

Description

TECHNICAL FIELD

[0001] The present invention relates to a filling machine to fill a capsule with a quantity of an incoherent product (i.e. which is without cohesion, adhesion between the parts of which it is composed and therefore is without a defining form such as a powder product or a liquid product).

[0002] The present invention finds advantageous application in a filling machine to fill a capsule with a quantity of a powdered pharmaceutical product, to which the following disclosure will make explicit reference without losing any generality.

PRIOR ART

[0003] At present, the automatic filling machines to fill a capsule with a quantity of a powdered pharmaceutical product are relatively complex (therefore expensive) and slow (that is, they are not able to achieve very high hourly productivity).

[0004] Patent applications WO2013035061A2, US4151698A, WO2010007633A1 and US4024694A describe some examples of automatic filling machines to fill a container with a quantity of an incoherent product.

DESCRIPTION OF THE INVENTION

[0005] The object of the present invention is to provide a filling machine to fill a capsule with a quantity of an incoherent product, the filling machine is both easy and inexpensive to implement and allows a higher hourly productivity to be obtained with respect to the known automatic filling machines. According to the present invention, a filling machine to fill a capsule with a quantity of an incoherent product is provided, as claimed in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The present invention will now be described with reference to the accompanying drawings, which illustrate an example of a non-limiting embodiment, wherein:

- Figure 1 is a perspective view of a capsule containing a quantity of an incoherent product;
- Figure 2 is a perspective and schematic view of a filling machine which performs the filling and sealing of the capsule of Figure 1 and is made according to the present invention;
- Figure 3 is a different perspective and schematic view of the filling machine of Figure 2;
- Figure 4 is a schematic and plan view of the filling machine of Figure 2;
- Figure 5 is a schematic and plan view of a tray used

in the filling machine of Figure 2;

- Figure 6 is a schematic view of a feeding unit of the filling machine of Figure 2;
- Figures 7, 8 and 9 are three schematic views of a vein of the feeding unit of Figure 6;
- Figure 10 is a schematic view of a cleaning device of the filling machine of Figure 2; and
- Figure 11 is a perspective and enlarged view of a cleaning nozzle of the cleaning device of Figure 10.

PREFERRED EMBODIMENTS OF THE INVENTION

[0007] Figure 1 illustrates a capsule 1 containing a quantity of an incoherent product 2 (that is, which is without cohesion, adhesion between the parts of which it is composed and therefore is without a defining form such as a powder product or a liquid product). The capsule 1 is cup-shaped and has an upper end 3 which is initially opened for introducing a quantity of an incoherent product and is subsequently sealed by applying a lid 4; preferably, at the upper end 3, the capsule 1 has an annular rim 5 on which the lid 4 is placed and heat-sealed to obtain an airtight seal. According to a possible, but not limiting embodiment the incoherent product is a powder product for medical use.

[0008] In Figures 2 and 3, number 6 denotes, as a whole, a filling machine that performs the filling and sealing of the capsules 1.

[0009] The filling machine 6 comprises a feeding unit 7 which receives a disorderly mass of empty capsules 1 (i.e. a mass of empty capsules 1 loosely arranged), sorts and arranges the empty capsules 1, and feeds the empty capsules 1 in corresponding trays 8 each provided with a plurality of pockets 9 (illustrated in Figure 5) designed to hold respective empty capsules 1. As illustrated in Figure 4, the feeding unit 7 comprises an input station S1 in which the empty trays 8 (i.e. without capsules 1) arrive to the feeding unit 7, an insertion station S2 in which the trays 8 progressively receive the empty capsules 1, and finally an output station S3 in which the full trays 8 (that is, in which all the pockets 9 contain respective empty capsules 1) leave the feeding unit 7. The feeding unit 7 comprises a feeding conveyor 10 (shown in Figure 4 with a pusher) which moves each tray 8 along a feeding direction D1 from the input station S1 to the output station S3 passing through the feeding station S2.

[0010] As better illustrated in Figure 5, each tray 8 comprises a plurality of pockets 9 arranged in a series of rows (ten rows in the non-limiting embodiment illustrated in Figure 5) each having a plurality of pockets 9 (ten pockets 9 in the non-limiting embodiment illustrated in Figure 5); according to an alternative embodiment not illustrated, the various rows have a number of differentiated pockets 9 (e.g. the first and the last row can comprise eight pockets 9 instead of ten pockets 9) and/or the pockets 9 of the various rows are all aligned to one another (e.g. the pockets 9 of the various rows can have two alignments interposed one with the other). Each pocket 9 is formed

by a blind hole which is obtained through an upper wall of the corresponding tray 8 and reproduces in negative the shape of the capsules 1 so as to house (with a minimum clearance) the capsules 1 themselves. In the embodiment illustrated in the accompanying drawings, the trays 8 have a square shape, but alternatively they can have a rectangular shape having two smaller shorter sides and two larger longer sides.

[0011] As illustrated in Figures 2, 3 and 4, the filling machine 6 comprises a filling unit 11 which receives the trays 8 filled with empty capsules 1 from the feeding unit 7 and provides to fill each empty capsule 1 with the corresponding quantity 2 of product and to apply to each full capsule 1 a corresponding lid 4. In addition, the filling machine 6 comprises a transferring unit 12 which receives from the filling unit 11 the trays 8 containing full capsules 1 and transfers the full capsules 1 to an output 13 of the filling machine 6. In Figures 2 and 3, at the output 13 of the filling machine 6 a container 14 is arranged (by way of non-limiting example) which receives the full capsules 1; by means of the container 14 the full capsules 1 can be fed to a packing machine which makes packs of full capsule 1.

[0012] Finally, the filling machine 6 comprises a main conveyor 15 which feeds the full trays 8 from the output station S3 of the feeding unit 7 to the input station S1 of the feeding unit 7 passing through the filling unit 11 and to the transferring unit 12. The main conveyor 15 can be formed by a single conveying device which extends along the entire path or it can be formed by several conveying devices arranged in series one after the other (in this case the plurality of conveying devices can all be of the same type or also of a different type). In the non-limiting example illustrated in the accompanying drawings, the main conveyor 15 is formed by two conveying devices that cyclically exchange, one with the other, the trays 8: a first conveying device which extends outside of the filling unit 11 and of the filling unit 12 and comprises a fixed guide arranged along the path and a series of slits, each of which is designed to slide along the fixed guide and supports a corresponding tray 8, and a second conveying device which extends into the filling unit 11 and into the filling unit 12 and comprises a conveyor belt which supports the trays 8; in the first conveying device, the slits are driven along the fixed rail by means of a linear electric motor having a stator (typically provided with electrical windings) arranged along the fixed guide and a series of sliders (typically provided with permanent magnets) each coupled to a slit.

[0013] As illustrated in Figure 4, the main conveyor 15 has a "spiral" shape having a final straight branch 16 arranged at the input station S1 of the feeding unit 7 and an initial straight branch 17 arranged at the output station S3 of the feeding unit 7; the feeding conveyor 10 of the feeding unit 7 picks up each tray 8 from the final branch 16 of the main conveyor 15 arranged at the input station S1 and feeds the tray 8 along the feeding direction D1 up to the initial branch 17 of the main conveyor 15 ar-

ranged at the output station S3 of the feeding unit 7. It is important to note that the branches 16 and 17 of the main conveyor 15 are perpendicular to the feeding direction D1 of the feeding conveyor 10 of the feeding unit 7, i.e. at the branches 16 and 17 the main conveyor 15 feeds the trays 8 along directions D2 which are horizontal and perpendicular to the feeding direction D1 of the feeding conveyor 10.

[0014] As illustrated in Figure 6, the feeding unit 7 comprises a funnel-shaped hopper 18 which is designed to receive, on the upper side, a disorderly mass of empty capsules 1 and has, on the lower side, an output opening facing downwards.

Underneath the output opening of the hopper 18 an intermediate conveyor 19 is provided, so as to receive the empty capsules 1 from the output opening of the hopper 18. The intermediate conveyor 19 comprises a plate 20 provided with lateral edges which is inclined downwards so that an input end of the intermediate conveyor 19 at the output opening of the hopper 18 is higher than an output end of the intermediate conveyor 19; moreover, the intermediate conveyor 19 comprises a vibrating device 21 (e.g. provided with an eccentric element which is set in rotation) which causes vibrations to the plate 20 to facilitate the flow of the empty capsules 1 along the plate 20 from the input end of the intermediate conveyor 19 to the output end of the intermediate conveyor 19. In other words, the empty capsules 1 move along the plate 20 of the intermediate conveyor 19 due to gravity, (as previously mentioned, the plate 20 is inclined downwards) and due to the vibrations generated by the vibrating device 21 which causes vibrations to the plate 20.

