Title: FLOW REGULATOR, IN PARTICULAR FOR FILLING MACHINES, AND FILLING MACHINE COMPRISING SUCH A FLOW REGULATOR

Abstract: A flow regulator (1) having a conduit (17) along which a pourable product flows to a container (2) to be filled with the pourable product; and shutter means for altering the pourable product flow section of the conduit (17); the shutter means having at least one deformable member (34) housed along the conduit (17) and defining an inner volume (35) separate from the conduit (17) and variable in controlled manner.
FLOW REGULATOR, IN PARTICULAR FOR FILLING MACHINES, AND FILLING MACHINE COMPRISING SUCH A FLOW REGULATOR

TECHNICAL FIELD

The present invention relates to a flow regulator. More specifically, the present invention relates to a flow regulator for a filling machine and for regulating flow of a pourable product, e.g. a food product, such as fruit juice, tea, or energy supplements, with which a container is filled.

BACKGROUND ART

Filling machines are known comprising a filling station, which is fed with empty containers, and feeds out containers filled with the pourable food product.

Normally, the filling station substantially comprises a carousel conveyor rotating about an axis of rotation; a tank containing the pourable food product; and a number of flow regulators connected fluidically to the tank and fitted to the conveyor, radially outwards with respect to the conveyor rotation axis.

Each flow regulator substantially comprises a body for attachment to the conveyor and defining a fill chamber connected fluidically to the tank; and a fill head oriented in a direction parallel to the conveyor rotation axis.

Each fill head comprises a shutter movable, inside the fill chamber, between a closed position, in which the shutter cuts off flow of the pourable food product
to the mouth of the container to be filled, and an open position, in which the chamber and the mouth of the container are connected fluidically to fill the container with the food product.

Flow regulators are known comprising a ball shutter, which, in its simplest form, comprises a substantially spherical body with a cylindrical cavity extending along an axis substantially coplanar with the axis along which fluid flows along a conduit, so that, in a fully open position, the cylindrical cavity of the shutter is substantially coaxial with the conduit. Flow regulators of this sort operate on the basis of rotating the shutter about an axis substantially perpendicular to the fluid flow axis, so as to gradually reduce, and even fully close, the flow section of the conduit.

Flow regulators are also known comprising a so-called "butterfly" shutter, which comprises a substantially flat body of substantially the same area as the flow section of the conduit along which the fluid flows, and rotates about an axis perpendicular to the fluid flow axis to substantially adjust the flow section between a fully open and a fully closed setting.

Each flow regulator is normally controlled in response to a signal from a device for detecting the level of the pourable product inside the container. The signal may, for example, be generated by an inductive probe, which determines the level of the pourable product inside the container directly, or may be the
result of processing an indirect measurement, such as
the weight of the container as it is being filled; in
which case, for a given cross section area of the
container and a given density of the pourable product,
the weight of the container can only be related to the
level of the product inside the container.

To fill a container, the shutter of the flow
regulator is moved from the closed position to an at
least partly open position.

Because the turbulence inside the container
increases as the pourable product nears the fill level —
especially when the container is a bottle with a
tapering cross section — and, at any rate, to prevent
overflow of the pourable product as the container is
being filled, filling comprises a first fast fill stage
followed immediately after by a second slow fill stage.
This substantially safeguards against overflow of the
pourable product from the container and, at the same
time, enables precise control of the product volume in
the container, which, in most commercial applications,
must correspond strictly to the volume indicated on the
retail package.

The first fill stage terminates when the pourable
food product reaches a given level, e.g. probe level or
a level corresponding to a given weight of the
container.

When the pourable product reaches this level, the
second slow fill stage commences, and continues for as
long as it takes to fill the container with a given amount of pourable food product.

When the pourable product contains added carbon dioxide - a common practice in the manufacture of carbonated beverages - each container, before being filled, is pressurized to the same pressure as the pourable food product during the filling process, by injecting a fluid, e.g., carbon dioxide, into the container, with the shutter of the flow regulator closed. After being filled, each container is depressurized, by expelling the carbon dioxide used to pressurize it, so that the pressure above the surface of the pourable product equals atmospheric pressure.

