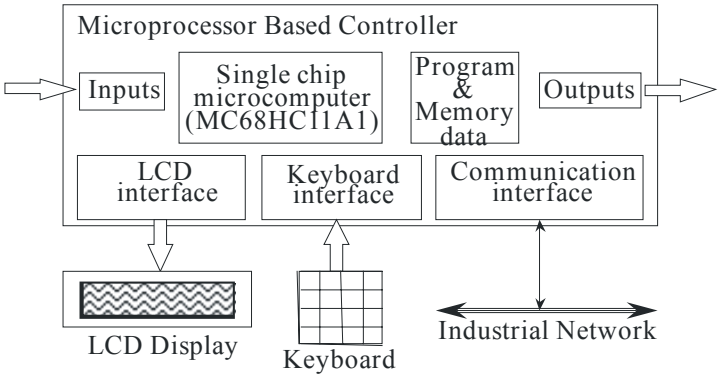

Fig. 4. Block diagram of the controller.

A single-chip microcontroller MC68HC11A1 is used as a CPU. It is supplied with a 32K RAM, for dynamic variable storage, and a 64K Flash memory separated in two pages (2x32KB).

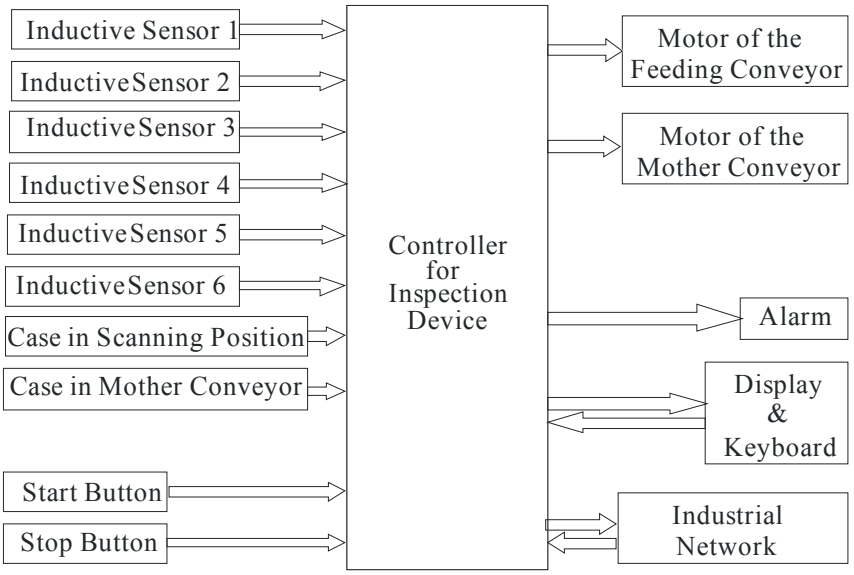

Fig. 5. Architecture of the inspection equipment controller.

In the first page of this memory is written the user's program that controls the inspector in normal work mode. In the second page is written a program, which is used for adjustment and diagnostics of the software. For communication with an operator there is used a liquid crystal display and a keyboard. Galvanic isolated serial interface for industrial area network is added too. It uses the integrated in the microcontroller serial communication port. Also, the controller has 16 inputs and 8 outputs, which are used to control actuators and sensors.

The experimental tests in real conditions showed that the activation of the inductive sensors by the last row and by the back edge of the case cannot be separately noted. It is because of the specific constructive features of the inductive sensors. The problem was solved as sensor S1 was moved. The new position of sensor S1 corresponds with the moment, when the last bottle row passes under the scanning device, but before the back edge of the case passes.

The so-described inspection equipment is realized and implemented in manufacturing.

5. CONCLUSION

The inspector for supplied cases with empty bottles is a part of automated information system and accomplishes the input control of a production beverage line. It is used for counting the input cases and the bottles in them. The proposed inspector allows performing early diagnostics of the next devices in the production line.

The proposed algorithm requires separation of the cases, when they pass under scanning device. For this purpose the time distance between cases is theoretically calculated and experimentally proved.

Series of experimental tests with the inspector for supplied cases with empty bottles are done. They show that the activation of the inductive sensors by the last bottle row and by the back edge of the case cannot be separately noted. This problem was solved as sensor S1 was resituated in an adequate position.

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