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3,282,020

QUANTITY CONTROL OF LIQUIDS FOR PACKAGING

Filed Aug. 12, 1963

2 Sheets-Sheet 1

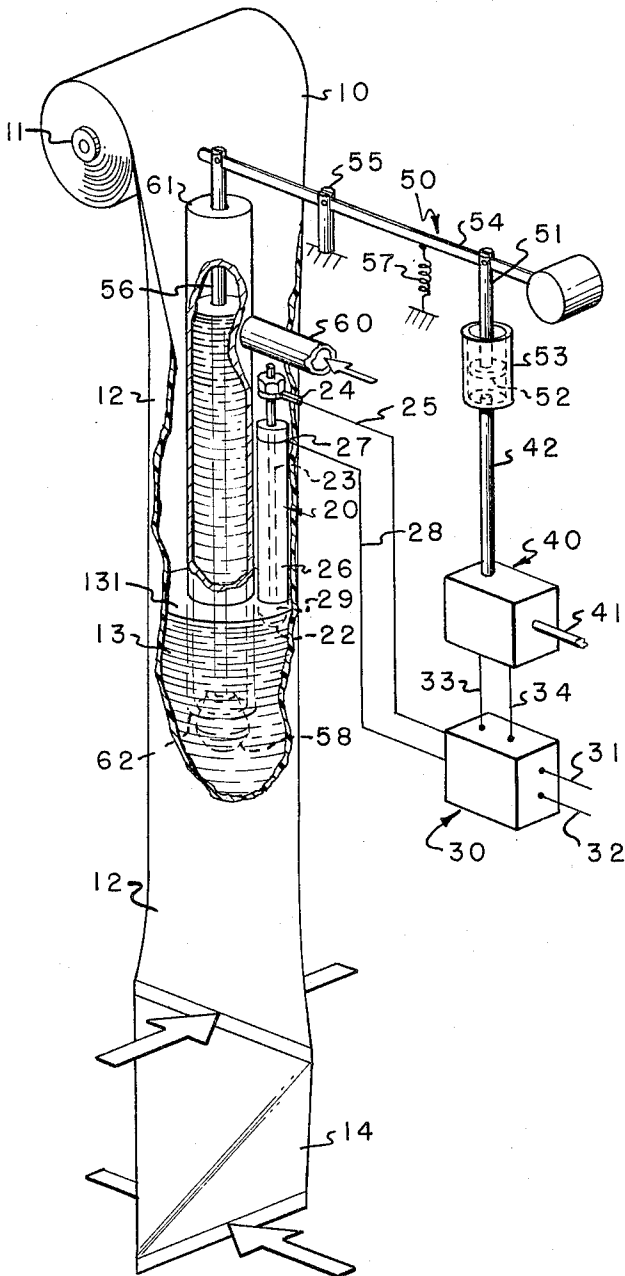


FIG. -1-

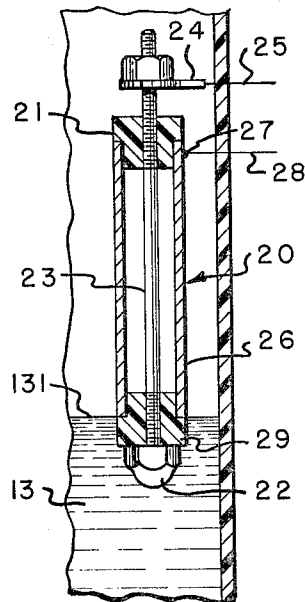


FIG.-2-

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2 Sheets-Sheet 2

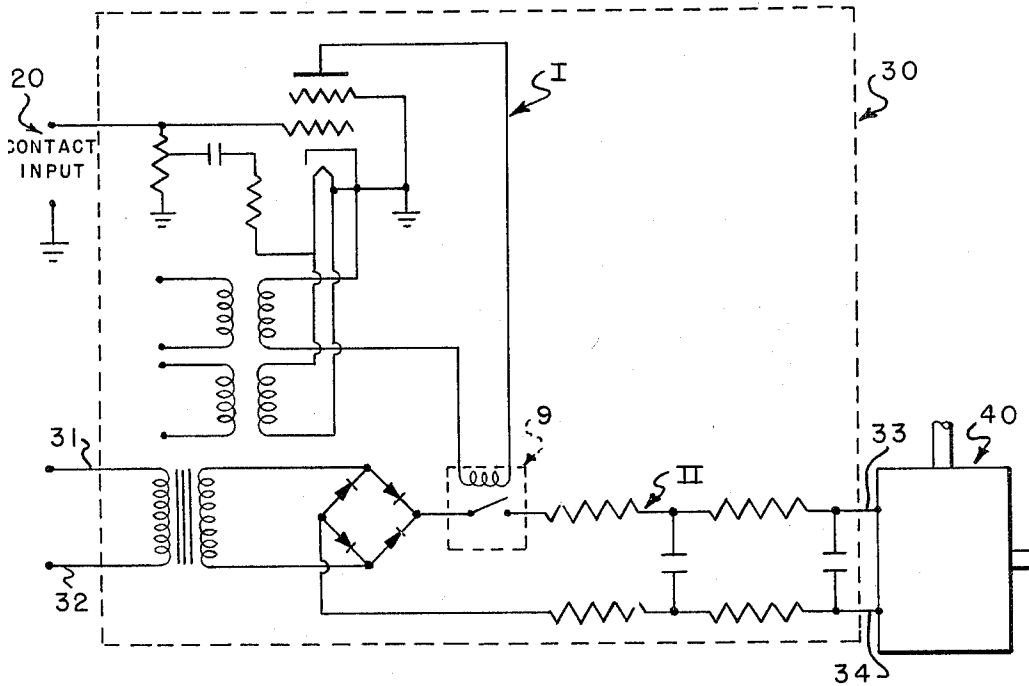


FIG. -3-

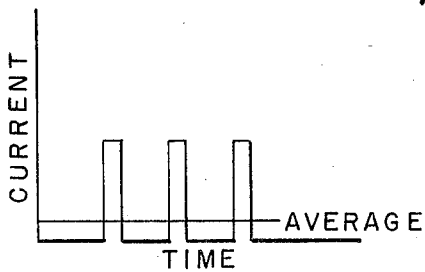


FIG. -4-

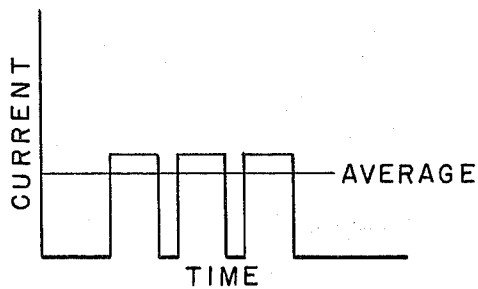


FIG. -5-

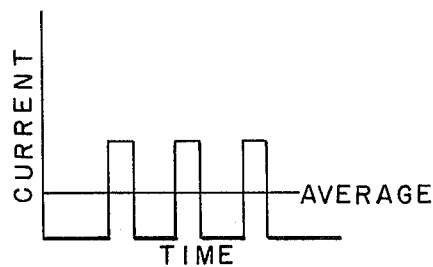


FIG. -6-

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QUANTITY CONTROL OF LIQUIDS FOR
PACKAGING

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4 Claims. (Cl. 53—180)

This invention relates to the art of controlling liquid levels. In particular, it relates to the art of producing tetrahedron shaped packages, and to the filling of these packages with liquid. More particularly, it relates to apparatus for controlling the level of the filling liquids introduced into such packages.

A unique problem, especially in liquid packaging, is that related to the control of rapidly changing liquid levels, especially those wherein liquid surfaces oscillate rapidly within relatively small limits. Such problem exists, for example, in the rapid filling of relatively small containers with liquids. Method and apparatus are thus known for continuously forming liquid filled tetrahedron packages and described, for example, in U.S. 3,090,175 and U.S. 3,086,336. Pursuant to the filling of such containers a flat web paper packaging material is continuously fed downwardly rolled into tubular shape and longitudinally sealed. The tubular form or blank is then transversely bottom sealed, and filled with a liquid to be packaged therein. The liquid filled tubular container thus formed is then closed at the top and transversely sealed at a right angle to the bottom seal to provide a tetrahedron package.

Pursuant to present manufacturing techniques the tubular shape, with the filling liquid therein, is progressively and transversely end sealed in two parallel planes, but each seal being applied at right angles to the other. The liquid filled tetrahedron packages thus formed are then in turn severed from the tubular body. The proper use of such apparatus thus contemplates a continuously moving tubular body transversely sealed at its lower end, which tubular body is supplied with a stream of the filling liquid under conditions favoring the continuous and rapid formation of such liquid filled tetrahedron packages each containing the proper amount of the filling liquid.

