June 24, 1969 E. M. MURLEY, JR 3,451,546

INSPECTING SEALED CONTAINERS IN CLOSED CARTONS

Filed Aug. 21, 1967 Sheet 1 of 2

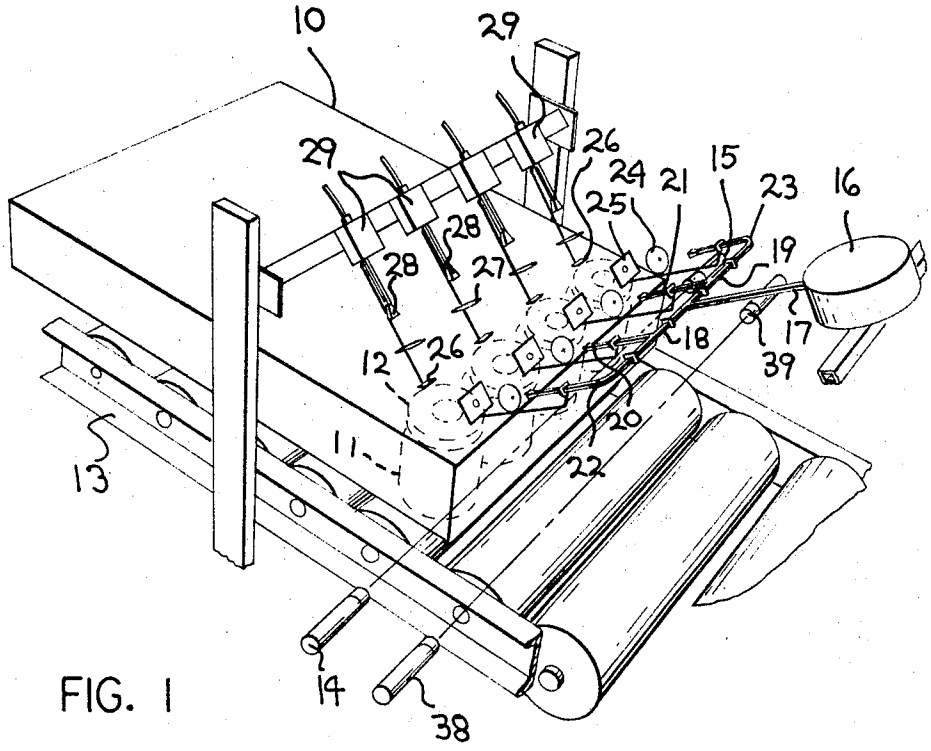


FIG. 1

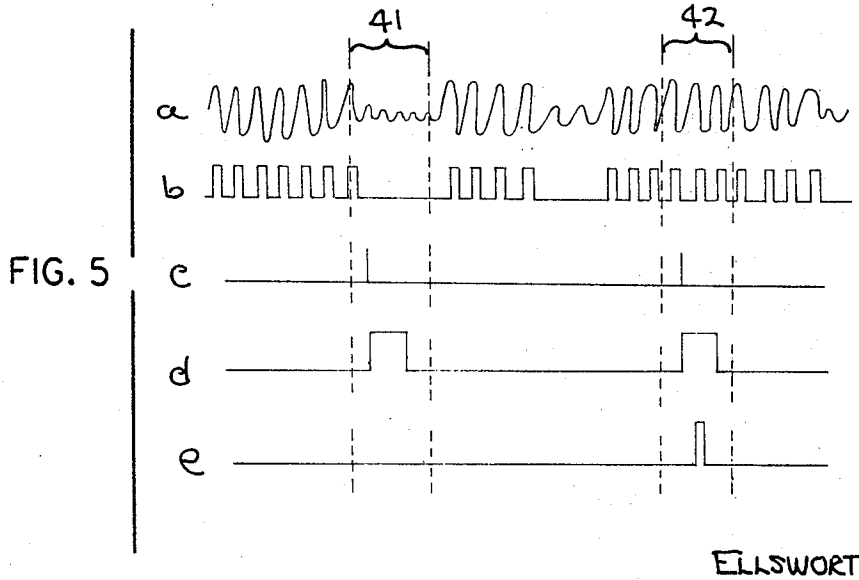


FIG. 5

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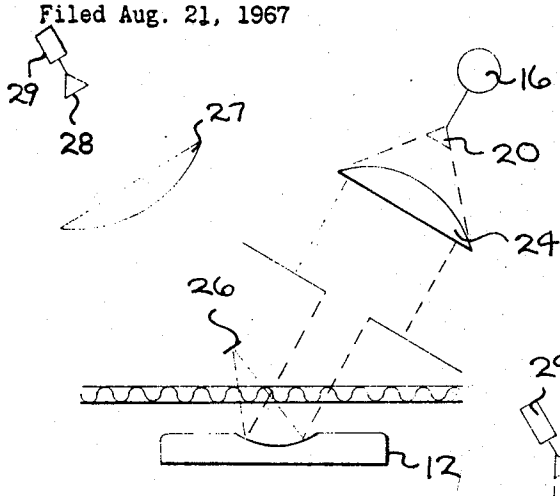


