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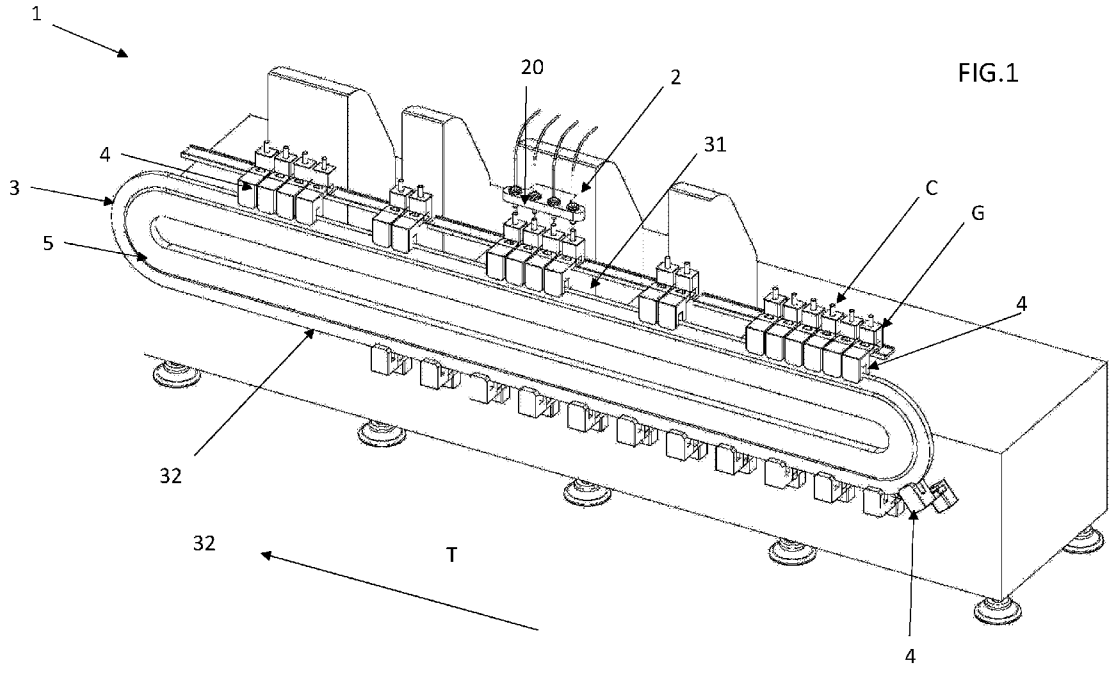


FIG.1

(57) Abstract: The invention relates to a cartridge filling machine (1) (C) for aerosol generators and presenting: a conveying assembly (3, 4, 5) arranged to convey the cartridges (C) along a conveying path (T); and at least a first filling head (2), arranged along the conveying path (T) and comprising at least one dispenser nozzle (20) for filling the cartridges (C) conveyed by the conveying assembly (3, 4, 5) with a product. The conveying assembly (3, 4, 5) has: a guide (3) defining a closed path and comprising a first portion (31), at which the first filling head (2) is arranged; a plurality of movable units (4), sliding along the guide (3) independently of each other and provided with means for receiving and holding the cartridges (C); a stator of a linear electric motor (5), fastened to the guide (3); and a plurality of magnets, fastened to the movable units (4) in order to interact with the stator of the linear electric motor (5) allowing the movable units (4) to be moved along the guide (3).

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Machine and method for filling cartridges of aerosol generators

CROSS-REFERENCE TO RELATED APPLICATIONS

This patent application claims priority from Italian patent application no. 102018000002628 filed on 13/02/2018, the entire disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

The present invention falls within the technical field of aerosol generators. In particular, the invention relates to a cartridge filling machine for aerosol generators and a cartridge filling method for aerosol generators.

Aerosol generators are those devices for personal use that dispense a gas in which liquid or solid particles are suspended. These aerosol generators have been widely used for years in the pharmaceutical industry (e.g. as medicinal inhalers), and also, more recently, in the tobacco industry (in particular for e-cigarettes).

PRIOR ART

Aerosol generators comprise a cartridge (i.e. a small container or vial) filled with a product to be dispensed. Depending on the application, the cartridge may also comprise other elements such as, for example, an absorbent substrate (if the cartridge is filled with a liquid product), or an air passage channel, or, in the specific case of electronic cigarettes, a wick with a resistance, or other elements.

The cartridge usually has a mainly longitudinal extension and may have, for example, a circular, oval or rectangular cross-section. For the purpose of filling, at one end thereof, the cartridge comprises one or more openings arranged symmetrically or asymmetrically with respect to the axis of said cartridge.

For the production of such aerosol generators, the cartridges are filled with the product to be dispensed by automatic machines.

A known cartridge filling machine for aerosol generators comprises, for example, a belt provided with seats for receiving the cartridges and for conveying the cartridges along a conveying path. The machine further comprises a plurality of filling heads, arranged above the belt and comprising corresponding dispensing nozzles to fill the cartridges conveyed by the belt with a product.

The above-described filling machine has, however, some drawbacks.

As mentioned above, the aerosol generator cartridges have a relatively small opening or in any case partially occluded by other components. As a result, filling of the same is complicated; in detail, the machines of the known art do not guarantee the precision necessary for this type of operations.

Consequently, not only is the filling of some cartridges unsuccessful, with several rejects affecting the overall productivity of the machine, but, in addition, the filling area is particularly dirty due to the product that does not reach the inside of the cartridges properly.

Patent application WO2015140768A1 discloses a cartridge filling machine for aerosol generators comprising: a conveyor assembly arranged to convey the cartridges along a conveying path, and a first filler head that is arranged along the conveying path and comprises at least one dispenser nozzle for filling the cartridges conveyed by the conveyor assembly with a product.

DESCRIPTION OF THE INVENTION

The purpose of the present invention is to overcome the aforementioned drawbacks.

This is achieved by proposing a cartridge filling machine for aerosol generators and a cartridge filling method for aerosol generators according to the appended claims.

Thanks to the invention, the filling operation of the cartridges is particularly precise: therefore, the several rejects that occurred in the prior art due to unsuccessful filling operations are avoided, to the benefit of overall productivity; in addition, the costs related to such rejects are eliminated or in any case significantly reduced, as well as the presence of unwanted product due to a lack of filling.

BRIEF DESCRIPTION OF THE DRAWINGS

Further advantages will be more evident from the description below, with the help of the attached drawings, wherein:

- Figure 1 is a perspective view of a cartridge filling machine for aerosol

generators according to the invention, according to a first embodiment;

- Figure 2 is a perspective view of a cartridge filling machine for aerosol generators according to the invention, according to a second embodiment;
- Figure 3 is a perspective view of an assembly and filling system according to the present invention;
- Figures 4A and Figure 4B are two perspective and schematic views of two aerosol generator cartridges of different types;
- Figures 5A and Figure 5B are two enlarged plan views of two cartridges C for aerosol generators of different types.

PREFERRED EMBODIMENTS OF THE INVENTION

With reference to Figures 1-3, reference numeral 1 denotes a cartridge filling machine C for aerosol generators according to the present invention. As mentioned above, said cartridges C may be used in the pharmaceutical sector (for devices dispensing medicines) or in the tobacco sector (for electronic cigarettes).