Given the above operating conditions, regardless of whether the pourable product is carbonated or not, the flow regulator of the filling machine must be capable of assuming three distinct positions: (i) a fully closed position; (ii) a first open (possibly, fully open) position corresponding to the fast fill stage; and (iii) a second open position, to a lesser degree than the first open position, and corresponding to the slow fill stage.

Ball and butterfly shutters of the above type are theoretically capable of assuming any number of partly open positions between the fully closed and fully open position, but have several drawbacks. In particular, they are hard to clean, on account of the small clearance between the shutter itself and the wall of the
pourable product conduit; they are expensive to produce and, like all relatively rotating or sliding mechanical parts, are subject to severe wear; and, in filling machine applications of the type described, rapid response to the level signal is essential. As regards the latter, a ball or butterfly shutter capable of assuming virtually any number of intermediate positions between the open and closed position serves little purpose from the control standpoint, since, in actual use, the shutter should cyclically rotate rapidly about its axis from the first open (or fully open) position to a given intermediate position, followed by equally rapid rotation into the fully closed position when the target level of the pourable product in the container is reached. The above operating mode obviously subjects the structure of the shutter to severe mechanical wear, as well as requiring precise adjustment of the controller and actuator, to ensure rotation of the shutter corresponds accurately with a given opening.

US2004/0075069 describes an on-off valve for fluids, comprising a tubular member made of deformable material and defining a fluid conduit inside. The deformable tubular member is housed inside a second tubular member made of steel and having an opening, through which a compressed operating fluid is fed to choke the deformable tubular member laterally and so close the conduit airtightly.

A valve of this sort has the advantage of having no
relatively rotating or sliding mechanical parts, and of being cheaper to produce and maintain than a ball or butterfly valve.

On the other hand, though ideal for use as an "on-off flow switch", i.e. switching directly from a fully open to a fully closed position, it is poorly suited to the demands of a filling machine of the type described above, which calls for a flow regulator capable of quickly and easily assuming a partly open position for the slow fill stage.

Even if it were possible to determine the operating fluid pressure required to slightly flex the wall of the deformable tubular member and so only partly choke the conduit defined by it, this would call for a control system capable of selectively, cyclically, and precisely controlling two distinct operating fluid pressures, so as to selectively close the conduit partly or fully.

Moreover, the deformable tubular member would be flexed over large part of the work cycle, both at the closing and slow fill stage, thus resulting in significant energy consumption, as well as serious design complications of the flow regulator and control system. Also, cyclic stress of this sort could eventually impair the accuracy of the valve, if permanent deformation were to permanently alter the size of the partly constricted flow section.

OBJECT OF THE INVENTION

Demand therefore exists, within the industry, for a
flow regulator featuring no relatively sliding or rotating mechanical parts, and which meets the specific requirements of filling containers with a pourable product on a filling machine of the type described above.

A need is also felt for a flow regulator designed to reduce manufacturing cost, especially in terms of straightforward design, and running costs (maintenance, energy consumption, etc.).

At least one of the above demands is met by the present invention, which relates to a flow regulator as claimed in Claim 1, and a filling machine as claimed in Claim 12.

BRIEF DESCRIPTION OF THE DRAWINGS

A number of preferred embodiments of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic section of a flow regulator, in accordance with the invention, in a fully closed position;

Figure 2 shows a schematic section of the Figure 1 flow regulator in a fully open (fast fill) position;

Figure 3 shows a schematic section of the Figure 1 and 2 flow regulator in a partly open (slow fill) position.

PREFERRED EMBODIMENTS OF THE INVENTION

Number 1 in Figure 1 indicates as a whole a flow regulator, in accordance with the present invention,
which may be integrated in a filling station (not shown) of a filling machine for filling containers 2 with a pourable product.

The filling station is supplied with *empty containers 2, fills containers 2 with the pourable product, and comprises a tank 3 containing the pourable product, and, if necessary, a fluid source, e.g. of carbon dioxide, by which to pressurize the containers before they are filled; and a carousel conveyor (not shown) rotating about a vertical axis, and from which project a number of flow regulators 1 and a number of supports for respective containers 2.

More specifically, flow regulators 1 are rotated by the conveyor, and the supports are movable to and from the flow regulators along respective vertical axes.

More specifically, each container 2 comprises:
- a mouth 4, through which container 2 is filled by the filling machine, and from which the pourable product is subsequently poured from container 2;
- a bottom wall (not shown) at the opposite end to mouth 4; and
- a neck portion 5 adjacent to mouth 4 and bounded at the top by mouth 4, and at the bottom by a ring 6, so that ring 6 is located below mouth 4.

