(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 335 763 A1**

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.03.2024 Bulletin 2024/11

(21) Application number: **22194482.0**

(22) Date of filing: **07.09.2022**

(51) International Patent Classification (IPC):
B65B 55/02 *(2006.01)* ***B65B 31/02*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B65B 55/025; B65B 31/025; B65B 55/027

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(54) **FILLING MACHINE COMPRISING AIRFLOW SYSTEM**

(57) A paperboard container filling machine (10) comprising an aseptic chamber (30, 40), having: an upper air distribution chamber (35, 45); a lower processing chamber (36, 46) housing processing equipment (32, 42, 49) configured for interacting with paperboard containers passing through the processing chamber; a throughflow plate (37, 47) separating the distribution chamber (9) and the processing chamber (36, 46); and a paperboard container transport sub-system (12) configured for transporting the paperboard containers through the processing chamber along a container transport path (14) from an inlet opening (31, 41) to an outlet opening (33, 43) of the processing chamber. The throughflow plate has a predefined thickness (T) and comprises a plurality of slits (38, 48) configured for directing the air from the air distribution chamber to the processing chamber, the slits having a predefined length (L), a predefined width (W) and a predefined length/width ratio (L/W), wherein said thickness is at least 1.5 times said predefined width, and wherein said predefined length/width ratio is larger than any one of: 4, 6, 8, 10, 15 and 20. A related method is also described.

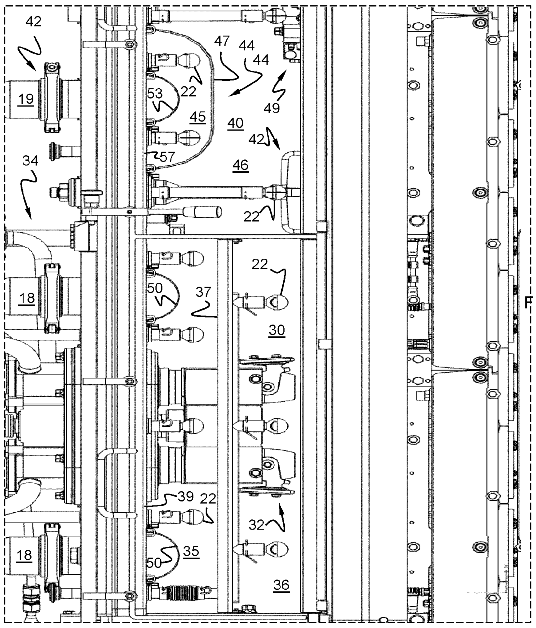

Fig. 2

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Description

Field of invention

[0001] The present disclosure relates to a paperboard container filling machine, in particular a filling machine for producing paperboard containers, also known as cartons, for a pourable foodstuff. In particular, the present disclosure relates to an airflow system in such a machine, e.g. to an airflow system in an aseptic chamber positioned downstream of a sterilization chamber in a paperboard container filling machine.

Background

[0002] When packaging a pourable food stuff in paperboard containers in a filling machine, the containers are usually sterilized in a sterilization chamber and then forwarded to an aseptic chamber in which the containers are filled and then to an aseptic chamber in which the containers are top-sealed. The first aseptic chamber, sometimes referred to as a filling chamber, typically comprises one or a plurality of filling devices, each comprising a filling nozzle from which the pourable food stuff is dispensed into the containers, and a filling valve, which controls the flow of the pourable food stuff through the filling nozzle, normally dosing the pourable food stuff according to the size of the containers being filled. The second aseptic chamber, sometimes referred to as a sealing chamber, typically comprises one or a plurality of sealing jaws configured to seal the containers.

[0003] In order to prevent contamination of any kind and to maintain the sterile condition of the containers established in the sterilization chamber, an aseptic and uniform airflow should advantageously be provided in the aseptic chambers. However, it may be challenging to maintain a uniform airflow in the aseptic chambers due to moving parts in the chambers, in particular processing equipment for executing filling and sealing of the containers. Also, the containers themselves being transported through the filling machine may disturb the airflow in the aseptic chambers. Furthermore, due to containers moving into and out of the aseptic chamber it is difficult to keep the aseptic chamber airtight. Turbulence within the aseptic chamber combined with the aseptic chamber not being airtight may cause impure air to seep into the aseptic chamber and contaminate filling machine equipment and/or the containers.

[0004] An objective of the present disclosure is to provide a paperboard filling machine having an improved airflow in the aseptic chamber(s). Another objective of the present disclosure is to provide a uniform flow of clean air through the aseptic chamber(s).

Summary

[0005] According to a first aspect, the present disclosure provides a paperboard container filling machine comprising an aseptic chamber, the aseptic chamber comprising:

- an upper air distribution chamber;
- a lower processing chamber housing processing equipment configured for interacting with paperboard containers passing through the processing chamber;
- a throughflow plate separating the air distribution chamber and the processing chamber; and
- a paperboard container transport sub-system configured for transporting the paperboard containers through the processing chamber along a container transport path from an inlet opening to an outlet opening of the processing chamber.

[0006] The throughflow plate has a predefined thickness and comprising a plurality of slits configured for directing the air from the air distribution chamber to the processing chamber, the slits having a predefined length, a predefined width and a predefined length/width ratio, wherein said predefined thickness is at least 1.5 times said predefined width, and wherein said predefined length/width ratio is larger than any one of: 4, 6, 8, 10, 15 and 20.

[0007] The slits may be rectilinear and/or arranged along a plurality of parallel lines.

[0008] The slits may occupy any one of: 5 - 50 % of the total area of the throughflow plate; and 10 - 30 % of the total area of the throughflow plate.

[0009] The slits may be aligned with the container transport path.

[0010] The throughflow plate may be planar. The slits may be arranged parallel to or substantially parallel to each other.

[0011] The slits may be aligned parallel to or substantially parallel to the transport path.

[0012] The throughflow plate may comprise a substantially horizontal planar section, and first and second, curved sections, each curved section displaying a convex ruled surface facing the processing chamber, the ruled surface being defined by rulings which are parallel and extend orthogonal or substantially orthogonal to said transport path.

[0013] According to a second aspect, the present disclosure provides a method of establishing an airflow in an aseptic chamber of a paperboard container filling machine, the aseptic chamber comprising:

- an upper air distribution chamber configured for receiving air from an air supply channel;
- a lower processing chamber housing processing equipment configured for interacting with paperboard containers passing through the processing

chamber; and

a paperboard container transport sub-system configured for transporting the paperboard containers through the processing chamber along a container transport path from an inlet opening to an outlet opening of the processing chamber,

the method comprises the step of bringing the air from the distribution chamber to the processing chamber through a throughflow plate having a predefined thickness and comprising a plurality of slits configured for directing the air from the air distribution chamber to the processing chamber, the slits having a predefined length, a predefined width and a predefined length/width ratio, wherein said predefined thickness is at least 1.5 times said predefined width, and wherein said predefined length/width ratio is larger than any one of: 4, 6, 8, 10, 15 and 20.

[0014] According to a further aspect, the present disclosure provides paperboard container filling machine comprising an aseptic chamber, the aseptic chamber comprising:

an upper air distribution chamber;

a lower processing chamber housing processing equipment configured for interacting with paperboard containers passing through the processing chamber;

a throughflow plate separating the air distribution chamber and the processing chamber, the throughflow plate comprising a plurality of through-openings configured for directing the air from the air distribution chamber to the processing chamber, and

a paperboard container transport sub-system configured for transporting the paperboard containers through the processing chamber along a container transport path from an inlet opening to an outlet opening of the processing chamber,

[0015] The throughflow plate comprises a substantially horizontal planar section and first and second curved sections, each curved section displaying a convex ruled surface facing the processing chamber, the ruled surface being defined by rulings which are parallel and extend orthogonal or substantially orthogonal to said transport path.

[0016] The trough-openings may be slits. The slits may be rectilinear.

[0017] The slits may be arranged along a plurality of parallel lines.

[0018] The slits may be aligned with the container transport path.

[0019] The through-openings may occupy any one of: 5 - 50 % of the total area of the throughflow plate; and 10 - 30 % of the total area of the throughflow plate.

[0020] The filling machine may comprise an elongated air distribution duct configured for receiving air from an air supply channel, the air distribution duct comprising a plurality of throughflow holes configured for distributing the air in the air distribution chamber and displaying a semi-tubular convex surface facing the throughflow plate and comprising a rectilinear duct axis extending orthogonal or substantially orthogonal to the container transport path.

[0021] According to yet a further aspect, the present disclosure provides a method of establishing an airflow in an aseptic chamber of a paperboard container filling machine, the aseptic chamber comprising:

an upper air distribution chamber;

a lower processing chamber housing processing equipment configured for interacting with paperboard containers passing through the processing chamber; and

a paperboard container transport sub-system configured for transporting the paperboard containers through the processing chamber along a container transport path from an inlet opening to an outlet opening of the processing chamber.

[0022] According to a further aspect, the present disclosure provides a paperboard container filling machine comprising an aseptic chamber, the aseptic chamber comprising:

an upper air distribution chamber;

a lower processing chamber housing processing equipment configured for interacting with paperboard containers passing through the processing chamber;

a throughflow plate separating the air distribution chamber and the processing chamber;

a paperboard container transport sub-system configured for transporting the paperboard containers through the processing chamber along a container transport path from an inlet opening to an outlet opening of the processing chamber; and

an elongated air distribution duct configured for receiving air from an air supply channel and comprising a plurality of throughflow holes configured for distributing the air in the air distribution chamber.

[0023] The air distribution duct displays a semi-tubular convex surface facing the throughflow plate and comprises a rectilinear duct axis extending orthogonal or substantially orthogonal to the container transport path.

[0024] The throughflow holes may be circular.