[0015] Arranged at the output end of the intermediate conveyor 19 and underneath the output end of the intermediate conveyor 19 an input end of an arranging conveyor 22 is arranged provided with a conveyor belt 23 having a plurality of pockets 24 arranged in rows and designed to each hold a capsule 1. The arranging conveyor 22 is inclined upwards so that the input end of the arranging conveyor 22 is lower than the output end of the arranging conveyor 22. According to a preferred, but not limiting, embodiment, the arranging conveyor 22 is provided with a vibrating device 25 (e.g. provided with an eccentric element which is set in rotation) which causes vibrations to the arranging conveyor 22. In the arranging conveyor 22 the vibrations do not have the function of feeding the empty capsules 1 (the feeding action is delegated to the movement of the conveyor belt 23), but have the function of imparting a continuous change of arrangement to the empty capsules 1 arranged above the conveyor belt 23 so as to facilitate the insertion of the empty capsules 1 into the pockets 24.

[0016] According to a preferred but not limiting embodiment, the feeding unit 7 comprises a separator drum 26 arranged above the arranging conveyor 22, close to the output end of the arranging conveyor 22 and rotates in the opposite direction relative to the arranging conveyor 22; in other words, the separator drum 26 rotates in a

direction opposite to the arranging conveyor 22 as illustrated in Figure 6 and tends to push the empty capsules 1 in the opposite direction relative to the feeding direction of the arranging conveyor 22. Preferably, the separator drum 26 is arranged immediately above the arranging conveyor 22 and at a short distance from the arranging conveyor 22 so that between the separator drum 26 and the arranging conveyor 22 there is only enough space to pass empty capsules 1 inserted in corresponding pockets 24 and not empty capsules 1 inserted in corresponding pockets 24 (which are then pushed back by the separator drum 26 until they enter the corresponding pockets 24). In other words, the separator drum 26 performs the function of a "scraper" that "cleans" the arranging conveyor 22 thus preventing the passage of empty capsules 1 that are not inserted into corresponding pockets 24.

[0017] According to a preferred, but not limiting, embodiment, the feeding unit 7 comprises a transferring drum 27 which is arranged at the output end of the arranging conveyor 22 and has a plurality of pockets 28 arranged in a row, each of which is designed to contain an empty capsule 1 and receives the empty capsule 1 from a pocket 24 of the arranging conveyor 22. According to a preferred, but not limiting, embodiment, the pockets 28 of the transferring drum 27 are provided with suction means to hold the capsules 1 by suction.

[0018] According to a preferred, but not limiting, embodiment, the arranging conveyor 22 comprises a pulley 29 which is arranged at the output end and beside the transferring drum 27 and comprises expulsion needles 30 (only one of which is schematically illustrated in Figure 6), each coupling a corresponding pocket 24 when the pocket 24 itself travels around the pulley 29 and radially moves under the thrust of a cam device 31 to expel an empty capsule 1 from the pocket 24 itself and towards (i.e. on the inside of) a pocket 28 of the transferring drum 27.

[0019] The feeding unit 7 comprises a plurality of veins 32, which are arranged beside one another in the insertion station S2, are substantially vertically arranged and due to gravity, feed the empty capsules 1 up to respective output ends; in particular, each vein 32 has an input end which is arranged beside (in close proximity) to the transferring drum 27 to receive from the corresponding pockets 28 of the transferring drum 27 the empty capsules 1 one after the other and an output end which is arranged in the insertion station S2 above the feeding path of the trays 8 and in alignment with the corresponding pockets 9 of the trays 8. The input end at each vein 32 is arranged perpendicular to the outer limit of the transferring drum 27 (i.e. it is radially arranged relative to the rotation axis of the transferring drum 27) so as to be perfectly aligned with the corresponding pockets 28 of the transferring drum 27, while at the output, end each vein 32 is vertically arranged to maximize the thrust effect of gravitational force.

[0020] According to a preferred, but not limiting, embodiment, the transferring drum 27 is provided with a

pneumatic expelling device 33 arranged at the input ends of the veins 32; in essence, the pneumatic expelling device 33 comprises a plurality of nozzles (one for each pocket 28 of the same row) which, on command, blow a jet of air directed outwardly into the pockets 28 of the transferring drum 27 which are aligned with the input ends of the veins 32 to extract the empty capsules 1 from the pockets 28 and direct the empty capsules 1 into the veins 32.

[0021] According to a preferred, but not limiting, embodiment, the transferring drum 27 is provided with a pneumatic expelling device 34 arranged downstream of the veins 32 (therefore downstream of the pneumatic expelling device 33); in essence, the pneumatic expelling device 34 comprises a plurality of nozzles (one for each pocket 28 of the same row) which, on command, blow a jet of air directed outwardly into the pockets 28 of the transferring drum 27 to extract the capsules 1 from the pockets 28 and direct the capsules 1 towards a collecting container 35. The collecting container 35 receives and collects the loosely arranged empty capsules 1 that have not been transferred to the veins 32 and which are accumulated for being cyclically recycled (i.e. re-entered into the hopper 18). Obviously, the use of the pneumatic expelling device 34 is alternative to the use of the pneumatic expelling device 33: in fact, only an empty capsule 1 that has not been extracted by the pneumatic expelling device 33 can reach the area of the pneumatic expelling device 34 which is arranged downstream of the pneumatic expelling device 33.

[0022] According to a preferred embodiment, the pneumatic expelling device 34 is always actuated (redundantly) independently of the action of the pneumatic expelling device 33 to ensure a correct emptying of the pockets 28 of the transferring drum 27; i.e. the pneumatic expelling device 34 is always operated even if a pocket 28 of the transferring drum 27 may already be empty due to the action of the pneumatic expelling device 33 to expel (as far as possible) an empty capsule 1 that has not been previously expelled by the pneumatic expelling device 33 as a result of some sort of problem. In fact, if a pocket 28 of the transferring drum 27 arrives in front of an arranging conveyor 22 full (that is, still having an empty capsule 1), the corresponding expulsion needle 30 would push a new empty capsule 1 against the previous empty capsule 1 thus destroying both the empty capsules 1 and risking both a system overflow and damage to the mechanics of the system.

[0023] As illustrated in Figures 7, 8 and 9, the feeding unit 7 comprises an optical control device 36 which is coupled to the veins 32 and determines the presence of the empty capsules 1 inside the veins 32; in other words, the optical control device 36 is designed for determining the filling of each vein 32, to determine how many empty capsules 1 are arranged in vein 32. The optical control device 36 can comprise for each vein 32 two or more sensors which detect the presence of the empty 1 capsules in multiple key points.

[0024] As illustrated in Figures 7, 8, and 9, the feeding unit 7 comprises a regulating device 37 which is coupled to the veins 32 and is designed to enable or prevent the release of the empty capsules 1 from the output ends of the veins 32; in other words, the regulating device 37 is a mechanical "faucet" which is controlled to allow the release of an empty capsule 1 from the output end of a vein 32 when, an empty pocket 9 of a tray 8 is arranged underneath the output end of the vein 32, and to prevent the release of an empty capsule 1 from the output end of a vein 32 otherwise (i.e. when no empty pocket 9 of a tray 8 is arranged underneath the output end of the vein 32).

[0025] Finally, the feeding unit 7 comprises a control unit 38 (schematically illustrated in Figure 6) which administers the operation of the feeding unit 7 by controlling, among other things, the advancement of the trays 8 through the input station S2 due to the action of the feeding conveyor 10, the release of the empty capsules 1 from the output ends of the veins 32 due to the action of the regulating device 37, and the correct filling of the veins 32 with the empty capsules 1 as a function of the detections carried out by the control device 36 and by suitably driving the pneumatic expelling devices 33 and 34. In particular, when a vein 32 is completely full then the control unit 38 does not actuate the corresponding pneumatic expelling device 33 so as to not overload an already full vein 32 and therefore force the removal of the empty capsule 1 from the corresponding pocket 28 of the transferring drum 27 by the pneumatic expelling device 34; in this way, the empty capsules 1 are inserted only in the veins 32 which actually have the capacity (need) to house further empty capsules 1 and not in the veins 32 which are completely full and therefore are unable (temporarily) to receive additional empty capsules 1. In this regard it is important to note that the nominal feeding capacity of the transferring drum 27 exceeds (slightly) the nominal feeding capacity of the veins 32 in order to obtain a (slight) over-dimensioning; in this way, it is possible to compensate for any imbalance in the filling of the veins 32 due to causal factors (that is, it can happen that for some concatenated casual events some veins 32 are temporarily less full relative to other veins 32) since there is a "reserve" of empty capsules 1 that, by running the pneumatic expelling devices 33 and 34, is directed only into the veins 32 that need it.