In such apparatus, however, the proper amount of liquid for enclosing within the tetrahedron shaped containers is difficult to provide. This is because the sealing of the package is performed below the liquid level. Thus, as the seals are applied the tubular walls of the container are squeezed together and the liquid level rises drastically. On the other hand, as the walls of the container are released from the grasp of the seals the liquid level rapidly falls. When packaging at a rate of one or more packages per second it is apparent that the net overall effect is that the surface of the liquid oscillates at an extremely rapid rate. This makes proper filling of the packages rather difficult.

While present liquid level controllers for such usage have proven generally acceptable they have left much to be desired. Thus, e.g., in present pneumatic control devices wherein an air amplifier supplies a variable air pressure to an air cylinder which in turn actuates a shut off valve for controlling the supply of liquid to the tubular blank, variations, especially temperature induced variations, have produced erratically varying liquid levels. Such variations obviously interfere with proper packaging of the liquid producing, among other things, frothing and overfilling of the tubular blank.

In apparatus wherein the filling liquid is heated to produce aseptic conditions and wherein a high temperature aseptic gas covers the liquid the problem of main-

taining proper liquid level is intensely aggravated, is particularly acute and present control apparatus for this use is generally unsatisfactory.

Accordingly, it is an object of the present invention to provide a new and improved apparatus for the solution of these problems. In particular, it is an object to provide apparatus for accurately controlling a liquid level within small limits, even under adverse conditions wherein the surface level of the liquid is subjected to very rapid changes or wherein there are considerable temperature changes. Further, it is an object to provide a more reliable apparatus capable of functioning in such manner for long periods of trouble-free operation with minimum maintenance.

These and other objects are accomplished by use of the present apparatus combination which utilizes an oscillating liquid level to advantage to provide an almost constant average flow of the desired amount of a filling liquid from a source of supply. In accordance with this unique combination an oscillating liquid level is converted into an output electrical signal of direct proportion to the amplitude of oscillation of the liquid, which signal is in turn converted into an output pneumatic pressure of direct proportion to the electric signal received, and which pneumatic pressure in turn actuates a pneumatic control valve operatively associated with a source of supply liquid so that the net effect is that liquid is supplied in quantity directly proportionate to the average level of the oscillating liquid surface. In fact, an outstanding characteristic of the present invention is that a high frequency oscillating liquid level is utilized to advantage to provide very rapid response of the controlled medium to the controlling mechanism and a more smooth liquid packaging operation.

This will be better understood by reference to the following detailed description and to the figures wherein:

FIGURE 1 is a schematic elevation view, partially in section, of an embodiment according to the present invention,

FIGURE 2 illustrates, in detail, a probe providing a pair of electrical contacts for indicating or sensing liquid level,

FIGURE 3 is a schematic wiring diagram of a liquid level-to-electric current transducer in accordance with the invention, and

FIGURES 4, 5, and 6 represent wave forms produced by said liquid level indicator or probe.

The invention is best described by reference to FIGURE 1 demonstrating in part a conventional operation wherein a flexible flat web paper packaging material 10 is unwound from a supply package 11 and is fed continuously downwardly, and subsequently, through bending and folding means (not shown) the web 10 is rolled and the edges thereof joined laterally together, sealed and thereby transformed into tube 12. The tube 12, while filled with liquid for enclosing therein can then be formed into a tetrahedron package. Thus, in forming a tetrahedron package the walls of the tube 12, while filled with liquid 13 to be enclosed therein, are brought together and transversely sealed by pairs of seals (not shown) applied upon the tube 12 substantially at right angles to each other. Such pair of seals operate such as represented by the arrows of the figure to form a liquid containing tetrahedron package 14. Each tetrahedron package 14 so formed is separated from the tube 12 by severing across the upper transverse seal.

The present invention, specifically, is directed to the unique combination which provides a substantially constant average flow of the desired liquid to the tube 12, for enclosure as within a package 14. In accordance therewith probe 20, shown in detail in FIGURE 2, is

located within a body of liquid 13 the quantity of which is to be controlled by control of the surface level 131.

The probe 20 includes an electrode 23 and electrode 26, for contact with the liquid 13. Electrode 23 makes contact with the liquid through contact tip 22 and is in electrical communication with the liquid level-to-current transducer 30 via electrical lead 25 which connects to electrode 23 at the terminal or junction 24. Electrode 26, which surrounds electrode 23, makes contact with the liquid 13 through its outer wall and is in electrical communication with the liquid level-to-current transducer 30 via connection through the electrical lead 28 which is attached to electrode 26 through junction 27. It is a function of these liquid contacts 22, 26 which are electrically insulated from each other by means of cylindrical insulation members 21, 29 to open and close a circuit upon contact of the liquid 13 with both contacts 22, 26. Also, it is a function of the liquid level-to-current transducer 30 to translate this conducting and non-conducting condition to pulses of rectified current to provide an electrical output signal to the current-to-air transducer 40 which is directly proportional to the average height of the liquid level 131 of liquid body 13. This function is explained in greater detail by specific reference to FIGURES 2-6.

