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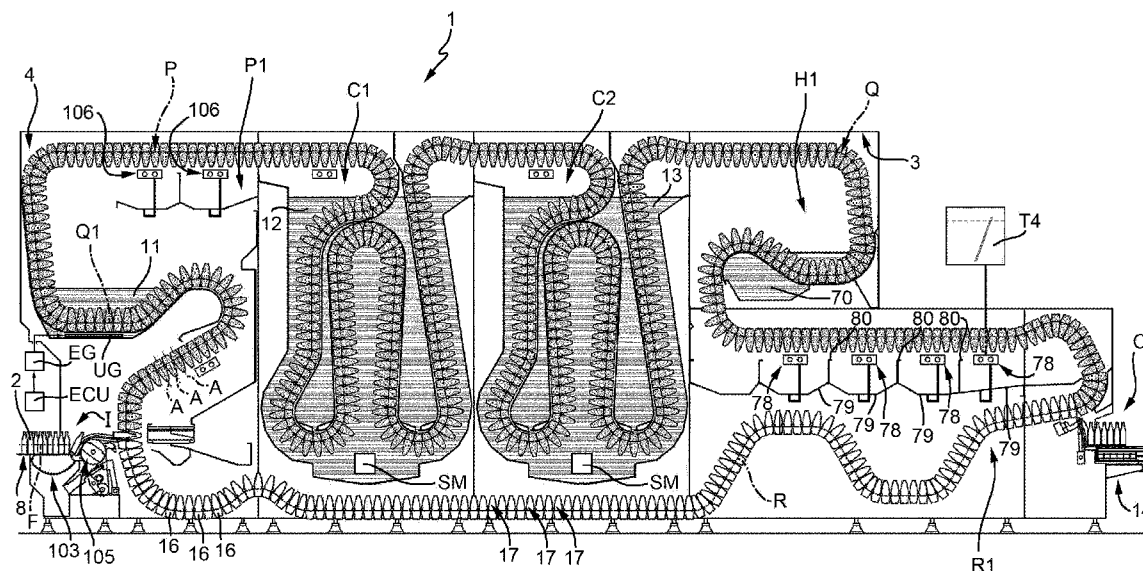


FIG. 1

(57) Abstract: A washing machine (1; 1'; 1'') for washing empty containers (2) includes a conveyor device (4) for conveying the containers (2) along a washing path (Q), at least one bath (11; 12) holding a cleaning medium and through which the washing path (Q) extends, and at least one corresponding ultrasonic wave generator (UG; UG'; UG'') coupled to the bath (11; 12) for propagating ultrasonic waves through the cleaning medium, such that the containers (2) receive an ultrasonic cleaning treatment during their advancement through the bath (11; 12).



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"A WASHING MACHINE FOR WASHING EMPTY CONTAINERS AND AN
OPERATING METHOD THEREOF"

The invention relates to a washing machine for washing
5 empty containers and to an operating method thereof.

In general, washing machines are known with the purpose
of cleaning the empty containers upstream of a filling and
a labelling station, in which the containers are respectively
filled with a pourable product and labelled with respective
10 labels.

An example of washing machine is known, e.g. from
EP2727660 in the name of the same Applicant.

Known washing machines essentially comprise:

- a feeding system;
- 15 - a washing tunnel;
- a looped chain conveyor advancing the containers along
a closed washing path and extending inside the washing tunnel
from an inlet station to an outlet station; and
- a plurality of sequential treatment zones arranged
20 between the inlet station and the outlet station, and through
which the chain conveyor advances the containers.

In detail, the chain conveyor comprises a plurality of
beams, which are fed at the inlet station by the feeding
system with respective rows of containers.

25 In particular, each beam comprises a plurality of
aligned pockets, which receive, convey and outlet the

respective washed containers.

Each beam is discharged of the respective washed containers at the outlet station and then is returned to the inlet station, where it receives new empty containers to be
5 washed.

According to the advancing direction of containers along the washing tunnel, the treatment zones comprise, in sequence, a prewash zone, a first cleaning zone, a second cleaning zone and a plurality of consecutive rinsing zones.

10 The prewash zone, the first cleaning zone, and the second cleaning zone comprise respective cleaning baths, which are filled with a washing chemical agent at high temperature and through which the containers are advanced.

Each rinsing zone comprises one or more rinsing baths
15 filled with rinsing liquid and/or ejecting devices for directing sprinkles of rinsing liquid toward the containers.

In general, containers needs to be treated through the cleaning zones for a relatively long time to be effectively deprived from the most encrusted dirt mounds, especially the
20 ones heavily sedimented at the bottom of the containers themselves.

Moreover, the treatment through the cleaning zones requires high consumption of energy, since being essentially based on the quantity of chemical agent used in a washing
25 cycle and the temperature of the same chemical agent.

An attempt to replace known washing machines with a cleaning device having an increased cleaning power and being

energetically efficient has been disclosed by WO2016202493, wherein ultrasonic waves are exploited for disaggregating dirt deposits onto empty containers to be washed.

In particular, WO2016202493 discloses a method for
5 cleaning containers and a corresponding cleaning device, according to which the containers are treated with a jet of water provided with air bubbles and ultrasonic waves herein generated and propagated.

The ultrasonic waves propagate in water and, more in
10 general, in a medium with a relative periodic motion with respect to the medium itself, such that local micro-zones within the medium pass periodically from a depressurized to a pressurized state.

During the depressurized state, air dissolved within
15 the medium tends to form many microbubbles, which implode when pressure increases so as to release energy.

Such energy may be useful to disaggregate the aforementioned encrusted dirt mounds, such that cleaning the containers results significantly eased.

20 Although the cleaning device disclosed by WO2016202493 represents an important contribution to the state of the art, a need is still felt to improve known washing machines from the point of view of saving energy and reducing operational times, as well as dimensions of the same washing
25 machines.

It is an object of the invention to provide a washing machine for washing empty containers, which allows meeting

the abovementioned need.

This object is achieved by the invention as it relates to a washing machine for washing empty containers, as claimed in claim 1.

5 The invention further relates to an operating method of a washing machine for washing empty containers, as claimed in claim 14.

Three preferred embodiments are hereinafter disclosed for a better understanding of the present invention, by way
10 of non-limitative examples and with reference to the accompanying drawings, in which:

- Figure 1 is a lateral view of a first embodiment of a washing machine for washing empty containers, according to the invention;

15 - Figure 2 is a lateral view in an enlarged scale of some components of the washing machine of Figure 1;

- Figure 3 is a lateral view of a second embodiment of a washing machine for washing empty containers, according to the invention;

20 - Figure 4 is a lateral view in an enlarged scale of some components of the washing machine of Figure 3;

- Figure 5 is a lateral view of a third embodiment of a washing machine for washing empty containers, according to the invention; and

25 - Figure 6 is a lateral view in an enlarged scale of a portion of the washing machine of Figure 5.

With reference to Figure 1, numeral 1 indicates a washing machine for washing containers 2, according to a first embodiment of the invention.

In particular, containers 2 are defined by respective
5 empty bottles intended to be filled with a pourable product.

As visible in Figure 2, each container 2 has an external surface 2a delimiting an inner volume 2b adapted to receive the pourable product and extends along an axis A (in particular, lying on a vertical plane) from a base portion
10 2c to a neck portion 2d.

