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(54) Benævnelse: **MODULÆRT SYSTEM TIL AT SKABE EN BEHANDLINGSENHED TIL GRANULAT**

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Modular system for the treatment of bulk materials

I. Field of application

The invention relates to the treatment of bulk materials, in particular the freeing of bulk materials of the dust contained therein, in particular by means of ionisation, since the dust frequently adheres to the granule grains by means of electrostatic charge. More specifically, the invention relates to a modular system for constructing a treatment unit for granules having the features of the preamble of claim 1.

II. Technical background

Especially in plastics technology, but also in pharmaceuticals and food technology, raw materials in the form of bulk materials – for example granules, ground materials, coarse powders or the like – often have to be handled, for example transported, and treated, for example dried and/or dedusted. For the purposes of the present application, all bulk materials are referred to by the abbreviating term “granules”.

Specifically the transportation of such bulk materials is often carried out by means of pneumatic conveying, in particular by means of dilute phase conveying, in which the granules are brought to the desired location by means of air flow and for the most part carried thereby through conveying lines.

For use in a consumer, for example for use as a raw material in a plastics injection moulding machine, the granules should be as clean as possible and in particular should not be loaded with dust-like impurities. These dust-like impurities can consist both of foreign material, which has inadvertently been added to the granules during production or transportation, or they may also be dust-like particles of the same material as the granules themselves, which may, however, likewise be undesirable depending on the subsequent intended use.

Dust or dust-like impurities within the context of the present description should preferably have a particle size whose diameter is not more than 1/10, better still not more than 1/30, better still not more than 1/100, better still not more than 1/1000 of the diameter of a granule grain.

Therefore, the general aim is to separate such granules from the dust contained therein before they are used.

Various techniques are available for this purpose, from simple sieving, through separation of the transport air from the granules and filtering of the transport air, to fraction separation by means of a cyclone.

One of the problems that occurs here is the strong adhesion of dust particles and granule particles to one another, but also the adhesion of dust particles to apparatus parts such as conveying lines or granule containers.

This strong adhesion is often caused by electrostatic charge, so that the dust can generally be removed by mechanical measures only once these binding forces have been eliminated.

In principle, this is known to be possible by statically discharging the differently charged and thus mutually attracted parts, in this case dust particles on the one hand and granule particles on the other hand, for example by grounding one fraction.

However, where there are a very large number of very small particles, as is the case here, this is difficult in practice.

For example, attempts have already been made to separate the granules by continually swirling them upwards in the dust extraction container, which is closed at the bottom, and bringing them into intimate contact with ionised air. However, this can cause further abrasion and thus dust simply as a result of granule grains colliding.

Furthermore, attempts have been made to suction the dust-laden air via an air outlet opening rather than forcing it out by means of excess pressure, wherein the air outlet opening was closed by a screen through which a granule grain was unable to pass.

Furthermore, the granules often have to be dried before they are used in a consumer such as an injection moulding machine, in order to reduce the amount of moisture contained therein especially to such an extent that no cavities caused by vapour formation develop in the injection-moulded part during injection moulding.

If this is necessary, the dryer is the last processing station for the granules before the consumer and is often mounted directly at the granule inlet of the consumer. Depending on whether drying of the granules is or is not necessary, the dust extractor is mounted either on the dryer or directly at the granule inlet of the consumer.

DE 10 2016 119 827 A1 discloses a dust extraction system, the components of which include a modular system having the features of the preamble of claim 1.

EP 2 711 097 A1 discloses a treatment unit for granules having:
a) a closure unit for a stream of granules flowing through, having
- a housing,
- a granule inlet opening for the granules in the upper part of the housing,
- a granule outlet opening in the lower part of the housing,
- a closure element in the housing, which closure element is so configured that it is able to close a granule through-flow opening, in particular a granule outlet opening, of a component located above it, from the underside thereof,
b) a dust extractor for extracting dust from granules, having:
- a dust extraction container which has:
-- at least one granule inlet opening for the granules,
-- a granule outlet opening in the lower part of the dust extraction container, in particular in the base thereof, and

-- an air outlet opening which is arranged in particular in the upper part of the dust extraction container,

- an ioniser,

- a swirl unit for swirling the granules in the dust extraction container,

c) a controller which is capable of controlling all the relevant components of the treatment unit,

d) a granule dryer.

US 2734782 A describes a tank for powder or granules, in which compressed air is introduced in the lower region of the tank in order to facilitate the flow of the powder or granules downwards out of the tank through an outlet.

DE 342 197 C, EP 0 166 959 A2, EP 0 117 397 A1, DE 20 41 230 A1 and US 2015/151229 A1 disclose closure units having a cone-shaped closure element pointing from bottom to top, which closure element is, however, not fastened here so as to be pivotable about one or more horizontal axes. Publication WO9002643A1 discloses a feed apparatus for bulk material having a cone-shaped damming and supporting member.

There are further known from US 3799367 A, CN 206857425 U and JP S4719974 U inlet valves which are designed with a pivotable, cone-shaped valve body, but these are provided for different applications, in the case of the JP specification for a dust collecting container, in the case of the US specification for a blast furnace for melting iron, and in the case of the CN specification for a silo, no description being given of the further design features thereof, such as connecting elements to upstream and downstream units or the nature of the emptying.