A cartridge C (illustrated in two schematic perspective views in Figures 4A and 4B, in two different examples, and with two enlarged top views in Figures 5A and 5B, according to two different examples) generally has a longitudinal extension axis H and a container body B defined by side walls L and a bottom F. On the opposite side with respect to the bottom F there is an end E with an open zone A where access to the inside of the cartridge C is provided, and an at least partially occluded zone O at which access to the inside of the cartridge C is prevented. The longitudinal extension axis H passes through said end E and the bottom F.

In particular, the open area A of the end E is understood to mean an area accessible for the purpose of filling the cartridge C, while the area at least partially occluded O is understood to mean an area at which access to the inside of the cartridge C for the purpose of filling is prevented or obstructed. In detail, as already anticipated in the introductory part of the present discussion, the at least partially occluded zone O may be determined, for example, by the presence of some components V arranged inside the cartridge C (e.g., as already

mentioned, an absorbent substrate, an air passage channel, a wick with a resistance, etc.). In Figure 5A a cartridge C of this type (in particular a cartridge C for an electronic cigarette) is visible from above and in Figure 4A, a schematic and perspective view of another cartridge C of this type is shown.

According to a further example, schematically illustrated in Figure 4B, the at least partially occluded zone O may be determined by a wall P of said cartridge C, arranged at the aforementioned end E, opposite the bottom F. In other words, in this case, the opening of the cartridge C may be arranged asymmetrically with respect to the longitudinal axis H of said cartridge C, and/or may have an irregular profile, or one or more small open zones A may still be present. With reference to figure 5B, a cartridge C is represented, from above, having a substantially rectangular cross-section and with two small open zones A arranged asymmetrically with respect to the longitudinal axis H of the cartridge C.

In Figures 1-3 a cartridge filling machine C for aerosol generators according to the present invention has been indicated with the numerical reference 1.

Also with reference to the appended figures 1-3, the cartridges C are transported along the entire machine 1 inside support containers G, also called godets, which are provided for unstable and/or small products. It is clear that the cartridges C can move, according to a variant not shown, along the entire machine 1 even in the absence of such support containers G, providing appropriate expedients. Therefore, in the following discussion, when talking about operations carried out on the cartridges C, this will be understood to mean, in general, both operations performed directly on the cartridges C, and operations performed on the support containers G housing the cartridges C.

The filling machine 1 comprises: a conveying assembly 3, 4, 5 arranged to convey the cartridges C along a conveying path T, and at least a first filling head 2 arranged along the conveying path T and comprising at least one dispensing nozzle 20 to fill with a product the cartridges C conveyed by the conveying assembly 3, 4, 5 along the conveying path T.

In particular, the conveying assembly 3, 4, 5 comprises a guide 3 that defines a

closed path (e.g. substantially elliptical, oval or rectangular) and that is arranged at least partially along the conveying path T, so that the first filling head 2 is arranged at a first portion 31 of the guide 3 (preferably above the first portion 31 of the guide 3).

Furthermore, the conveying assembly 3, 4, 5 comprises a plurality of movable units 4, which slide along the guide 3 independently of each other and are provided with means for receiving and holding the cartridges C (e.g. pincers or the like, not visible in the attached figures) possibly housed in a support container G as described above.

The conveying assembly 3, 4, 5 further comprises: a linear electric motor 5 (illustrated schematically in Figures 1-3) comprising a stator (i.e. a fixed primary) that is arranged in a fixed position along the guide 3, i.e. is fastened to the guide 3, and a plurality of movable sliders (i.e. movable secondary), each of which is electro-magnetically coupled to the stator to receive a driving force from said stator and is rigidly connected to a corresponding movable unit 4; in particular the movable sliders comprise permanent magnets (not visible in the attached figures) that are fastened to the movable units 4 to interact with the stator of the linear electric motor 5 allowing the movement of the movable units 4 along the guide 3.

The stator of the linear electric motor 5 comprises a ferromagnetic armature having a series of cavities housing the windings suitable to be driven by variable electric currents over time to generate corresponding stator magnetic fields (variable over time); each slider of the linear electric motor 5 comprises a ferromagnetic armature in which at least one permanent magnet is placed that generates a rotor magnetic field (constant over time) that interacts with the stator magnetic field to generate an electromagnetic driving force on the slider. In each movable unit 4, the slider is mounted so as to be in close proximity (approximately 1-2 mm) with the stator to minimize the gap between the ferromagnetic armature of the slider and the ferromagnetic armature of the stator.

Advantageously, the machine according to the present invention guarantees

extreme accuracy of the filling operations. In fact, the movable units 4 are independently movable along the guide 3, thanks to the presence of the linear electric motor 5 and the magnets borne by said movable units 4. Thus, a correct positioning of each movable unit 4 with respect to the dispenser nozzle 20 is always guaranteed, i.e. the correct positioning of the open area A of the cartridge C with respect to the dispenser nozzle 20 of the first filling head 2 (i.e. the perfect synchronisation of the movable units and the corresponding cartridges C with respect to the filling head 2). This is ensured by the fact that the cartridges C are filled while held by the movable units 4.

Thus, a cartridge C can be filled even in the presence of an open area A of reduced size or the presence of components V that in the known art made such filling more complex.

Therefore, not only is the productivity of the machine optimized with respect to the known solutions, but waste and the related costs are also reduced. In fact, with the proposed machine, the cartridges C are correctly filled, also avoiding the unwanted spillage of the filling product (liquid or powder) into the machine.

In the known art, however, it was not possible to move the cartridges C individually and, therefore, the possibility of unsuccessful filling of several cartridges C was multiplied with consequent rejects and undesirable presence of filling product in the machine.

The presence of a guide 3 that defines a closed path allows the recirculation of the movable units 4 along the same: in this way it is possible to take advantage of this closed path, possibly preparing additional stations at different points of the closed path of the guide 3, as will be clearer in the examples presented below. In this way, furthermore, the movable units 4 are not obliged to change feed direction at the end of the conveying operations.

As mentioned above, the drive of the movable units 4 along the guide 3 is given by the presence of the linear electric motor 5 and by the magnets that interact electro-magnetically with each other.

With reference to the figures, the guide 3 and the linear electric motor 5 have the

same extension and development (i.e. they define the same profiles); the linear electric motor 5 is, in particular, placed inside the closed path defined by the guide 3. Therefore, when information and details about the extension and/or profile of the guide 3 are provided below, it is understood that the same expedients may be provided for the linear electric motor 5.

Preferably, both the guide 3 and the linear electric motor 5 are modular, i.e. each provide a plurality of parts that can be coupled together to define a closed path.

The linear electric motor 5 comprises a plurality of windings that, when energized, produce an electromagnetic field capable of interacting with the magnets borne by the movable units 4.

The magnets are for example permanent magnets, preferably borne in pairs by each movable unit 4.

The movable units 4 are for example "U-shaped" to allow the insertion of the guide 3 into the recess of the U. The magnets are preferably borne on the inner surface of the U, so as to be facing the windings of the linear electric motor 5, fastened to the guide 3 as described above.

The movable units 4, for example, include wheels (not visible in the attached figures) that allow them to slide along the guide 3. The latter are preferably made of plastic material.

Preferably, each movable unit 4 comprises a carriage.