When liquid level 131 of liquid body 13 rises above the lower liquid contact 22 and comes into contact also with upper liquid contact 26 a circuit defined by the liquid between electrode contacts 22, 26 the electrodes 23, 26 and leads 25, 28 to the liquid level-to-current transducer 30 is closed. Upon closure of these contacts 22, 26 the circuit is rendered conducting. Prior to the time of contact of the liquid with both electrode contacts 22, 26 the enclosed circuit was, of course, non-conducting. In accordance with preferred practice the contacts 22, 26 are not merely a portion of a single circuit but rather part of a smaller primary circuit I employed to activate a larger secondary circuit II. The linking of such primary circuit with a secondary circuit can be performed by numerous techniques well known to the art. One simple technique is to employ, for the opening and closing of the secondary circuit by activation of the primary circuit, any of several types of switches—viz. magnetic, mercury and even mechanical. In the present discussion, use of a relay is assumed for purposes of illustration. Activation then of the secondary, circuit as by closure of a relay then produces an output signal via leads 33, 34 to the current-to-air transducer 40. Such circuits, schematically defined in FIGURE 3 by well known electrical symbols, include a secondary circuit having a power supply in direct communication with a filter circuit which is, in turn, in direct communication with the current-to-air transducer 40. It is a function of the primary circuit, wherein is included the probe 20 to open and close, e.g., the relay 9 to activate this secondary circuit so that voltage via leads 31, 32 to the A.-C. power supply is converted into D.-C. voltage, and smoothed by the filter circuit, for transmission as an average output signal to the current-to-air transducer 40 via leads 33, 34. The probe 20 is represented in FIGURE 3 by the pair of terminals designated "contact input." Such signal is, in fact, constantly generated so long as the liquid covers both contacts 22, 26. The signal, as stated however, ceases at any time the liquid level falls sufficiently so that it is no longer in contact with both contacts 22, 26. It thus follows, that if the liquid rises and falls so that the liquid covers both contacts 22, 26 for only short intervals of time, then current will flow for only short intervals of time. At other times the current will be zero. Such condition is illustrated by the waveform shown by reference to FIGURE 4, which is a time-current graph. It will also be apparent as shown in this figure that the average current resultant from such condition is relatively low. On the other hand, however, where the liquid level remains sufficiently high to cover both electrodes 22, 26 for longer periods of time the wave form

will differ in that current will flow for longer periods of time and the average current will be higher, as shown by reference to the wave form of FIGURE 5. It, obviously, follows that where the rise and fall of the liquid 13 is of an intermediate level then the wave form will be intermediate the latter as to the time-current relation; and also the average current will be of intermediate value, as represented by FIGURE 6. But, whatever the wave form, the current is filtered to produce a composite or average electrical output signal which is directly proportional to the average height of the oscillating liquid level 131. It is this output signal, representing the average condition of the liquid level 131 which is fed via lines 33, 34 to the current-to-air transducer 40.

A feature of this invention resides in the use of the current-to-air transducer 40 as a portion of the combination. Such feature provides superior modulation, e.g., as compared with the use of a current actuated solenoid valve. Thus, a characteristic of this invention is that the valve means assumes a relatively stable condition as contrasted with an on-off condition.

The current-to-air transducer 40 converts the electrical signal received into an output pneumatic pressure which is directly proportional to the electrical input signal. Such current-to-air transducers 40 are well known to the art and need not be described in detail here. For a full explanation of such device, e.g., reference is had to manual TI-39-83, issued by the Foxboro Company, Foxboro Massachusetts U.S.A. This booklet shows a type 69 TA current-to-air valve transducer, which type of instrument is suited for use in the present combination.

Pursuant to the use of such current-to-air transducer 40 then, an input pneumatic pressure received at the instrument 40 via line 41 is converted into an output pressure, and transmitted via line 42 to a modulated control valve. The pneumatic signal transmitted is in direct proportion to the electric input signal. The art is replete with suitable mechanism for conversion of pneumatic pressure into a proportionate opening and closing impulse upon a valve in contact with a supply of liquid. Suitable mechanism of this type includes those wherein the pneumatic pressure acts directly or indirectly upon a pneumatically operated diaphragm valve or upon a cylinder-piston arrangement any of which devices converts the pneumatic pressure received into mechanical motion for opening or closing a liquid inlet valve. The invention therefore should obviously not be limited to any precise mechanism, and the following is given by way of illustration.