III. Description of the invention

a) Technical problem

The problem according to the invention is, therefore, to provide a modular system having a plurality of modules for constructing a treatment unit, which modules, depending on the application and the desired operating mode of the treatment unit upstream of a consumer, allow this treatment unit to be configured individually in a simple manner and from a small number of modules, and thus with a low inventory level at the manufacturer, and to be assembled and mounted in a simple manner.

b) Solution to the problem

This problem is solved by the features of claim 1. Advantageous embodiments will become apparent from the dependent claims.

Depending on the nature of the pretreatment and/or aftertreatment of the granules, the granule outlet opening of the dust extractor must be capable of being closed or not, for example in order to be able to operate it continuously in one case and batchwise in another case.

It has been found that it is not optimal always to install at the granule outlet opening a closure element that is integrated into the dust extractor and simply allow this closure element to be opened when the desired nature of the operating mode of the treatment unit requires the granule outlet opening of the dust extractor to be permanently open.

According to the invention, the modular system comprises a closure element for the granule outlet opening of the dust extractor in the form of a separate closure unit which can be mounted beneath the dust extractor or can also be used at a different location, which has further advantages, for example because the housing of the

closure unit constitutes an additional intermediate container for granules, and also in respect of easier maintenance and repair of the treatment unit as a whole.

In order to be able to configure the treatment unit individually in a simple manner and from a small number of modules, and thus with a low inventory level at the manufacturer, depending on the application and the desired operating mode of the treatment unit, there is proposed according to the invention a modular system which contains the required modules, which are specifically designed for free mutual combinability.

This means that the individual modules and their connecting elements for mutual connection are specifically so designed that the modules can be fastened quickly and easily to one another, in particular on one another, so that, in this assembled state, they can cooperate with one another as a treatment unit, that is to say in particular the lower granule outlet opening of an upper module overlaps, in particular is in alignment with, the upper granule inlet opening of a module mounted beneath it, wherein the number and order of the modules for the treatment unit are freely selectable depending on the application, wherein at least each of the following three mounting configurations is alternatively made possible:

- dust extractor on closure unit, closure unit optionally on a dryer, or
- dust extractor on dryer, or
- dryer on closure unit,

wherein such a treatment unit can be mounted on a consumer.

The dust extractor – as is known – has a dust extraction container having at least one granule inlet opening and one granule outlet opening and additionally an air outlet opening for removing, in particular by suction, the air together with the dust that is to be removed.

If – as is known – the granules are to be transported to the dust extractor by means of a conveying air stream, a conveying stream generator, in particular in the form of an

ejector compressed-air nozzle having a compressed-air connection, is required and can likewise form a module of the modular system.

The granule inlet opening and/or the air outlet opening will preferably be located in the upper region of the dust extractor, in particular in the upper half or in the upper third, one of said openings, in particular the air outlet opening, preferably being located in the upper cover of the dust extraction container.

The granule outlet opening, on the other hand, will be located in the lower region, in particular in the lower third or preferably in the base of the dust extraction container.

A known dust extractor further comprises a swirl unit for swirling the granules in the dust extraction container by the injection of compressed air, and a controller, in particular an electronic controller, which is capable of controlling the entire dust extractor, in particular an entire treatment unit which comprises such a dust extractor, that is to say in particular all the moving parts, in particular valves, and/or all the pneumatically or electrically or electronically functioning parts thereof.

According to the invention, however, the dust extractor does not comprise an activatable and deactivatable closure element for the granule outlet opening.

Instead, the dust extractor comprises connecting elements, in particular screw openings, in the lower region for connection – preferably direct connection – to a component arranged beneath it, for example a closure unit which can close the granule outlet opening of the dust extractor.

A separate closure unit accordingly comprises an activatable and deactivatable closure element at one of the granule openings, in particular at its upper granule inlet opening for the granule stream flowing from the upstream module, – in particular, but not only – a granule stream flowing through from a dust extractor.

Apart from a granule inlet opening for the granules in the upper part of the housing, in particular in the cover plate thereof, the closure unit comprises a granule outlet opening in the lower part of the housing, and connecting elements, in particular screw openings, in the upper and lower regions of the housing, which are so configured that they can be used for quick and easy connection to a component arranged above or beneath it.

The closure element is so configured and arranged in the housing that it is able to close a granule through-flow opening that is present in the upper region of the closure unit or above the closure unit, in particular is able to close said opening from the underside thereof.

This granule through-flow opening can be the granule inlet opening belonging to the closure unit in the upper region thereof. This granule inlet opening is preferably formed in a cover plate, which is arranged, preferably removably, on a sleeve-shaped housing part of the closure unit, for example in order to be able to mount cover plates with granule inlet openings of different sizes as required.

In this manner, the granule inlet opening of the closure unit can be adapted to the granule outlet opening of a module arranged above it. The two openings can be chosen to be of the same size, for example.

However, the granule through-flow opening can also directly be the granule outlet opening of a module mounted above it, such as, for example, of the dust extractor, which can be closed by the closure element. In some circumstances, the cover plate on the closure unit is then not necessary and can be omitted.

