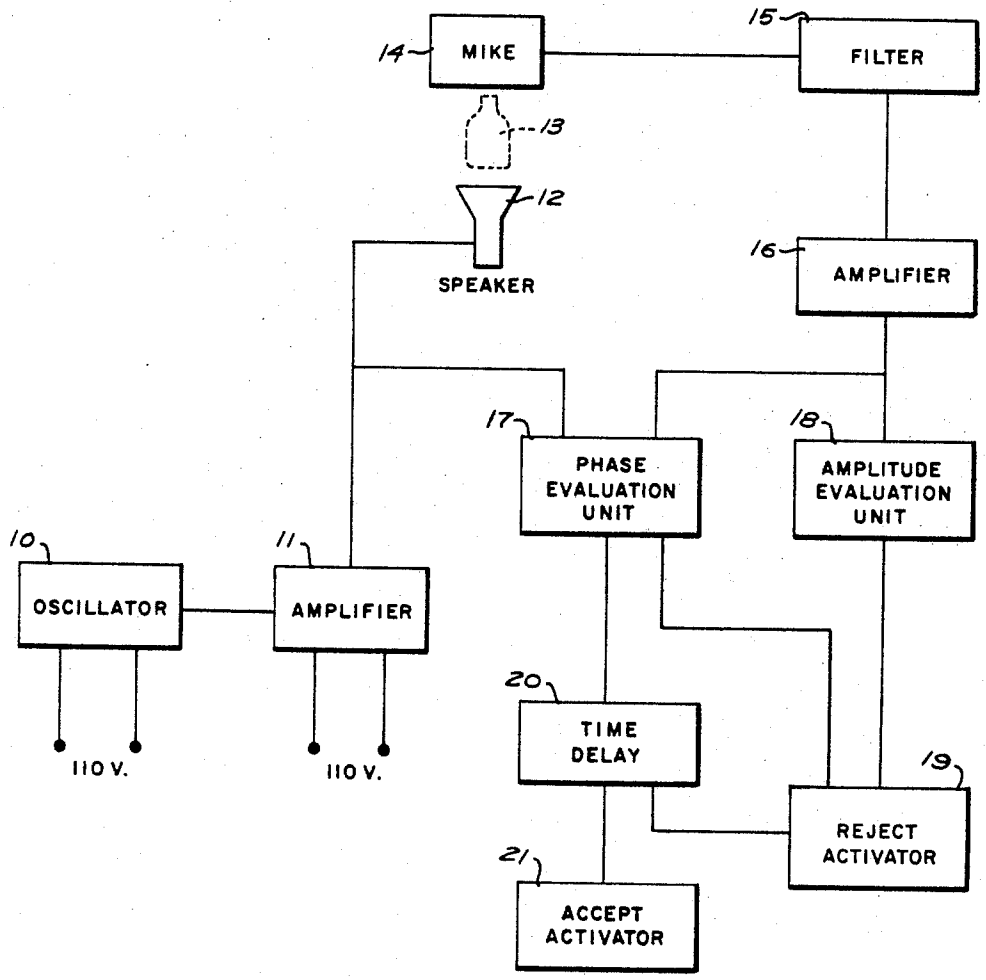
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INSPECTION APPARATUS AND METHOD

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INVENTOR.
RALPH W. GOBLE

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INSPECTION APPARATUS AND METHOD

Ralph W. Goble, Boulder, Colo., assignor, by mesne assignments, to Imco Container Company, Kansas City, Mo., a corporation of Delaware

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ABSTRACT OF THE DISCLOSURE

A method for maintaining quality standards in relatively thin walled plastic containers having flexible side and bottom walls, including establishing a known vibration response from a container of known quality, then inducing the same vibration in a container of unknown quality, sensing the response from the second container, comparing the responses from the two containers and determining whether the second container is of a quality like the first container.

The present invention is directed to a method and apparatus for maintaining quality standards in manufactured articles. This invention is adapted for rapid conversion from the inspection and quality control of one article to the inspection and quality control of a different article and does not require technically-trained people for its operation. The invention can be readily placed in a production line without undue sensitivity surrounding conditions.

This invention is particularly adapted for inspection of containers, such as blow molded containers fabricated from flexible plastic materials, including polyethylene, polypropylene, polyvinyl chloride and the like.

Plastic containers have defects, due to the many variables in this manufacturing process which result in rejection of the container. A sporadic defect of prime importance is the presence of a hole in the container, commonly known as a "pin hole." The presence of a pin hole in the container is a defect which is not predictable from a manufacturing standpoint and has a random and sporadic distribution throughout the production run. The present invention is a reliable and positive procedure for rejecting any containers having pin holes therein. Another defect which is quite important in plastic containers is a thin wall portion in part of the container. Many manufacturing variables can contribute to the production of a thin wall container portion and thus its presence lacks predictability and has a random distribution throughout the production run. The present procedure is very effective in rejecting containers having thin wall portions.