[0026] Figures 7, 8 and 9 schematically illustrate the filling of the pockets 9 of a tray 8 in the insertion station S2: the feeding conveyor 10 step-feeds (that is, with feeding steps alternated with rest steps) the tray 8 through the insertion station S2 so as to stop the empty pockets of the tray 8 underneath the output ends of the veins 32; when underneath the output ends of the vein 32 empty pockets 9 of the tray 8 remain stationary, the regulating device 37 lowers the empty capsules 1 from the veins 32 to insert the empty capsules 1 into the corresponding empty pockets of the tray 8. In other words, the feeding conveyor 10 step-feeds each tray 8 through the insertion

station S2 and underneath the output ends of the veins 32 so as to stop, with every step, the tray 8 with a row of empty pockets 9 aligned with the output ends.

[0027] It is important to note that, as illustrated in Figures 2 and 3, the feeding unit 7 is arranged to work in parallel, i.e. the arranging conveyor 22 has a series of rows of pocket 24 (in each row all the pockets 24 are axially aligned one with the other), the transferring drum 27 has a series of rows of pockets 28 (in each row all the pockets 28 are axially aligned one with the other), and row of veins 32 axially aligned one with the other is provided. In the non-limiting embodiment illustrated in Figures 2 and 3, there are one hundred veins 32 that simultaneously insert the empty capsules 1 into ten corresponding trays 8; similarly, each row of pockets 28 of the transferring drum 27 comprises one hundred pockets 28 and each row of pockets 24 of the arranging conveyor 22 comprises one hundred pockets 24.

[0028] As illustrated in Figures 2, 3 and 4, the filling unit 11 comprises three cleaning devices 39 arranged one after the other that work in parallel (that is, simultaneously) a cleaning cycle (better described hereinafter) of the empty capsules 1 contained in corresponding trays 8, five filler devices 40 which are arranged downstream of the cleaning devices 39 and work in parallel (that is, simultaneously) the filling of the empty capsules 1 contained in respective trays 8, and a closure device 41 which is arranged downstream of filler devices 40 and apply the lids 4 to the filled capsules 1 contained in each tray 8.

[0029] As better illustrated in Figure 10, each cleaning device 39 is provided with a plurality of cleaning heads 42, each coupled to a corresponding empty capsule 1 so as to perform a cleaning of the empty capsule 1 itself. In each cleaning device 39, the cleaning heads 42 (arranged in matrix by assuming the arrangement of the pockets 9 of the trays 8) are carried by a common support that is vertically movable (i.e. along a vertical direction D3 which is perpendicular to the feeding direction D2 of the main conveyor 15): when a tray 8 is stationary underneath the cleaning device 39, the common support is lowered to couple the cleaning heads 42 to the corresponding empty capsules 1 brought by the tray 8 and perform the cleaning cycle; at the end of the cleaning cycle, the common support 43 is raised again to separate the cleaning heads 42 from the corresponding empty capsules 1 brought by the tray 8 and thus allow the feeding of the tray 8 and the simultaneous arrival of a subsequent tray 8.

[0030] As illustrated in Figure 11, each cleaning head 42 comprises a tubular body 43 having a lower edge resting on the annular rim 5 of the corresponding empty capsule 1, so as to temporarily create a closed chamber on the inside of which the cleaning is performed; in other words, each tubular body 43, in use, is coupled to the corresponding empty capsule 1, so as to temporarily create a closed chamber on the inside of which the cleaning is performed. Each tubular body 43 contains at least one

feeding nozzle 44, which feeds a cleaning fluid within the corresponding empty capsule 1 and a plurality of suction openings 45, which are arranged alongside the feeding nozzle 44 and suck the cleaning fluid. As illustrated in Figure 11, the feeding nozzle 44 is arranged more externally relative to the suction openings 45 (i.e. the feeding nozzle 44 protrudes beyond the suction openings 45) so that the nozzle 44 blows the cleaning fluid onto the bottom of an empty capsule 1; the cleaning fluid blown by the feeding nozzle 44 after impacting against the bottom of the empty capsule 1 rises upwardly by skimming the side wall of the empty capsule 1 until it reaches the suction openings 45. In this way, on the inside of the empty capsule 1, an optimal fluid circulation is established which effectively cleans the entire inner surface of the empty capsule 1 itself. According to a preferred, but non-binding, embodiment, the cleaning fluid is ionized air to which additional cleaning and/or disinfecting agents may be added.

As illustrated in Figure 10, each cleaning head 42 comprises a feeding means 46 providing the cleaning fluid to all feeding nozzles 44 and a sucking means 47 that sucks the cleaning fluid from all the suction openings 45. According to a possible embodiment, a recirculation system for the cleaning fluid from the sucking means 47 to the feeding means 46 can be provided; typically, the recirculation system performs filtration and regeneration of the cleaning fluid.

[0031] As mentioned above, the three cleaning devices 39 work in parallel, i.e. they simultaneously perform the cleaning of the empty capsules 1 carried by three trays 8 arranged one after the other along the main conveyor 15.

[0032] According to a possible, but not binding, embodiment, each cleaning device 39 also cleans the upper part of the corresponding tray 11, in particular for eliminating product residue that may have been left behind by a filler device 40 during the previous filling cycle; for this purpose, each cleaning device 39 may comprise cleaning heads 42 exclusively dedicated to clean the upper part of the corresponding tray 11.

[0033] Each filler device 40 is provided with a plurality of filler nozzles, each coupled to a corresponding empty capsule 1 carried by a tray 8 to feed, from the top, the corresponding quantity 2 of product in the empty capsule 1 itself. As mentioned above, the five filler devices 40 work in parallel, that is, they simultaneously fill the empty capsules 1 carried by five trays 8 arranged one after the other along the main conveyor 15.

[0034] A closing device 41 uses a tape of thermoplastic material which is unwound from an initial spool 48 and then rewound into a final spool 49; between the initial spool 48 and the final spool 49 an applicator head 50 is arranged which is provided with a plurality of heat-sealing means having circular blades. When a tray 8 is stationary underneath the applicator head 50, the applicator head 50 is pressed from the top against the filled capsules 1 contained in tray 8 with the interposition of the tape of

thermoplastic material; in this manner around each full capsule 1 the corresponding lid 4 is cut out by a circular blade while a heat-sealing means performs a heat-sealing of the lid 4 itself to the annular rim 5 of the full capsule 1. The initial spool 48 contains the new tape of thermoplastic material (from which the circular lids 4 will be obtained) while the final spool 49 contains the used tape of thermoplastic material (i.e. "punctured" following the removal of the circular lids 4) (which constitutes a scrap (that is, a processing waste). Cyclically (that is, when the initial spool 48 runs out) it is necessary to replace the spools 48 and 49.

[0035] According to an alternative embodiment illustrated, the final spool 49 could be replaced by a shredder device, which shreds the tape of used thermoplastic material (i.e. "punctured" following the removal of the circular lids 4) and feeds the shredded remains into a collecting container. In this embodiment, a semi-automatic or automatic change of the initial spool 48 can be provided; consequently, two initial spools 48 are always present arranged side by side: an initial spool 48 currently in use, and a new initial spool 48 ready to replace the initial spool 48 currently in use as soon as it runs out.

[0036] According to a possible embodiment, the filling unit 11 comprises one or more control stations wherein the correct conformation of the capsules 1 (normally by means of non-contact optical control) is verified and the discharge of the defective capsules 1 is programmed.

As illustrated in Figures 2 and 3, the transferring unit 12 comprises at least one robotic arm having a suction head reproducing the arrangement of the pockets 9 of each tray 8 (in Figures 2 and 3, two robotic arms working in parallel are illustrated); in use, each robotic arm cyclically moves the suction head from the main conveyor 15 to pick up the capsules 1 from a tray 8 at the output 13 of the filling machine 6 to release the capsules 1. Alternatively, the transferring unit 12 may also have a different conformation, e.g. a first robotic arm could pick up the capsules 1 from a tray 8 and release the capsules 1 to a second robotic arm, which modifies the spatial arrangement of the capsules 1 (normally to reduce the gap between two capsules 1 that are next to one another) and then deposits the capsules 1 in a new support located in the output 13 of the filling machine 6.