The closure element is preferably an upwardly projecting closure element such as, for example, a closure hemisphere or a closure cone, which in the closing state preferably projects upwards through the upper granule inlet opening of the closure unit and projects into the module mounted directly above it through a granule outlet opening, for example, provided there.

If the upwardly projecting closure element such as, for example, the closure cone is not to close the granule inlet opening of the closure unit but instead is to directly close the granule outlet opening of the module arranged above it, that opening only needs to have a predetermined contour with a predetermined size range in order that it can close the upwardly projecting closure element.

This facilitates combinability with different fitted modules which have at their lower end slightly differently sized granule openings that are to be closed.

For close annular contact, the upwardly projecting closure element, in particular the closure cone, is fastened to a closure element base so as to be pivotable about at least one horizontal axis, better still about two intersecting horizontal axes.

The housing preferably has at least one circumferential wall, which forms the sleeve-like housing part, and an upper and a lower fastening flange projecting radially outwards therefrom, which facilitates connection to components arranged above and beneath it.

Furthermore, there is preferably an air opening in the housing, in particular in its circumferential wall, to which an air filter is connected in a fluidically sealed manner in order to filter air flowing through. A gas, for example, preferably air, which passes into the closure unit from the module arranged above or beneath it, for example from a granule dryer arranged beneath it, is able to flow out through said air opening, so that the air opening then functions as an air outlet opening.

Likewise, ambient air could flow into the closure unit and, from there, into a module mounted beneath it and/or, when the closure element is open, into the module mounted above it, if this is necessary for the operating mode of this adjoining module.

Generally, the closure unit also has its own, preferably electronic, controller, which controls the closure element. This controller has signal connections – in particular in the form of a plug/socket connection or in the form of a terminal, in particular a screw terminal – for connection in particular to another controller, for example to the controller of the dust extractor, wherein this other controller can then function as the master controller.

The controller of the closure unit and/or of the dust extractor can also comprise a mill controller:

If the treatment unit supplies granules to an injection moulding machine as the consumer, the waste products that are formed at the injection moulding machine are to be returned to the consumer and, before that, to the treatment unit.

The waste products are especially sprues or rejects. These are introduced into a mill in order to be ground to a size that is not substantially larger than the size of the granule grains, so that they can be returned to the dust extractor via the granule inlet opening.

The mill controller contains an input option for the length of time for which the mill is to be emptied and the ground waste products are to be returned to the granule inlet of the dust extractor, in particular in order that the material to be ground that is located in the mill is not ground too finely.

The mill controller can also have an actuating element for the immediate, one-time emptying of the mill. The actuating element and also the input option are preferably present on the housing of the controller of the closure unit.

The modular system also has the mentioned granule dryer as a further module.

The granule dryer generally has an approximately cylindrical, upright, approximately sleeve-shaped housing having an upper granule inlet opening and a lower granule

outlet opening, as well as an inflow opening in the lower region via which the warm and/or dry drying air can be introduced in order to flow through the granules in the interior of the granule dryer and dry them. The lower granule outlet opening can in most cases be closed directly or indirectly by an activatable closure element.

Generally, the outlet opening on the one hand and the inlet opening on the other hand are arranged in the lower and in the upper end face.

If the granule dryer is mounted directly beneath the closure unit, the granule outlet opening of the closure unit, when seen in a top view, lies, in the mounted state, wholly inside the granule inlet opening of the dryer, in particular the two openings should lie concentrically with one another or be identical.

In the case of the granule dryer too, there are connecting elements on the housing both at the upper and at the lower end, which connecting elements are configured for easy and quick connection to a module that is seated thereon or that follows beneath it. The upper connecting elements, in particular in the form of screw openings, should be so arranged that the openings overlap or cover one another as described above when another module is seated thereon.

The lower connecting elements should preferably be designed as universally as possible, since a granule dryer often has to be fitted and fastened directly on a consumer, but there are a large number of such consumers which presumably cannot all be fastened with a single universal design of the lower connecting elements.

It is then expedient to provide an adapter having as small an axial height as possible, in particular a plate-shaped, in particular annular, adapter, between the lowermost module of a treatment unit, for example the granule dryer, and the consumer, which adapter in turn has two types of connecting elements, of which one type can cooperate with the connecting elements of the module seated thereon and the other type can cooperate with the connecting elements of the consumer located

therebeneath. The two different types of connecting elements can also differ solely in terms of their position on or in the adapter.

The adapter can also be used to be inserted between two modules of the treatment unit, within the context of a modular system in which all the modules of the modular system come from the supplier of the modular system itself, should an adapter between the modules, however, not be necessary.

The modular system can further also have an intermediate container which consists substantially only of a housing that is open vertically throughout, for example a cone-shaped or sleeve-shaped housing, with connecting elements in the upper and lower region for connection to a component arranged above or beneath it, for example to a module of the modular system or to a consumer arranged beneath it.

The purpose of such an intermediate container is to make the interior space available as an additional buffer space for granules, which can be necessary, for example, for a following, downstream intake shaft of an injection moulding machine, in particular if the treatment unit as a whole does not comprise a closure unit.