Many plastic containers have a threaded neck portion on the upper end for dispensing the commodity from the container. It is common trade practice to have a post-molding operation, known as a "core and trim" operation, which reams the inside of the neck and cuts off the top of the neck to a standard length. It is quite important that the overall length of the container be consistent since it is filled on an automatic filling line and differences in height can result in malfunction of the filling lines. The present invention is very effective in detecting differences in height of the container, and particularly variations in the length and configuration of the neck, and thereby rejecting containers which do not fulfill the tolerance limitations.

The procedure of the present invention is very important in improving production facilities. The data collected from an inspection system, such as the present invention, produces information which can be fed back to the production facility and improving the overall quality of the

containers. The ultimate effect of the present invention is to improve the production facilities from the standpoint of reducing the number of rejects produced by the production facility and ultimately reducing the production costs of the container while improving the quality of the container.

The drawing illustrates the present preferred embodiment of the invention and illustrates the connection of the various instrumentalities necessary for proper operation of the present invention.

Briefly, the present invention is based upon the principle of inducing a vibration in a flexible plastic container of known quality, which results in a vibrational response from the container. The response is a composite wave structure resulting from the overtones and harmonics generated within the container. From the response, it is possible to establish parameters for the particular container and these parameters are used to evaluate other similar containers, thereby maintaining a quality standard. The vibration which is induced in the container is normally a resonant frequency for the container since it is the most easily tabulated frequency from the standpoint of establishing parameters for the quality standards. The vibration can be induced in the container by any known means, such as an ultrasonic generator or a conventional sound generator, or any instrumentality generating frequencies from ultrasonics through the conventional sonic range down to the infra-sonic range. The vibration inducing instrumentality may be coupled to the container through a gaseous or liquid phase, directly coupled to the container, or magnetic and capacity coupling may be used. After establishing the parameters for the response from the container of acceptable quality, and recording such parameters, a similar container to be inspected is placed in the position and vibration induced in the similar container. The response from the similar container when compared with the response from the first container, determines whether the second container is of acceptable quality. If the similar container has a pin hole therein, its response will not be the same as the response from the first container and thus it will be rejected. The response from the container is a composite wave resulting from the overtones and harmonics generated in the container and which manifest themselves in amplitude and phase configurations. Specifically, the present invention determines the phase and the amplitude of the container response frequency. If there has been either a phase shift (leading or lagging the parameters) or a change in the amplitude (which can be positive or negative relating to the parameters) this indicates that the similar container being tested is not of the same quality as the first container of known quality. For example: under certain circumstances, if the amplitude of the response of the similar container has changed, this indicates thinness of the wall area of the container, or, if the phase of the frequency has shifted this indicates a pin hole in the similar container. By proper evaluation it can be determined which defects in the similar container result in specific responses and thus parameters can be accurately set depending upon the quality standards which are to be maintained. By adjustment of various filters and driving frequencies, various container defects can be accentuated in the response signal.

Referring specifically to the drawing, an oscillator **10** of conventional construction (such as a Hawlett-Packard Model No. 241–A) is used to generate a signal of desired frequency and this signal is preferably amplified by conventional amplifier **11** (such as a Bogen-Presto Model AP–60) and the signal is radiated through a speaker or transducer **12**. The articles to be inspected as shown in the drawing in dashed lines in the configuration of a

hollow, flexible-walled, plastic container **13**, is positioned adjacent the speaker, preferably with the bottom wall of the container positioned toward the speaker and the neck of the container positioned away from the speaker, whereby the flexible container has a vibration induced in the walls of the container due to impingement thereon of the signal from the speaker **12**. The response to the vibration is generated by the container in the form of a signal due to the walls thereof moving and causing pulsations in the air within the container, and is picked up by a microphone **14** which passes the response signal through a selective filter **15**, of known construction and used to filter out any undesirable signals, and to a conventional amplifier **16** which preferably amplifies the response signal. The microphone may be mounted concentrically in front of the speaker or transducer, and the container to be inspected is placed adjacent thereto with the open neck end of the container facing the microphone. The response signal is then passed to a phase evaluation unit **17** and an amplitude evaluation unit **18**. These units are of conventional construction and the phase evaluation unit includes a Sealey discriminator capable of registering a phase change as a DC voltage, a balancing means so that the phase angle between the driven and received signals can be adjusted to zero DC output, and a conventional meter relay with zero center scale and adjustable independent upper and lower limit units; and the amplitude evaluation unit is set to read only the output of the microphone and then fed to a zero center relay meter of the above type with an adjustable bucking voltage adjustable to a predetermined output from the test sample to zero, so that either a higher or lower voltage indication from the present parameters can be determined by upper and lower limit units as previously described. The original signal from amplifier **11** is also passed to the phase evaluation unit **17** and can be passed to the amplitude evaluation unit **18** if desired. The amplitude evaluation unit also can be preset to the amplitude of the original signal generated by the oscillator **10**. Unit **18** compares the response signal from the amplifier **16** with the preset or fed in signal. Depending upon the parameter set up, the amplitude evaluation unit **18** can activate a reject activator **19** which rejects the container as being substandard or not within the quality standards maintained by the units. A time delay unit **20** is activated when the initial signal is broadcast by the speaker **12** and in the event that the reject activator is not activated within a set time period, the accept activator **21** is automatically activated to accept the container. The phase and amplitude evaluation units **17** and **18** have been preset with parameters established by examination of the container of known quality and if the response signal of the container being examined does not conform within preset limits of the parameters, the container is rejected. The evaluation unit can be set to compensate for changes and variation in the input signal to the container being examined and thus the input signal is fed to the units **17** and **18** to activate compensation devices if necessary. If the input signal for the container being examined is substantially identical to the signal used to establish the parameters from the container of known quality, it is not necessary to feed the input signal to the units **17** and **18** when examining containers. The compensation devices in units **17** and **18** are set based upon historical data obtained in examination of prior containers.