FIG. 2

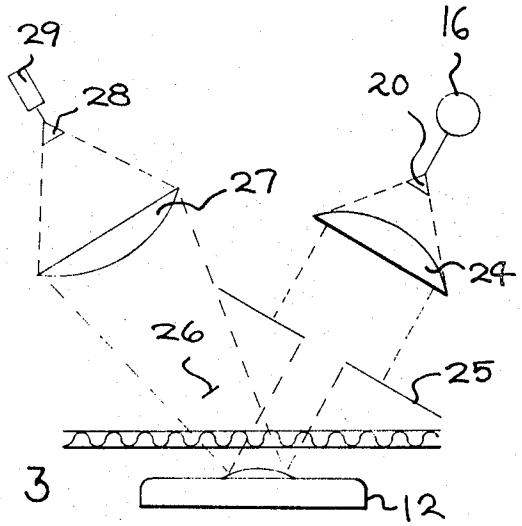


FIG. 3

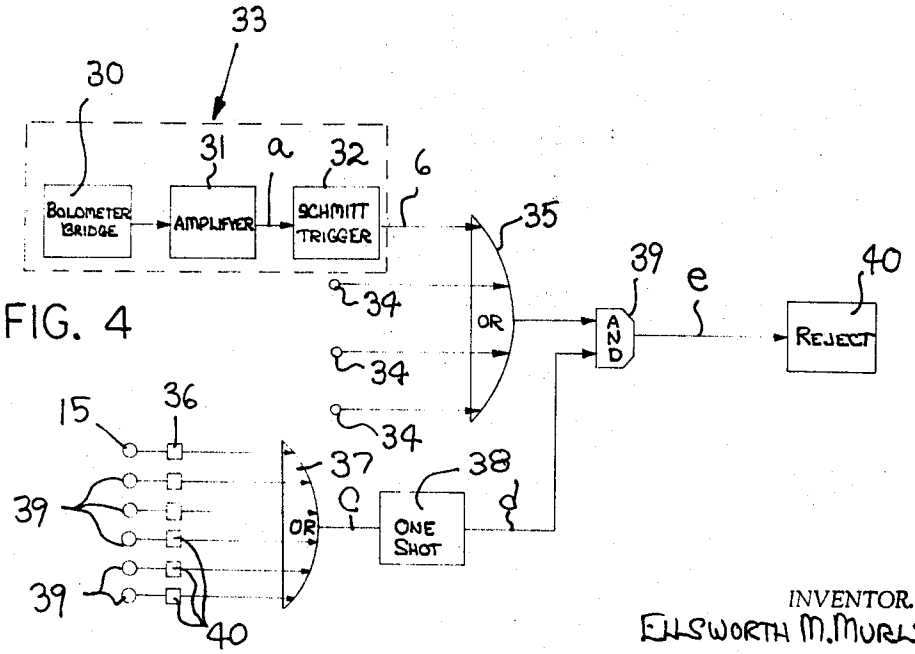


FIG. 4

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INSPECTING SEALED CONTAINERS IN CLOSED CARTONS

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Int. Cl. C07c 5/34, 5/12
U.S. Cl. 209—73 9 Claims

ABSTRACT OF THE DISCLOSURE

The inspection of sealed containers, particularly glass containers, having metal caps which incorporate a flip-panel that assumes a concave configuration when the container is under sufficient vacuum and a convex configuration when the vacuum is unsatisfactory, is carried out after the containers are packed within a carton by using microwave radiation and reflection technique. A klystron operated in the millimeter wave band at low power is coupled to feed horns and by the use of dielectric lenses the millimeter waves, which penetrate the cartons, are directed toward and reflected from the container flip-panels. The reflected waves are picked up by horns coupled to bolometers. The pickup horns are positioned behind masks so that divergent reflected waves will reach the horns while convergent reflections will be intercepted by the mask, thus the output of the bolometer serves as an indication of the vacuum condition of the containers.