The closure unit naturally also contains such a buffer space, but this is not to be understood as being an intermediate container within the context of the present description. An intermediate container is to be understood as being only a container that does not have a closure element in its upper region, in particular does not have a closure element at all.

The modular system can further have as a further module a conveying stream generator, which in particular can be connected to the granule inlet opening of the dust extractor and generates a conveying air stream for transporting granules that are carried therein and introducing them into the dust extractor.

Such a conveying stream generator can be in particular an ejector compressed-air nozzle which is operated by means of compressed air and must accordingly have a

compressed-air connection, and in particular can be arranged in a suction lance which can be inserted into a granule supply in order to suction granules therefrom.

The modular system can also comprise as a further module a dust separator, as can be used for separating the dust from the exhaust air leaving the dust extractor and accordingly can be connected to the air outlet opening of the dust extractor.

Such a dust separator can in particular comprise an exhaust air filter.

Such a dust separator can also have its own low-pressure generator in order to transport the dust-laden air to the dust separator, for example again a compressed-air-operated ejector compressed-air nozzle.

Such an ejector compressed-air nozzle injects the compressed air that is present at a high flow velocity into a conveying line, for example, whereby ambient air is drawn in by the low pressure that develops and likewise carries and transports with it granules present in the feed.

c) Exemplary embodiments

An embodiment of a treatment unit composed of modules of the modular system according to the invention and of the modules thereof for separating granules from the conveying air and extracting dust from the granules according to the invention will be described hereinbelow by way of example in different functional states with reference to the figures, in which:

Figure 1a, b: show a closure unit with the granule inlet opening closed, in vertical section and in a view from above,

Figure 1c: shows the closure unit according to Figure 1a, b, again in vertical section with the granule inlet opening open,

Figure 2a: shows a treatment unit consisting of a dust extractor mounted on the closure unit, with the granule inlet opening of the closure unit closed,

Figure 2b: shows the treatment unit according to Figure 2a with the granule inlet opening of the closure unit open,

Figure 3a: shows a treatment unit consisting of a dust extractor mounted on the closure unit and a granule dryer mounted beneath it, which is mounted on a downstream consumer, wherein the granule inlet opening of the closure unit is closed,

Figure 3b: shows the treatment unit according to Figure 3a with the granule inlet opening of the closure unit open, but with an additional adapter between the granule dryer and the consumer,

Figure 4a: shows a treatment unit consisting only of a dust extractor, which is mounted on a consumer arranged beneath it,

Figure 4b: shows a treatment unit according to Figure 4a, but with an additional intermediate container between the dust extractor and the consumer,

Figure 4c: shows a treatment unit according to Figure 4b, but with a closure unit between the dust extractor and the intermediate container.

Figures 1a to c show the closure unit 40 as a single part:

The housing 41 of the closure unit 40 comprises, when seen in the axial direction 41', which is in general in the mounted state the vertical direction, a circumferential, polygonal, in particular rectangular, or rotationally symmetrical, circumferential wall 41a which surrounds an interior space that is open at the top and bottom, and from the upper end of which an annular, upper fastening flange 41b projects outwards and

from the lower end of which an annular, lower fastening flange 41c, which in particular is identical to the upper fastening flange, projects outwards.

On the upper fastening flange 41b there lies a cover plate 41d – which could at the same time also be the fastening flange 41b – which is releasably connected, preferably screwed, thereto, and in which there is formed, preferably centrally, a granule inlet opening 42 which is significantly smaller than, for example has approximately half the diameter of, the free inside diameter of the circumferential wall 41a.

On account of the removable cover plate 41b, cover plates with granule inlet openings 42 of different sizes can optionally be used. Screwing with respect to the rest of the housing of the closure unit 40 preferably takes place together with the screwing of the closure unit 40 with respect to a module arranged above it, and for this reason there are provided as connecting elements in this case through-openings 49 both in the fastening flange 41b and in the cover plate 41b at mutually aligned positions and in particular of equal sizes.

The lower granule outlet opening 43 is the lower end of the interior space enclosed by the circumferential wall 41a.

On the circumferential wall 41a there is shown on the right, in the lower region, a fill-level sensor 48 which, through the circumferential wall 41a, measures a fill level of granules which may be present in the housing 41.

On the circumferential wall 41a there is shown on the left-hand side, in the upper region, an air filter 47 which is tightly fitted to an air opening 46 in the circumferential wall 41a and by which a gas, in particular air, which flows out of the housing 41 or into the housing 41 is filtered.

The closure element 44 is in the form of a closure cone 44 which is arranged in the housing 41 and is adjustable in the axial direction 41' thereof, which is generally the vertical:

Since the closure cone 44, which in particular is rotationally symmetrical and the tip of which points upwards, has a larger diameter, when seen in a top view, than the round granule inlet opening 42 in the cover plate 41d, the closure cone 44 closes the granule inlet opening 42 according to **Figure 1a** when it is located so far up that its tip projects upwards out of the granule inlet opening 42 and its cone surface is in close contact with the inner circumferential surface of the granule inlet opening 42, the lower circumferential edge of which can preferably be chamfered slightly for this purpose.