[0025] According to yet a further aspect, the present disclosure provides a method of establishing an airflow in an aseptic chamber of a paperboard container filling machine, the aseptic chamber comprising:

an upper air distribution chamber;

a lower processing chamber housing processing equipment configured for interacting with paperboard containers passing through the processing chamber;

a throughflow plate separating the air distribution chamber and the processing chamber; and

a paperboard container transport sub-system configured for transporting the paperboard containers through the processing chamber along a container transport path from an inlet opening to an outlet opening of the processing chamber,

[0026] The method comprises the step of distributing air in the air distribution chamber by bringing the air from an air supply channel to the air distribution chamber through an air distribution duct comprising a plurality of throughflow holes configured for distributing the air in the air distribution chamber, the air distribution duct displaying a semi-tubular convex surface facing the throughflow plate and comprising a rectilinear duct axis extending orthogonal or substantially orthogonal to the container transport path.

[0027] According to a further aspect, the present disclosure provides an airflow system for an aseptic chamber in a blank fed pourable food stuff container filling machine. The aseptic chamber may comprise at least one inlet opening and at least one outlet opening for passage of containers, and a container transport sub-system configured for transporting the containers through the aseptic chamber along a container transport path from the inlet opening(s) to the outlet opening(s). Typically, the containers will be transport through a sterilization chamber before arriving in the aseptic chamber. The transport subsystem could be a conveyor-based system or any other kind of sub-system able to transport the containers. The aseptic chamber comprises an upper air distribution chamber configured for receiving air from at least one air supply channel, a lower processing chamber housing processing equipment configured for interacting with the containers and a throughflow plate separating the distribution chamber and the processing chamber. Preferably the throughflow plate extends over the entire interface between the upper air distribution chamber and the lower processing chamber. The throughflow plate comprises a plurality of slits configured for directing the air from the air distribution chamber to the lower processing chamber. The slits may be aligned parallel or substantially parallel with the transport path.

[0028] In an embodiment of the airflow system, the air distribution chamber comprises at least one elongated air distribution duct receiving air from the air supply channel(s), wherein the at least one air distribution duct comprises a plurality of throughflow holes configured for distributing the air in the upper air distribution chamber.

[0029] In an embodiment of the airflow system, the air distribution duct is connected to a top wall of the air distribution chamber and displays a semi-tubular convex surface facing the throughflow plate.

[0030] In an embodiment of the airflow system the air distribution duct comprises a rectilinear duct axis extending orthogonal or substantially orthogonal to the container transport path.

[0031] In an embodiment of the airflow system, the throughflow plate is planar and arranged horizontally or substantially horizontally in the aseptic chamber.

[0032] In an embodiment of the airflow system, the aseptic chamber is an aseptic filling chamber comprising a filling nozzle, and the throughflow plate is positioned at a height above a dispensing opening of the filling nozzle.

[0033] In an embodiment of the airflow system, the at least one throughflow plate comprises a substantially horizontal planar and section and first and second, curved sections, each curved section displaying a convex ruled surface facing the lower processing chamber, the ruled surface being defined by rulings which are parallel and extend orthogonal or substantially orthogonal to said transport path.

[0034] In an embodiment of the airflow system, the throughflow plate symmetrically envelops said at least one elongated distribution duct.

[0035] In an embodiment of the airflow system, the throughflow plate is positioned in an aseptic sealing chamber.

[0036] In an embodiment of the airflow system, the system further comprises a bottom wall having at least one exhaust air outlet. The outlet may be provided with suction provided with suction.

[0037] In an embodiment of the airflow system, the slits are evenly spaced apart on the throughflow plate.

[0038] In an embodiment of the airflow system, the slits occupy 5 - 50 %, more preferably 10 - 30 % of the total area of the throughflow plate.

[0039] In an embodiment of the airflow system, the slits have a length / width ratio larger than any one of: 4, 6, 8, 10, 15 and 20.

[0040] In an embodiment of the airflow system, the angle of the slits relative to the transport path does not deviate from parallel with more than anyone of 2, 4, 6, 8, 10, 15 and 20 degrees.

[0041] Another aspect of the present disclosure relates to a method for establishing an airflow in the aseptic chamber as described above and comprises the step of directing the air from the air distribution chamber to the processing chamber through said slits.

[0042] In an embodiment of the method, the method further comprises the step of subjecting the upper air distribution chamber to a first pressure and the lower processing chamber to a second pressure which is lower than the first pressure, but higher than ambient pressure.

[0043] Said aspects, and features thereof, may be used in combination with each other.

[0044] The protection for which is claims is defined by the appended claims.

Brief description of drawings

[0045] To facilitate the understanding of the present disclosure, reference is made to the accompanying drawings. In the drawings the same reference number refer to the same feature if not otherwise stated.

Fig 1 shows a container filling machine comprising an aseptic filling chamber and an aseptic sealing chamber.

Fig. 2 shows the container filling machine according to Fig. 1 in greater detail and with side plates removed.

Fig. 3 shows the container filling machine according to Fig. 2 in a perspective view from below.

Fig. 4 shows the container filling machine according to Fig. 1 a perspective view from above.

Fig. 5 shows the aseptic filling chamber and aseptic sealing chamber according to Fig. 1 in a perspective view.

Fig. 6 shows inlet openings and outlet openings in the aseptic filling chamber and the aseptic sealing chamber according to Fig. 1.

Fig. 7 shows an embodiment of a throughflow plate for an aseptic filling chamber.

Fig. 8 shows a close-up of the throughflow plate according to Fig. 7.

Fig. 9 shows an embodiment of a throughflow plate for an aseptic sealing chamber.

Fig. 10 shows an embodiment of an air distribution duct.

Fig. 11 illustrates processing chambers of a filling chamber and a sealing chamber of an embodiment of a filling machine.

Detailed description

[0046] In the following an embodiment of a blank-fed paperboard container filling machine 10 according to the present disclosure will be discussed in more detail with reference to the appended drawings.

[0047] The filling machine 10 comprises a sterilization chamber 20 configured for sterilizing open-top paperboard containers (not disclosed) folded from blanks (not disclosed).

[0048] The filling machine 10 further comprises a first aseptic chamber 30 arranged downstream of the sterilization chamber and forming a filling chamber of the filling machine 10. The filling chamber 30 is configured for filling the sterilized open-top paperboard containers with a pourable food-stuff. To this end, filling nozzles 32 are arranged in the filling chamber 30. The food-stuff is supplied to the filling nozzles 32 from a food-stuff supply system 11 (see Fig. 1).

[0049] The filling machine 10 also comprises a second aseptic chamber 40 arranged downstream of the filling chamber 30 and forming a sealing chamber of the filling machine 10. The sealing chamber 40 is configured for top-sealing the paperboard containers having been filled in the filling chamber 30. To this end, folding and sealing means 42 are arranged in the sealing chamber 40 (see Fig. 2). Also, the sealing chamber 40 may comprise nitrogen flushing nozzles 49 arranged to fill remaining space in the containers with nitrogen prior to the containers being sealed.

[0050] Consequently, after having passed through the sterilization chamber 20, the containers first pass through the filling chamber 30 in which the containers are filled with a pourable food-stuff. After having passed through the filling chamber 30, the containers pass through the sealing chamber 40 where the containers are sealed.

[0051] Both the filling chamber 30 and the sealing chamber 40 are aseptic chambers providing an environment which is sufficiently sterile to give the filled containers a predetermined shelf-life. Consequently, the aseptic nature of the filling chamber 30 and the sealing chamber 40 is such that it supresses contaminants that may otherwise degrade the shelf-life of the filled containers. Such contaminants may for example be bacteria, viruses, or other microorganisms. The filling chamber 30 and the sealing chamber 40 both comprises cleaning nozzles 22 allowing the chambers 30, 40 to be dozed by a cleaning fluid and cleaned during cleaning cycles.

[0052] In order to uphold the sterile condition of the containers and the food-stuff until the containers are safely sealed, the filling machine 10 comprises a first airflow system 34 configured for providing a controlled flow of clean air through the filling chamber 30 and a second airflow system 44 configured for providing a controlled flow of clean air through the sealing chamber 40. Said clean air may for example be sterile or near-sterile air, aseptic air or HEPA-air. HEPA-air is produced by filtering the air through a high-efficiency particulate air (HEPA) filter. As will be discussed in more detail below, the airflow systems 34, 44 are configured to provide an airflow of clean air that envelopes the containers as they are handled by processing equipment in the filling and sealing chambers.

[0053] A container transport subsystem 12 is configured to transport each container along a transport path 14 through the filling machine 10, including through the filling chamber 30 and the sealing chamber 40 (see Fig. 4). The container transport subsystem 12 may comprise a conveyor or linear actuator configured to convey carriers for the containers through the filling machine 10. In the disclosed embodiment, the filling machine 10 comprises three parallel transport paths 14 for the containers and the container transport subsystem 12 comprises carriers 16 configured to carry three containers in parallel (see Fig. 4 - the container transport subsystem 12 is disclosed without containers). In the present embodiment, each container transport path 14 is rectilinear. In other words, the container transport subsystem 12 is configured to convey the containers through the filling machine along rectilinear and parallel paths.

[0054] The filling chamber 30 is provided with inlet openings 31 arranged to allow containers to be carried into the filling chamber 30 by the container transport subsystem (see Fig. 6). The filling chamber 30 is also provided with outlet openings 33 arranged to allow containers to be carried out of the filling chamber 30 by the container transport subsystem. Similarly, the sealing chamber 40 is provided with inlet openings 41 arranged to allow the containers to be carried into the sealing chamber 40 by the container transport subsystem, and outlet openings 43 arranged to allow containers to be carried out of the sealing chamber 40. The outlet openings 33 of the filling chamber 30 may form the inlet openings 41 of the sealing chamber 40, thus allowing the containers to be transported directly from the filling chamber 30 to the sealing chamber 40.

[0055] In the filling chamber 30 the containers are conveyed from the inlet openings 31 to the outlet openings 33 along said parallel and rectilinear container transport paths 14. Likewise, in the sealing chamber 40 the containers are conveyed from the inlet openings 41 to the outlet openings 43 along said parallel and rectilinear container transport paths 14.