With particular reference to the position of container 2 in Figures 1 to 3, ring 6 of each container 2 is located below mouth 4.

For the sake of simplicity, the following
description is limited to one flow regulator 1 and respective container 2.

Flow regulator 1 comprises a body 11 for attachment to the conveyor; and a shutter assembly 12.

More specifically, body 11 extends from a first end 13 fitted to the conveyor, to a second end 14 fitted removably to shutter assembly 12, and comprises, between ends 13 and 14, a cylindrical portion 15, of axis A, defining an inner cavity 16 connected fluidically to tank 3. More specifically, body 11 defines a first portion of a conduit 17, along which the pourable product flows to container 2.

Shutter assembly 12 comprises a body 18 fitted at its top end 19 to the bottom end 14 of body 11, and which defines an inner cavity 20 connected fluidically to cavity 16. Shutter assembly 12 also comprises an oblong inner body 21 extending substantially along axis A of body 18, housed inside cavity 20, and fixed to body 18.

Body 18 comprises a first and second substantially cylindrical end portion 22, 23 with the same outside diameter; and a cylindrical intermediate projection 24 larger in outside diameter than first and second portion 22, 23.

Inner body 21 comprises:

- a first cylindrical portion 25 which engages cavity 20 along at least part of first end portion 22;
- a second cylindrical portion 26 with a diameter
smaller than that of first portion 25, and at any rate smaller than the inside diameter of projection 24; and
a conical third portion 27 with a base diameter equal to the diameter of second portion 26.

In the example shown, inner body 21 also comprises a truncated-cone-shaped portion 28 extending between first and second portion 25 and 26, and having a narrow-end diameter smaller than the diameter of first portion 25, and a wide-end diameter equal to the diameter of second portion 26.

A second portion of pourable product conduit 17 is thus at least partly defined between the inner surface 29 of body 18 and the surface 30 of inner body 21. More specifically, the second portion of conduit 17 comprises an annular-section portion 31, and a circular-section portion 32; portions 31 and 32 being connected by an annular-section, intermediate portion 33, which increases in area from a minimum, equal to the area of the annular section at second portion 26, to a maximum, equal to the area of the circular section. In other words, intermediate portion 33 of conduit 17 is defined between the inner surface 29 of body 18 and surface 30 of the inner body at conical portion 27.

Body 18 preferably also comprises, at projection 24, a deformable annular member 34 located between the inner surface of body 18 and surface 29 of the inner body, and fixed to body 18.

More specifically, deformable annular member 34 is
a strip of elastic material, such as natural rubber or elastomeric material, formed into a loop and fixed at its top and bottom edges to body 18 to define, between inner surface 29 of body 18 and annular member 34 itself, a first chamber 35 for receiving an operating fluid.

Being defined at least partly by member 34, chamber 35 varies in volume as a function of deformation of member 34. More specifically, in an undeformed configuration of annular member 34 (Figure 3), chamber 35 partly engages the flow section of conduit 17, i.e. the undeformed configuration of member 34 partly opens pourable product conduit 17 to produce a pourable product flow corresponding to slow fill of container 2.

Advantageously, the configuration of member 34 can be altered to increase the volume of chamber 35 with respect to the undeformed configuration, by moving member 34 into a first deformed configuration (Figure 1), in which chamber 35 fully engages the flow section of conduit 17, i.e. the first deformed configuration of member 34 fully closes pourable product conduit 17 to cut off pourable product flow to container 2 (zero flow).

Advantageously, the configuration of member 34 can also be altered to reduce the volume of chamber 35 with respect to the undeformed configuration, by moving member 34 into a second deformed configuration (Figure 2), in which chamber 35 engages the flow section of
conduit 17 to a lesser extent with respect to the undeformed configuration. The volume of chamber 35 is preferably reduced by deforming member 34 so that chamber 35 leaves the flow section of conduit 17 substantially clear. That is, the second deformed configuration of member 34 substantially fully opens pourable product conduit 17 to produce a pourable product flow corresponding to fast fill of container 2.