In order to ensure such close contact at the corresponding height position of the closure cone 44, the closure cone is pivotable about all horizontal directions, that is to say directions running transverse to the axial direction 41', in particular in that it is seated with a recess, which is open at the bottom and has an approximately hemispherical, accordingly upwardly facing, base, on a sphere 45 which fits into this recess and has a radius analogous to the base thereof, and which forms the cone base 45.

The sphere 45 is preferably fastened to the upper end of a piston rod 51 which projects from a pneumatic cylinder 50 and is tightly displaceable in the cylinder 52, which runs in the axial direction 41' and is arranged in the housing 41 beneath the closure cone 44 and which is in communication with a compressed-air connection 53 in the circumferential wall 41a of the housing.

By applying compressed air, the piston rod 51, and thus the closure cone 44, is moved upwards until it is in contact with the granule inlet opening 42, and by extracting air it falls downwards under the force of gravity into the open position, in which the upwardly pointing tip of the closure cone 44 is preferably also located inside the housing 41, as shown in **Figure 1c**.

Configuring the closure element 44 with an upwardly directed tip, that is to say in particular as a cone, prevents granules from accumulating on the surface of the closure element 44, especially in the open state.

In the fastening flanges 41b, c there are arranged, distributed over the circumference, a plurality of vertically extending through-openings 49 as connecting elements 49, in particular all on the same circle, which in particular is arranged concentrically around the longitudinal centre 41" of the housing 41.

Figures 2a, b show the closure unit 40 mounted – in accordance with the gravity-induced through-flow direction 10 of the granules 4 – beneath a granule separator and dust extractor 1, so that the granules 4 are able to fall from the granule outlet opening 8 of the dust extractor 1 and the granule inlet opening 42 of the closure unit 40, which is arranged directly beneath it and in this case is also of the same size, generally circular when seen in a top view, into the interior of the housing 41 of the closure unit 40 when the opening 8 or 42 is open, as shown in **Figure 2b**.

Only the closure unit 40 but not the dust extractor 1 has a closure therefor.

In the open state, the closure cone 44 of the closure unit 40 is located wholly beneath these openings and thus wholly in the height region of the circumferential wall 41a, so that the granule grains 4 falling into the closure unit 40 fall onto the tip or the cone surfaces of the closure cone 44, from where they slide further downwards.

As can better be seen in **Figure 2a** – in which the closure cone 44 has moved so far upwards that it closes the granule inlet opening 42 of the closure unit 40 and thus the passage between the dust extractor 1 and the closure unit 40 – the dust extractor 1 first comprises a dust extraction container 9 in the form of an upright cylinder, which mostly consists of glass and is closed at the top and bottom by corresponding parts, which mostly consist of metal.

In the upper region of the dust extraction container 9 there opens the inlet connection piece 18, which is guided through from the side and is bent downwards with its free end and the free opening of which is the granule inlet opening 7 of the dust extractor 1, through which the conveying air 3 including the granules 4 conveyed thereby, but also the dust 11 contained therein, is supplied in the flow direction 10.

In the lower region of the dust extraction container 9, that is to say in the wall thereof, there is a gas feed opening 21 through which ionised gas 19 is supplied. This is mostly air, which is supplied via a compressed-air connection 22 and flows along an ionising tip, which is part of an ioniser 20 arranged on the outside of the dust extraction container 9.

There is likewise arranged in the lower region of the dust extraction container 9, on the outside of the wall thereof, a fill-level sensor 13 which delivers a signal as soon as a heap of granules 4 has built up from below to such an extent that it reaches the fill-level sensor 13.

The lower open end of the glass cylinder which forms the dust extraction container 9 is closely followed by the outlet cone 16, in the inner cone surface 16' of which, which becomes narrower from top to bottom, there open the mouths of so-called swirl nozzles 17, into which compressed air for swirling granules 4 located in the lower region of the dust extraction container 9 can be injected via a compressed-air connection 22.

The swirl nozzles are preferably directed upwards, that is to say at an angle which differs from the vertical by not more than 45°, better still not more than 30°, better still not more than 20°, better still not more than 10°, in order to prevent the granule grains as far as possible from striking the side walls of the dust extractor.

At the upper end, the upper air outlet opening 12 of the dust extraction container 9 is closed by a cover 15, in which there is a screen 5 through which air and dust 11, but not the grains of the granules 4, can pass. Attached to this air outlet opening 12 is a

connection piece for conveying away the exhaust air 6 laden with dust 11, said exhaust air being suctioned through the screen 5 by means of a low pressure which is generated by an ejector compressed-air nozzle 14 as the low-pressure generator, which is arranged in the connection piece downstream of the screen 5 and is in turn supplied with compressed air via a compressed-air connection 22.

The dust-laden exhaust air 6 is supplied to a dust collection container (not shown) and a filter located there as a dust separator.

All the moving parts as well as all the valves and/or nozzles of the dust extractor and in particular of the treatment unit as a whole are controlled by an electric controller 2.

From the lower end of the outlet cone 16 there projects outwards an annular, plate-shaped flange, which is seated on the cover plate 41d of the closure unit 40.