[0056] The filling chamber 30 comprises an upper air distribution chamber 35 and a lower processing chamber 36 (see Fig. 2). The filling chamber 30 further comprises a throughflow plate 37 separating the air distribution chamber 35 from the processing chamber 36 (also see Fig. 3). The throughflow plate 37 may monolithic, i.e. produced in one solid, unbroken piece. Preferably, however, the throughflow plate 37 consists of several part-plates 37a-37d which together separate the air distribution chamber 35 from the processing chamber 36, e.g. as is illustrated in Fig. 7.

[0057] The air distribution chamber 35 is configured for receiving clean air from air supply channels 18, and the throughflow plate 37 comprises a plurality of slits 38 (e.g. see Fig. 8) configured for directing the clean air from the air distribution chamber 35 to the processing chamber 36. As previously stated, said clean air may for example be sterile or near-sterile air, aseptic air or HEPA-air. In other words, the clean air is provided from the air supply channels 18 and the resulting airflow goes from the air distribution chamber 35 to the processing chamber 36 via the throughflow plates 37. In the processing chamber 36, the filling nozzles 32 are configured for dispensing the food-stuff in the containers.

[0058] In the present embodiment, the air distribution chamber 35 is configured to receive clean air from four air supply channels 18 (e.g. see Fig. 3). In other embodiments, however, air distribution chamber 35 may be configured to receive clean air from one, two, three, five or more air supply channels.

[0059] The throughflow plate 37 is preferably planar and the slits 38 are preferably aligned in parallel or substantially in parallel with the container transport paths 14. The purpose of this configuration is to envelope the containers in an uniform flow of clean air flowing from the throughflow plate 37 towards the carriers 16. Preferably, the uniform airflow is to fill the entire processing chamber 36 without forming turbulent eddies or vortexes, thereby preventing contaminated air from being drawn into the filling chamber from outside of the processing chamber 36, in particular via openings 60 formed at a bottom wall or floor 61 of the processing chamber 36, which openings 60 are configured to accommodate containers to be filled (see Fig. 11). Preferably, in the processing chamber 36 an aseptic zone should extend from the throughflow plate 37 and all the way down to the bottom wall 61, thus preventing contaminated air from entering the open containers extending through the openings 60 (the top of which containers are held above the bottom wall 61 by the carriers 16).

[0060] The throughflow plate 37 may display a continuous surface only being broken by the slits 38 and by openings to be occupied by necessary processing equipment extending through the throughflow plate 37, e.g. openings 26 for filling nozzles and openings 27 for cleaning fluid ducts (see Fig. 7).

[0061] As illustrated in Fig. 8, the slits 38 have a large aspect ratio, i.e. a large length / width ratio. Preferably the aspect ratio of the slits 38 is larger than any one of: 4, 6, 8, 10, 15 and 20. However, as long as the throughflow plate is structurally sound, the aspect ratio of the slits may be even larger. According to one embodiment, the aspect ratio of the slits 38 is within the range of 5-30, or more preferably within the range of 10-20. According to one embodiment, the length L of each slit 38 may be within the range of 10-40 mm and the width W within the range of 5-30 mm, or more preferably within the range of 10-20 mm. The throughflow plate 37 may be made from stainless steel sheet metal having a thickness T within the range of 1-5 mm. The slits 38 may occupy 5-50 %, preferably 10%-30% of the total area of the throughflow plate 37. Preferably the slits 38 are arranged evenly spaced apart on the throughflow plate 38.

[0062] As previously stated, the slits 38 may be aligned in parallel with the transport paths 14 of the containers.

Such an alignment has been found to cause relatively little turbulence in the processing chamber 36. Without wishing to be bound by theory, it is believed that such an alignment of the slits 38 provide stable, parallel "air knifes" which are relatively unaffected by the containers as they move through the processing chamber 36 and, thus, causes limited or no turbulence in the clean air flow. As stated above, elongated slits aligned parallel or substantially parallel to the transport paths 14 of the containers have been found to cause relatively little turbulence in the processing chamber 36. A slight angle of the slits 38 relative to the transport paths 14 will give a similar, but somewhat less positive effect. It has been found that the angle of the slits 38 relative to the transport paths 14 should preferably not deviate from parallel with more than anyone of 2, 4, 6, 8, 10, 15 and 20 degrees.

[0063] Preferably, the slits 38 are provided with rounded ends as seen in Fig. 8. This may be advantageous with regards to cleaning as materials having 90 degrees angles are harder to keep clean.

[0064] In a preferred embodiment show in Figs. 2 and 3 the first airflow system 34, in addition to the throughflow plate 37, comprises elongated air distribution ducts 50 configured for receiving said clean air from the air supply channels 18 and distributing the clean air in the air distribution chamber 35. Each air distribution duct 50 comprises a plurality of throughflow holes 51 (see Fig. 10). In the air distribution chamber 35, each air distribution duct 50 may be connected to a top wall or ceiling 39 of the air distribution chamber (see Fig. 2) for distributing the supplied air throughout the air distribution chamber 35. The purpose of the air distribution duct 50 is to even out pressure gradients inside the air distribution chamber 35 in order to provide a more even flow of air through all parts of the throughflow plate(s) 37.

[0065] In a preferred embodiment, each air distribution duct 50 is substantially semi-tubular and comprises a convex surface 52 facing the throughflow plate 37 (see Figs. 3 and 10). Advantageously, the air distribution ducts 50 extend from one side of the air distribution chamber 35 to an opposite side thereof. Preferably, each air distribution duct 50 has a rectilinear duct axis A (see Fig. 3) extending substantially orthogonal to the container transport paths 14 (see Fig. 6). Furthermore, the size of the throughflow holes 51 and/or the distribution of the throughflow holes 51 can be adjusted according to the distance from the air supply channel (s) 18 in order to obtain the same throughflow per area over the entire air distribution duct 50.

[0066] In a preferred embodiment seen in Figs. 2 and 3, the throughflow plate 37 is substantially planar and horizontally positioned in the filling chamber 30 at a height just above the lower part of the filling nozzles 32. In order to accommodate the filling nozzles 32 and the food-stuff supply system 11, the throughflow plate 37 may be cut or shaped as indicated in Fig. 7. Preferably, the throughflow plate is closely fitted to the filling nozzles 32 and the food-stuff supply system 11 in order to avoid large openings causing uneven throughflow of clean air from the air distribution chamber 35 to the processing chamber 36.

[0067] The sealing chamber 40, like the filling chamber 30, comprises an upper air distribution chamber 45 and a lower processing chamber 46 (see Fig. 2). The sealing chamber 40 also comprises a throughflow plate 47 separating the air distribution chamber 45 from the processing chamber 46 (also see Fig. 3). The air distribution chamber 45 is configured for receiving clean air from air supply channels 19, and the throughflow plate 47 comprises a plurality of slits 48 (e.g. see Fig. 9) configured for directing the clean air from the air distribution chamber 45 to the processing chamber 46. As previously discussed, said clean air may for example be sterile or near-sterile air, aseptic air or HEPA-air.

[0068] In the present embodiment, the air distribution chamber 45 is configured to receive clean air from three air supply channels 19 (e.g. see Fig. 3). In other embodiments, however, air distribution chamber 45 may be configured to receive clean air from one, two, four, five or more air supply channels.

[0069] In a preferred embodiment the throughflow plate 47 comprises a planar section 55 and two curved sections 56 adjoining the planar section 55 and being connected to a top wall or ceiling 57 of the sealing chamber 40 (e.g. see Fig. 2). The planar section 55 is horizontally aligned and thus displays a down-wards facing, planar surface facing the processing chamber 46. The curved sections 56 each display a convex ruled surface facing the processing chamber 46, the ruled surface being defined by rulings which are parallel and extend orthogonal or substantially orthogonal to said container transport path 14. The throughflow plate 47 thus displays a generally U-shaped cross-section. This configuration provides space in the processing chamber 46 for processing equipment such as folding and sealing means 42 and nitrogen flushing nozzles 49 (see Fig. 2). In the cross-direction of the sealing chamber 40 the throughflow plate 47 extends across the width of the sealing chamber 40 adjoining side walls of the sealing chamber 40.

[0070] Like the slits 38, the slits 48 have a large aspect ratio. Preferably the aspect ratio of the slits 48 is larger than any one of: 4, 6, 8, 10, 15 and 20. According to one embodiment, the aspect ratio of the slits 48 is within the range of 5-30, or more preferably within the range of 10-20. According to one embodiment, the length of each slit 48 may be within the range of 10-40 mm and the width within the range of 5-30 mm, or more preferably within the range of 10-20 mm. The throughflow plate 47 may be made from stainless steel sheet metal having a thickness within the range of 1-5 mm. The slits 48 may occupy 5-50 %, preferably 10%-30% of the total area of the throughflow plate 47. Preferably the slits 48 are arranged evenly spaced apart on the throughflow plate 48. The throughflow plate 47 may comprise rectangular and planar part-sections 47a-47k which are adjoined to form the throughflow plate 47, as is indicated in Fig. 9.

[0071] The slits 48 are aligned with the container transport paths 14. Consequently, in the planar section 55 the slits 48 are arranged substantially parallel to the container transport paths 14, while in the curved sections 56 the slits 48 are arranged in parallel, vertical planes. Such an alignment has been found to cause limited turbulence in the processing chamber 46. The purpose of this configuration of the throughflow plate 47 is to envelope the top of the containers in a uniform flow of clean air flowing from the throughflow plate 47 towards a bottom wall or floor 62 of the processing chamber 46 (see Fig. 11). Preferably, the uniform airflow is to fill the entire processing chamber 46 without forming turbulent eddies or vortexes, thereby preventing contaminated air from being drawn into the sealing chamber 40 from the outside, in particular via openings formed at the bottom wall 62 of the filling chamber 30 (see Fig. 11), e.g. openings formed by guiding slots 63 configured to fold the top of the containers prior to the containers being top-sealed. Preferably, the guiding slots 63 are the only openings being present in the bottom wall 62, thereby contributing to an aseptic zone extending from the throughflow plate 47 and all the way down to the bottom wall 62.