The neck portion 2d is provided with an inlet opening 2f about axis A, which allow the filling of the inner volume 2b of the corresponding container 2.

Making again reference to Figure 1, washing machine 1
15 comprises:

- a washing tunnel 3, in which empty containers 2 are fed and accordingly washed; and

- a chain conveyor 4 for advancing containers 2 inside washing tunnel 3 along a closed loop path P, in particular
20 lying on a vertical plane.

In detail, chain conveyor 4 comprises:

- a pair of chains 15 elongated parallel to path P and parallel to one another; and

- a plurality of subsequent conveying beams 16, which
25 extend between chains 15 in a transversal and, more in detail, orthogonal manner to chains 15 and path P.

Specifically, each beam 16 comprises a row of pockets

17 aligned orthogonally to path P and adapted to receive corresponding containers 2.

In such a manner, containers 2 carried by a corresponding beam 16 are aligned orthogonally to path P and
5 housed inside the respective pockets 17.

Washing machine 1 comprises also a feeding system 8 for feeding a sequence of empty containers 2 along a direction F and at an inlet station I of washing tunnel 3. In particular, containers 2 fed along direction F are arranged
10 in rows orthogonal to path P.

Feeding system 8 comprises:

- a plurality of endless conveyors 103 (of which only one is schematically shown) configured to convey the rows of containers 2 towards the inlet station I;
- 15 - a motor (not shown), which drives conveyors 103; and
- a sequencing device 105, arranged between inlet station I and endless conveyors 103 and configured to receive a row of containers 2 at a time from conveyors 103 and to feed the received row to the chain conveyor 4 at inlet
20 station I.

In particular, the most forward containers 2 of each row of containers 2 are transferred by sequencing device 105 to the respective pockets 17 of the beam 16 that is travelling at inlet station I.

25 The operation and construction of the sequencing device 105 is known as such and, therefore, not described further in detail.

Direction F is horizontal and orthogonal to axes A of containers 2 fed along the same direction F.

Washing machine 1 further comprises an outfeed conveyor 14, which receives rows of cleaned containers 2 from chain conveyor 4 at an outlet station O of washing tunnel 3.

In view of the above, path P comprises:

- a washing branch Q, which extends from inlet station I to outlet station O and along which containers 2 are advanced by chain conveyor 4; and
- 10 - a return branch R, which extends from outlet station O to inlet station I and defines a return zone R1, through which beams 16 return towards inlet station I without containers 2.

Furthermore, according to the advancing direction of the same containers 2, washing machine 1 comprises in sequence along washing branch Q:

- a prewash zone P1;
- a first cleaning zone C1;
- a second cleaning zone C2; and
- 20 - a final rinsing zone H1.

In the foregoing of the present disclosure, for the sake of clarity, terms like "upstream of" and "downstream of" are to be intended throughout the whole description with reference to such advancing direction of the containers 2 along path P.

Within prewash zone P1, washing machine 1 comprises a prewashing apparatus comprising, in turn, a bath 11 filled

with a cleaning agent and a plurality of sprinkling devices
106 arranged in sequence along washing branch Q downstream
of bath 11.

Sprinkling devices 106 deliver, in use, sprinkles of
5 the above cleaning agent to external surfaces 2a and inner
volumes 2b of containers 2, while the latter are advanced
through the prewash zone P1 itself.

The cleaning agent within bath 11 and the cleaning agent
ejected by sprinkling devices 106 are brought to a relatively
10 high temperature, for instance between 45 °C and 60 °C, so
that the encrusted dirt on containers 2 starts to dissolve
as containers 2 themselves advance through prewash zone P1.

Within first cleaning zone C1 and second cleaning zone
C2, washing machine 1 comprises respective baths 12, 13
15 filled with corresponding cleaning agents and defining a hot
washing apparatus.

The cleaning agent within baths 12, 13 is brought to a
higher temperature than that within bath 11, for instance
between 65 °C and 80 °C, so that dirt on advancing containers
20 2 is fully removed together with possible labels arranged on
the respective external surfaces 2a.

The above removed labels precipitate due to gravity
action and due to a pushing action exerted by the same
advancing containers 2 toward the bottom of bath 12 or of
25 bath 13, based on where containers 2 are immersed during the
detachment of the labels from the respective external
surfaces 2a.

In view of that, washing machine 1 comprises two suction apparatus SM, which are respectively arranged at the bottom of bath 12 and 13 and are both configured to suck the detached labels so as to remove the latter from the corresponding
5 baths 12, 13.

Conveniently, the cleaning agents filling the respective baths 11, 12, 13 comprise corresponding basic aqueous solutions that include, in particular, sodium hydroxide.

10 Containers 2 come out from bath 13 cleaned and heated up to a temperature likely between 60 °C and 70 °C, so that the same containers 2 needs to be cooled down to environmental temperature before being discharged at outlet station O.

15 Furthermore, containers 2 coming out from bath 13 present residuals of cleaning agent, which needs to be removed before the same containers 2 are discharged at outlet station O.

In view of that, washing machine 1 comprises a rinsing
20 apparatus 101, which is arranged within final rinsing zone H1 and is configured to cool and rinse containers 2 by bringing the same containers 2 in contact with a rinsing medium, in particular water, at a temperature lower than that of the cleaning agent within bath 13.

25 Specifically, rinsing apparatus 101 comprises a bath 70 filled with the rinsing medium and positioned such that beams 16 are conveyed by chains 15 through the same bath 70.

In such a manner, beams 16 and external surfaces 2a of containers 2 advancing through the bath 70 are fully in contact with such rinsing medium and, in particular, immersed therein.

5 Furthermore, rinsing apparatus 101 comprises an ejection assembly 77 arranged along washing branch Q downstream of bath 70.

Ejection assembly 77 comprises a plurality of sprinkling devices 78 arranged in sequence along washing
10 branch Q for delivering sprinkles of the rinsing medium to external surfaces 2a and inner volumes 2b of containers 2, as well as to beams 16 carrying the same containers 2.

At least one of the sprinkling devices 78 is supplied by a source of rinsing medium; specifically washing machine
15 1 comprises a tank T4 defining the above source of rinsing medium.

In particular, tank T4 supplies only the last sprinkling device 78 of the respective sequence, according to the advancing direction of containers 2.

20 To supply all the other sprinkling devices 78, ejection assembly 77 comprises also a plurality of basins 79 respectively arranged in sequence below sprinkling devices 78 and fluidly connected thereto.

The last basin 79 in the respective sequence gathers
25 the rinsing medium that is ejected by the corresponding sprinkling device 78, since the same ejected rinsing medium falls down from containers 2 and beams 16 that advance above

the same last basin 79.

As it will be explained in the foregoing of the disclosure, the previously referred last basin 79 supplies, in use, all the other basins 79, which in turn supply the
5 corresponding sprinkling devices 78.

In detail, as schematically illustrated in Figure 1 and according to the advancing direction of containers 2, each basin 79, with exception of the first of the respective sequence, comprises at the top a corresponding spillway 80
10 toward the immediately upstream basin 79.

Therefore, when a basin 79 (excluded the first one of the respective sequence) is completely filled with rinsing medium, a superficial portion of the latter falls by means of the spillway 80 into the immediately upstream basin 79.

15 The last basin 79 in the respective sequence is the first one that is completely filled since indirectly receiving rinsing medium from tank T4 via the corresponding sprinkling device 78; the other basins 79 are completely filled in succession according to a direction opposite to
20 the advancing direction of containers 2.