In the cover plate there are through-openings 23 as connecting elements 23 of the dust extractor 1, preferably in the same circumferential position and radial position as the through-openings 49 as connecting elements 49 at the top of the closure unit 40, so that screws can be inserted through both and the two modules can be tightly connected to one another.

Such connecting elements 23 / 49 of the dust extractor 1 on the one hand and/or of the closure unit 40 on the other hand can be configured differently or be located at different radial positions or circumferential positions and thus constitute two different types of connecting elements, as depicted by way of example in **Figure 1b** on two different concentric circles or in the form of a slot, either extending radially as shown or also extending in the circumferential direction.

In this manner, the granule outlet opening 8 of the dust extractor 1 can be closed until a batch 4' of the granules 4 is introduced via the granule inlet opening 7, and the granule feed is stopped as soon as the fill-level sensor 13 delivers a corresponding

signal, and the dust is then removed from the granules 4 batchwise by swirling this batch for a defined period of time and at a defined pressure and volume flow from the swirl nozzles 17, while a low pressure is at the same time applied at the upper air outlet opening 12.

Figures 3a, b show a treatment unit which, apart from the dust extractor 1 and the closure unit 40 mounted beneath it – as shown in Figures 2a, b – further comprises a granule dryer 30 which is mounted beneath the closure unit 40.

This entire treatment unit is mounted on a consumer 100 – here on the inlet into its conveying channel 101, in which a conveying screw 102 is located – so that granules which have been separated from the air stream and from which dust has been extracted in the dust extractor 1 fall under the force of gravity first into the closure unit 40 – when the passage between them has been freed by the closure element 44 as shown in **Figure 3b** – and from there further into the granule dryer 30 and the consumer 100.

Of the granule dryer 30 there is shown only the sleeve-shaped housing 31 with the upper granule inlet opening 32 – which in this case is identical to the granule outlet opening 43 of the closure unit 40 located above it – and the lower granule outlet opening 33 and also the annular fastening flanges, which here too extend radially outwards from the upper and lower ends of the sleeve-shaped housing 31, in which there are connecting elements 34, here again in the form of screw openings 34, for connection to modules arranged above and beneath it.

While in **Figure 3a** the screw openings 34 in the lower fastening flange are in alignment with screw openings in the consumer 100 arranged therebeneath, this is not the case in the representation of **Figure 3b**, where the screw openings of the consumer instead lie on a circle with a larger diameter than that of the granule dryer 30 and optionally also at other circumferential positions.

Therefore, in **Figure 3b**, an adapter 70, in particular an annular adapter, is arranged between the granule dryer 30 and the consumer 100, which adapter has screw openings which match both the component to be screwed above it and the component to be screwed beneath it:

Matching the screw openings of the consumer 100, screw openings are preferably arranged in this adapter 70 at the same circumferential position and the same radius, preferably as through-openings without a thread.

Matching the lower screw openings 34 of the granule dryer 30, threaded blind holes that are open at the top are preferably arranged in the adapter 70, that is to say at the same circumferential position and at the same radial position and with a size such that screws can be inserted through the screw openings 34 of the granule dryer 30 and can be screwed into the threaded blind hole of the adapter 70.

There is further shown in **Figure 3a** a suction lance 24, connected to the granule inlet connection piece 18, in which a conveying stream generator 90 in the form of an ejector compressed-air nozzle 14 is arranged, in order thus to be able to suction granules 4 from a granule supply (not shown).

Analogously to Figures 2a, b, in **Figures 3a, b** too, the closure unit 40 is shown in the closed state in **Figure 3a** and in the open state in **Figure 3b**.

Figures 4a, b show a treatment unit which does not comprise either a granule dryer 30 or a closure unit 40 and thus also does not comprise a closure element 44.

The granules 4 are thus able to fall from the permanently open lower granule outlet opening 8 of the dust extractor 1 directly into the consumer 100, on which it is mounted directly in **Figure 4a**.

In **Figure 4b**, on the other hand, an intermediate container 80 is mounted between the dust extractor 1 and the consumer 100, which intermediate container consists

only of a cylindrical circumferential wall and, at the upper and lower ends thereof, radially outwardly projecting annular fastening flanges having fastening elements such as, for example, screw openings.

An additional buffer space for granules is thus created between the lower granule outlet 8 of the dust extractor 1 and the intake into the consumer 100, which may be necessary, for example, because the consumer works batchwise and the amount of granules 4 stored in its conveyor channel 101 is not sufficient for such a batch.

Figure 4c differs from **Figure 4b** in that there is a closure unit 40 directly beneath the dust extractor 1 and thus between the dust extractor 1 and the intermediate container 80.

The treatment unit is generally assembled in this combination if the volume for granules that is present inside the housing of the closure unit 40 is not sufficient for the consumer 100 and is to be made larger by the additional volume of the intermediate container 80.