As mentioned above, the movable units 4 are provided with means to receive and hold the cartridges C (e.g. pincers) which, in the case illustrated, are arranged to hold the support container G housing the respective cartridge C.

Preferably, the movable units 4 do not have mechanical brakes, but are entirely controlled by the interaction between the linear electric motor 5 and the magnets.

For example, each movable unit 4 is operated intermittently, i.e. in a non-continuous motion that involves an alternation of motion phases and stop phases along the guide 3, as will be more evident below.

The movable units 4, as already mentioned, are independently controlled from each other. Advantageously, this fact makes it possible to treat each movable

unit 4 or assembly of movable units 4 independently (for example by providing a stop rather than an acceleration or a deceleration, varying the distance between one movable unit 4 and the adjacent one, varying the law of motion etc.). This optimizes the efficiency and flexibility of the machine 1.

According to one embodiment, the movable units 4 are moved (thanks to the linear electric motor 5 and the magnets, as mentioned above) to reach the first portion 31 of the guide 3 and to stop at the first portion 31 of the guide 3. According to this embodiment, the first filling head 2 is positioned above said first portion 31 of the guide 3 and is movable along forward and return vertical filling paths to allow the filling of the cartridges C in the movable units 4 when these stop along the first portion 31 of the guide 3. The vertical filling strokes are transverse, preferably perpendicular, to the direction of movement of the cartridges C in the first portion 31 of the guide 3.

Advantageously, this ensures the maximum accuracy of the filling operations, since the cartridges C are filled when they are stationary.

For example, in general, the first filling head 2 comprises a plurality of dispenser nozzles, as in the case illustrated. Each dispenser nozzle 20 (which for example comprises a needle) enters at least partially into the open zone A of a cartridge C to be filled when it is moved vertically from top to bottom during the vertical filling strokes, and then makes a return stroke, opposite the forward stroke. The product can be dispensed at the end of the forward stroke of the dispenser nozzle 20, but also immediately afterwards (during the first portion 31 of the return stroke) and/or immediately before (during the last portion of the forward stroke).

Preferably, the first filling head 2 comprises a plurality of dispenser nozzles 20, as in the case illustrated.

According to a different embodiment, the movable units 4 are moved to reach the first portion 31 of the guide 3 and travel along the first portion 31 of the guide 3 without stopping there; in addition, the first filling head 2 is positioned above the first portion 31 of the guide 3 and is movable along forward and return vertical

filling paths, and also along horizontal forward and return chasing paths to allow the filling of the cartridges in the movable units 4 while they move along the first portion 31 of the guide 3. In this case, then, the movable units 4 do not stop at the first portion 31 of the guide 3 (as, instead, in the embodiment described above), while they may for example maintain a constant speed or slow down.

According to this embodiment, the first filling head 2, in addition to performing the vertical filling strokes, during which the cartridges C are filled, follows the cartridges C i.e. the movable units 4 that travel along the first portion 31 of the guide 3 with forward and return strokes parallel to the movement direction of the cartridges C in the first portion 31 of the guide 3. Advantageously, with this embodiment the time to perform the operations is particularly reduced, thanks to the pursuit of the first filling head 2 during the transit of the cartridges C along the first portion 31 of the guide 3.

Preferably, the filling machine 1 further comprises a first weighing station 6 placed upstream with respect to the first filling head 2 along the conveying path T, to weigh the cartridges C to be filled. The first weighing station 6 is shown schematically and by way of example only in figure 2.

For example, the first weighing station 6 is arranged alongside the guide 3 and comprises at least one scale (not illustrated). According to this embodiment, the machine 1 may comprise first pick-up and transfer means (for example of the so-called "pick and place" type, not illustrated) arranged to take the empty cartridges C (or the support containers G containing the cartridges C) placed on the movable units 4 and transfer them to the scale of the first weighing station 6. Following the weighing of each cartridge C, this (possibly with the relative support container G, as mentioned) is replaced on a movable unit 4 arranged on the guide 3 by the first pick and place means.

Furthermore, the filling machine 1 may comprise a second weighing station 7 arranged downstream of the first filling head 2 along the conveying path T, for weighing the cartridges C that have been filled. The second weighing station 7 is indicated schematically and by way of example only in figure 2.

For example, the second weighing station 7 is arranged alongside the guide 3 and comprises at least one scale (not illustrated). According to this embodiment, the machine 1 may comprise second pick-up and transfer means (for example of the so-called "pick and place" type, not illustrated) arranged to take the filled cartridges C (or the support containers G containing the cartridges C) placed on the movable units 4 and transfer them to the scale of the second weighing station 7. Following the weighing of each cartridge C, this (possibly with the relative support container G) is replaced on a movable unit 4 arranged on the guide 3 by the second pick and place means.

Preferably, the first weighing station 6 and/or the second weighing station 7 each comprise multiple scales, to allow the simultaneous weighing of multiple cartridges C.

Advantageously, the first weighing station 6 and the second weighing station 7 allow the correct filling of the cartridges C (i.e. the correct quantity of product being introduced by the first filling head 2) to be checked. In fact, the difference between the weight of each cartridge C detected in the second weighing station 7 and that detected in the first weighing station 6 can be calculated, which coincides with the weight (and therefore indicates the amount) of product introduced into each cartridge C by the first filling head 2. This value is compared (e.g. via a control unit, not illustrated) with a reference value (or a range of reference values). If the detected value does not coincide with the reference value (or does not fall within the reference value range) the cartridge C can be rejected.

According to a preferred embodiment of the invention, if the detected value is less than the reference value (or range of values), the filling of the cartridge C can be suitably integrated, as will be better clarified below.

Preferably, the guide 3 of the conveying assembly 3, 4, 5 further comprises a second portion 32, arranged downstream of the first portion 31 (i.e. the first filling head 2) with respect to the conveying path T, with the movable units 4 being moved to also reach the second portion 32 of the guide 3.

For example, the second portion 32 of the guide 3 is arranged downstream of the second weighing station 7 described above. According to this embodiment, the filling machine 1 comprises a second filling head 22 (schematically illustrated and by way of example in figure 2), arranged along the conveying path T at the second portion 32 of the guide 3 and comprising at least one dispenser nozzle (the latter not illustrated). In particular, the second filling head 22 is operable to fill with a product the cartridges C placed in the movable units 4 along the second portion 32 of the guide 3, exiting the second weighing station 7. In other words, the second filling head 22 is provided for integrating the filling of the cartridges C the weight of which is below the reference value (or below the reference value range) mentioned above. Clearly, the second filling head 22 is arranged to fill a cartridge C with the amount of product needed to reach the reference value (or the range of reference values). Advantageously, this embodiment avoids rejecting those cartridges C that have been filled with a quantity of liquid less than the reference value (or range of values), thereby reducing the rejects and related costs.

With regard to the shape and movement of the second filling head 22, reference is made to the description above of the first filling head 2. In any case, in the same machine, the first filling head 2 and the second filling head 22 are not necessarily shaped and moved in the same way (e.g., in the first portion 31 of the guide 3, the first filling head 2 may fill the cartridges C when they are moving, and in the second portion 32 of the guide 3, the second filling head 22 may fill the cartridges C when they are stationary, or vice versa, and/or the filling heads may have a different number of dispensing nozzles 20).