Advantageously, washing machine 1 comprises an ultrasonic wave generator UG, which is coupled to bath 11 and configured to propagate ultrasonic waves through the cleaning agent within bath 11 itself, such that containers
25 2 may receive an ultrasonic cleaning treatment while advancing through bath 11.

More in detail, ultrasonic wave generator UG comprises

a plurality of ultrasonic transducers 90 (Figure 2), which are conveniently plate-shaped, configured to convert electric power into ultrasounds, and sequentially arranged adjacent and parallel to each other along a stretch Q1, which
5 is part of washing branch Q and extends through bath 11.

In particular, ultrasonic transducers 90 has a thickness between 70 mm and 110 mm and preferred planar dimensions about 500 mm x 300 mm.

Ultrasonic transducers 90 preferably emit ultrasonic
10 waves having an action range of at least 350 mm and a frequency between 25 kHz and 28 kHz.

Specifically, ultrasonic transducers 90 are parallel to stretch Q1 and fixed with respect to bath 11, so as to be placed immediately below the advancing beams 16. In such a
15 manner, ultrasonic transducers 90 face in close proximity the base portions 2c of the containers 2 advanced through bath 11.

In particular, ultrasonic transducers 90 have a maximum clearance from the bottom of base portions 2c that is equal
20 to 10 mm, according to a direction orthogonal to stretch Q1. Possibly, a slight crawling between base portions 2c and ultrasonic transducers 90 may be tolerated.

Moreover, while beams 16 advance through stretch Q1, the same beams 16 have respective portions facing ultrasonic
25 transducers 90 in close proximity.

In the first embodiment of the invention, stretch Q1 is rectilinear and horizontal. Moreover, stretch Q1 has a length

conveniently between 0.5 m and 2 m.

Preferably, containers 2 are advanced throughout the whole stretch Q1 during a time interval between 20 s and 60 s, in order to have optimal performances of the ultrasonic cleaning treatment.

Washing machine 1 further comprises:

- an electric power generator EG connected to ultrasonic transducers 90; and

- a control unit ECU connected to the electric power generator EG and configured to control power supply of each ultrasonic transducer 90 by operating electric power generator EG.

In particular, control unit ECU controls the activation of ultrasonic transducers 90 in a periodic or discontinuous manner, e.g. for a duration of 30 s after each period of 420 working hours of the washing machine 1.

Moreover, control unit ECU is configured to inhibit emissions of ultrasonic waves during downtimes.

The operation of washing machine 1 is described in detail in the following.

Feeding system 8 advances a plurality of rows of containers 2 to be washed through conveyor 103 in a parallel manner to direction F.

The properly positioned containers 2 are arranged with respective axes A orthogonal to path P and with respective base portions 2c lying on conveyor 103.

Beams 16 of chain conveyor 4 withdraw respective rows

of containers 2 at inlet station I from sequencing device 105, advance containers 2 inside washing tunnel 3 along the washing branch Q, discharge rows of cleaned containers 2 at outlet station O onto outfeed conveyor 14, and return along
5 return branch R without containers 2.

In detail, containers 2 of each row are first carried by pockets 17 through prewash zone P1, where containers 2 are preliminary washed and heated through immersion within bath 11 and by means of sprinkling devices 106.

10 Containers 2 receive within bath 11 also a complete ultrasonic cleaning treatment by means of ultrasonic wave generator UG, with above described modes.

Hence, the same containers 2 are conveyed also through following baths 12, 13, respectively at cleaning zones C1,
15 C2, so that containers 2 are completely cleaned and deprived of any labels attached thereon.

Here, both containers 2 and beams 16 receive heat from cleaning agent within baths 12, 13 up to reach elevated temperatures, for instance between 60 °C and 70° C.

20 Then, containers 2 are rinsed and cooled through the final rinsing zone H1 before the same containers 2 are discharged at outlet station O.

With reference to Figure 3, numeral 1' indicates a washing machine for washing empty containers 2, according to
25 a second embodiment of the invention.

Washing machine 1' is similar to washing machine 1 and will be described hereinafter only as far as it differs

therefrom; corresponding or equivalent parts of washing machines 1, 1' will be indicated where possible by the same reference numerals.

In particular, washing machine 1' differs from washing machine 1 for comprising, in replacement of ultrasonic wave generator UG, an ultrasonic wave generator UG' coupled to bath 12 and configured to propagate ultrasonic waves through the cleaning agent within bath 12 itself, such that containers 2 may receive an ultrasonic cleaning treatment while advancing through bath 12.

More in detail, ultrasonic wave generator UG' comprises a plurality of ultrasonic transducers 90' (Figure 4), which are functionally and constructively similar to ultrasonic transducers 90.

Ultrasonic transducers 90' are sequentially arranged adjacent and parallel to each other along a stretch Q2, which is part of washing branch Q and extends through bath 12.

Ultrasonic transducers 90' are parallel to stretch Q2 and fixed with respect to bath 12 so as to face in close proximity the base portions 2c of the containers 2 advanced through bath 12.

In particular, ultrasonic transducers 90' have a maximum clearance from the bottom of base portions 2c that is equal to 10 mm, according to a direction orthogonal to stretch Q2.

In the second embodiment, stretch Q2 is rectilinear and vertical. Moreover, stretch Q2 has a length conveniently

between 0.5 m and 2 m. In general, the vertical arrangement of flattened ultrasonic transducers 90' is convenient because dirt detached from containers 2 slips away from the ultrasonic transducers 90' themselves with easiness.

5 Preferably, containers 2 are advanced throughout the whole stretch Q2 during a time interval between 20 s and 60 s, in order to have optimal performances of the ultrasonic cleaning treatment.

10 Ultrasonic transducers 90' are connected to electric power generator EG in order to receive power supply therefrom under the control of control unit ECU. In particular, control unit ECU controls the activation of ultrasonic transducers 90' exactly in the same way ultrasonic transducers 90 are controlled.

15 Conveniently, ultrasonic transducers 90' are spaced apart from suction apparatus SM within bath 12, such that the action of the same ultrasonic transducers 90' does not interfere with that of suction apparatus SM itself. In other words, ultrasonic wave generator UG' and suction apparatus
20 SM within bath 12 have respective action areas that are separated from one another.

25 In such a manner, turbulences inducted in the cleaning agent by suction apparatus SM do not affect cleaning effectiveness of ultrasonic waves. In fact, Applicant has found experimentally that cleaning effectiveness of ultrasonic waves dramatically drops if the latter are propagated through a disturbed fluid. Furthermore,

ultrasonic waves in a disturbed fluid are known to produce an intense high-amplitude noise, also colloquially recognized as "ultrasonic scream"

The operation of washing machine 1' is similar to that of washing machine 1 and is described only insofar as it differs therefrom.

In particular, the operation of washing machine 1' differs from that of washing machine 1 in that containers 2 receive the ultrasonic cleaning treatment while advancing through bath 12 in cleaning zone C1, instead of through bath 11 in prewash zone P1.

The cleaning effectiveness of the treatment within bath 12 is higher than that of the treatment within bath 11 due to the higher temperatures of the cleaning agent within bath 12 than that of the cleaning agent within bath 11.

With reference to Figure 5, numeral 1'' indicates a washing machine for washing empty containers 2, according to a third embodiment of the invention.