[0072] In a preferred embodiment show in Figs. 2 and 3, the second airflow system 44, in addition to the throughflow plate 47, comprises an air distribution duct 53 configured for receiving said clean air from the air supply channels 19 and distributing the clean air in the air distribution chamber 45. The air distribution duct 53 is preferably configured in the same manner as the air distribution ducts 51 in the filling chamber 30. Consequently, the air distribution duct 53 preferably comprises a plurality of throughflow holes 51 (see Fig. 10) and the air distribution duct 53 is preferably connected to the top wall or ceiling 57 of the air distribution chamber 45 (see Fig. 2) for distributing the supplied air throughout the air distribution chamber 45.

[0073] In a preferred embodiment, the air distribution duct 53 is, like the air distribution duct 50, substantially semi-tubular and comprises a convex surface 52 facing the throughflow plate 47 (see Figs. 3 and 10). Advantageously, the air distribution duct 53 extends from one side of the air distribution chamber 45 to an opposite side thereof. Also, preferably, the air distribution duct 53 has a rectilinear duct axis A (see Fig. 3) extending substantially orthogonal to the container transport paths 14 (see Fig. 6). Furthermore, the size of the throughflow holes 51 and/or the distribution of the throughflow holes 51 can be adjusted according to the distance from the air supply channel(s) 19 to obtain the same throughflow per area over the entire air distribution duct 53. Preferably, the throughflow plate 47 symmetrically envelops the distribution duct 53.

[0074] In operation of the filling machine 10, all clean air passing from the air distribution chamber 35 to the processing chamber 36 in the filling chamber 30 should preferably pass through the slits 38 in the throughflow plate 37. The clean air may then be evacuated from the processing chamber 36 through the openings 60 in the bottom wall 61 (or more precise through sections of the openings 60 not occupied by containers - see Fig. 11).

[0075] Likewise, in operation of the filling machine 10 all clean air passing from the air distribution chamber 45 to the processing chamber 46 in the sealing chamber 40 should preferably pass through the slits 48 in the throughflow plate 47. The clean air may then be evacuated from the processing chamber 46 through the guiding slots 63 (see Fig. 11).

[0076] The area of the air outlets, e.g. the openings 60 and the guiding slots 63, may preferably be distributed evenly along the transport paths 14 populated by the container in order to envelop the containers in a uniform air flow. In some applications this may enhance the flow of aseptic air from the throughflow plates 37, 47 towards the bottom walls 61, 62. Also or alternatively, the air outlets may be provided with suction. However, if suction is provided, it should not be so strong as to cause pressure in parts of the respective processing chamber to sink below ambient pressure as this could cause unclean air to enter into the processing chambers 36, 46 through any gaps.

[0077] According to the present disclosure a method for establishing an airflow of clean air in an aseptic chamber of a filling machine, e.g. in a filling or a sealing chamber, comprises the step of directing clean air from the air distribution chamber 35, 45 to the processing chamber 36, 46 through said throughflow plate 37, 47.

Claims

1. A paperboard container filling machine (10) comprising an aseptic chamber (30, 40), the aseptic chamber (30, 40) comprising:

   an upper air distribution chamber (35, 45);
   a lower processing chamber (36, 46) housing processing equipment (32, 42, 49) configured for interacting with paperboard containers passing through the processing chamber (36, 46);
   a throughflow plate (37, 47) separating the air distribution chamber (35, 45) and the processing chamber (36, 46); and
   a paperboard container transport sub-system (12) configured for transporting the paperboard containers through the processing chamber (36, 46) along a container transport path (14) from an inlet opening (31, 41) to an outlet opening (33, 43) of the processing chamber (36, 46),
   characterised by the throughflow plate (37, 47) having a predefined thickness (T) and comprising a plurality of slits (38, 48) configured for directing the air from the air distribution chamber (35, 45) to the processing chamber (36, 46), the slits (38, 48) having a predefined length (L), a predefined width (W) and a predefined length/width ratio (L/W),

wherein said predefined thickness (T) is at least 1.5 times said predefined width (W),
and wherein said predefined length/width ratio (L/W) is larger than any one of: 4, 6, 8, 10, 15 and 20.

2. The filling machine (10) according to claim 1, wherein the slits (38, 48) are rectilinear.

3. The filling machine (10) according to any one of claims 1 and 2, wherein the slits (38, 48) are arranged along a plurality of parallel lines.

4. The filling machine (10) according to any one of the preceding claims, wherein the slits (38, 48) occupy any one of: 5 - 50 % of the total area of the throughflow plate (14); and 10 - 30 % of the total area of the throughflow plate (37, 47).

5. The filling machine (10) according to any one of the preceding claims, wherein the slits (38, 48) are aligned with the container transport path (14).

6. The filling machine (10) according to any one of the preceding claims, wherein the throughflow plate (37, 47) is planar.

7. The filling machine (10) according to claim 6, wherein the slits (38, 48) are arranged parallel to or substantially parallel to each other.

8. The filling machine (10) according to claim 7, wherein the slits (38, 48) are aligned parallel to or substantially parallel to the transport path (14).

9. The filling machine (10) according to any one of claims 1-5, wherein the throughflow plate (37, 47) comprises a substantially horizontal planar section (55), and first and second, curved sections (56), each curved section (56) displaying a convex ruled surface facing the processing chamber (36, 46), the ruled surface being defined by rulings which are parallel and extend orthogonal or substantially orthogonal to said transport path (14).

10. A method of establishing an airflow in an aseptic chamber (30, 40) of a paperboard container filling machine (10), the aseptic chamber (30, 40) comprising:

an upper air distribution chamber (35, 45) configured for receiving air from an air supply channel (18, 19);
a lower processing chamber (36, 46) housing processing equipment (32, 42, 49) configured for interacting with paperboard containers passing through the processing chamber (36, 46); and
a paperboard container transport sub-system (12) configured for transporting the paperboard containers through the processing chamber (36, 46) along a container transport path (14) from an inlet opening (31, 41) to an outlet opening (33, 43) of the processing chamber (36, 46),
the method being **characterised by** the step of bringing the air from the distribution chamber (38, 48) to the processing chamber (36, 46) through a throughflow plate (37, 47) having a predefined thickness (T) and comprising a plurality of slits (38, 48) configured for directing the air from the air distribution chamber (35, 45) to the processing chamber (36, 46), the slits (38, 48) having a predefined length (L), a predefined width (W) and a predefined length/width ratio (L/W),
wherein said predefined thickness (T) is at least 1.5 times said predefined width (W),
and wherein said predefined length/width ratio (L/W) is larger than any one of: 4, 6, 8, 10, 15 and 20.