The apparatus may be scheduled such that in the event an accept activator is not activated within a set time period, the reject activator automatically rejects the container. This is merely a reversal of the arrangement described above.

All of the units illustrated are of conventional design and construction.

The oscillator **10** can generate any desired signal and by maximizing the amplitude or voltage indications at the microphone, the resonant frequency of the particular article being tested can be determined. It is not imperative that the resonant frequency be used in testing the containers, however, it has been found that the resonant frequency is the best operable frequency. Ideally, the parameters are established at the same frequency which is used in the subsequent testing of the containers.

The present invention was specifically designed to evaluate and test blow-molded plastic containers made on a conventional apparatus and in conventional ways. One of the practical problems in the manufacture of plastic articles is that the article is ejected from the mold to a conveyor system for subsequent treatment. Frequently, the article is ejected from the mold before it has completely set and cooled and therefore upon hitting the conveyor system the article is distorted from its desired configuration. The present invention can detect such defect in the manufactured article and specifically can detect the presence of a neck formation which has been bent. This is an important consideration in the quality standards of a blow molded container since a bent neck can severely interfere with an automatic filling line conventionally used in the industry in filling plastic containers.

While the drawing illustrates the container with the bottom wall adjacent the speaker **12**, it must be appreciated that the vibration can be induced in the container by impinging the signal on any portion of the container. The drawing illustrates a known embodiment in which the signal is impinged on the bottom wall and the response signal is picked up by the microphone **14** which is positioned adjacent the neck of the plastic container.

While the present application described the preferred embodiment of the invention, it may be otherwise embodied within the scope of the following claims:

I claim:

1. In a method for maintaining quality standards in relatively thin-walled plastic containers having flexible side and bottom walls, comprising:

(a) directing a signal toward the walls of a container of known quality thereby inducing vibration in a wall of said container;

(b) sensing the response of said container to said induced vibration;

(c) then, subjecting the wall of a second one of said containers of unknown quality to the same induced vibration;

(d) sensing the response of said second one of said containers to said induced vibration;

(e) comparing said responses from the containers; and,

(f) determining from said comparison whether said said second one of said containers is of a quality like said first one of said containers.

2. In a method according to claim **1**, wherein:

(a) the phase and amplitude of said responses are compared; and,

(b) rejecting said second one of said containers if the comparison indicates a change in phase or amplitude.

3. In a method according to claim **1**, wherein:

(a) the induced vibration is at the resonant frequency of said first one of the containers.

4. In a method according to claim **1** wherein said articles are relatively thin-walled plastic containers having side and bottom walls, including:

(a) inducing said vibration in the bottom wall of the container; and,

(b) sensing the response to said vibration at the opposite end of the containers.

5. In an apparatus for maintaining quality standards relatively thin-walled plastic containers having said and bottom walls, including:

(a) an oscillator for generating a signal of desired frequency;

(b) means operatively associated with said oscillator to broadcast said signal when one of said containers in a position so that a wall of the container can be vibrated by said broadcasted signal;

(c) receiver means adjacent said one container to receive the response of said one container to the vibration;

(d) evaluation means to receive and compare said response with a known parameter; and,

(e) means responsive to said evaluation means to accept or reject said one container.

6. In an apparatus according to claim 5 wherein:

(a) said evaluation means includes means to determine a phase shift from the known paramter, and means to determine an amplitude change from the known parameter.

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ALLEN N. KNOWLES, *Primary Examiner.*

RICHARD A. SCHACHER, *Assistant Examiner.*

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