Washing machine 1'' is similar to washing machines 1' and will be described hereinafter only as far as it differs therefrom; corresponding or equivalent parts of washing machines 1', 1'' will be indicated where possible by the same reference numerals.

In particular, washing machine 1'' differs from washing machine 1' for comprising, in addition to ultrasonic wave generator UG', another ultrasonic wave generator UG'' coupled to bath 12 and configured to propagate ultrasonic

waves through the cleaning agent within bath 12 itself.

In particular, ultrasonic wave generator UG'' is similar to ultrasonic wave generator UG' and, therefore, comprises a plurality of ultrasonic transducers, each
5 identical to one of ultrasonic transducers 90' and not shown in view of such identity. Ultrasonic transducers of ultrasonic wave generator UG'' are connected to control unit ECU to be activated in analogous ways with respect to ultrasonic transducers 90'.

10 Ultrasonic wave generator UG'' is at least partially arranged within bath 12 in a position spaced from ultrasonic wave generator UG'.

More precisely, ultrasonic wave generator UG'' faces ultrasonic wave generator UG' on the opposite side thereof,
15 with respect to stretch Q2. Ultrasonic wave generator UG'' is configured to generate ultrasonic waves that propagate according to a propagation direction opposite to that of ultrasonic waves generated by ultrasonic wave generator UG'.

In particular, such a propagation direction is coplanar
20 to path P and preferably orthogonal to stretch Q2.

Specifically, ultrasonic transducers of ultrasonic wave generator UG'' are sequentially arranged adjacent and parallel to each other along a stretch Q4, which is part of washing branch Q and extends through bath 12, in particular
25 downstream of and preferably parallel to stretch Q2.

Moreover, washing machine 1'' differs from washing machine 1' for comprising an inspection tunnel T'', which

extends through bath 12 orthogonally to path P, is fluidly isolated from bath 12, and is accessible by a maintenance operator U from the outside of washing machine 1''.

In detail, as shown in Figure 5, tunnel T'' is arranged
5 between stretches Q2, Q4 and preferably has a rectangular cross section coplanar to path P.

Tunnel T'' comprises:

- a top and a bottom wall opposite to one another and preferably orthogonal to stretches Q2, Q4; and
- 10 - a pair of lateral walls orthogonal to both top and bottom walls, i.e. preferably parallel to stretches Q2, Q4.

Ultrasonic wave generators UG', UG'' are respectively coupled to the lateral walls.

Tunnel T'' has a width orthogonal to stretches Q2, Q4,
15 an height parallel to stretches Q2, Q4, and a length orthogonal to path P.

The height and the width of tunnel T'' are sufficient to allow operator U to move through tunnel T'' and inspect the inner of washing machine 1'', without being exposed to
20 the operating components thereof or without the need of washing machine 1'' being in downtime.

Ultrasonic wave generators UG', UG'' comprise:

- respective operative surfaces parallel to stretches Q2, Q4, immersed within bath 12 and configured to generate
25 ultrasonic waves; and
- corresponding generative stages G'' fluidly isolated from bath 12, i.e. arranged outside the latter bath 12.

Washing machine 1'' comprises two compartments CM1'', CM2'' fixedly placed at the respective lateral walls of tunnel T'' and respectively housing the generative stages G'' of ultrasonic wave generators UG', UG''.

5 Compartments CM1'', CM2'' communicate, at least selectively, with tunnel T''; for instance, washing machine 1'' comprises not shown doors movable to selectively open and close communications between the compartments CM1'', CM2'' and tunnel T''.

10 In this way, generative stages G'' are accessible by means of tunnel T'', in particular by maintenance operator U to perform maintenance operations thereon. In other words generative stages G'' are maintainable by maintenance operator U.

15 As shown in Figures 5 and 6, the distance between ultrasonic wave generators UG', UG'', or essentially between stretches Q2, Q4, coincides with the width of tunnel T''.

 In view of the arrangement of ultrasonic wave generators UG'', even the latter has an action area spaced from that of
20 suction apparatus SM, which is placed at the bottom of bath 12.

 Furthermore, path P of washing machine 1'' comprises within bath 12 a curvilinear stretch Q3 upstream of stretch Q2, i.e. of the action area of ultrasonic wave generator
25 UG', and along which containers 2 advances with respective inlet openings 2f above the corresponding base portions 2c, i.e. in a right side up configuration.

In such a manner, containers 2 advanced along stretch Q3 towards stretch Q2 have their inner volumes 2b filled with cleaning agent due to the gravity action.

In other words, stretch Q3 is placed upstream of
5 ultrasonic wave generators UG', UG'', such that propagation of ultrasonic waves within inner volumes 2b is enhanced.

The operation of washing machine 1'' is similar to that of washing machine 1' and is described only insofar as it differs therefrom.

10 In particular, containers 2 receive within bath 12 a double ultrasonic cleaning treatments, thanks to the additional presence of ultrasonic wave generator UG'' along stretch Q4.

During operation of washing machine 1'', maintenance
15 operator U may access to ultrasonic wave generators UG', UG'' by means of tunnel T and, accordingly, perform maintenance operations on ultrasonic wave generators UG', UG''. From an analysis of the features of washing machines 1, 1', 1'' and of the method according to the invention, the
20 advantages they allow to obtain are apparent.

In particular, ultrasonic generators UG, UG', UG'' have an extremely simplified structure and respectively integrate with easiness to baths 11, 12, which correspond to washing apparatus normally present in known washing machines.

25 Therefore, ultrasonic generators UG, UG', UG'' may be applied into already existent and operative washing machines, in order to increase efficiency of the latter.

It is evident that washing machines 1, 1', 1'' can be designed to have smaller dimensions than known washing machines, with significant cost savings. Indeed, a shorter washing branch Q is abundantly compensated by the increase
5 of cleaning performances due to the use of ultrasounds.

The flattened shape of ultrasonic transducers 90, 90' allows a simple and compact arrangement of ultrasonic wave generators UG, UG', UG'' within the corresponding baths 11, 12 in close proximity to the base portions 2c of the
10 containers 2, which advance along the corresponding stretches Q1, Q2.

The fact that ultrasonic transducers 90, 90' are immersed within the corresponding baths 11, 12, so as to be surrounded by a wave transmission medium, increases the
15 cleaning performances of the emitted ultrasonic waves.

In particular, the reduced spacing between ultrasonic transducers 90, 90' and base portions 2c optimizes the effectiveness of the cleaning treatment of containers 2, since an increased amount of energy affects the limescale or
20 encrusted dirt deposits on the base portions 2c themselves.

The energetic impact of the operation of ultrasonic wave generators UG, UG', UG'' is particularly limited thanks to the intelligent control performed by electronic control unit ECU, which selectively activate ultrasonic transducers
25 90, 90' according to a predetermined optimized period.

The provision of tunnel T'' allows an easy maintenance of ultrasonic wave generators UG', UG'' during operation of

washing machine 1'', such that uneconomic machine downtimes are advantageously avoided.

The parallel vertical arrangement of ultrasonic wave generators UG', UG'' along the respective stretches Q2, Q4, results particularly compact and effective in respect of cleaning performances.

Moreover, vertical arrangement of stretches Q2, Q4 eases the labels detached from containers 2 to move toward the bottom of bath 12, i.e. toward suction apparatus SM, due to the gravity action.