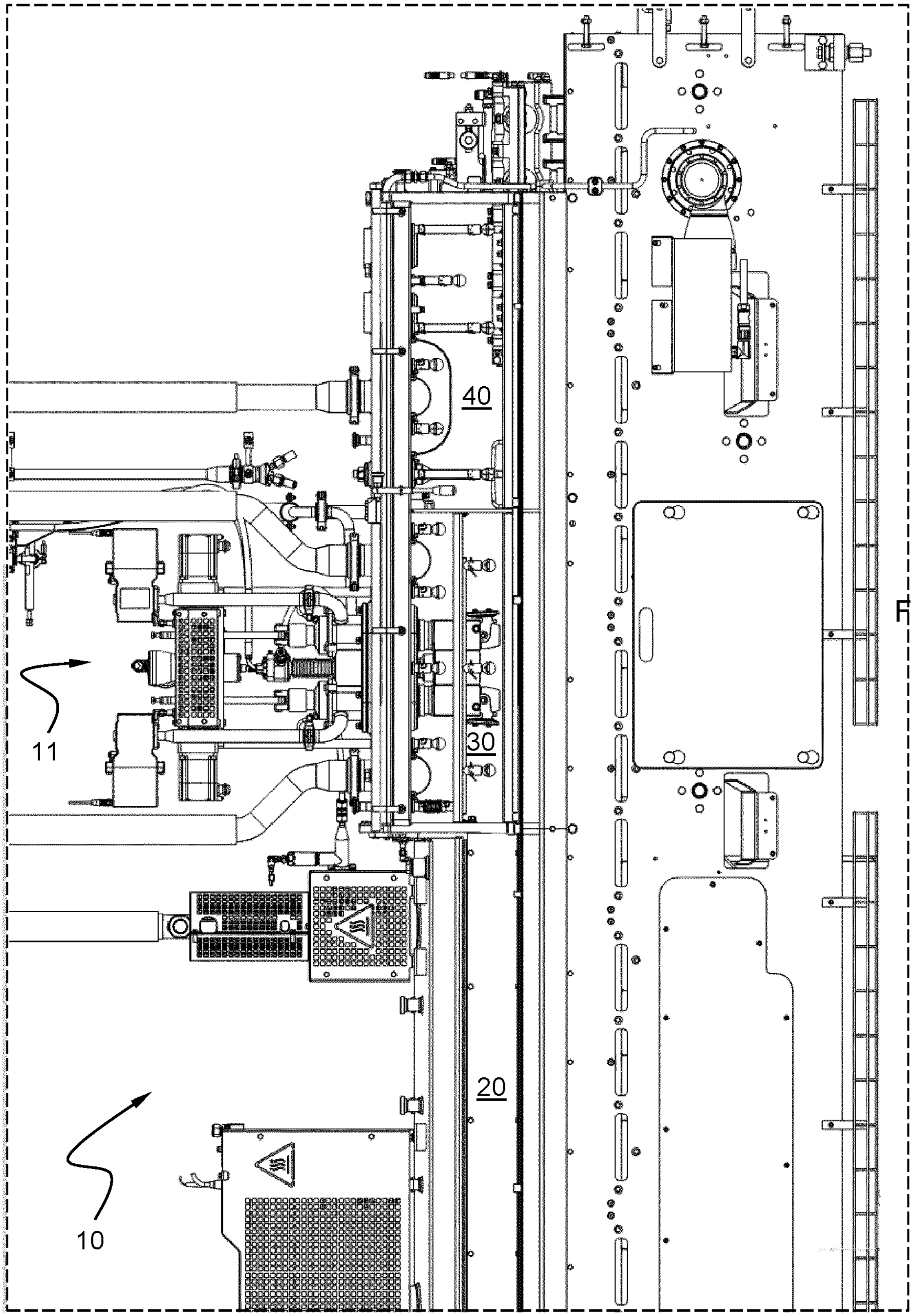

Fig. 1

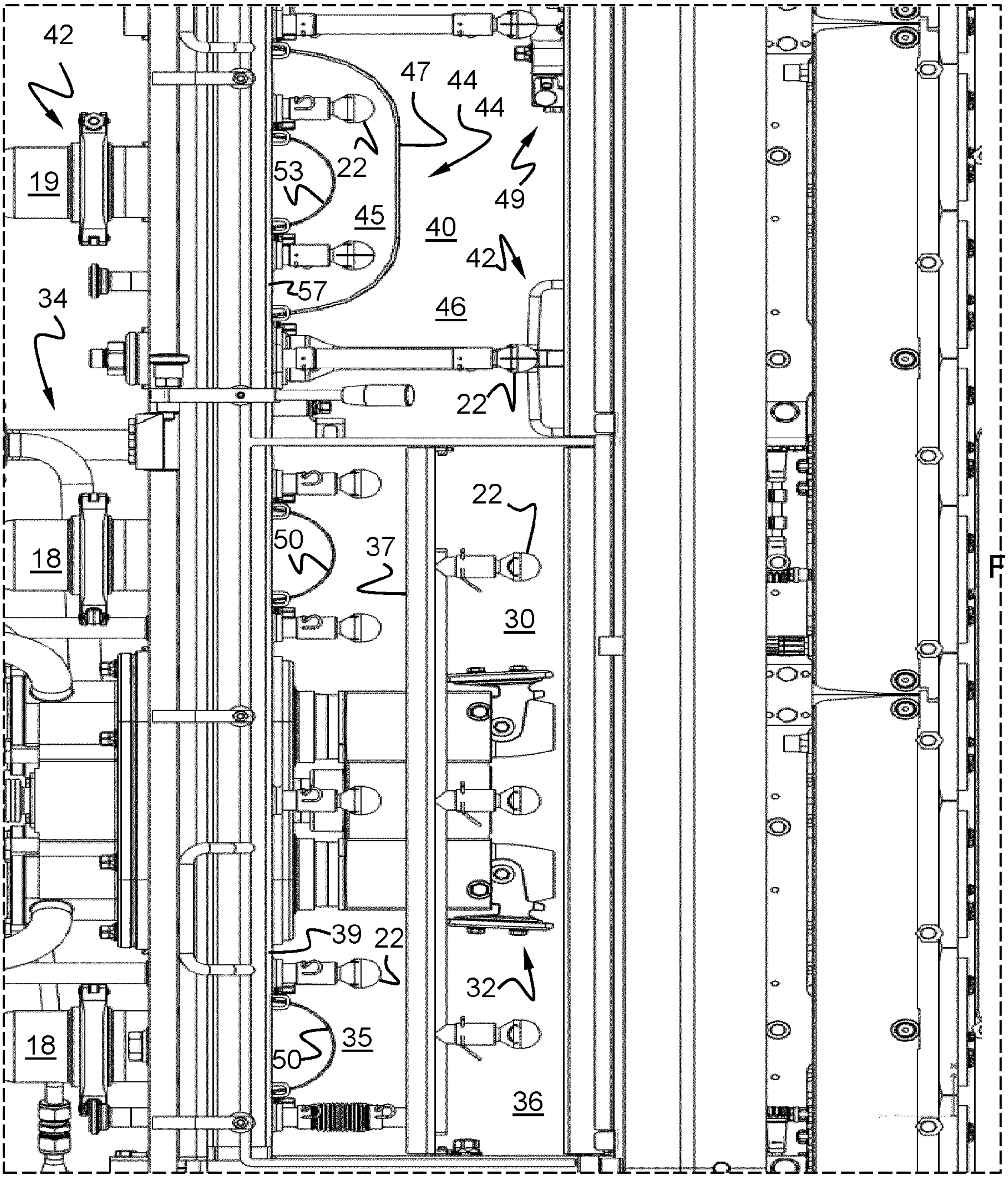
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Fig. 2