[0037] According to a possible embodiment illustrated in Figure 4, the filling unit 11 comprises an encasement 51 (typically of glass material) that encloses the filling unit 11; the encasement 51 is a container (casing, shield) made of a rigid material that encloses and protects the various devices of the filling unit 11. In particular, the encasement 51 may be internally provided with a suction to maintain a certain internal depression that prevents the release of particles of the product from the encasement 51 which is dosed into the capsules 1.

[0038] In the embodiment illustrated in the attached figures, each cleaning device 39, each filler device 40 and closing device 41 operates in the same manner on all the capsules 1 carried by the same tray 8, i.e. there

is no differentiation between the capsules 1 carried by the same tray 8; according to an alternative (and more complex) embodiment, each cleaning device 39, each filler device 40 and/or closing device 41 operates by independently controlling the operations on the capsules 1 carried by the same tray 8, i.e. by individually controlling the operations on each capsule 1.

[0039] The filling machine 6 described above has many advantages.

[0040] First, the filling machine 6 described above is very fast, that is, it allows to achieve very high hourly productivity, while guaranteeing high speeds of the capsules 1 at all speeds.

[0041] In addition, the filling machine 6 described above allows to reduce the percentage of waste (i.e. of defective capsules 1); this result is achieved due to the fact that the filling machine 6 described above guarantees a very gentle treatment (that is, without excessively high accelerations/ decelerations) of the capsules 1.

[0042] The filling machine 6 described above allows to reduce occupancy of space and improve accessibility for performing cleaning, maintenance and format change (i.e. all the parts of the filling machine 6 described above are easily accessible by an operator).

[0043] Finally, the filling machine 6 described above is relatively simple and inexpensive to implement.

Claims

1. A filling machine (6) to fill capsules (1) with respective quantities (2) of an incoherent product; the filling machine (6) comprises:

at least one tray (8) having a plurality of first pockets (9), which are designed to each hold a corresponding capsule (1);
 a feeding unit (7), which receives a disorderly mass of empty capsules (1) and inserts the capsules (1) into the first pockets (9) of the tray (8) so as to fill the tray (8);
 a filling unit (11), which receives, from the feeding unit (7), the tray (8) containing empty capsules (1), so as to feed into each capsule (1) the corresponding quantity (2) of product;
 a transferring unit (12), which receives, from the filling unit (11), the tray (8) containing full capsules (1) and transfers the full capsules (1) to an output (13) of the filling machine (6); and
 a main conveyor (15), which feeds the tray (8) from an output station (S2) of the feeding unit (7) to an input station (S1) of the feeding unit (7) passing through the filling unit (11) and the transferring unit (12).

2. The filling machine (6) according to claim 1, wherein the main conveyor (15) has a final straight branch (16), which is arranged at the input station (S1) of

the feeding unit (7), and an initial straight branch (17), which is arranged at the output station (S3) of the feeding unit (7) and is parallel to as well as faces the final branch (16).

3. The filling machine (6) according to claim 2, wherein the feeding unit (7) comprises a feeding conveyor (10), which picks up the tray (8) from the final branch (16) of the main conveyor (15) arranged at the input station (S1) and feeds the tray (8), along a feeding direction (D1), up to the initial branch (17) of the main conveyor (15) arranged at the output station (S3) of the feeding unit (7).

4. The filling machine (6) according to claim 3, wherein the final branch (16) and the initial branch (17) of the main conveyor (15) are perpendicular to the feeding direction (D1) of the feeding conveyor (10) of the feeding unit (7).

5. The filling machine (6) according to any of the claims from 1 to 4, wherein the feeding unit (7) comprises:

an insertion station (S2), which is arranged between the input station (S1) and the output station (S3) and in which the tray (8) progressively receives the empty capsules (1);
 a plurality of veins (32), which are arranged beside one another in the insertion station (S2) and feed the capsules (1), because of gravity, up to respective output ends; and
 a feeding conveyor (10) which step-feeds the tray (8) through the insertion station (S2) and underneath the output ends of the veins (32), so as to stop, with every step, the tray (8) with a row of first pockets (9) aligned with the output ends.

6. The filling machine (6) according to claim 5, wherein the feeding unit (7) comprises:

an arranging conveyor (22), which is provided with a conveyor belt (23) having a plurality of second pockets (24), each designed to contain a capsule (1); and
 a transferring drum (27), which is arranged between an output end of the arranging conveyor (22) and an upper end of the veins (32) and has a plurality of third pockets (28), each of which is designed to contain a capsule (1), receives the capsule (1) from a second pocket (24) of the arranging conveyor (22) and releases the corresponding capsule (1) to a vein (32).

7. The filling machine (6) according to claim 6, wherein:

the arranging conveyor (22) is inclined upwards, so that an input end of the arranging conveyor

- (22) is lower than the output end of the arranging conveyor (22); and
the arranging conveyor (22) is provided with a first vibrating device (25), which causes vibrations to the arranging conveyor (22).
8. The filling machine (6) according to claims 6 and 7, wherein:
- the transferring drum (27) is provided with a first pneumatic expelling device (33), which is designed to extract the capsule (1) from a third pocket (28) of the transferring drum (27) so as to lead the capsule (1) towards a vein (32); and the transferring drum (27) is provided with a second pneumatic expelling device (34), which is designed to extract the capsule (1) from a third pocket (28) of the transferring drum (27) so as to lead the capsule (1) towards a collecting container (35).
9. The filling machine (6) according to claims 6, 7 and 8, wherein the arranging conveyor (22) comprises a pulley (29), which is arranged at the output end and beside the transferring drum (27) and comprises expulsion needles (30), each coupled to a corresponding second pocket (24) and is radially movable, pushed by a cam device (31), so as to expel a capsule (1) from the second pocket (24).
10. The filling machine (6) according to any of the claims from 6 to 9, wherein the feeding unit (7) comprises a separator drum (26), which is arranged above the arranging conveyor (22), close to the output end of the arranging conveyor (22) and rotates in the opposite direction relative to the arranging conveyor (22).
11. The filling machine (6) according to any of the claims from 6 to 10, wherein the feeding unit (7) comprises:
- a funnel-shaped hopper (18), which is designed to receive, on the upper side, the disorderly mass of empty capsules (1) and has, on the lower side, an output opening; and
an intermediate conveyor (19), which is arranged underneath the output opening of the hopper (18) so as to receive the empty capsules (1) from the output opening of the hopper (18) and releases the empty capsules (1) to the arranging conveyor (22).
12. The filling machine (6) according to claim 11, wherein the intermediate conveyor (19) comprises:
- a plate (20), which is inclined downwards so that an input end of the intermediate conveyor (19) at the output opening of the hopper (18) is higher than an output end of the intermediate conveyor (19) at the arranging conveyor; and
a second vibrating device (21), which causes vibrations to the plate (20).
13. The filling machine (6) according to any of the claims from 5 to 12, wherein the feeding unit (7) comprises:
- an optical control device (36), which is coupled to the veins (32) and determines the presence of the empty capsules (1) on the inside of the veins (32); and
the feeding unit (7) comprises a control unit (38), which regulates the feeding of the empty capsules (1) into the veins (32) depending on the signals received from the optical control device (36).
14. The filling machine (6) according to any of the claims from 5 to 13, wherein the feeding unit (7) comprises a regulating device (37) which is coupled to the veins (32) and is designed to enable or prevent the release of the capsules (1) from the output ends of the veins (32).
15. The filling machine (6) according to any of the claims from 1 to 14, wherein the filling unit (11) comprises:
- at least one filler device (40), which is provided with a plurality of filler nozzles, each coupled to a corresponding capsule (1) so as to feed the corresponding quantity (2) of product; and
a cleaning device, which is arranged upstream of the filler device (40) and is provided with a plurality of cleaning heads (42), each coupled to a corresponding capsule (1) so as to clean the capsule (1).
16. The filling machine (6) according to claim 15, wherein each cleaning head (42) comprises at least one feeding nozzle (44), which feeds a cleaning fluid, in particular ionized air, into the corresponding capsule (1) and at least one suction opening (45), which is arranged beside the feeding nozzle (44) and sucks the cleaning fluid.
17. The filling machine (6) according to claim 15 or 16, wherein:
- each cleaning head (42) comprises a tubular body (43), which, in use, is coupled to the corresponding capsule (1), so as to temporarily create a closed chamber and contains, on the inside, the feeding nozzle (44) and the suction opening;
- each cleaning head (42) comprises one single feeding nozzle (44) arranged in the middle and a plurality of suction openings (45), which are

arranged around the feeding nozzle (44); and the feeding nozzle (44) protrudes beyond the suction opening (45).