According to one embodiment of the invention, the filling machine 1 further comprises, a capping station 8 placed along the second portion 32 of the guide 3 for capping the cartridges C in the movable units 4 when they are in the second portion 32 of the guide 3. The capping station 8 is indicated schematically and by way of example only in figure 2.

At the capping station 8, substantially, the cartridges C filled with the product are

closed with a cap by dedicated means (for example, of the "pick and place" or similar type, not illustrated), arranged in the capping station 8.

For example, the filling machine may further comprise at least one inspection station 9 placed along the second portion 32 of the guide 3 to perform an inspection of the cartridges C in the movable units 4 when they are in the second portion 32 of the guide 3. The inspection station 9 is shown schematically and by way of example only in figure 2.

Alternatively, the inspection station 9 may be arranged outside the guide 3, for example it may be alongside the guide 3. In this case, suitable means may be provided that pick up each cartridge C (with or without its support container G, depending on the inspection to be carried out) from the movable unit 4 and bring it to the inspection station 9, and then return it to the movable unit 4 once the inspection is completed.

The inspection station 9 may be provided to carry out inspections of different types. For example, the inspection may be a functional inspection of the cartridge C. In the case of cartridges C for electronic cigarettes, for example, the inspection may concern the operation of the resistance provided for heating the product. For example, if the resistance or other components of the cartridge C malfunction, the cartridge C may be rejected.

Alternatively, according to another example, the inspection station 9 may be provided to verify the actual presence of the cap. In this case, clearly, the inspection station 9 is arranged downstream of the capping station 8. In case of absence of the cap, for example, the cartridge C, in the movable unit 4, can be recirculated along the closed path of the guide 3 to reach the capping station 8 again where the cap is positioned. In this case, advantageously, the possibility of recirculating the cartridges C prevents any cartridges C without a cap from being rejected.

According to another example, the inspection station 9 may be provided to verify the presence of any component of the cartridge C, as in the case of a component previously assembled to the cartridge C. If necessary, the correct assembly of the

component in the cartridge C may be verified.

Preferably, the second portion 32 of the guide 3 is parallel to the first portion 31 of the guide 3.

According to one embodiment of the invention, illustrated for example in Figure 1 and Figure 3, the closed path defined by the guide 3 lies on a vertical plane.

According to an alternative, illustrated for example in Figure 2, the closed path defined by the guide 3 lies on a horizontal plane.

Clearly, depending on whether the lying plane is vertical or horizontal, the stations/elements described above may or may not be present in the second portion 32 of the guide 3. For example, the second filling head 22 is present in the second portion 32 of the guide 3 if the closed path defined by the guide 3 lies on a horizontal plane.

The present invention further relates to a method of filling cartridges C for aerosol generators. The method according to the present invention is preferably, but not exclusively, implemented using a filling machine 1 as described above.

The method according to the invention comprises the steps of:

- conveying the cartridges C along a conveying path T;
- filling the cartridges C conveyed along the conveying path T with a product.

In particular, the conveying step comprises the sub-steps of: providing a plurality of movable units 4 to which magnets are fastened along a guide 3 defining a closed path; and providing a linear electric motor 5 fastened to the guide 3.

The method further comprises the steps of

- placing the cartridges C on the movable units 4;
- energizing the linear electric motor 5 with electric current so that it interacts with the magnets to convey the movable units 4 independently from each other along the conveying path T, allowing the filling of the cartridges C.

Advantageously, this ensures a high accuracy of the filling operations, even in the presence of a small open area A of cartridges C or of components V that would

obstruct the filling operations (i.e. the entrance of the dispenser nozzle 20 in the open area A). This is ensured by the fact that the cartridges C are conveyed independently of each other thanks to the presence of the movable units 4, which slide along the guide 3 thanks to the presence of the magnets and the linear electric motor 5. Preferably, the cartridges C are intermittently conveyed along the guide 3 to be filled and possibly reach other stations provided in the machine, as described above.

The invention further relates to a system S for assembling and filling cartridges C for aerosol generators, schematized by way of example in Figure 3.

The system S comprises a filling machine 1 for cartridges C of aerosol generators according to any of the above described embodiments and a machine 10 for assembling parts of cartridges C for aerosol generators, arranged upstream or downstream of the aforementioned filling machine 1.

The assembling machine 10 comprises:

- a plurality of assembling stations 11 for assembling parts of cartridges C of aerosol generators; and
- an assembling guide 30 defining a closed path and placed at least partially along the conveying path T;
- a plurality of movable units 40 sliding along the assembling guide 30 in an independent manner and provided with means for receiving and holding the cartridges (not visible).

In particular, the assembly stations 11 are arranged along the assembling guide 30 to assemble parts of cartridges C transported by the movable units 40 along the assembling guide 30.

The system further comprises:

- a linear electric motor 50 (schematically illustrated in figure 3) comprising a stator (i.e. a fixed primary) that is arranged in a fixed position along the guide 3, i.e. is fastened to the assembling guide 30, and a plurality of movable sliders (i.e. movable secondary), each of which is electro-magnetically coupled to the stator to receive a driving force from said stator

and is rigidly connected to a corresponding movable unit 40; and

- a plurality of magnets (not shown in the figures), fastened to the movable units 40 and forming part of the corresponding sliders in order to interact with the stator of the linear electric motor 50 allowing the movable units 40 to be moved along the assembling guide 30.

The stator of the linear electric motor 50 comprises a ferromagnetic armature having a series of cavities housing the windings suitable to be driven by variable electric currents over time to generate corresponding stator magnetic fields (variable over time); each slider of the linear electric motor 50 comprises a ferromagnetic armature in which at least one permanent magnet is placed that generates a rotor magnetic field (constant over time) that interacts with the stator magnetic field to generate an electromagnetic driving force on the slider. In each movable unit 40, the slider is mounted so as to be in close proximity (approximately 1-2 mm) with the stator to minimize the gap between the ferromagnetic armature of the slider and the ferromagnetic armature of the stator.

The system S further comprises at least one transfer device 12, for transferring the assembled cartridges C from the assembling machine 10 to the filling machine 1 or vice versa.

With regard to the characteristics of the assembling guide 30, the linear electric motor 50 of the machine 10 assembling the relative movable units 40, refer to the above description for the filling machine 1.

As for the assembling stations 11, these may be of different types. In the case in which the assembling machine 10 is arranged upstream of the filling machine 1 and in the case of cartridges C for electronic cigarettes, for example, the assembling stations 11 may comprise: a supply station of a base element; a supply station of an electronic circuit and an assembly station to the base element (for example by means of “pick and place” type devices), a station supplying and assembling a heater element and/or an air passage element to an already pre-assembled group, etc.

The various components/parts are then gradually assembled on each movable

unit. To this end, the assembling stations 11 are arranged consecutively with each other along the assembling guide 30.

Again, as in the case of the above-described filling machine 1, the assembling guide 30 may comprise two portions 33, 34 or two parallel branches, and the assembling stations 11 may be arranged on both portions 33, 34.

On the other hand, if the assembling machine 10 is arranged downstream of the filling machine 1 described above, the assembling stations 11 may be provided for the assembly of additional components/parts. According to one example, a first or second capping device of the cartridge C may be provided (i.e. a capping station may be provided).