Moreover, the filling of containers 2 with cleaning agent, which is caused by the peculiar shape of stretch Q3, renders the propagation of ultrasonic waves easier within inner volumes 2b, such that effectiveness of the ultrasonic cleaning treatment is enhanced.

Finally, the lengths of stretches Q1, Q2, Q4 are chosen according to an optimized compromise between energetic expenditure and cleaning performances, as demonstrated by several experiments accomplished by the Applicant.

Clearly, changes may be made to washing machines 1, 1', 1'', and to the method as described and illustrated herein without, however, departing from the scope of protection as defined in the accompanying claims.

In particular, the shape and arrangement of ultrasonic transducers 90, 90' may be different from what described and illustrated in the above disclosure. More in particular, stretch Q1 may be vertical, instead of horizontal, and

stretch Q2 may be horizontal, instead of vertical.

In replacement or in addition to ultrasonic wave generator UG', another ultrasonic wave generator may be coupled to bath 13 for propagating ultrasonic waves through
5 the cleaning agent contained therein.

Eventually, a washing machine according to the invention might comprise two or all of the disclosed ultrasonic wave generators UG, UG', UG''.

CLAIMS

1.- A washing machine (1; 1'; 1'') for washing empty containers (2), the washing machine comprising:

5 - a conveyor device (4) configured to convey a plurality of said containers (2) along a washing path (Q); and

 - at least one bath (11; 12) suitable for holding a cleaning medium; said washing path (Q) extending through said bath (11; 12);

10 characterized by further comprising at least one corresponding ultrasonic wave generator (UG; UG'; UG'') coupled to said bath (11; 12) and configured to propagate ultrasonic waves through said cleaning medium, such that said containers (2) can receive an ultrasonic cleaning
15 treatment during their advancement through said bath (11; 12).

2.- The washing machine of claim 1, wherein said washing path (Q) comprises a prewash zone (P1) and a hot washing zone (C1) arranged downstream of said prewash zone (P1),
20 according to an advancing direction of said containers (2) along said washing path (Q); said washing machine (1; 1'; 1'') further comprising prewashing means (11, 106) and washing means (12, 13) respectively arranged within said prewash zone (P1) and said hot washing zone (C1) for cleaning
25 said containers (2) correspondingly at lower and higher temperature; said bath (11; 12) being part of one of said prewashing means (11, 106) and said washing means (12, 13).

3.- The washing machine of claim 2, wherein said bath (12) is part of said washing means (12, 13), said washing machine (1; 1') further comprising suction means (SM) arranged within said bath (11; 12) and operable to remove
5 from said bath (11; 12) labels detached from said containers (2) during their advancement through said bath (11; 12);

said suction means (SM) and said ultrasonic wave generator (UG; UG'; UG'') having respective action areas spaced from one another.

10 4.- The washing machine of claim 3, wherein said suction means (SM) are arranged at a bottom portion of said bath (11, 12).

5.- The washing machine of any one of the foregoing claims, wherein said ultrasonic wave generator (UG; UG';
15 UG'') comprises at least one ultrasonic transducer (90; 90') being plate-shaped, configured to convert electric power into ultrasounds, and arranged within said bath (11; 12) in such a manner to face respective base portions (2c) of said containers (2) in close proximity during the advancement of
20 said containers (2) through said bath (11; 12).

6.- The washing machine of claim 5, further comprising a control unit (ECU) connected to said ultrasonic transducer (90) and configured to control power supply of said ultrasonic transducer (90).

25 7.- The washing machine of claim 6, wherein said control unit (ECU) is configured to activate said ultrasonic transducer (90; 90') according to a predetermined period and

for a predetermined activation duration; said predetermined period and duration being, in particular, selected in view of an advancing velocity of said containers (2) to guarantee an optimized balance between cleaning performance of said ultrasonic cleaning treatment and energy expenditure.

8.- The washing machine of any one of the foregoing claims, wherein said ultrasonic wave generator (UG; UG'; UG'') comprises a plurality of ultrasonic transducers (90; 90') being plate-shaped, configured to convert electric power into ultrasounds, and sequentially arranged adjacent and parallel to each other along a stretch (Q1; Q2; Q4) of said washing path (Q); said stretch (Q1; Q2; Q4) extending within said bath (11; 12).

9.- The washing machine of claim 8, comprising:

15 - a first said ultrasonic wave generator (UG') with said ultrasonic transducers (90') being sequentially arranged adjacent and parallel to said stretch (Q2); and

- a second said ultrasonic wave generator (UG'') with said ultrasonic transducers being sequentially arranged adjacent and parallel to a further stretch (Q4) of said washing path (Q);

said further stretch (Q4) extending within said bath (12) parallel to and spaced from said stretch (Q2).

10.- The washing machine of claim 8 or 9, wherein said stretch (Q1; Q2) has a length between 0.5 m and 2 m.

11.- The washing machine of any of the foregoing claims, further comprising an inspection tunnel (T''), which:

- extends through said bath (12);
- is fluidly isolated from said bath (12); and
- is accessible by a maintenance operator (U) from the outside of said washing machine (1'');

5 said washing machine (1'') further comprising a compartment (CM1'', CM2'') communicating, at least selectively, with said inspection tunnel (T'');

 said ultrasonic wave generator (UG', UG'') having a maintainable portion (G'') housed within said compartment
10 (CM1'', CM2'') such that said maintenance operator (U) is able to perform maintenance operations on said maintainable portion (G''), by accessing said compartment (CM1'', CM2'') from said inspection tunnel (T'').

12.- The washing machine of claim 11, comprising a
15 further said ultrasonic wave generator (UG'') and a further compartment (CM2'') spaced from said compartment (CM1''), housing the further said ultrasonic wave generator (UG''), and communicating, at least selectively, with said inspection tunnel (T'').

20 13.- The washing machine of any of the foregoing claims, wherein said conveyor device (4) is configured to convey said containers (2) according to an advancing direction and wherein said washing path (Q) comprises a curvilinear stretch (Q3) extending within said bath (12) upstream of the action
25 area of said ultrasonic wave generator (UG''), according to said advancing direction;

 said containers (2) comprising:

- respective base portions (2c);

- respective end portions (2d) spaced from said base portions (2c) along corresponding axes (A) and provided with corresponding inlet openings (2f); and

5 - respective external surfaces (2a) delimiting corresponding inner volumes (2b), which are adapted to receive a pourable product;

 said conveyor device (4) being configured to convey, in use, said containers (2) along said curvilinear stretch (Q3)
10 with said inlet openings (2f) respectively above the corresponding base portions (2c), such that a portion of said cleaning medium fills, in use, the corresponding said inner volumes (2b) due to gravity action.

14.- An operating method of a washing machine (1; 1';
15 1'') for washing empty containers, the method comprising the steps of:

i) advancing a plurality of said containers (2) along a washing path (Q); and

ii) filling a bath (11; 12) with a cleaning medium;
20 said washing path (Q) extending through said bath (11; 12); characterized by further comprising the step of:

iii) ultrasonic cleaning said containers (2) by propagating ultrasonic waves through said cleaning medium during the advancement of said containers (2) through said
25 bath (11; 12).