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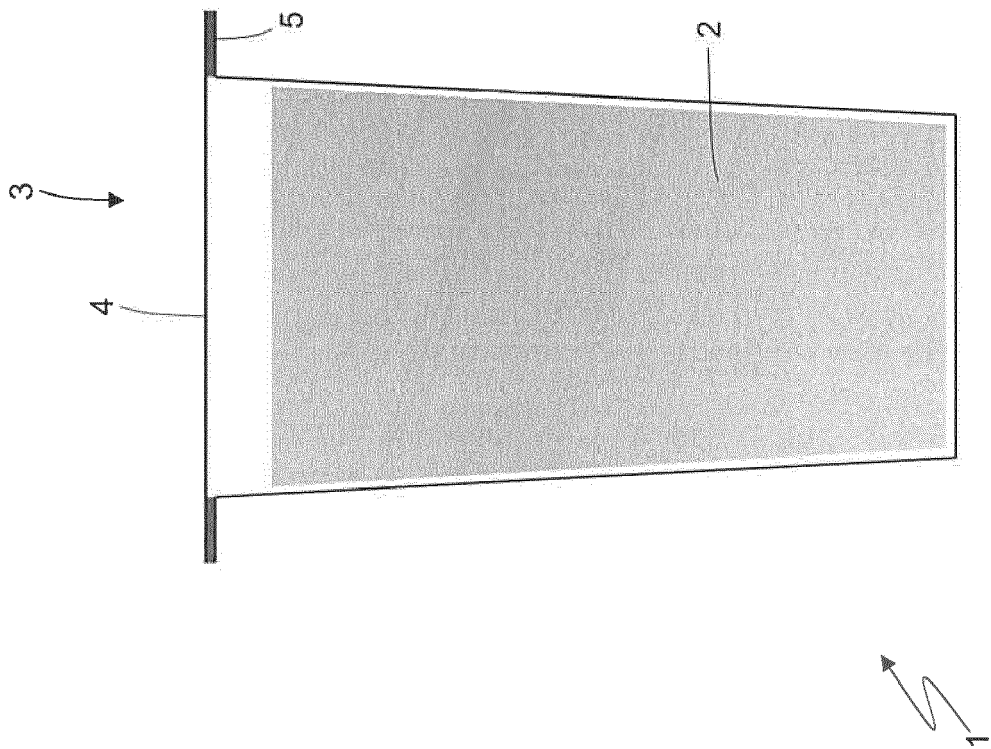