Body 18 advantageously comprises at least two conduits 36, 37 extending radially with respect to axis A, and for connecting the inside of chamber 35 fluidically to a pressurized operating fluid source 39 and a vacuum source 38 respectively.

Regulator 1 preferably also comprises respective control valves 40, 41 interposed between sources 38, 39 and conduits 36, 37.

In the example shown, a first fluid line 47 connects conduit 37 to source 38, and a second fluid line 49 connects conduit 36 to fluid line 47 and source 39; and control valves 40, 41 are located along the portions of respective fluid lines 47, 49 extending between the intersection of the fluid lines and respective sources 38, 39.

Control valves 40, 41 are each movable between an open position (shown in white in Figures 1 to 3) connecting respective sources 38, 39 fluidically to conduits 37, 36, and a discharge position (shown in black in Figures 1 to 3) disconnecting sources 38, 39.
fluidically from conduits 37, 36 and connecting conduits 37, 36 to substantially atmospheric pressure.

Body 18 preferably also comprises a second deformable annular member 42 housed in chamber 35 and fixed to body 18. More specifically, second annular member 42 is a strip of elastic material, similar to the material of annular member 34, formed into a loop and shorter in height than member 34 in a direction parallel to axis A. Annular member 42 is fixed at its top and bottom edges to body 18 to define, between inner surface 29 of body 18 and annular member 42 itself, a second chamber 43 for receiving an operating fluid, and fluidically separate from first chamber 35 in which it is housed.

Being defined at least partly by member 42, chamber 43, like chamber 35, varies in volume as a function of deformation of annular member 42. As shown in Figures 1 to 3, annular member 42 is generally positioned so that at least a central portion of it extending along axis A cooperates with annular member 34.

Body 18 advantageously comprises a conduit 44 extending radially with respect to axis A and for connecting the inside of chamber 43 fluidically to vacuum source 38 and pressurized operating fluid source 39.

In the example shown, a third fluid line 46 connects conduit 44 to a portion of fluid line 49 extending between source 39 and control valve 41; and
the same portion is fitted with a further control valve 45 movable between an open position (shown in white in Figures 1 to 3) connecting source 39 fluidically to conduits 36, 44, and a discharge position (shown in black in Figures 1 to 3) disconnecting source 39 fluidically from conduits 36, 44, and connecting conduits 36, 44 to substantially atmospheric pressure.

Flow regulator 1 advantageously comprises control means 50 for selectively activating control valves 40, 41, 45.

In actual use, a container 2 is filled with the pourable product by appropriately alternating the above configurations of regulator 1.

As of the first deformed configuration in Figure 1, corresponding to full closure of conduit 17, fast fill of container 2 is started by closing valve 45 and opening valve 40 and valve 41 (if any); and operating fluid is drawn from chamber 35 and chamber 43 (if any) by connecting the chambers fluidically to vacuum source 38. Accordingly, annular member 34 and annular member 42 (if any) shift from the first deformed configuration (Figure 1), in which chamber 35 and chamber 43 (if any) are larger in volume with respect to the undeformed configuration (Figure 3), to the second deformed configuration (Figure 2), in which chamber 35 and chamber 43 (if any) are smaller in volume with respect to the undeformed configuration, and annular member 34 minimally engages the flow section of conduit 17 to
allow pourable product flow through body 18 at the maximum rate permitted by regulator 1.

When the fast fill stage is completed, i.e. when the pourable product, as stated, reaches a given level in container 2, slow fill of container 2 is started by restoring annular member 34 and annular member 42 (if any) to the undeformed configuration by closing valves 40 and 41 to disconnect chambers 35 and 43 fluidically from vacuum source 38; valve 45 already being closed at the fast fill stage. Accordingly, annular member 34 partly engages the flow section of conduit 17 to partly open conduit 17 and reduce pourable product flow through body 18 to an intermediate rate compatible with slow fill requirements.

When slow fill of container 2 is completed, i.e. when the predetermined pourable product level is reached, pourable product flow through regulator 1 is cut off by restoring annular member 34 and annular member 42 (if any) to the first deformed configuration by connecting pressurized operating fluid source 39 fluidically to chamber 35 and/or chamber 43 (if any). In the Figure 1 example, valve 45 in the open position only connects pressurized operating fluid source 39 fluidically to chamber 43, since member 34 is deformed by deformation (inflation) of member 42.