Background of the invention

Present-day packers of food products, such as baby foods, where the containers used are glass; normally seal the containers with a metallic closure. Even during the filling of the containers, the product may be relatively warm and after the containers are filled and the closures sealed thereon, the containers are frequently placed in retorts for the purpose of heating the container contents to above the pasteurization temperature, so as to be sure that no bacteria remains in the food product. Even in those situations where pasteurization is not necessary, the containers are usually filled with a hot product and steam is used to expel air as the closure is sealed onto the container. Cooling down of the container will produce a degree of vacuum within the container which results in depressing the flip-panel normally associated with this type of closure. The containers are usually inspected after they are sealed to determine if the proper degree of vacuum is present within the container by examining the flip-panel of the container optically with a system such as that disclosed in United States Patent No. 3,131,815 issued May 5, 1964, and assigned to the assignee of this application. After the containers are filled, sealed and inspected, they are placed in cartons and the carton flaps are glued or otherwise closed and the product is ready to be shipped to the market or wholesalers, as the case may be.

Those food packers who pack and ship large quantities of food stuff such as baby food, have found it advisable in some instances to regularly reopen cartons in their warehouses to check the contents of the containers for what are termed "slow leakers." These are containers in which the vacuum seal was satisfactory at the time the container was filled and sealed; however, due to the circumstances of handling or due to the presence of small defects in the lid of the container, the vacuum was gradually lost during the storage period. Obviously, to reopen and reinspect all of the packed containers, becomes both an expensive and time-consuming operation.

The present invention provides a system for inspecting containers having flip-panel closures for vacuum condition without requiring the opening of the cartons in which they are packed or without requiring removal of the containers from their carton.

Summary of the invention

This invention relates to a method and apparatus for inspecting containers having flip-panel closures while the containers are closed in a paperboard carton. The containers are inspected for vacuum condition by using a beam of microwave energy which impinges on the closure and is reflected therefrom, with the degree of scattering of the reflected beam being utilized to indicate acceptable or non-acceptable vacuum condition present in the containers. The microwaves are produced by a klystron and collimated by a dielectric lens with the collimated output beam is being directed against the metal closure on the container at a selected angle.

Brief description of the drawings

FIG. 1 is a schematic, perspective view of the inspection apparatus of the invention;

FIG. 2 is a diagrammatic, side elevational view of the inspection system of the apparatus when viewing a properly sealed container;

FIG. 3 is a view similar to that of FIG. 2, illustrating the apparatus when viewing an improperly sealed container;

FIG. 4 is a schematic circuit diagram of the electronic system associated with the apparatus of the invention; and

FIG. 5 is a diagram of the wave forms of the electronic apparatus of FIG. 4.

With particular reference to FIGS. 1–3, the mechanical details and functional operation of the apparatus will be described.

A carton **10** which is filled and closed contains a plurality of sealed containers **11** having what are termed "flip-panel" type end closures **12** positioned in rows therein. For illustration purposes in FIG. 1 only the first row is shown in which there are depicted four containers. It should be readily understood that there are, within the carton **10**, a plurality of containers in columns in line with each of the containers in the first row. The carton **10** is moved along a roller type conveyor **13** and when the carton is advanced to the position illustrated in FIG. 1, the forward edge of the carton will intercept a beam of light which extends laterally across the conveyor **13** between a source **14** and a pickup **15**.

Positioned above the conveyor **13** is a klystron **16** of commercial design, it being understood that a klystron is fundamentally an oscillator which operates to produce a fairly high frequency output. The output of the klystron is coupled to a T **17** with the base of the T being connected to the klystron and the two branches of the T being in turn coupled to a second pair of T couplers **18** and **19**. Each of the couplers **18** and **19** has an output horn **20** and **21** respectively connected thereto. Both the T's **15** and **18** are also coupled to elbow couplings **22** and **23** which in turn have horns similar to **20** and **21** coupled to their ends. In each instance the horns are spaced apart the same distance as adjacent containers in a row within the carton **10**, with each horn being directed toward an individual container. With this arrangement and with the klystron operating to produce millimeter waves, the coupled horns will be producing millimeter wave radiation. Each horn has associated therewith and positioned in front thereof, a dielectric lens **24** which serves to collimate the millimeter wave radiation. The collimated millimeter wave coming from the dielectric lens **24** passes through an apertured mask **25** which reduces the size of

the collimated millimeter wave beam to a relatively small cross-sectional area.

Millimeter waves readily penetrate dielectric material such as cardboard and most plastics with relative, little loss, thus the beam will impinge on the flip-panel portion of the container closures **12** at the center portion thereof. If the center portion of the container closure **12** is depressed, or concave in configuration, indicating that a proper vacuum is present within the container, the reflected beam of radiation will be focused by the lid.