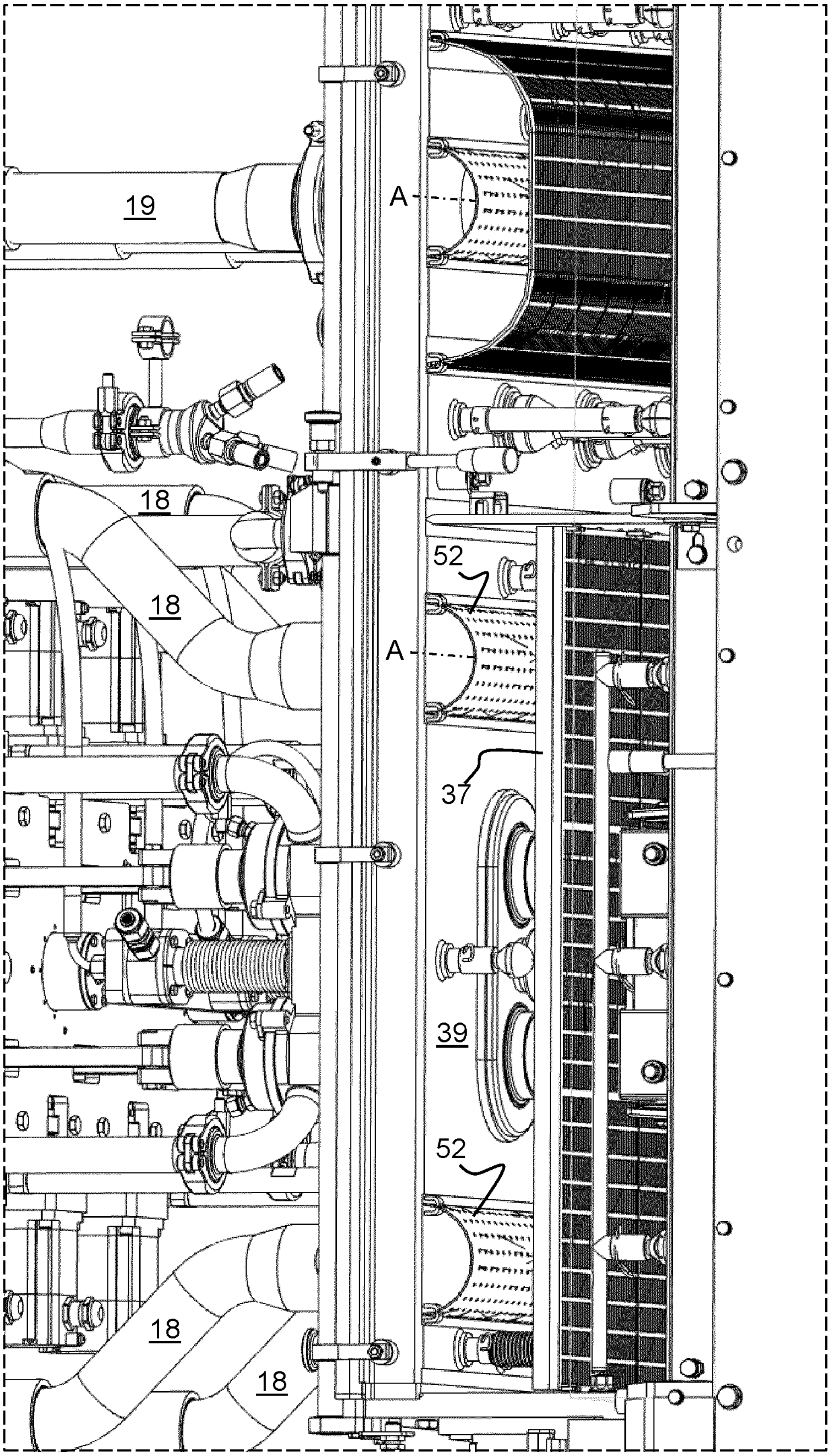

Fig. 3

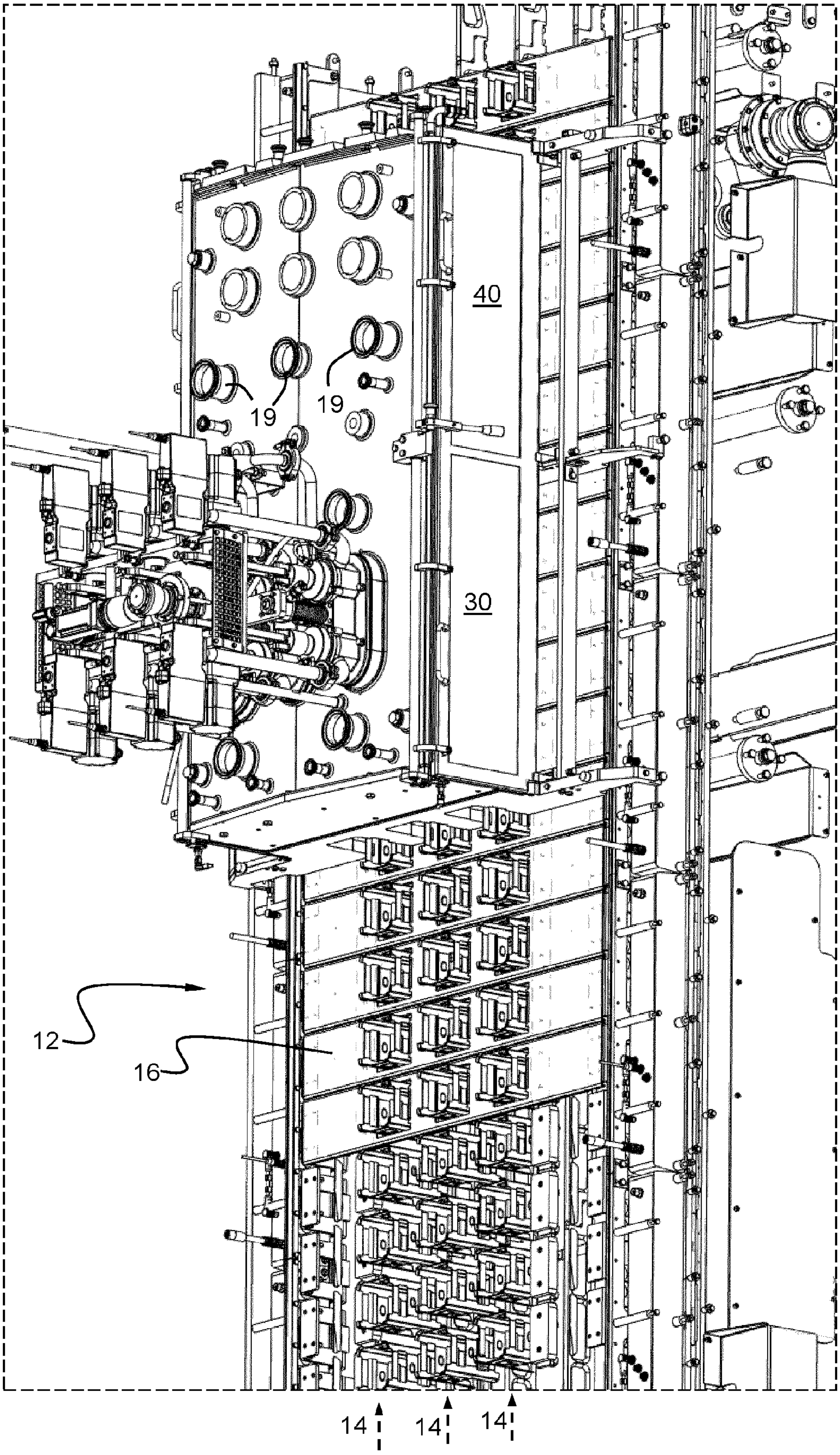

Fig. 4

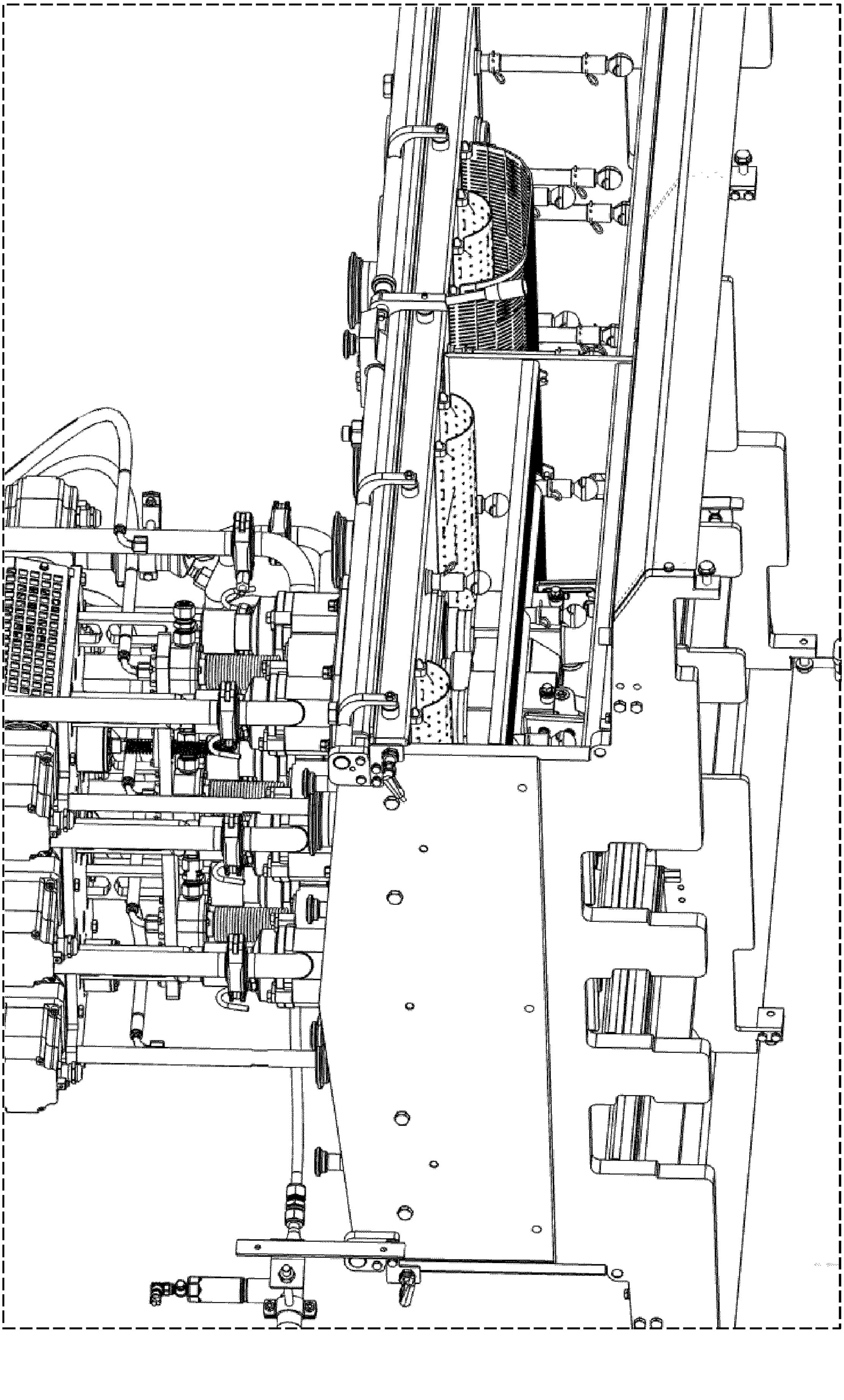

Fig. 5

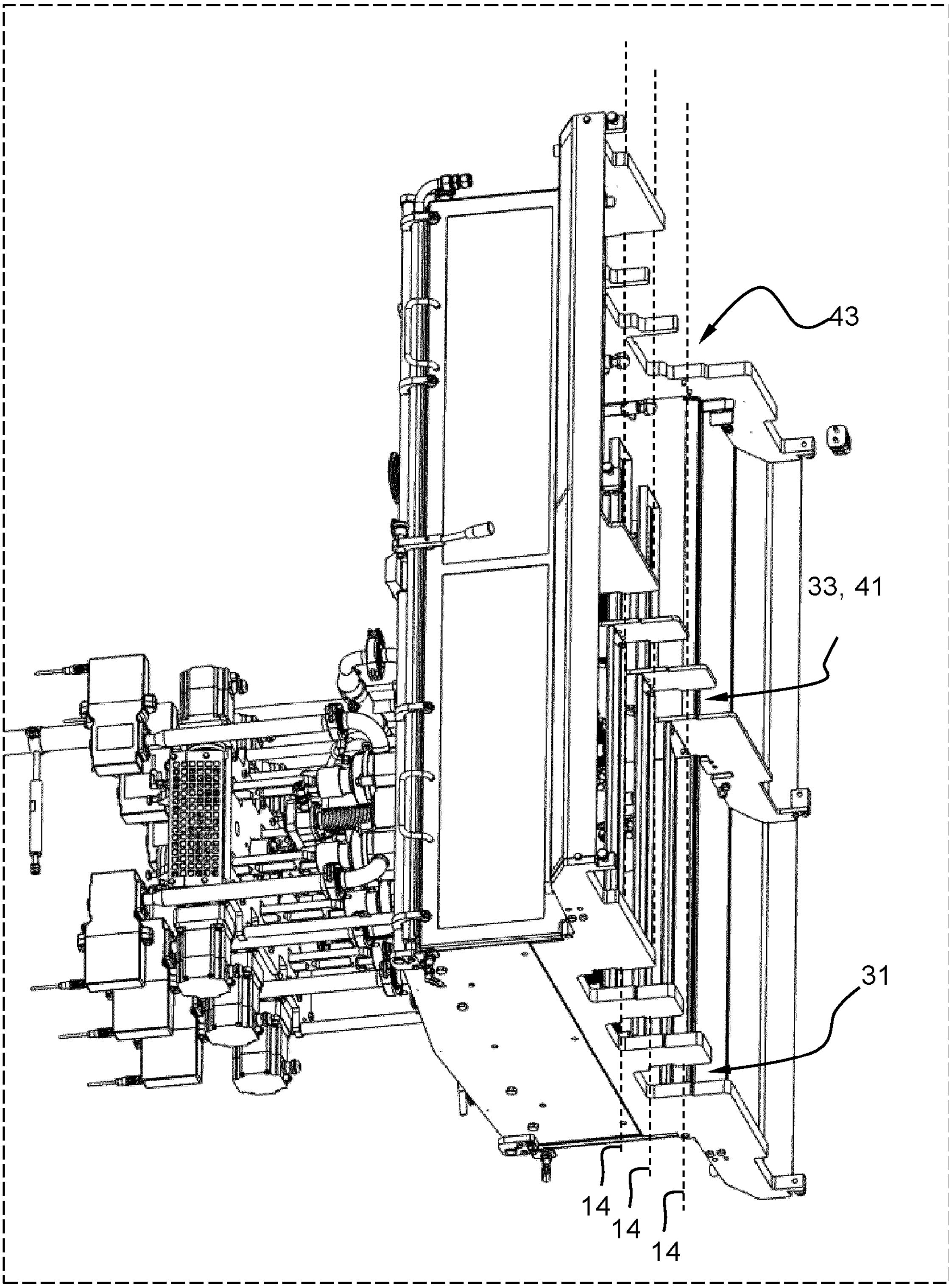

Fig. 6

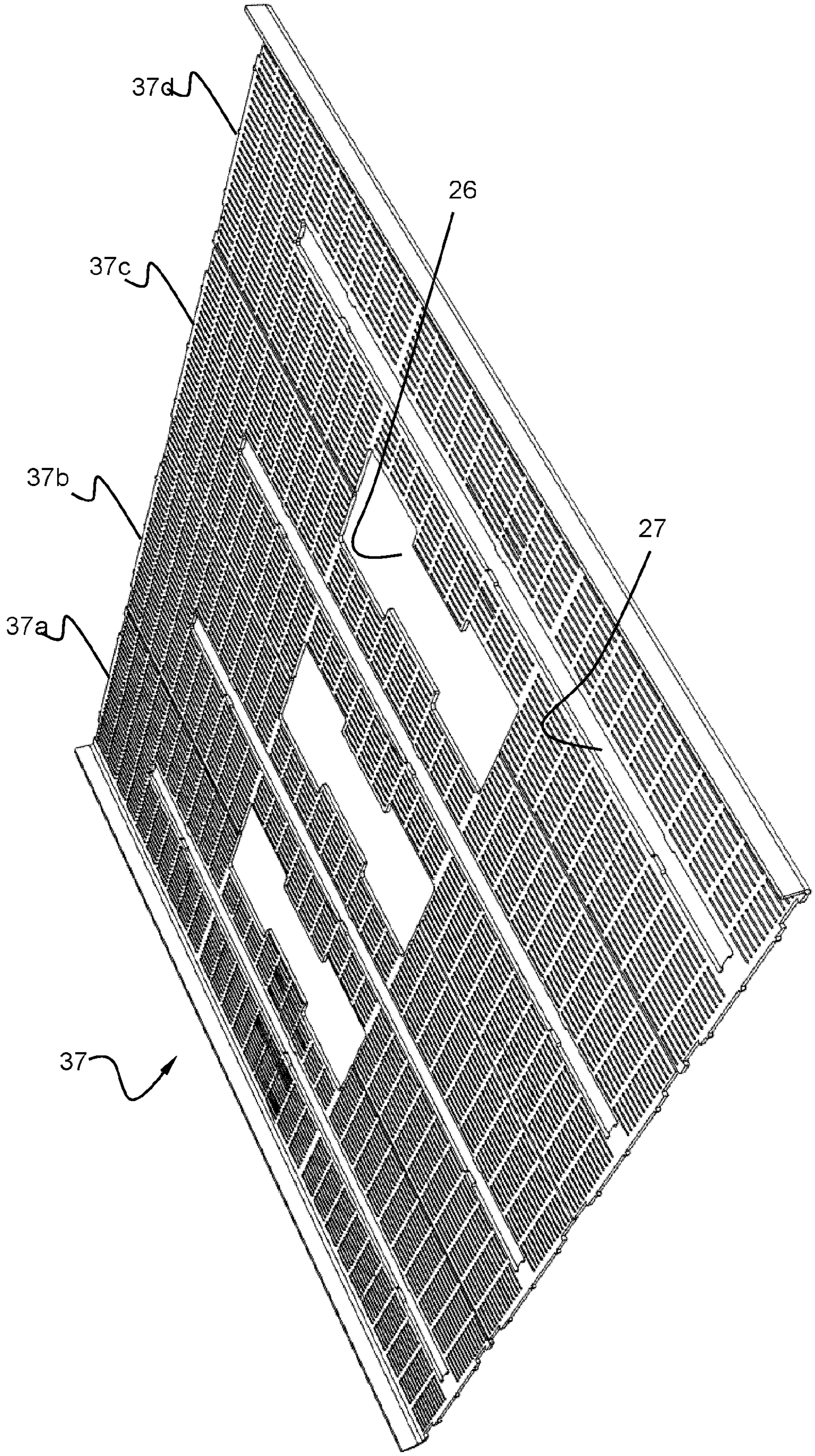

Fig. 7

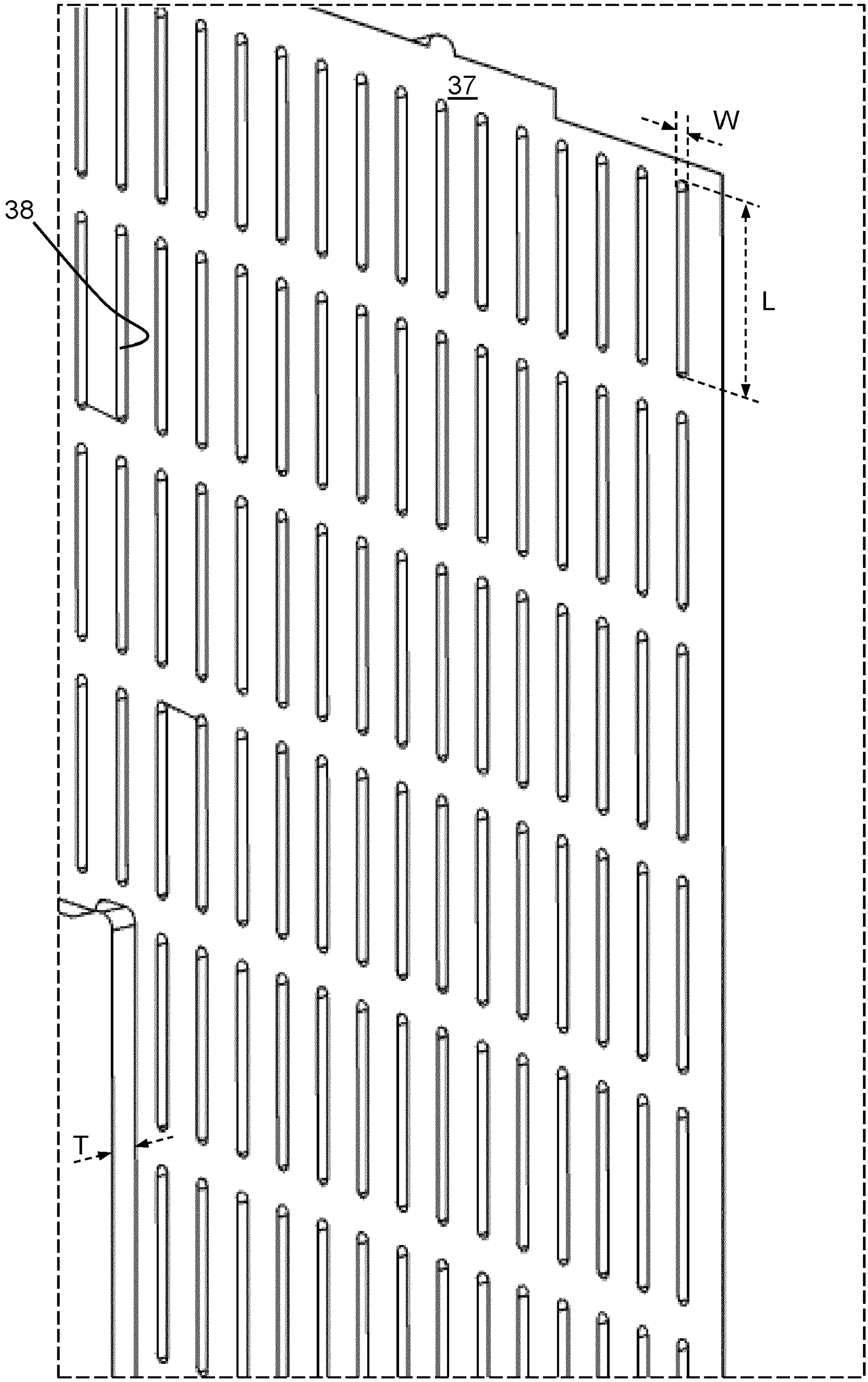