If there is no annular member 42, member 34 is deformed directly, for example, by also opening valve 41 and fluidically connecting chamber 35 directly to
pressurized operating fluid source 39.

The advantages of regulator 1 according to the present invention will be clear from the above description.

Regulator 1 provides for filling a container 2 with a pourable product as typically required in the filling machine industry, and with no recourse to relatively moving mechanical parts, by exploiting the deformability of an elastic member subject to none of the wear problems commonly associated with conventional regulators. In addition, regulator 1 is also cheaper to produce and maintain.

The embodiment comprising deformable annular member 34 and second deformable annular member 42 has the advantage of any tears or punctures in member 34 being easily detected, by part of the pourable product leaking into chamber 35 and being sucked into fluid line 47 when regulator 1 is set to the fully open position. In other words, leakage of the pourable product into fluid line 47 substantially indicates damage to annular member 34.

Clearly, changes may be made to regulator 1 as described and illustrated herein without, however, departing from the scope of the accompanying Claims.
CLAIMS

1) A flow regulator (1) comprising a conduit (17) along which a pourable product flows to a container (2) to be filled with the pourable product; and shutter means for altering the pourable product flow section of said conduit (17); the flow regulator being characterized in that said shutter means comprise at least one deformable member (34) housed along the conduit (17) and defining an inner volume (35) separate from the conduit (17) and variable in controlled manner.

2) A flow regulator as claimed in Claim 1, characterized in that, in an undeformed configuration, said at least one deformable member (34) partly engages the flow section of the conduit (17) to slow fill said container (2).

3) A flow regulator as claimed in Claim 2, characterized in that said at least one deformable member (34) can be set to a first deformed configuration defining an inner volume (35) larger with respect to the inner volume in said undeformed configuration, and such as to fully engage the flow section of the conduit (17) to close said flow regulator (1).

4) A flow regulator as claimed in Claim 2 or 3, characterized in that said at least one deformable member (34) can be set to a second deformed configuration defining a smaller inner volume (35) with respect to the undeformed configuration, and such as to
engage the flow section of said conduit (17) to a lesser
degree than the undeformed configuration, so as to fast
fill said said container (2).

5) A flow regulator as claimed in any one of the
foregoing Claims, characterized by comprising means (44,
45, 46) for selectively connecting said inner volume
(35) fluidically to a pressurized operating fluid source
(39).

6) A flow regulator as claimed in any one of the
foregoing Claims, characterized by comprising means (36,
37, 40, 41, 44, 46, 47, 49) for selectively connecting
said inner volume (35) fluidically to a vacuum source
(38).

7) A flow regulator as claimed in any one of the
foregoing Claims, and comprising a first body (18)
defining a substantially cylindrical inner cavity (20);
and a second body (21) housed inside the cavity (20) and
fixed to the first body (18); said conduit (17) being
defined annularly between said first and second body
(18, 21); said at least one deformable member (34) being
fixed annularly to said first body (18); and said inner
volume (35) extending between said at least one
deformable member (34) and the first body (18).

8) A flow regulator as claimed in any one of the
foregoing Claims, and comprising a secondary deformable
member (42) housed in said inner volume (35) and
cooperating with said at least one deformable member
(34); the secondary deformable member (42) defining a
secondary inner volume (43) separate from said inner volume (35) and variable in controlled manner.

9) A flow regulator as claimed in Claim 8, characterized in that said secondary deformable member (42) can be set to a first deformed configuration defining an inner volume (43) larger with respect to its inner volume in its undeformed configuration, and wherein the secondary deformable member (42) cooperates with the at least one deformable member (34) to fully engage the flow section of the conduit (17) and so close said flow regulator (1).

10) A flow regulator as claimed in Claim 8 or 9, characterized by comprising means (44, 45, 46) for selectively connecting said secondary inner volume (43) fluidically to said pressurized operating fluid source (39).

11) A flow regulator as claimed in any one of Claims 8 to 10, characterized by comprising means (40, 41, 44, 46) for selectively connecting said secondary inner volume (43) fluidically to said vacuum source (38).

12) A filling machine comprising a flow regulator (1) as claimed in any one of Claims 1 to 11.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER,
INV. B67C3/26 B67C3/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B67C F16K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search: 20 August 2010

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Name and mailing address of the ISA:
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International application No:
PCT/IT2009/000540