A metal mask **26** is placed at the focal point of the concave lid so that the focused, reflected radiation will be blocked by the mask. This is illustrated specifically in FIG. 2. In the event that the container has lost its vacuum, the flip-panel of the closure will assume a convex configuration, as illustrated in FIG. 3. With the convex configuration, the reflected radiation from the container closure **12** will be divergent or scattered to a certain extent and a substantial portion of the radiation will pass by the metal mask **26**. This scattered radiation is collected by a dielectric lens **27** which will generally focus the reflected radiation into a pickup horn **28**. The pickup horns **28**, one associated with each row of containers, is coupled individually to a bolometer **29**.

The bolometer is a microwave detector consisting of a piece of fine wire whose resistance changes in proportion to the amount of radiation impinging on it. The bolometer resistance wire, sensing element is connected to a bolometer bridge **30** (FIG. 4) which is nothing more than three additional resistance wires forming a balanced Wheatstone bridge. The output of the bridge **30** is connected to an amplifier **31** with the output of the amplifier being connected to a Schmitt trigger **32**.

In the particular embodiment of the apparatus disclosed, there are four columns of containers, thus there are four channels of inspection present with a bolometer associated with each. Thus, for each bolometer there will be a measuring signal, output channel **34** similar to the one channel illustrated in FIG. 4 and designated by the dotted line enclosure and arrow **33**. The outputs of the four channels are all connected to the input of an "OR" gate **34**, it being understood that the "OR" gate functions to pass a signal when a signal is received from any of the input channels **33** or **34**.

As previously stated, a light beam extending across the conveyor between light **14** and photo-diode **15** is interrupted when the carton is in inspection position. The photodiode is actually the sensing element of a light-sensitive Schmitt trigger which is illustrated in block form at **36** in FIG. 4. The trigger **36** produces a pulse of limited duration when the light is blocked from the photo-diode, with the output signal being fed to the input of an "OR" gate **37**.

Since there are six rows of containers in the carton, applicant provides six triggering pulses by providing additional light sources **38** and pickups **39**, shown connected to triggers **40**. Each of the triggers **40** are connected to the "OR" gate **37**. The "OR" gate **37** has its output connected to a "one-shot" or monostable multivibrator **38** whose output is in the form of a signal having a specific pulse width.

Both the outputs from the "one-shot" **38** and the "OR" gate **35** are connected to an "AND" gate **39** with the output of the "AND" gate connected to a reject mechanism **40** which may take the form of a motor operated pusher bar for moving a carton having a defectively sealed container therein from the line of the conveyor or may be a signal to indicate to an operator that the carton should be selected out.

With particular reference to FIGS. 4 and 5, the functional explanation of the gauging circuitry will be given. For simplification, a single channel will be described in detail, it being understood that the other channels will be functioning in an identical mode.

For an aid in understanding the invention, the waveforms of FIG. 5, designated *a–e* are applied to the circuit diagram of FIG. 4 at the leads which carry the signals of the respective waveforms.

Waveform *a* of FIG. 5 shows the amplified output of one of the bolometer bridges. The portions of the waveforms designated **41** and **42** represent the periods of inspection when viewing an acceptable container (waveform zone **41**) and defectively sealed container (waveform zone **42**).

As can be seen when viewing waveform *a*, zone **41**, the bolometer output is minimal when the container has a vacuum closure which has retained its seal. The low output signal is due to the fact that the mask **26** will interrupt most of the reflected microwaves. The bolometer output, however, will be fairly high when the closure is convex (FIG. 3), and the signal will appear as at **42** in FIG. 5, waveform *a*.

The waveform *b* indicates the signal output of the Schmitt trigger which takes the form of a square wave of predetermined amplitude. When the incoming signal to the Schmitt trigger is below a certain level, the trigger does not fire and, therefore, has no output signal.

Waveform *c* is the gating signal or "read" pulse signal due to the interruption of the cross conveyor beams by the position of the carton. These signals *c* are applied to a "one-shot" whose output is of a square waveform of predetermined duration corresponding to the period when the carton and the containers are in inspection position.

When signals are received at both inputs to the "AND" gate, then a reject signal (waveform *e*) is passed by the "AND" gate to a reject system.

As can be seen when viewing FIG. 5, when an acceptable container is inspected (zone **41**), no signal is passed by the "AND" gate. When a defectively sealed container is viewed, the square wave *b* is passed by the "AND" gate and the reject system is energized.