LIST OF REFERENCE SIGNS

1	Apparatus for dust extraction, dust extractor
2	Controller
3	Conveying air
4	Granules, granule accumulation, granule grain
4'	Batch
5	Screen
6	Exhaust air
7	Granule inlet opening
8	Granule outlet opening
9	Dust extraction container
10	Flow direction
11	Dust
12	Air outlet opening
13	Fill-level sensor
14	Ejector compressed-air nozzle, low-pressure generator
15	Cover
16	Outlet cone
16'	Cone surface
17	Swirl nozzle
18	Inlet connection piece
19	Ionised gas
20	Ioniser
21	Gas feed opening
22	Compressed-air connection
23	Connecting element, through-opening
24	Suction lance
30	Granule dryer
31	Housing
32	Granule inlet opening

33	Granule outlet opening
34	Connecting element
40	Closure unit
41	Housing
41'	Axial direction, vertical
41"	Longitudinal centre
41a	Circumferential wall
41b, c	Fastening flange
41d	Cover plate
42	Granule inlet opening
43	Granule outlet opening
44	Closure element, closure cone
45	Closure element base, cone base
46	Air opening
47	Air filter
48	Fill-level sensor
49	Connecting element, through-opening
50	Pneumatic cylinder
51	Piston rod
52	Cylinder
53	Compressed-air connection
70	Adapter
80	Intermediate container
90	Conveying stream generator
100	Consumer
101	Conveying channel
102	Conveying screw

Patentkrav

1. Modulsystem til konstruktion af en behandlingsenhed for granulat (4), hvilket modulsystem omfatter følgende moduler:

a) en lukkeenhed (40) til en strøm af granulat, der strømmer igennem, med
- et hus (41),
- en granulatindløbsåbning (42) for granulatet (4) i den øvre del af huset (41), især i dækpladen (41d) deraf,
- en granulatudløbsåbning (43) i den nederste del af huset (41),
- et lukkeelement (44) i huset (41), hvilket lukkeelement er således udformet, at det er i stand til at lukke en granulatgennemstrømningsåbning, især granulatindløbsåbningen (42) eller en granulatudløbsåbning af en komponent placeret over den, især er i stand til at lukke åbningen fra undersiden deraf,
- forbindelseselementer (49), især skrueåbninger (49), i det nederste område af huset (41) til forbindelse med en komponent, der er anbragt derunder, og

b) en afstøvningsmaskine (1) til afstøvning af et granulat (4), især i portioner, med:
- en støvudsugningsbeholder (9), som har:
- mindst én granulatindløbsåbning (7) til granulatet (4),
- en granulatudløbsåbning (8) i den nederste del af støvudsugningsbeholderen (9), især i bunden af denne, og
- en luftudløbsåbning (12), der er anbragt især i den øverste del af støvudsugningsbeholderen (9),
- en ionisator (20),
- en hvirvelenhed til at hvirvle granulatet (4) i støvudsugningsbeholderen (9),

c) en styreenhed (2), som er i stand til at styre alle de bevægelige dele, især ventiler, af afstøvningsmaskinen (1),

kendetegnet ved, at

- styreenheden er også i stand til at styre hvirvelenheden,

- lukkeenheden (40) har forbindelseselementer (49), især skrueåbninger (49), i det øvre område af huset (41) til forbindelse med en komponent placeret over den,
- afstøvningsmaskinen (1) har forbindelseselementer (23), især skrueåbninger (23), i det nederste område af støvudsugningsbeholderen (9) til forbindelse med en komponent, der er anbragt under den, især lukkeenheden (40),
- modulsystemet omfatter en granulattørrer (30) som et yderligere modul, hvor granulatudløbsåbningen (43) er anbragt i lukkeenheden (40) og granulatindløbsåbningen (32) i granulattørreren (30) på en sådan måde, at når lukkeenheden (40) og granulattørreren (30) er monteret direkte oven på hinanden ved hjælp af forbindelseselementerne, især skrueåbninger, som er til stede på begge sider, ligger granulatudløbsåbningen (43) set fra oven inde i granulatindløbsåbningen (32), især koncentrisk hermed eller er kongruent dermed,
- og hvor modulerne (1, 40, 30) og deres forbindelseselementer til indbyrdes forbindelse er specifikt udformet til fri indbyrdes kombinerbarhed, således at mindst hver af de følgende tre monteringskonfigurationer er valgfrit muliggjort:
- montering af afstøvningsmaskinen (1) på granulattørreren (30) med indskud af lukkeenheden (40) mellem afstøvningsmaskinen (1) og granulattørreren (30),
- montering af afstøvningsmaskinen (1) på granulattørreren (30) uden indskydning af lukkeenheden (40) mellem støvsugeren (1) og granulattørreren (30), og
- montering af granulattørreren (30) på lukkeenheden (40).

2. Modulsystem ifølge krav 1,
kendetegnet ved, at
granulatudløbsåbningen (8) er anbragt i afstøvningsmaskinen (1), og granulatindløbsåbningen (42) er anbragt i lukkeenheden (40), således at når støvsugeren (1) og lukkeenheden (40) monteres oven på hinanden ved hjælp af forbindelseselementerne (23, 49), især skrueåbninger, der er til stede på begge sider, er granulatudløbsåbningen (8) af afstøvningsmaskinen (1) og

granulatindløbsåbningen (42) af lukkeenheden (40) anbragt koncentrisk, især på linje, over hinanden.