15.- The operating method of claim 14, further comprising the steps of:

iv) prewashing said containers (2) within a prewash zone (P1) of said washing path (Q); and

v) hot washing said containers (2) at an higher temperature with respect to said step iv) within a hot washing zone (C1) of said washing path (Q) downstream of said prewash zone (P1), according to an advancing direction of said containers (2) along said washing path (Q);

wherein one of said steps iv) and v) comprises the step of:

vi) advancing said containers (2) through said bath (11; 12).

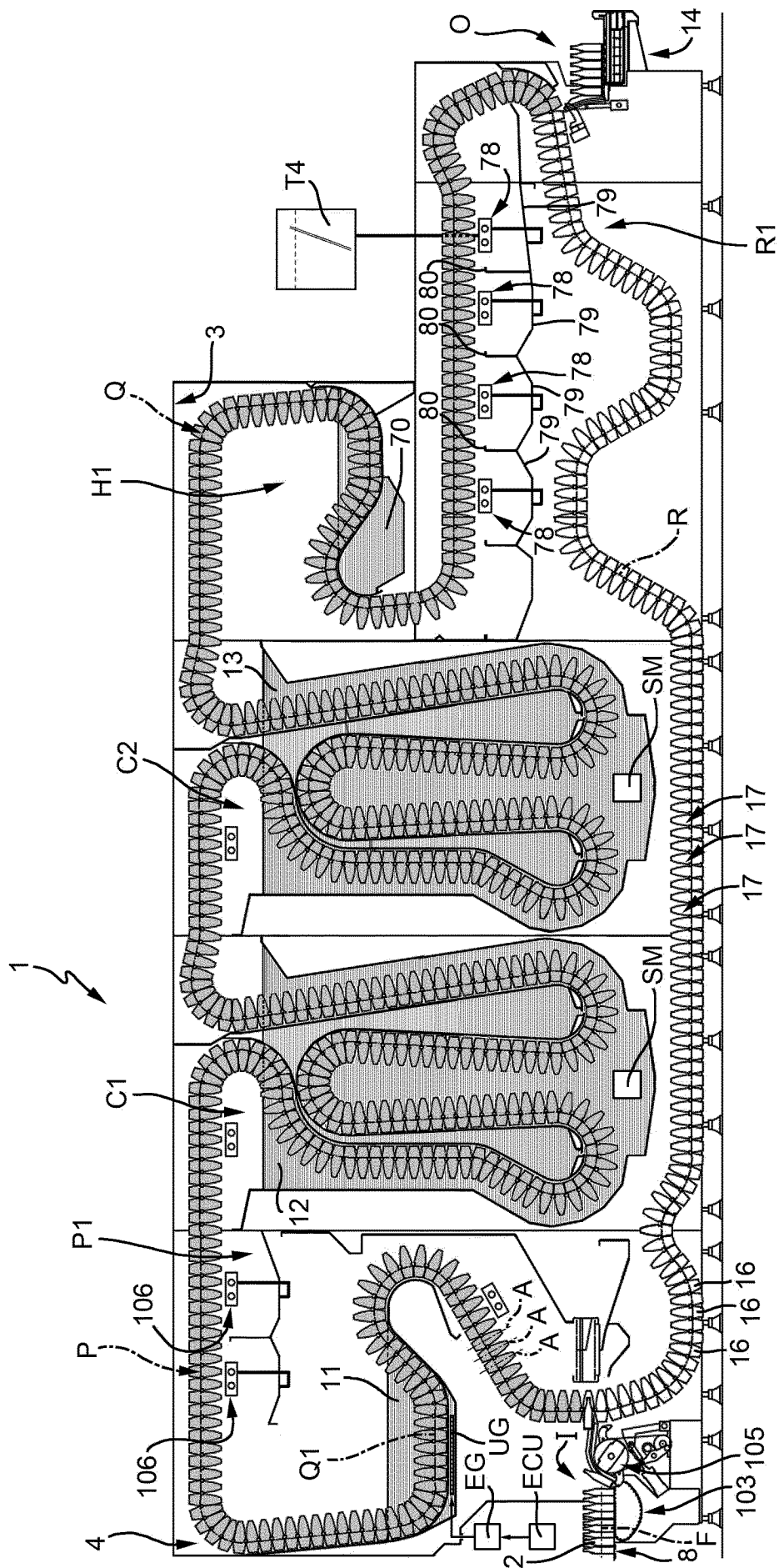
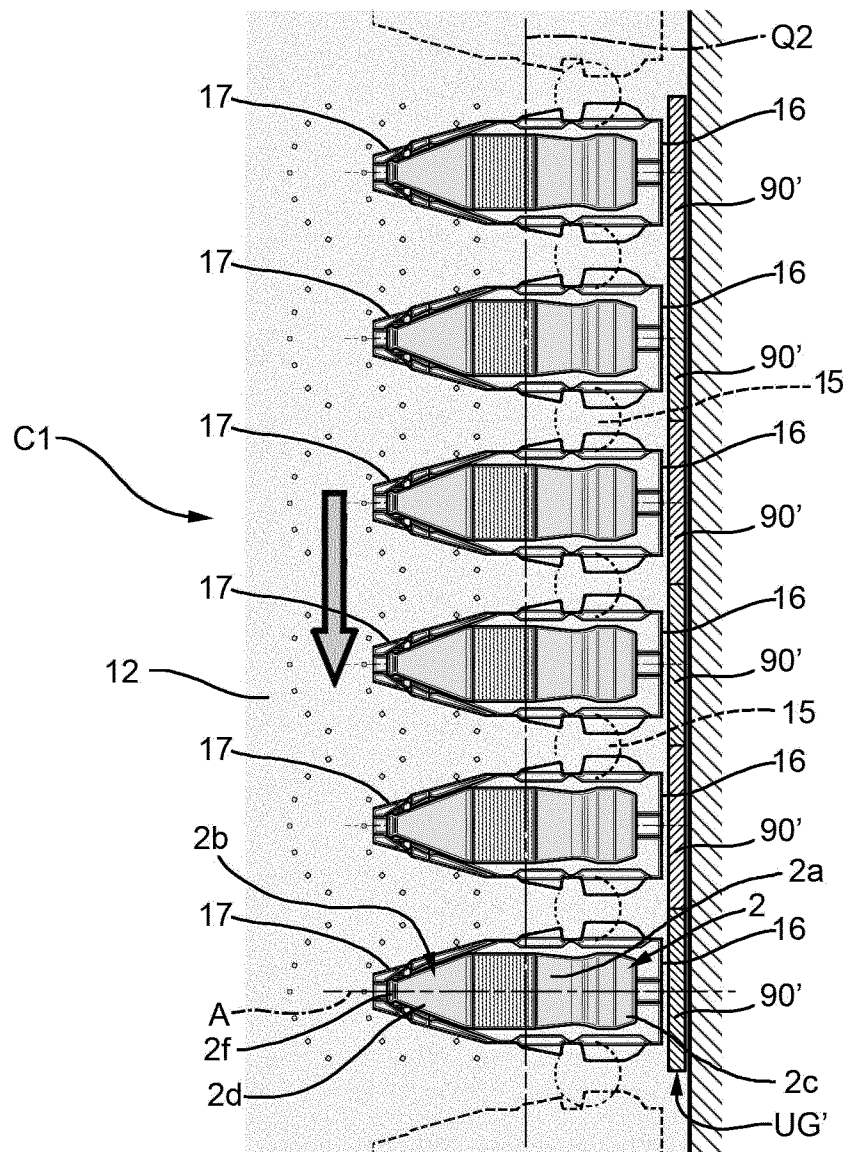
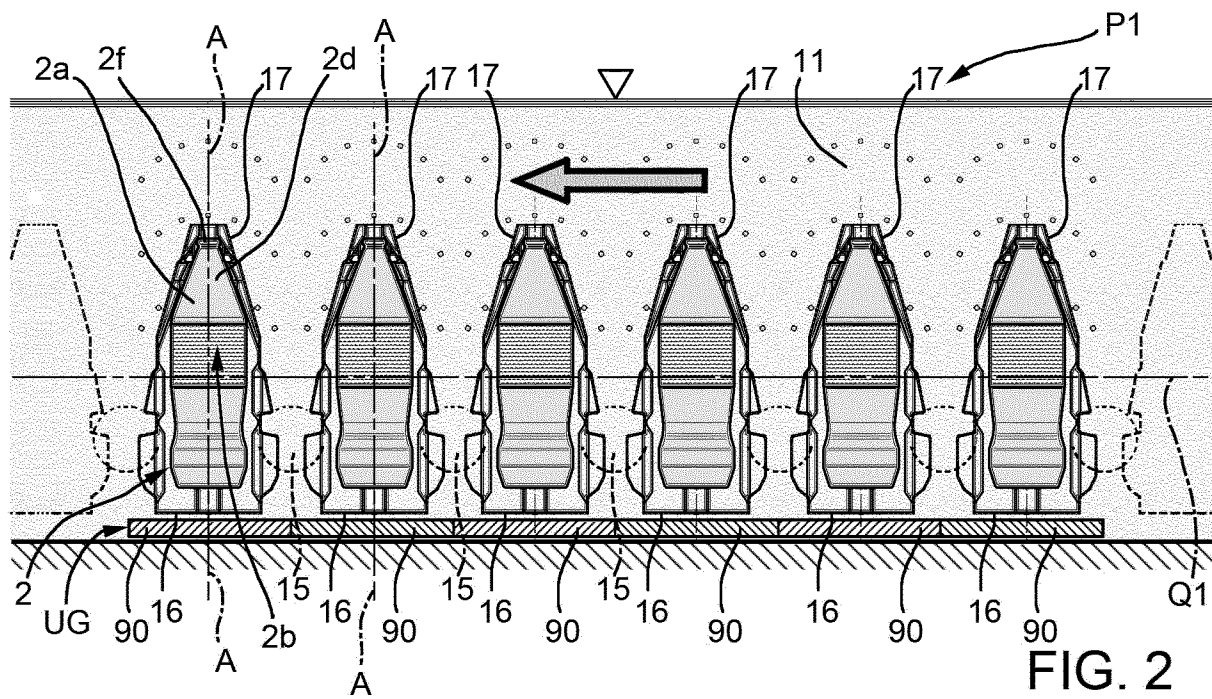