As a specific example of a mode of operation of the device, the Klystron was operated to produce radiation of 1.75 mm. wave length. Furthermore, it should be kept in mind that in order to avoid spurious readings, it is necessary that the diameter of the aperture in the mask **25** must be at least three times the wave length of the radiation passing therethrough. If the mask aperture were too small in relation to the wave length of the radiation, then birefringence would be produced resulting in a non-collimated radiation beam output.

Other and further modifications may be resorted to without departing from the spirit and scope of the appended claims.

I claim:

1. The method of determining when the vacuum in a container enclosed in a paperboard carton falls below a predetermined level which method comprises, moving the cartons with the containers therein continuously in succession past an inspection station, directing a beam of electromagnetic radiation to which the paperboard carton is transparent, directly into the flip-panel of a container as it reaches the inspection station, causing said beam to be reflected by said flip-panel portion upwardly into a predetermined area, causing a portion of said reflected beam to bypass said area when the vacuum in the container is unsatisfactory, creating a signal in response to the bypassing of said reflected beam, directing a second beam of radiant energy in the path of said cartons causing each carton to interrupt said second beam as it reaches the inspection station, creating a pulse of predetermined time interval in response to the interruption of said second beam and rejecting the carton when the signal created by the bypassed portion of said first beam occurs simultaneously with the time interval of the pulse created by interruption of the second beam.

2. The method of determining when the vacuum in a container enclosed in a paperboard carton falls below a predetermined level where the container includes a flip-

panel that assumes a concave configuration when the vacuum is satisfactory and a convex configuration when the vacuum is unsatisfactory, which method comprises moving the cartons with the containers therein continuously in succession past an inspection station, directing a first beam of electromagnetic radiation to which the paperboard carton is transparent, directly into the flip-panel of a container as it reaches the inspection station, causing said beam to be reflected by said flip-panel portion upwardly into a predetermined area, causing a portion of said reflected beam to bypass said area when the vacuum in the container is unsatisfactory, creating a first signal in response to the bypassing of said first beam, directing a second beam of radiant energy in the path of said cartons causing each carton to interrupt said second beam as it reaches the inspection station, creating a pulse of predetermined time interval in response to the interruption of said second beam and rejecting the carton when the first signal created by the bypassed portion of said first beam occurs simultaneously with the time interval of the pulse created by interruption of the second beam.

3. The method of claim 2, further comprising the steps of directing additional beams of electromagnetic radiation to which the paperboard carton is transparent, in parallel with said first beam directly into the flip-panel of the row of containers in the carton, and individually creating signals when any of said first beams are reflected divergently from their respective flip-panels.

4. The method of claim 3, further comprising repeating the steps set forth for each row of containers enclosed within the carton.

5. Apparatus for determining whether the vacuum in a sealed container enclosed in a paperboard carton is satisfactory, where the container has a flip-panel that assumes a generally concave configuration when the vacuum in the container is satisfactory and a convex configuration when the vacuum in the container is unsatisfactory, the combination comprising means for directing a collimated beam of millimeter wave radiation downwardly through the carton onto the flip-panel of the container at such an angle that the beam is reflected from the flip-panel in

accordance with the curvature thereof, a mask positioned at the focal point of the reflected beam from the flip-panel having a concave configuration, a bolometer, a millimeter wave pickup horn coupled to said bolometer and having its open end in alignment with the reflected beam and said mask, a dielectric collecting lens between the horn and the mask and adapted to collect millimeter wave radiation passing beyond the periphery of the mask and direct it into the horn and means energized by said bolometer for indicating when the reflected radiation beam exceeds the size of the mask a predetermined amount indicating that the container has insufficient vacuum.

6. The apparatus of claim 5, wherein said means for directing the collimated beam of radiation comprises a millimeter wave klystron, an output horn coupled to said klystron and a dielectric lens mounted in front of the output horn for collimating the millimeter wave radiation from the horn.

7. The apparatus of claim 6, wherein said klystron and output horn are operated to produce radiation of about 1.75 mm. wave length.

8. The apparatus of claim 6, further including an apertured mask positioned between said dielectric lens and the container closure for limiting the size of the incident radiation beam to a size less than the diameter of the flip-panel portion of the closure.

9. The apparatus of claim 8, wherein said klystron and output horn are operated to produce millimeter wave radiation of a wave length at least three times smaller than the aperture in said mask.

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ALLEN N. KNOWLES, *Primary Examiner.*

U.S. Cl. X.R.

209—80, 82, 111.5; 324—58.5