Regarding the transfer device 12, this may be of any type. In the attached figure 3, by way of a non-limiting example a rotating, horizontal axis transfer device 12 is shown. Alternatively, a "pick and place" type device may be provided that takes a cartridge C from a movable unit placed on the assembling guide 30 of the assembling machine 10 and transfers it to the movable unit placed on the guide 3 of the filling machine 1.

With reference to figure 3, the assembling machine 10 comprises two assembling guides 30, each fastened to a corresponding linear electric motor 50. Clearly, various alternatives may be envisaged.

With the system S described above, advantageously, dirtying of the assembly area with the product delivered by the filling head 2 is avoided (for example in case of malfunction).

According to an embodiment not illustrated, the filling machine guide and the assembling guide of the assembling machine coincide (no transfer device is provided), just as the linear motor may coincide.

The invention further relates to a method of filling and assembling cartridges C for aerosol generators that may be implemented, but not exclusively, with the system S described above.

In addition to the steps already described for the aforementioned filling method, the method comprises, before or after such steps, the steps of:

- conveying the cartridges C (or parts of cartridges C) along a conveying path T;
- assembling the cartridges C (or parts of cartridges C) conveyed along the conveying path T.

In particular, the conveying step comprises the sub-steps of: providing a plurality of movable units 40 to which magnets are fastened along an assembling guide 30 defining a closed path; and providing a linear electric motor 50 fastened to the guide 30.

The method further comprises the steps of

- arranging the cartridges C (or parts of cartridges C) on the movable units 40;
- energizing the linear electric motor 50 with electric current so that it interacts with the magnets to convey the movable units 40 independently from each other along the conveying path T, allowing the assembly of the cartridges C.

CLAIMS

1) Cartridge (C) filling machine (1) for aerosol generators, comprising:

- a conveying assembly (3, 4, 5) which is placed to convey the cartridges (C) along a conveying path (T) and presents a guide (3) defining a closed path; and
- at least a first filling head (2), placed along a first portion (31) of the conveying path (T) and comprising at least one dispenser nozzle (20) for filling the cartridges (C) conveyed by the conveying assembly (3, 4, 5) with a product;

the filling machine (1) is **characterized in that** the conveying assembly (3, 4, 5) comprises:

- a plurality of movable units (4) sliding along the guide (3) in an independent manner and provided with means for receiving and holding the cartridges (C);
- a stator of a linear electric motor (5) that is fastened to the guide (3); and
- a plurality of magnets, fastened to the movable units (4) in order to interact with the stator of the linear electric motor (5) allowing the movement of the movable units (4) along the guide (3).

2) The filling machine (1) according to claim 1, wherein:
the movable units (4) are moved to reach the first portion (31) of the guide (3) and to stop at said first portion (31) of the guide (3); and
the first filling head (2) is positioned above said first portion (31) of the guide (3) and is movable along forward and return vertical filling paths to allow the filling of the cartridges (C) in the movable units (4) when these stop along the first portion (31) of the guide (3).

3) The filling machine (1) according to claim 1, wherein:
the movable units (4) are moved to reach the first portion (31) of the guide (3) and travel along the first portion (31) of the guide (3) without stopping there; and

the first filling head (2) is positioned above the first portion (31) of the guide (3) and is movable along forward and return vertical filling paths and also along horizontal forward and return chasing paths to allow the filling of the cartridges in the movable units (4) while they move along the first portion (31) of the guide (3).

4) The filling machine (1) according to any one of the preceding claims, further comprising a first weighing station (6) placed upstream with respect to the first filling head (2) along the conveying path (T), for weighing the cartridges (C) to be filled.

5) The machine (1) according to any one of the preceding claims, further comprising a second weighing station (7) placed downstream with respect to the first filling head (2) along the conveying path (T), for weighing the filled cartridges (C) so as to determine the weight of product introduced into each cartridge by the first filling head (2).

6) The machine (1) according to any one of the preceding claims, wherein the guide (3) further comprises a second portion (32) placed downstream of the first portion (31) with respect to the conveying path (T).

7) The machine (1) according to claim 6 comprising a second filling head (22) placed along the conveying path (T) at the second portion (32) of the guide (3); comprising at least one dispensing nozzle and being activatable to fill with the cartridges (C) with additional product, wherein the weight of product introduced by the first filling head (2) is less than a reference value.

8) The filling machine (1) according to claim 7, wherein the second filling head (22) feeds in a cartridge (C) an amount of product equal to the difference between the reference value and the weight of product introduced by the first filling head (2).

9) The filling machine (1) according to claim 6, 7 or 8 further comprising a capping station (8) placed along the second part (32) of the guide (3) for capping the cartridges (C) in the movable units (4) when they are in the second portion (32) of the guide (3).

10) The filling machine (1) according to any of the claims from 6 to 9, further comprising at least an inspection station (9) placed along the second portion (32) of the guide (3) to perform an inspection of the cartridges (C) in the movable units (4) when they are in the second part (32) of the guide (3).

11) The filling machine (1) according to any of the claims from 6 to 10, wherein the second portion (32) of the guide (3) is parallel to the first portion (31) of the guide (3).

12) The filling machine (1) according to any one of the preceding claims, in which the closed path defined by the guide (3) lies on a vertical plane.

13) The filling machine (1) according to any one of the preceding claims from 1 to 11, wherein the closed path defined by the guide (3) lies on a horizontal plane.

14) Method of filling cartridges (C) for aerosol generators, comprising the steps of:

- conveying the cartridges (C) along a conveying path (T) by means of a conveying assembly (3, 4, 5) presenting a guide (3) defining a closed path; and
- filling with a product and by means of a first filling head (2) the cartridges (C) conveyed along the conveying path (T);

the filling method is **characterised in that**:

the conveying step comprises the sub-steps of: providing a plurality of movable units (4) fitted with magnets and sliding along the guide (3); providing a stator of a linear electric motor (5) fastened to the guide (3); and

the further steps provided for are: placing the cartridges (C) on the movable units (4); and energizing the stator of the linear electric motor (5) so that it interacts with the magnets to convey the movable units (4) independently from each other along the conveying path (T), allowing the filling of the cartridges (C).

15) Assembly and filling system (S) of cartridges (C) for aerosol generators comprising:

a filling machine (1) according to any of the claims from 1 to 13;

an assembling machine (10) of parts of cartridges (C) for aerosol generators, placed upstream or downstream of the filling machine (1); and

at least a transfer device (12), for transferring the cartridges (C) assembled by the assembling machine (10) to the filling machine (1) or vice versa;

wherein the assembling machine (10) comprises:

- a plurality of assembling stations (11) for assembling parts of cartridges (C) of aerosol generators;
- an assembling guide (30) defining a closed path and placed at least partially along the conveying path (T);
- a plurality of movable units (40), sliding along the assembly guide (30) independently of each other and provided with means for receiving and holding the parts of cartridges (C); the assembling stations (11) being placed along the assembly guide (30) to assemble the parts of cartridges (C) parts conveyed by the movable units (40) along the assembling guide (30);
- a stator of a linear electric motor (50), fastened to the assembly guide (30); and
- a plurality of magnets, fastened to the movable units (40) in order to interact with the stator of the linear electric motor (50) allowing the movable units (40) to be moved along the assembly guide (30).