Fig.1

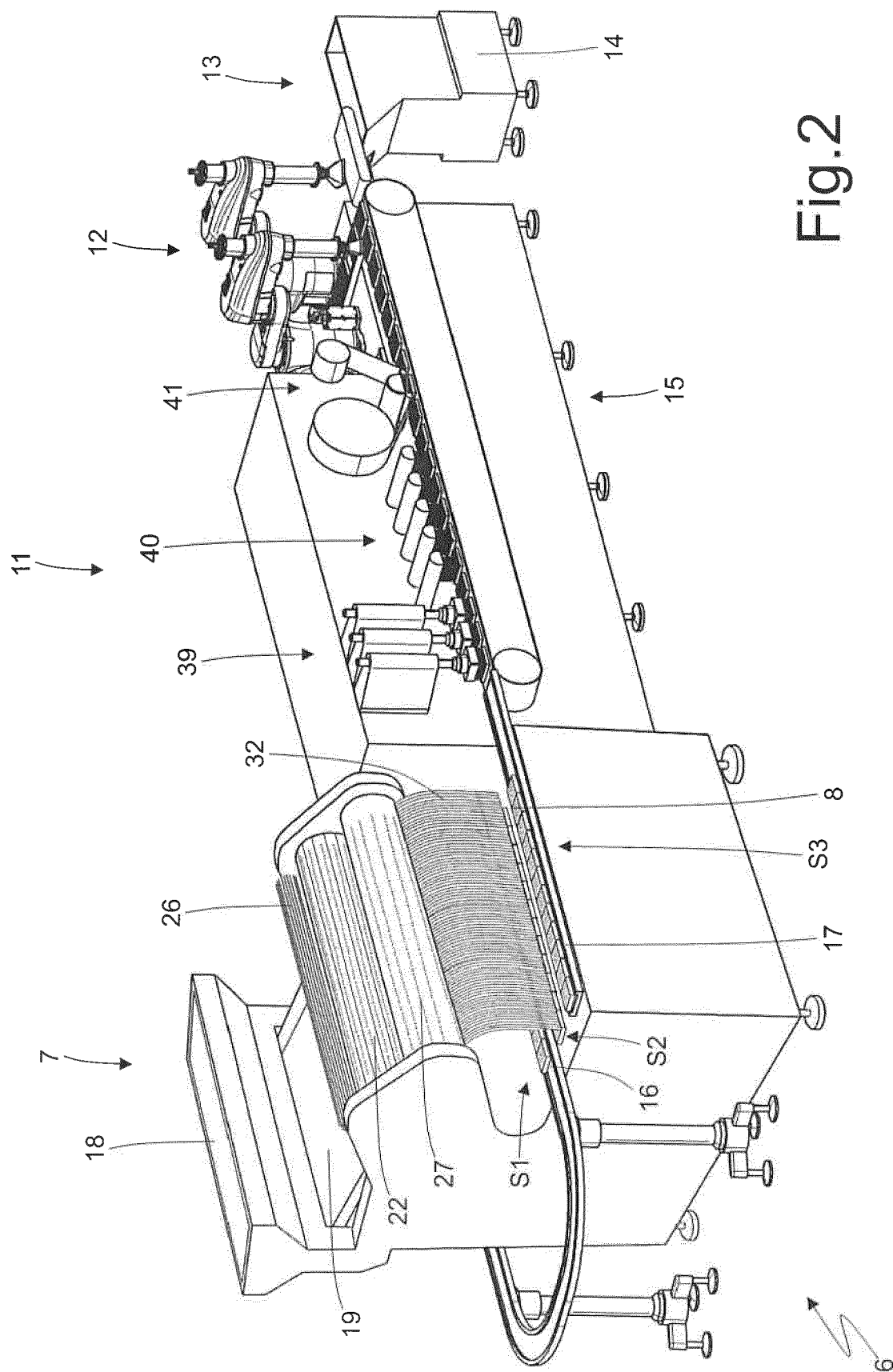


Fig. 2

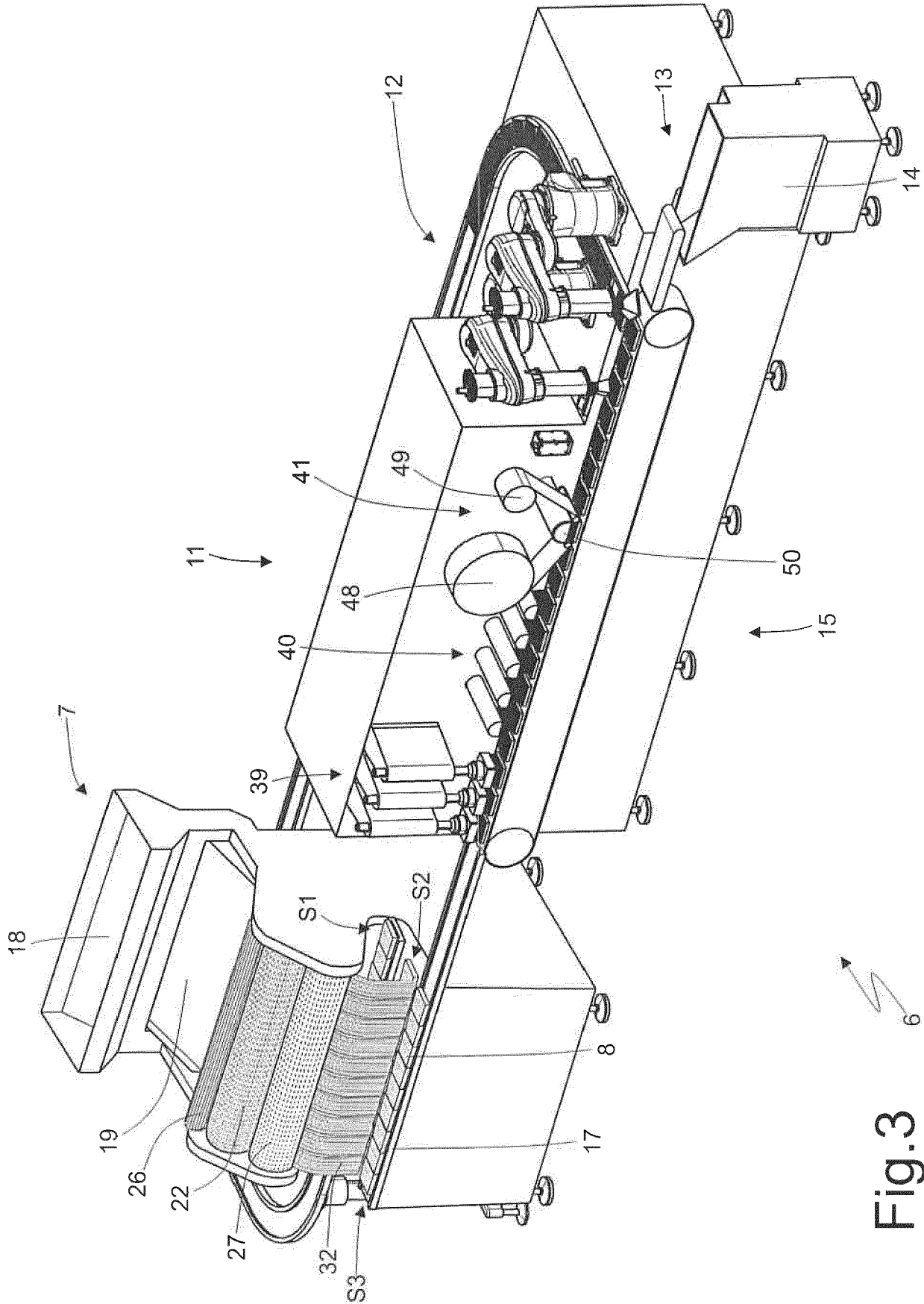
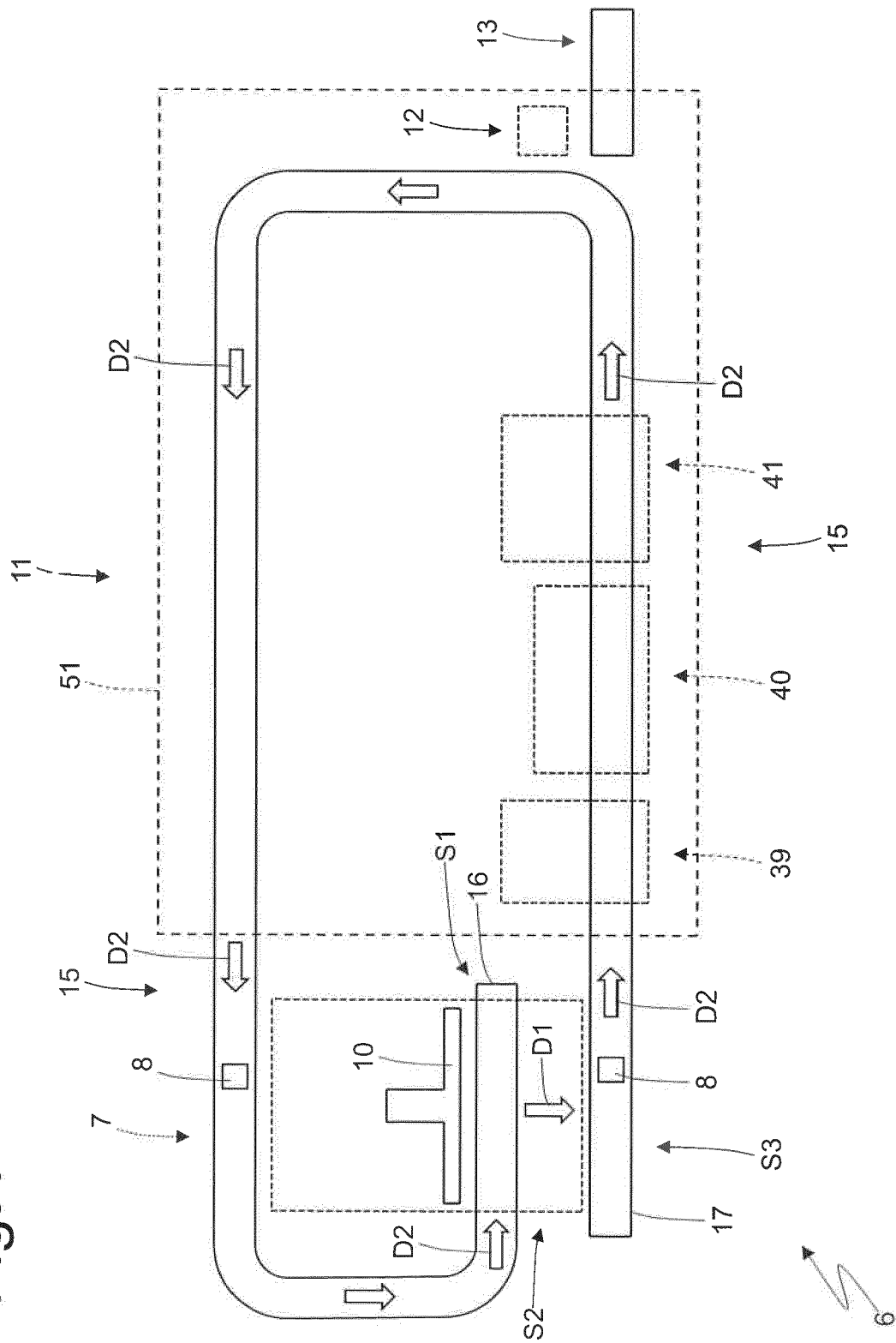