Fig. 8

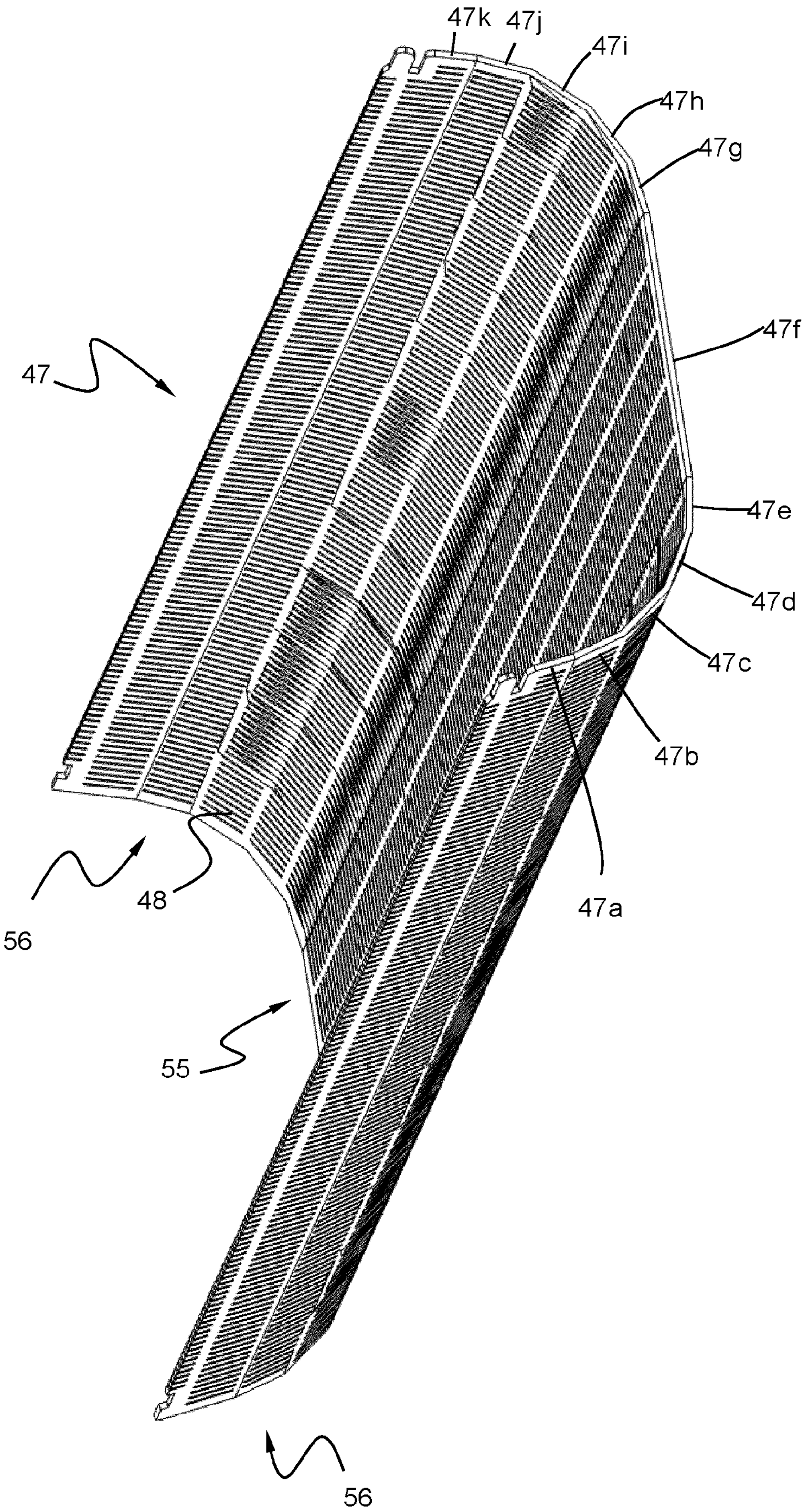

Fig. 9

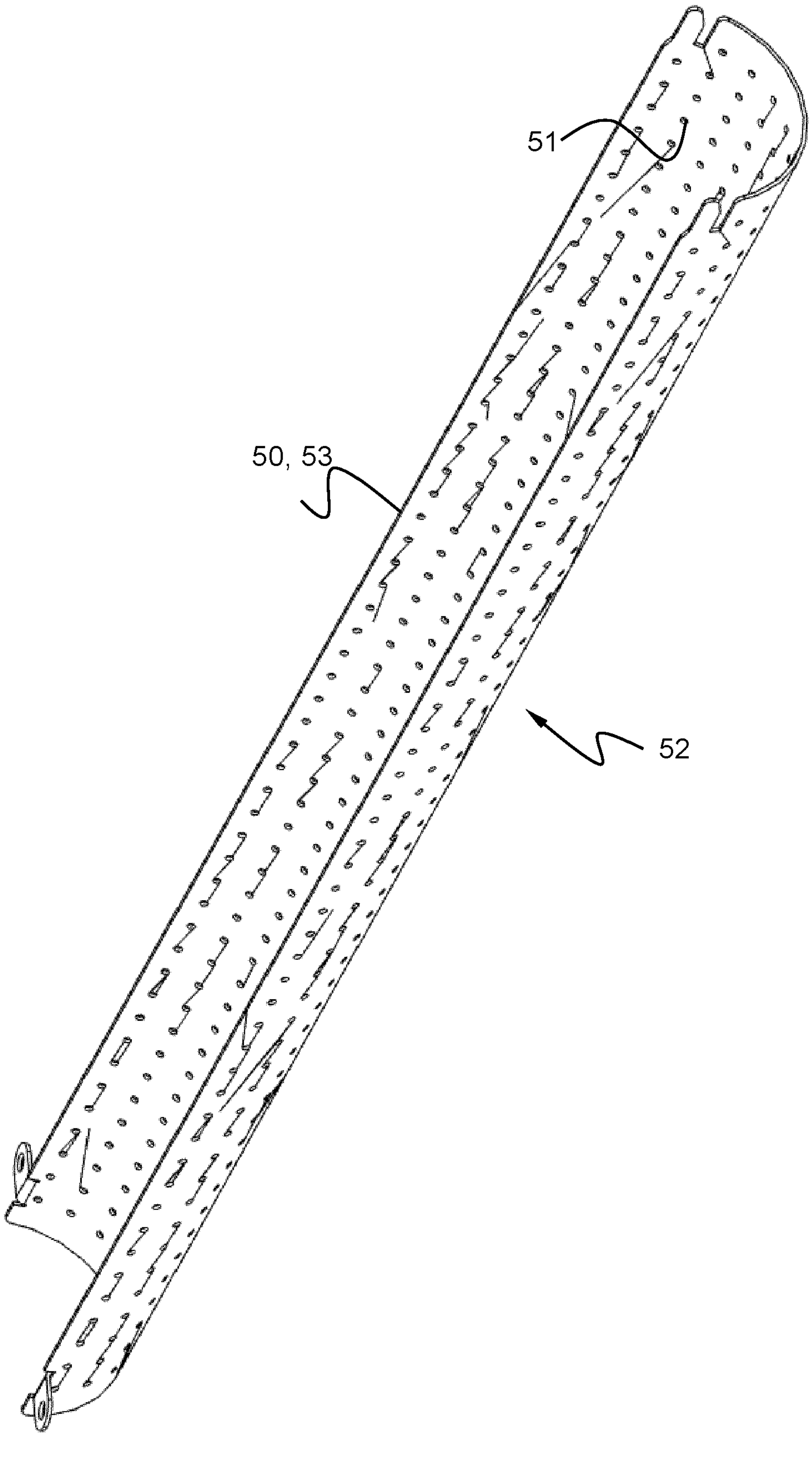

Fig. 10

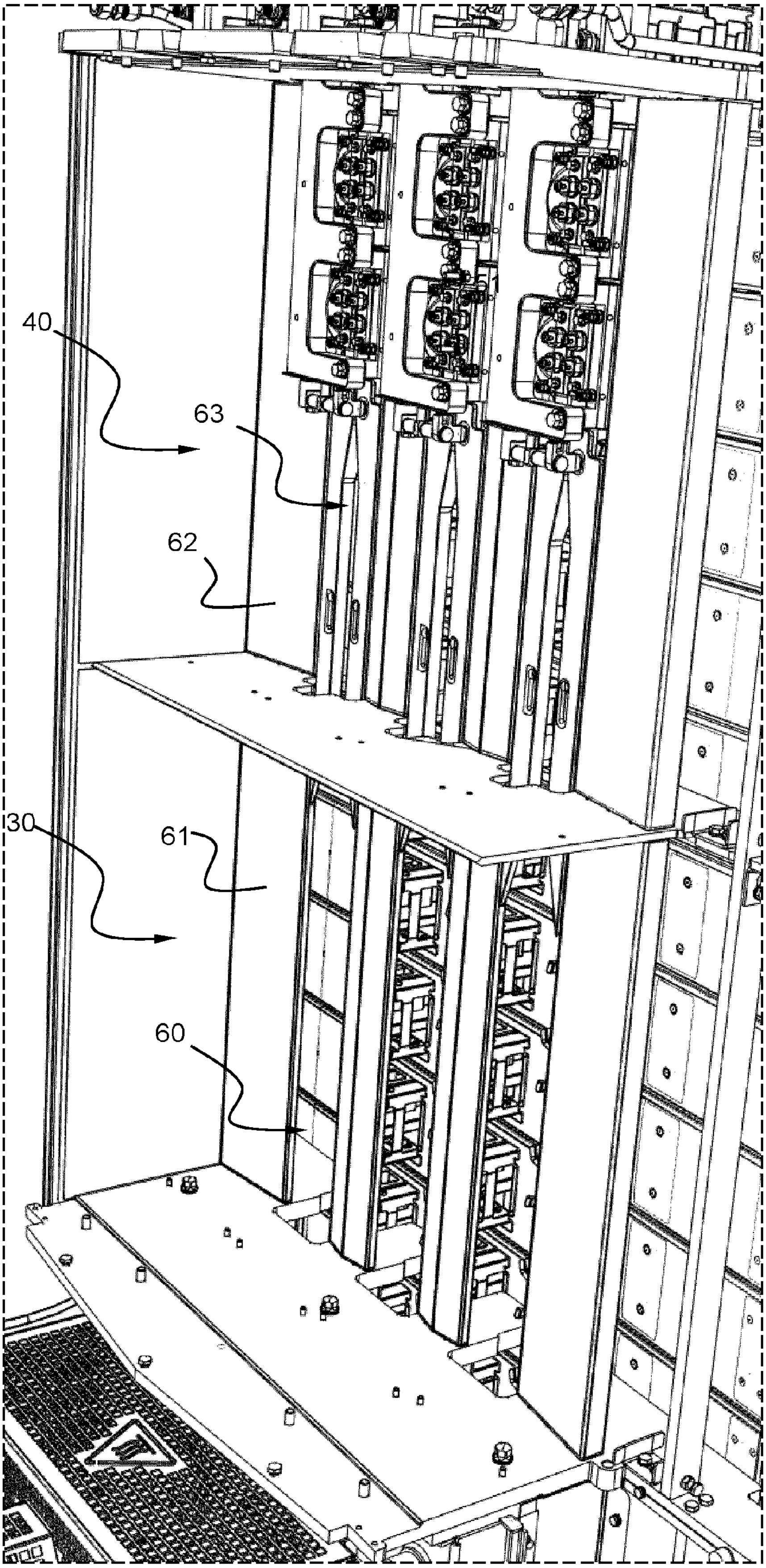

Fig. 11

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Application Number
EP 22 19 4482

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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
Munich	17 March 2023	Yazici, Baris

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Place of search	Date of completion of the search	Examiner
Munich	17 March 2023	Yazici, Baris

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