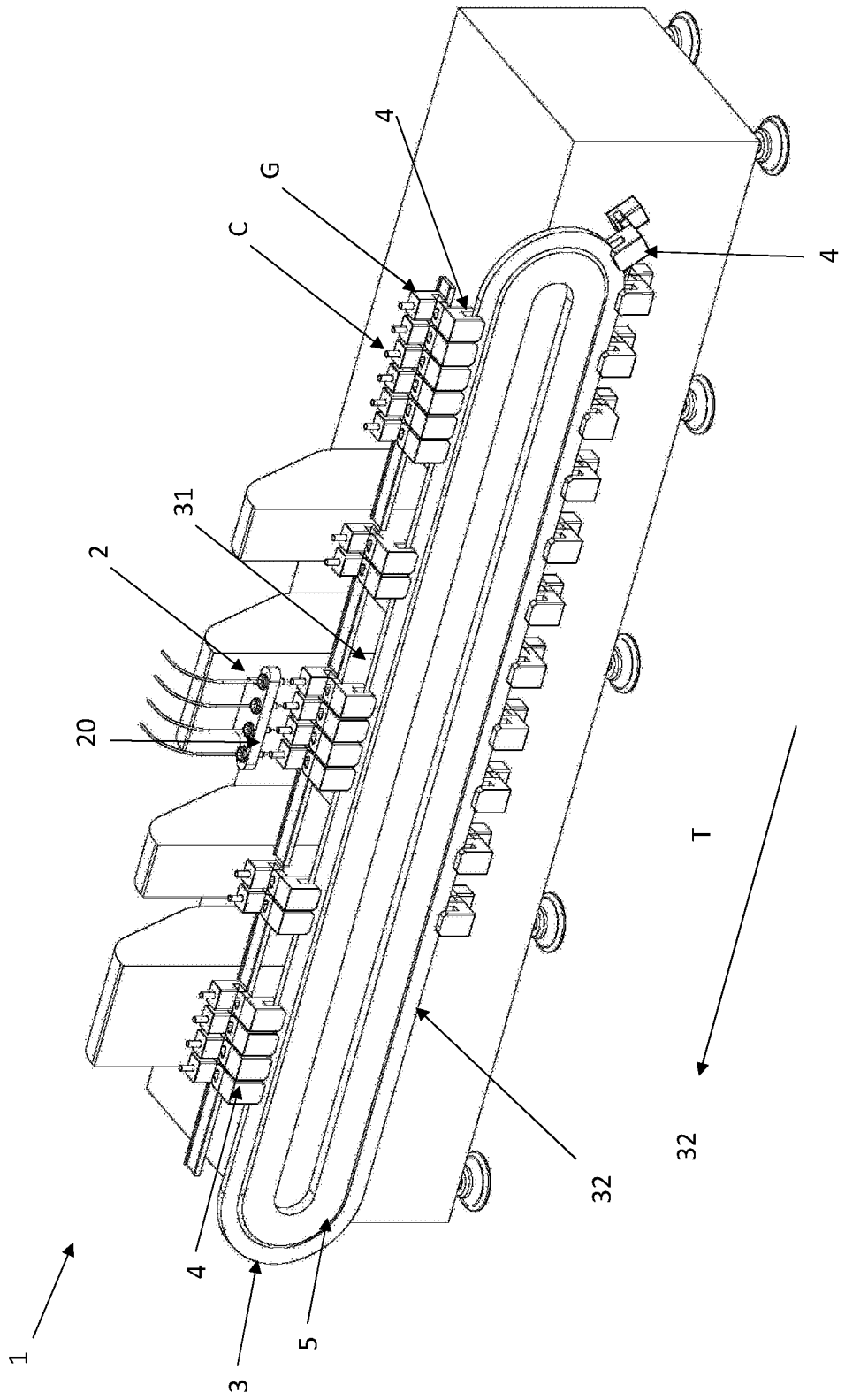


FIG.1

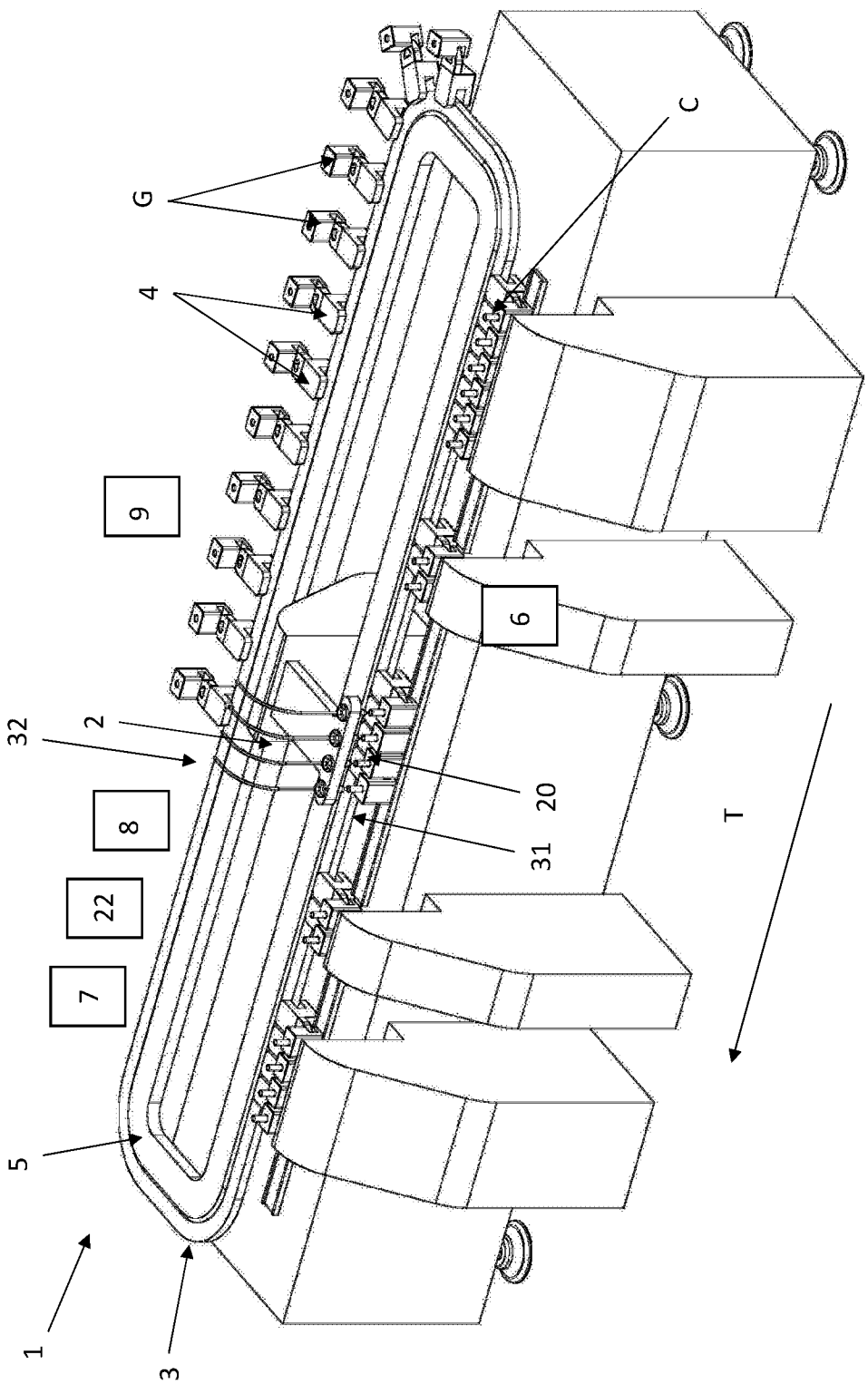


FIG.2

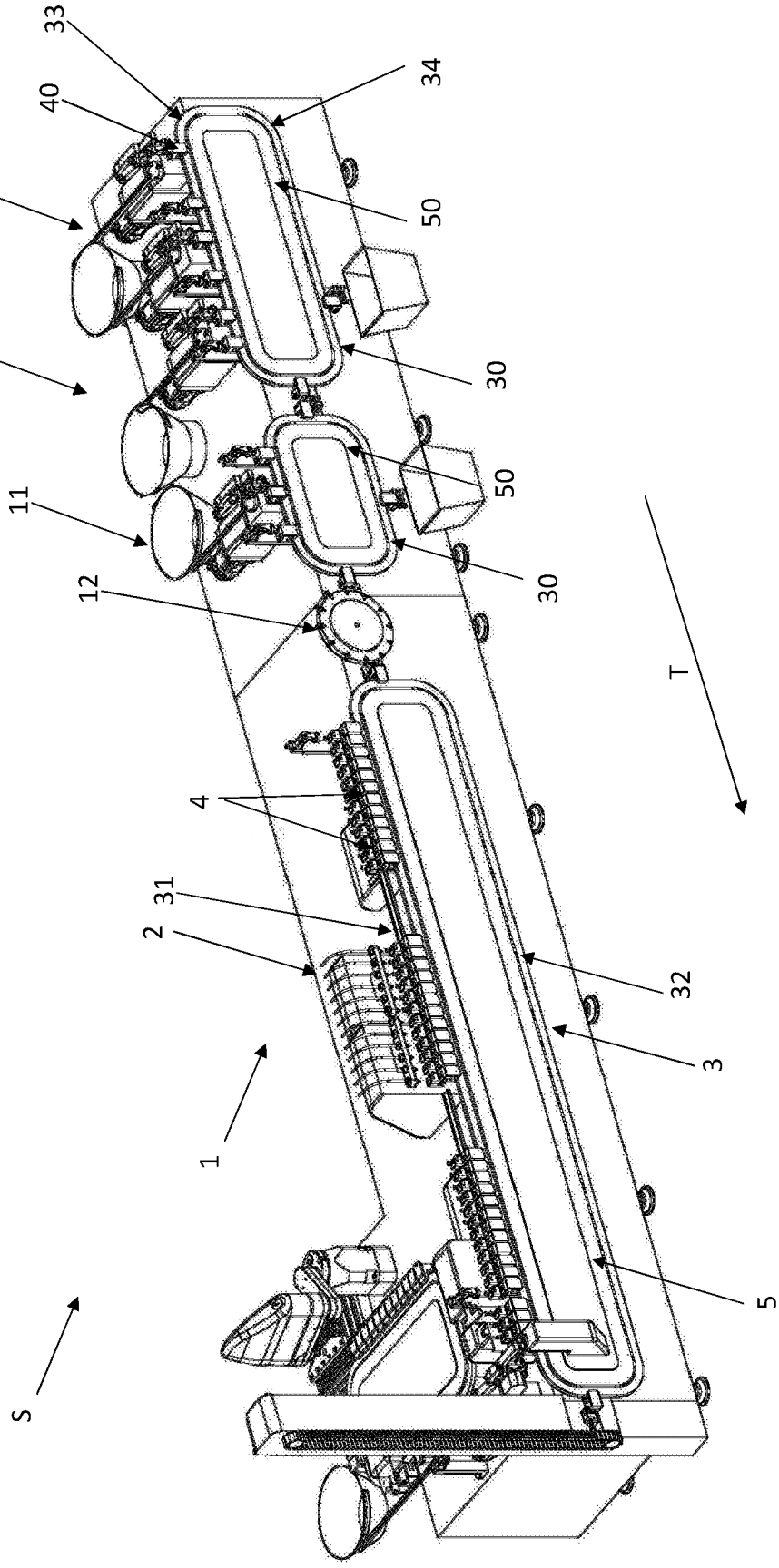


FIG.3

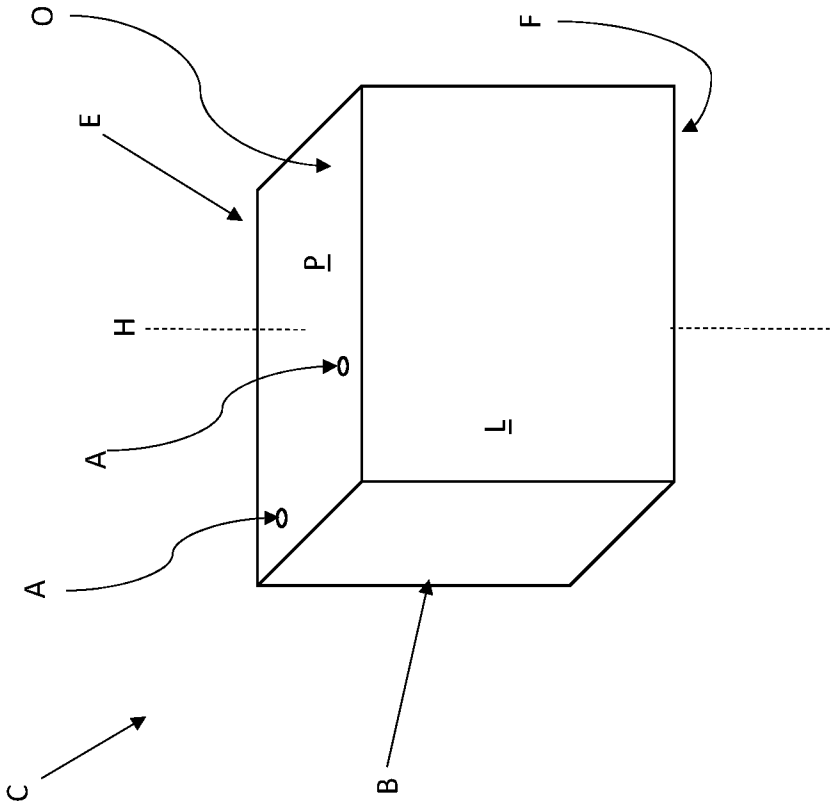


FIG.4B

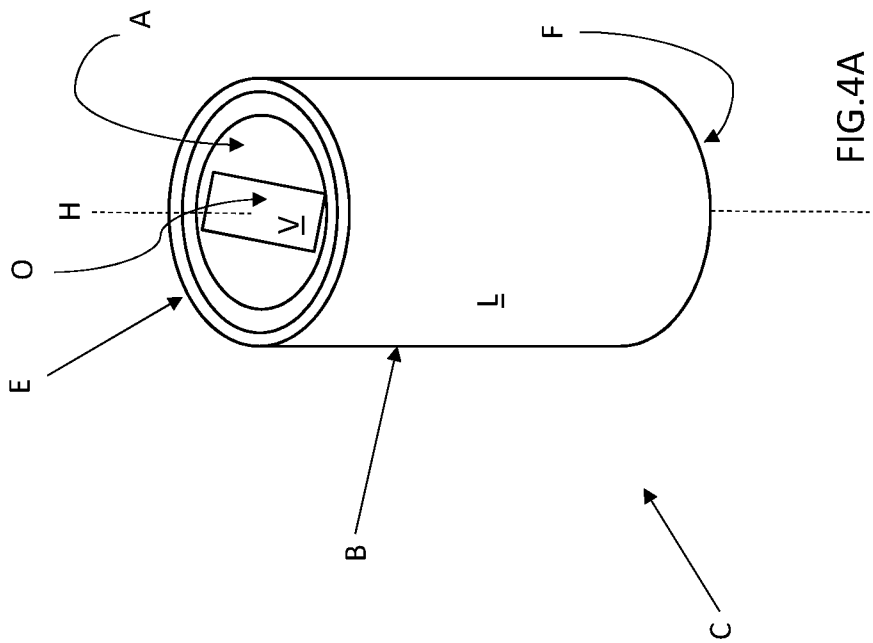


FIG.4A

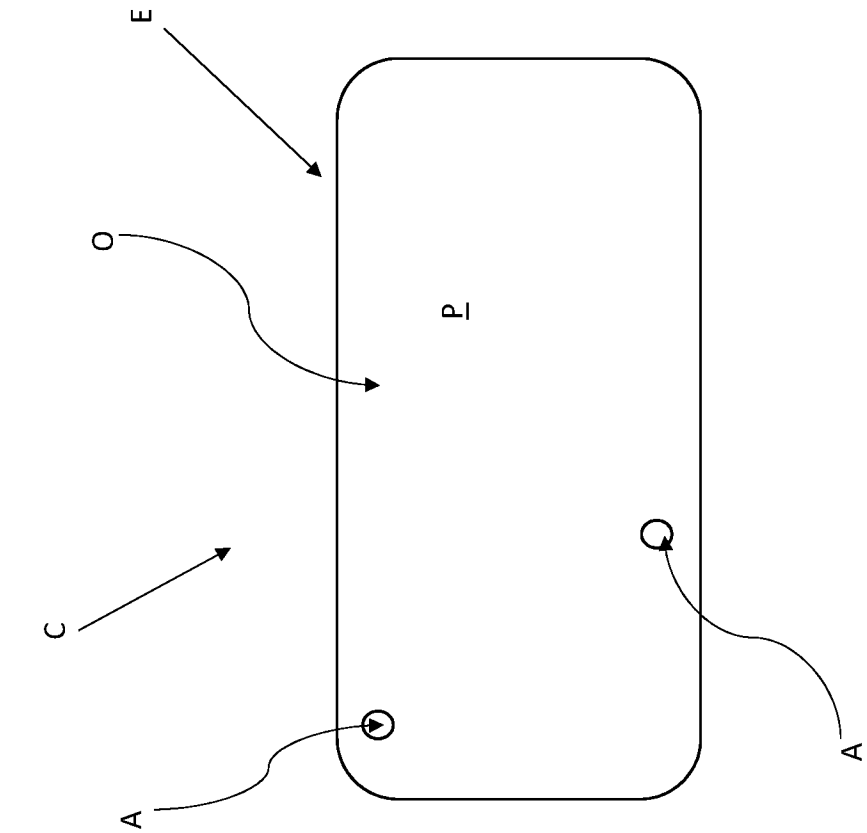


FIG.5B

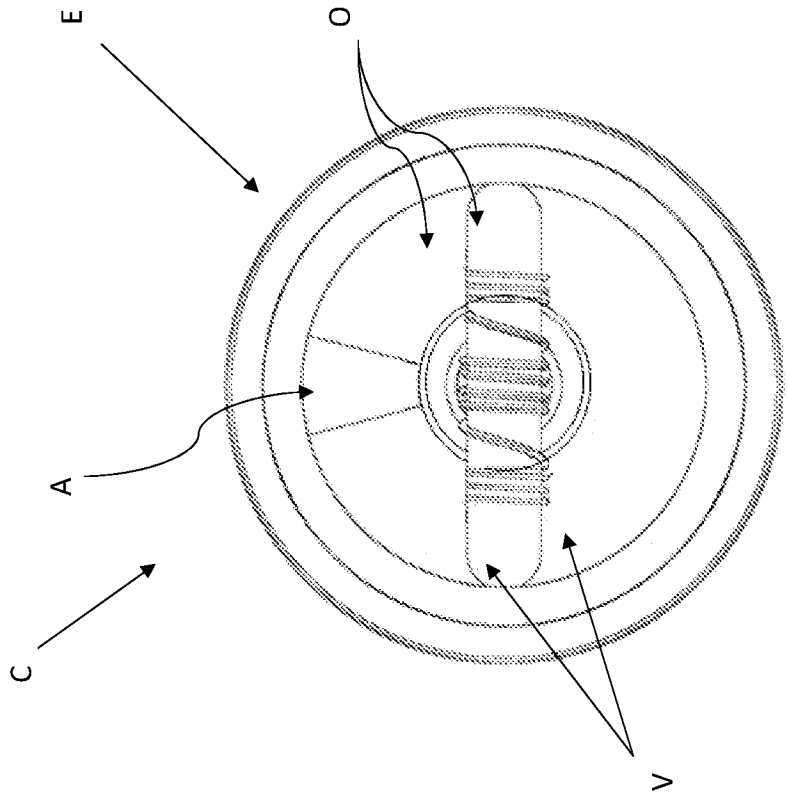


FIG.5A

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2019/051157

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65B43/54 B65B3/04
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)
B65B B65G

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2015/140768 A2 (GD SPA [IT]) 24 September 2015 (2015-09-24) abstract figures 3-4 figures 10-11 claim 8 -----	1-15
Y	EP 2 889 238 A1 (SIDEL SPA CON SOCIO UNICO [IT]) 1 July 2015 (2015-07-01) abstract figures 1-6 paragraph [0040] - paragraph [0045] paragraph [0051] ----- -/--	1-15