Fig.3

Fig.4



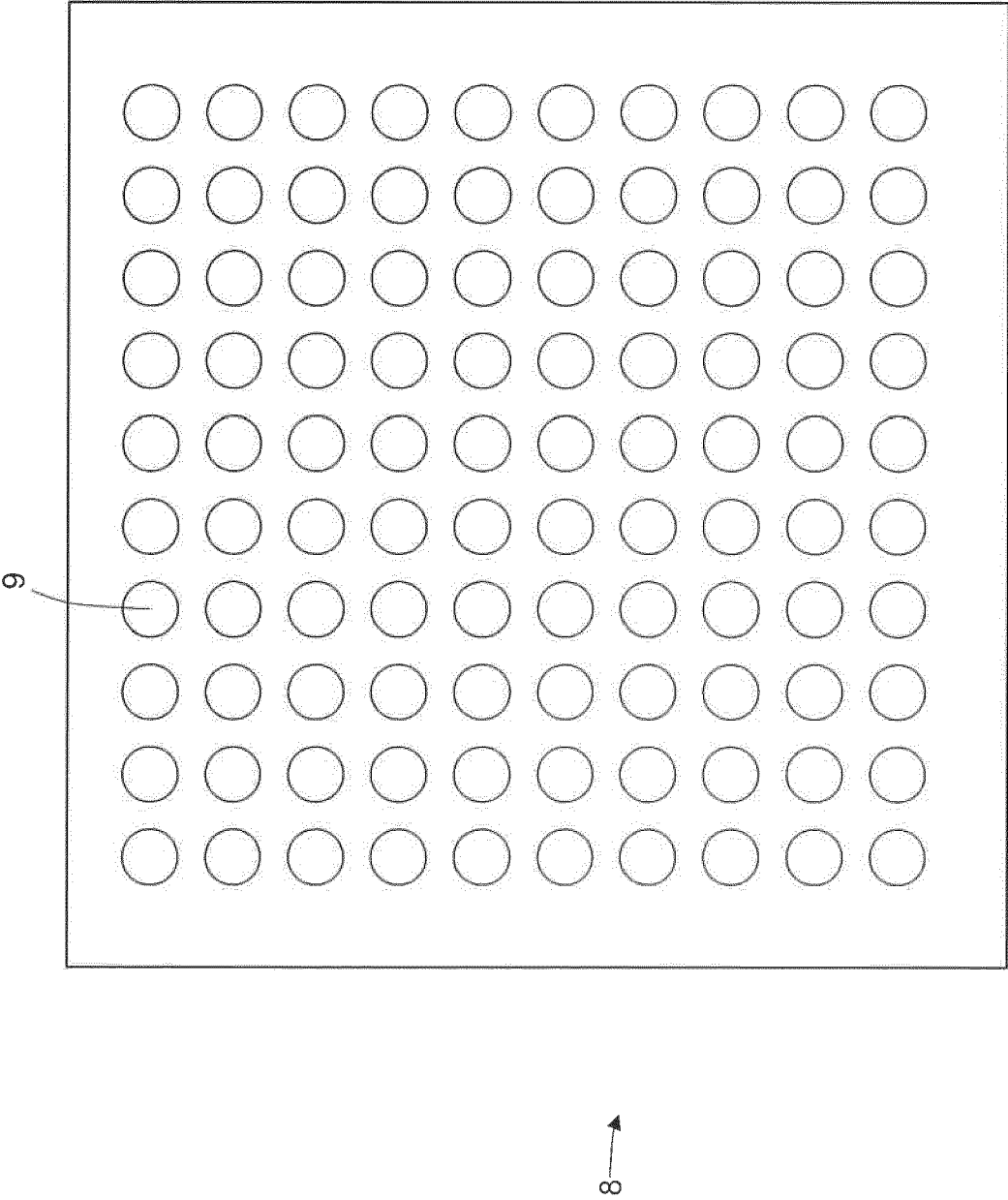


Fig.5

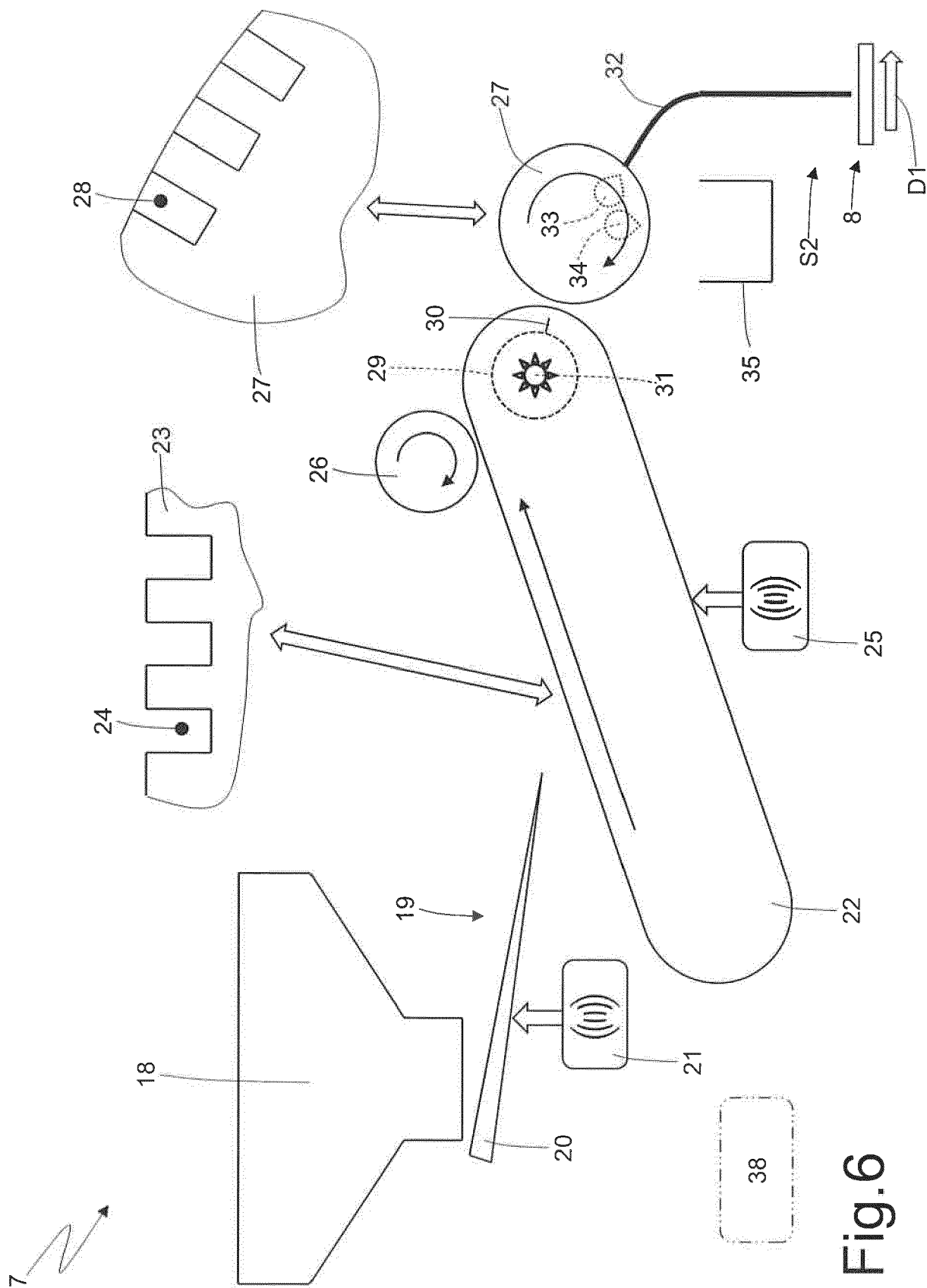


Fig. 6

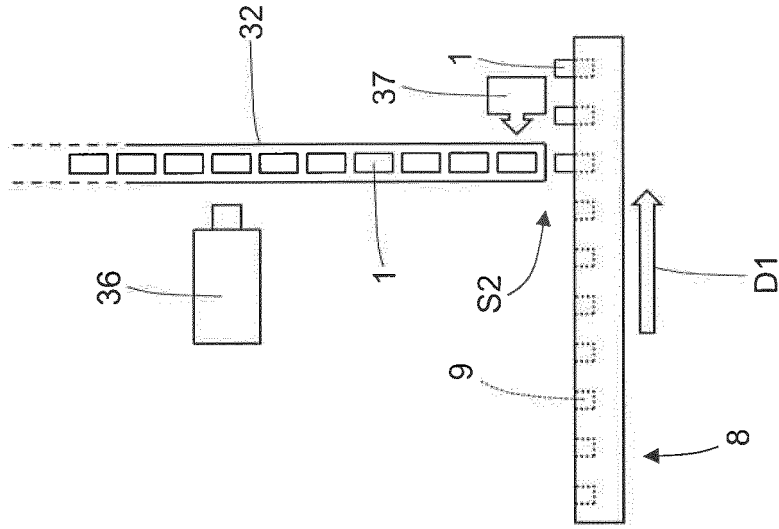


Fig. 7

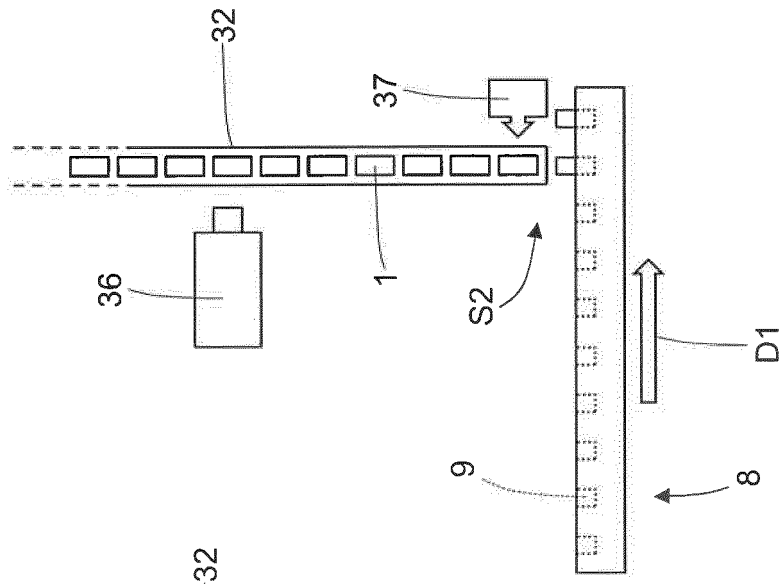


Fig. 8

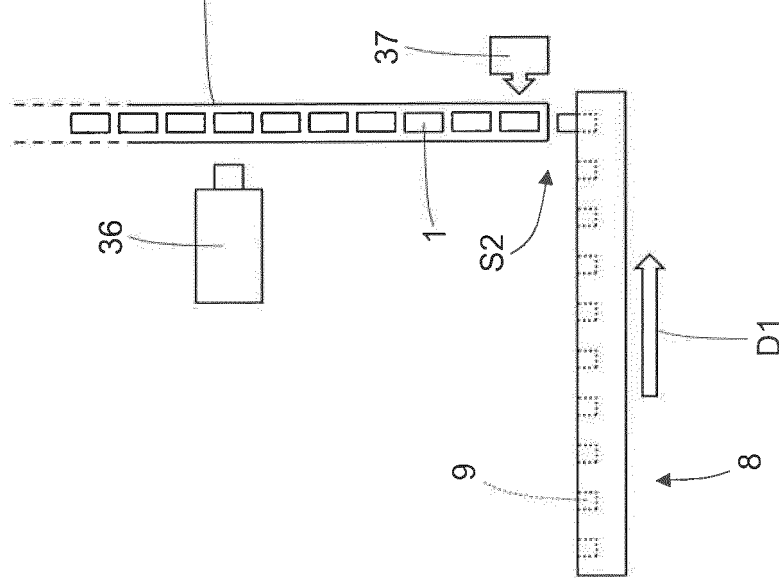