Suitable mechanism 50 is shown schematically in FIGURE 1 in combination with suitable valve inlet means. In the figure a liquid supply conduit 60 provides a supply of liquid into the cylindrical valve body 61 having at its exit 62 a member 58 which can open and close the said exit 62 to supply liquid or shut off the supply of liquid to the tube 12. The mating member 58 is directly connected via shaft 56 to the lever arm 54, which arm 54 in response to pneumatic signals from the instrument 40 via line 42 is capable of reciprocating shaft 56 upwardly or downwardly against the tension of spring 57 to open and close the valve 61.

The arm 54 thus moves this shaft 56 upwardly or downwardly to open and close the exit 62 in response to pneumatic pressure signals transmitted from the current-to-air transducer 40. The arm is thus pivoted upon a fulcrum 55 and is coupled on one side of the fulcrum 55 with shaft 56 and on the other to a cylinder-piston assembly which moves the arm 54 in response to pneumatic signals from the current-to-air transducer 40. Such cylinder-piston assembly is defined by the cylinder 53 within which moves the mating head 52 operatively connected to arm 54 via rod 51.

In operation then, when the oscillating liquid level 131 of liquid body 13 produces a filtered or average electrical output signal it is transmitted via the liquid level-to-current transducer 30 to the current-to-air transducer 40 and in

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response thereto an output pneumatic pressure activates the cylinder-piston assembly causing an end of arm 54 to be lowered, this moving shaft 56 upwardly to close liquid supply exit 62 to restrict flow of liquid via conduct 60 and cylinder chamber 61. When the electrical signal is reduced shaft 56 is moved in the opposite direction and liquid flow through the supply exit 62 is increased. But, in normal operation the valve assembly is modulated and movements of the shaft 56 is normally slight. In the event of a malfunction, however, the supply exit 62 is completely closed by total upward movement of shaft 56 because the air supply is shut off and the weighted end of arm 54 forces piston rod 51 to its total extent downward.

It will be apparent that various modifications and changes can be made without departing the spirit and scope of the invention. Thus, in essence the present invention contemplates novel apparatus combinations which rely upon an oscillating liquid level to open and close an electrical circuit, which circuit upon activation produces pulses which are filtered to produce an average or composite signal representing the average height of the liquid level. The combination also contemplates modulated valve means responsive to such output signal. Whereas pneumatic valve means provides superior modulation it is also feasible to employ electrically driven motor valve means operative in response to the composite signal.

Having described the invention, what is claimed is:

1. Apparatus to produce liquid filled packages comprising: means supplying a flat web of packaging material, said material being formed into a tube, means transversely sealing closed a lower portion of said tube, means supplying a liquid into said tube, said liquid having a oscillating liquid level, said means supplying liquid into said tube being closed to the atmosphere and having an outlet below said liquid level, modulated valve means operably associated with said liquid outlet, liquid level sensing means in said tube operably associated with said liquid level which include as a portion of an actuating circuit a pair of liquid sensing contacts which conduct only upon simultaneous contact with liquid and not other-

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wise to produce conducting and non-conducting conditions with the rise and fall of the oscillating liquid level to produce pulses of rectified current, said liquid level sensing means being electrically communicated with an electrical filter means for transforming these pulses into a composite electrical output signal of direct proportion to the average liquid level of the liquid body, said electrical filter being coupled with pneumatic transducer means so that the said electrical output signal thereto is transformed into an output pressure directly proportional to the electrical input signal, and operatively associated with said pneumatic transducer means, pressure responsive means operative upon said valve means for opening and closing said valve to provide liquid from said source of supply to said liquid body.

2. The structure of claim 1 wherein said valve means is below said liquid level at the outlet of said liquid supply means, said valve means having a valve stem projecting upwardly and outwardly of said tube, said valve stem being mechanically connected to said pressure responsive means.

3. The structure of claim 2 wherein one of said contacts surrounds a portion of said other contact and is electrically insulated therefrom.

4. The structure of claim 1 wherein said liquid level sensing means includes a probe, said pair of contacts being mounted on said probe with one of said contacts being vertically displaced from the other of said contacts and insulated therefrom.

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