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 July 2019	12/07/2019

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Damiani, Alberto

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2019/051157

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2014/090462 A1 (BOSCH GMBH ROBERT [DE]) 19 June 2014 (2014-06-19) abstract claim 1 figures 1-3	1-5,12, 14
Y	DE 41 33 114 A1 (RUPP MICHAEL [DE]) 8 April 1993 (1993-04-08) abstract claims 2-3	1-5,12, 14
Y	WO 2016/200259 A1 (SLUIS CIGAR MACHINERY BV [NL]) 15 December 2016 (2016-12-15) abstract page 9, line 32 - line 36	2,3
Y	US 2015/191266 A1 (HOLMES KIRK [US] ET AL) 9 July 2015 (2015-07-09) abstract claim 1	6-8
Y	US 2016/143363 A1 (BOLDRINI FULVIO [IT]) 26 May 2016 (2016-05-26) abstract figures 9, 11	15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2019/051157

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-5, 12, 14

   Filling machine with a filling head that is movable along horizontal forward and return chasing paths.

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2. claims: 6-11

   Filling machine comprising a second filling head.

   ---

3. claim: 13

   Filling machine with a guide lying on a horizontal plane.

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4. claim: 15

   Assembly and filling system with a plurality of assembling stations.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2019/051157

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		PL 3119678 T3	29-03-2019
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