Fig. 9

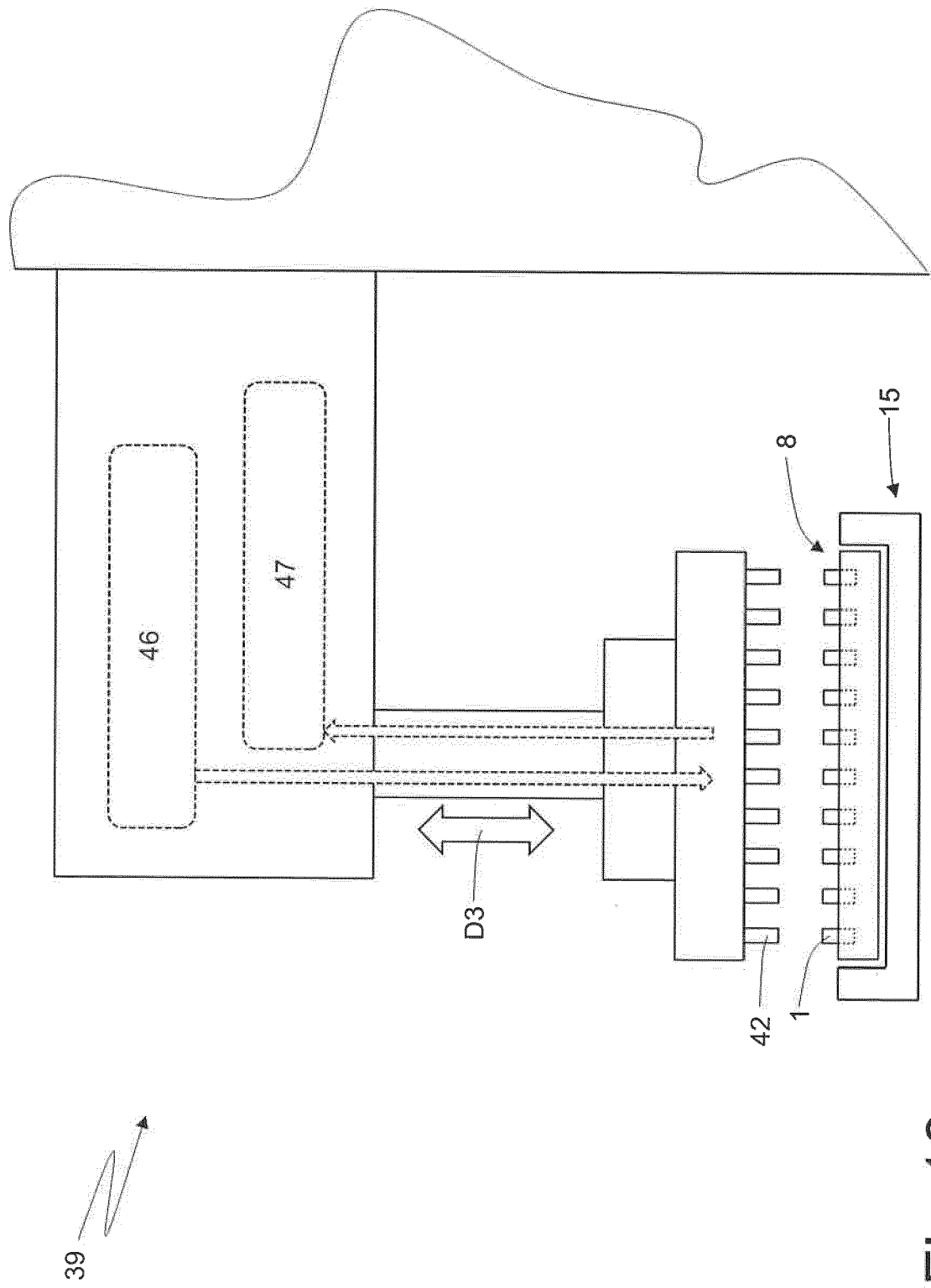


Fig.10

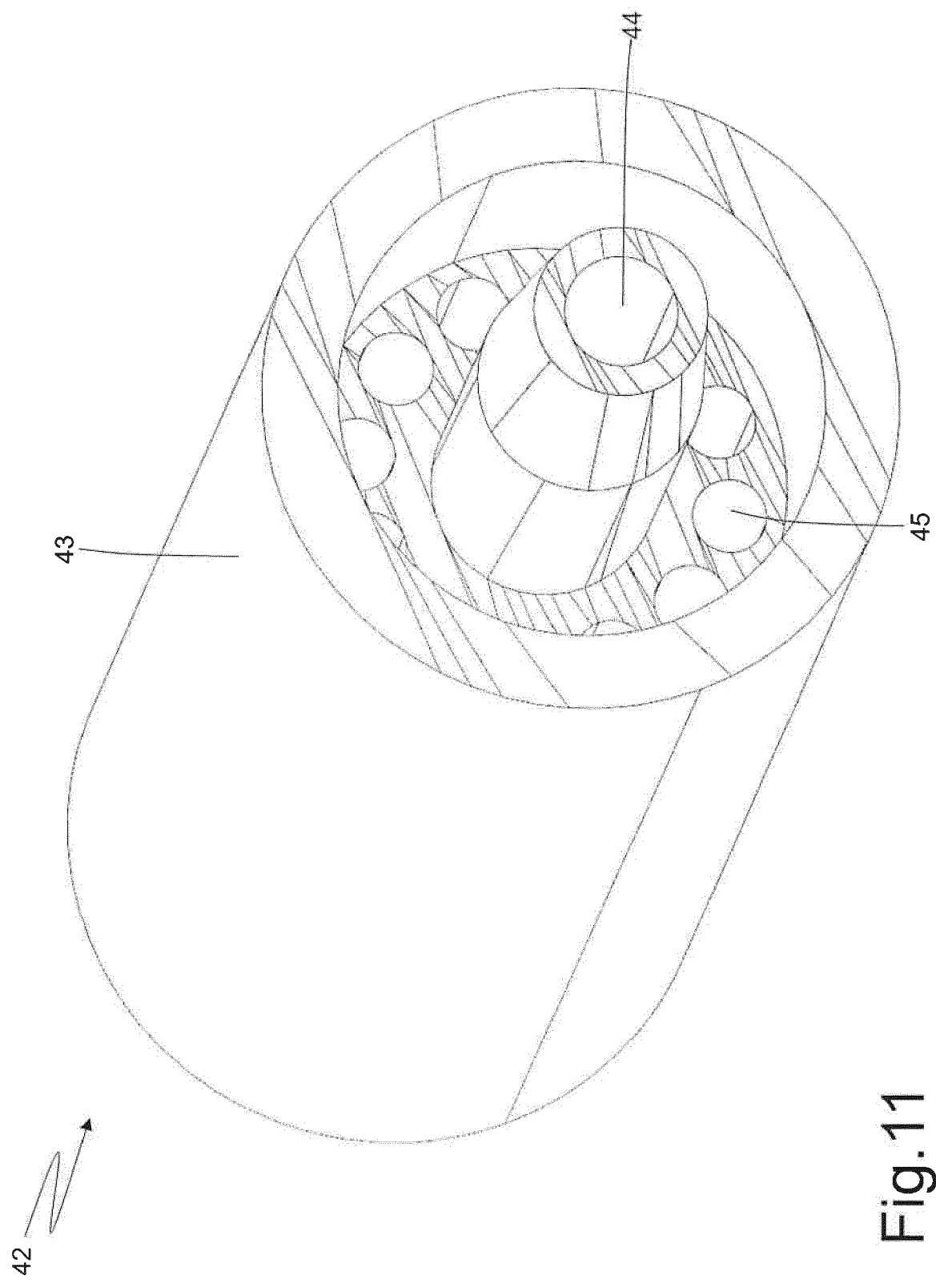


Fig. 11

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2013035061 A2 [0004]
- US 4151698 A [0004]
- WO 2010007633 A1 [0004]
- US 4024694 A [0004]