FIG. 1



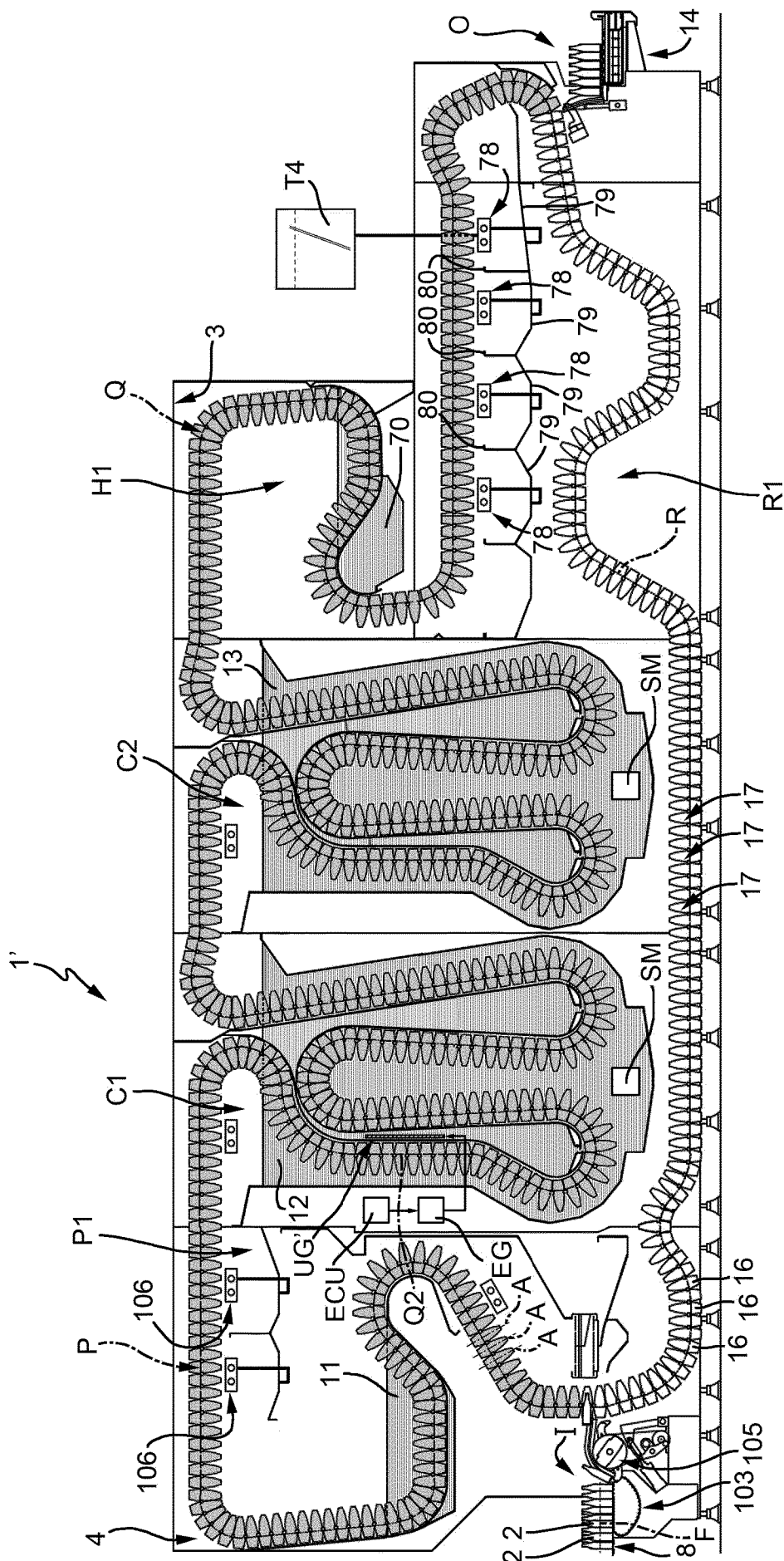


FIG. 3

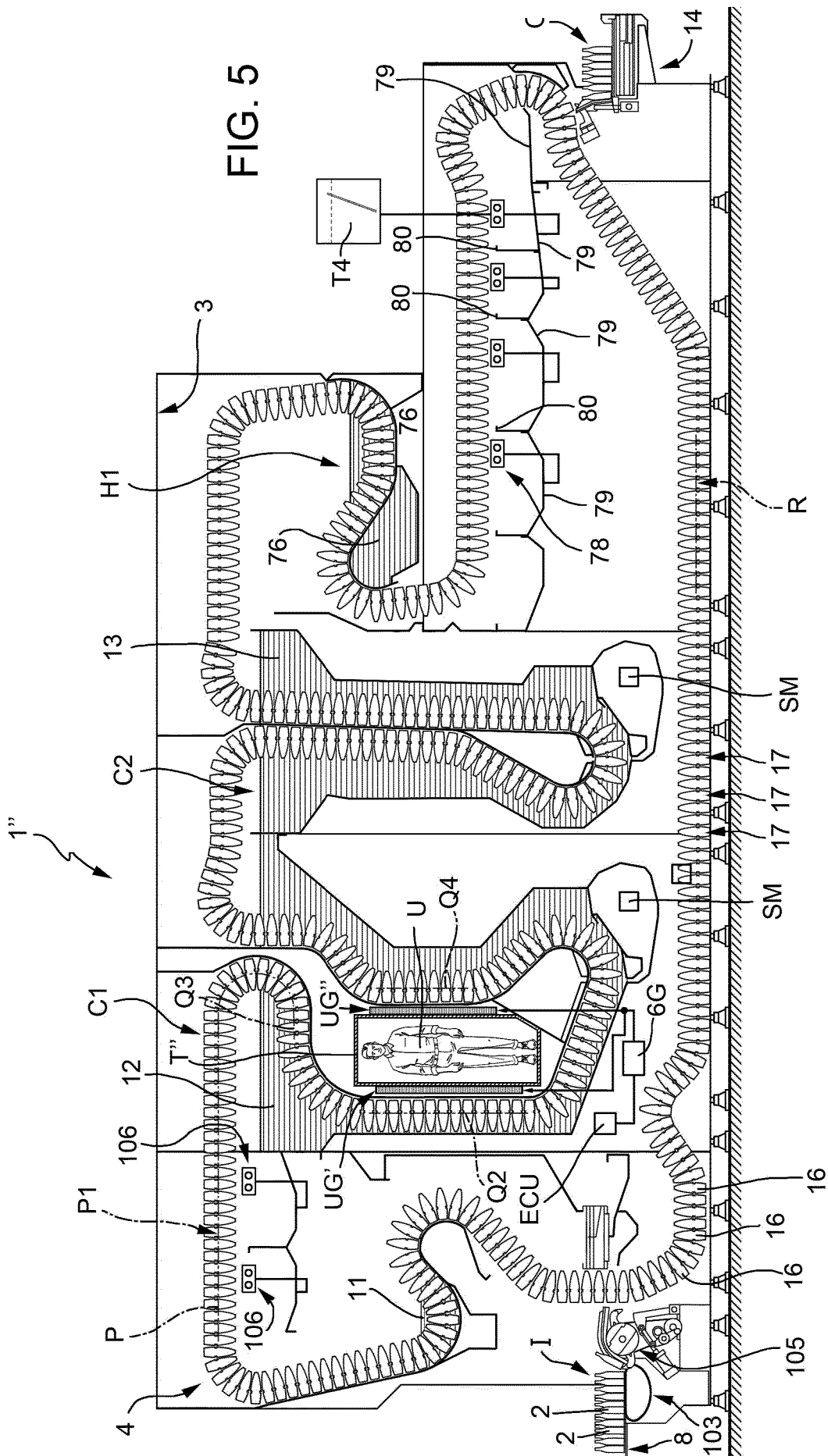
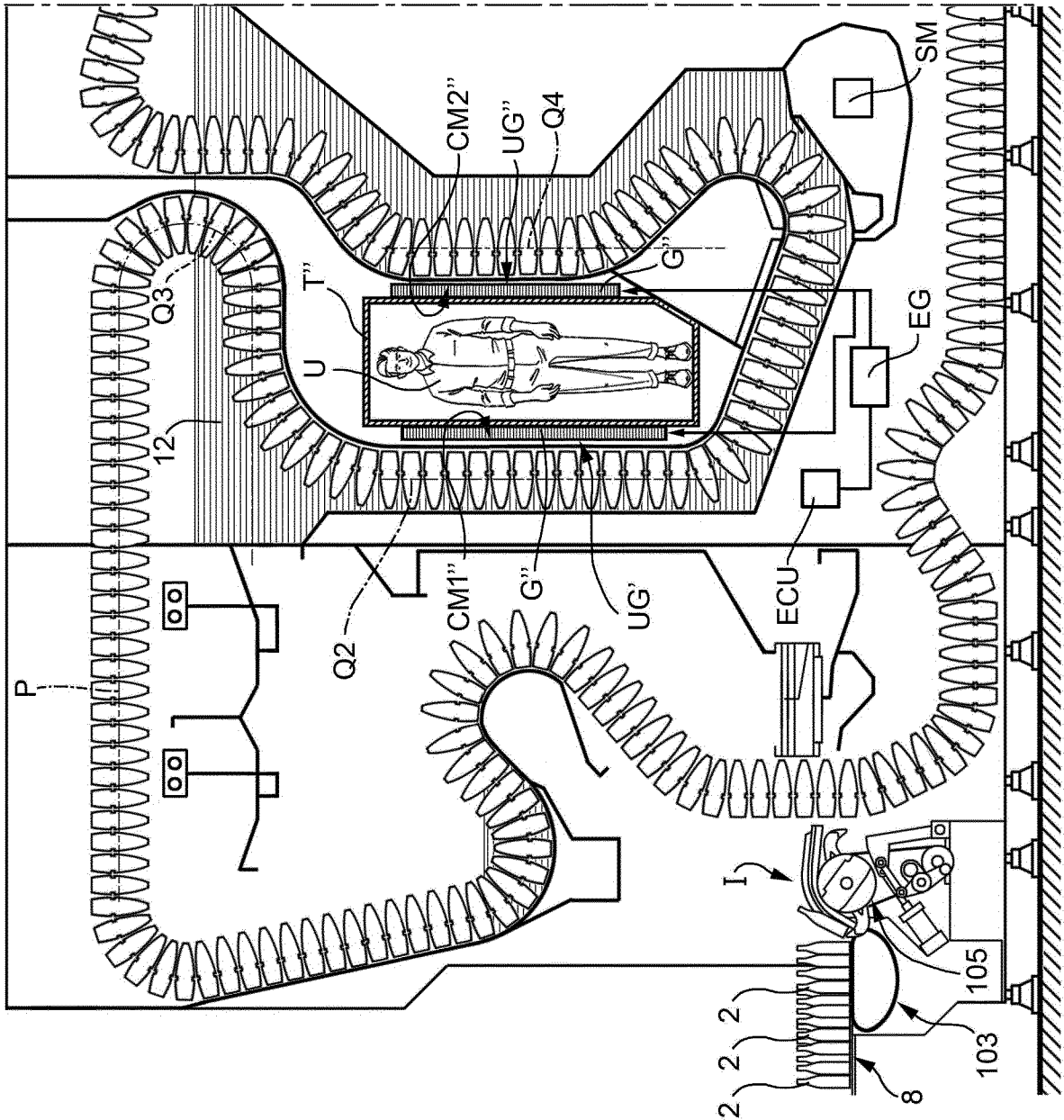


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2019/064883

A. CLASSIFICATION OF SUBJECT MATTER
 INV. B08B3/12 B08B9/30
 ADD.

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)
 B08B

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 practicable, search terms used)

EPO-Internal, WPI Data

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A		
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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

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2019/064883

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