3. Modulsystem ifølge krav 1 eller 2,
kendetegnet ved, at
- modulsystemet som et yderligere modul omfatter en især pladeformet, især ringformet adapter (70) med en lodret åben gennemgangsåbning og især en så lille aksial højde som muligt i passageretningen af gennemgangsåbningen, for at kunne montere adapteren (70) mellem to moduler i modulsystemet eller for at kunne montere et modul i modulsystemet, især granulattørreren (60), på en forbruger (100),
- hvor adapteren (70) har to typer forbindelseselementer, hvoraf den ene type er udformet således, at de er i stand til at samarbejde med forbindelseselementerne på modulet, der står derpå, og den anden type er konfigureret således, at de er i stand til at samarbejde med forbindelseselementerne af modulet placeret derunder eller med forbrugeren (100).

4. Modulsystem ifølge et af kravene 1 til 3,
kendetegnet ved, at
- modulsystemet som et yderligere modul omfatter en mellembeholder (80) med en lodret åben passageåbning for at kunne montere mellembeholderen (80) mellem to moduler i modulsystemet eller for at kunne montere et modul i det modulære system, især granulattørreren (60), på en forbruger (100),
- hvor mellembeholderen (80) har især to typer forbindelseselementer, hvoraf den ene type er således udformet, at de er i stand til at samvirke med modulets forbindelseselementer, der står derpå, og den anden type er således udformet, at de er i stand til at samarbejde med modulets forbindelseselementer, der er placeret derunder, eller med forbrugeren (100).

5. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at

- modulsystemet indeholder en transportstrømsgenerator (90), som især kan være anbragt opstrøms for støvudsugningsbeholderen (9) og især er i form af en udstødertrykluftdyse (14), som har en trykluftforbindelse og er især anbragt i en sugelanse (24),

eller/og

- modulsystemet omfatter en støvudskiller, især med et udblæsningsluftfilter og/eller en lavtryksgenerator, især en ejektor-trykluftdyse (14), som især kan være anbragt nedstrøms for støvudsugningsbeholderen (9).

6. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at
- afstøvningsmaskinen (1) ikke omfatter et lukkeelement til lukning af dets granulatudløbsåbning (8), det vil sige er lukkefri,
- de periferiske vægge, der omgiver støvudsugningsbeholderen (9), består i det mindste på de indre flader, der vender mod det indre, af et ikke-elektrisk ledende materiale, især glas.

7. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at
hvirvelenheden har opadrettede hvirveldyser (17), som er i forbindelse med en trykluftforbindelse i den nederste del af støvudsugningsbeholderen (9), især i eller tæt på granulatudløbsåbningen (8).

8. Modulsystem ifølge krav 7,
kendetegnet ved, at
- støvudsugningsbeholderens (9) tværsnit aftager i den nederste del mod granulatudløbsåbningen (8), især ved hjælp af mindst en konisk overflade (16'),
- hvirveldyserne (17) er anbragt i den overflade, der tilspidser tværsnittet nedad, især i den koniske overflade (16'),

- især hvirveldyserne (17) er rettet opad, det vil sige i en vinkel, der ikke afviger fra lodret med ikke mere end 45°, bedre endnu ikke mere end 30°, bedre endnu ikke mere end 20°, bedre endnu ikke mere end 10°,
- hvor hvirveldyserne (17) fortrinsvis kan styres med hensyn til tryk og/eller strømningshastighed og/eller volumenstrøm, især kan styres af styreenheden (2),
- hvor hvirveldyserne (17) fortrinsvis sammen med styreenheden (2) er i stand til at generere en opadrettet modstrøm, således de granulater (4), der hvirvles op af denne, afslutter deres opadgående bevægelse for det meste på grund af tyngdekraften, før de når den øverste luftudløbsåbning (12).

9. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at
- ionisatoren (20) omfatter en ioniserende spids, der er anbragt i det frie endeområde af en lufttilførselsledning og rager ind i en gastilførselsåbning (21) i væggen af støvudsugningsbeholderen (9) eller endda ind i det indre af støvudsugningsbeholderen (9), således at især den strømmende luft passerer hen over den,

eller/og

- gastilførselsåbningen (21) med ionisatoren (20) fastgjort dertil er anbragt i det nedre område af støvudsugningsbeholderen (9), især over udløbskonusen (16).

10. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at
luftudløbsåbningen (12) er dækket af en let aftagelig skærm (5) eller er permanent og især helt åben.

11. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at

- højden af støvudsugningsbeholderen (9) er mindst 100 mm, endnu bedre mindst 200 mm, endnu bedre mindst 300 mm, endnu bedre mindst 400 mm, eller/og
- støvudsugningsbeholderens (9) periferivæg er et opretstående glasrør, der er åbent foroven og forneden, især med et rotationssymmetrisk tværsnit, og tværsnittet forbliver uændret over hele længden.

12. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at
granulatindløbsåbningen (7) er anbragt i den øvre halvdel, især i den øverste tredjedel, af højden af støvudsugningsbeholderen (9).

13. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at
styreenheden (2) har driftstilstande til portionvis drift og til kontinuerlig drift, og styreenheden (2) kan skiftes mellem disse to driftstilstande.

14. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at
- støvudsugningsbeholderen (9) har en flerhed af granulatindløbsåbninger (8), eller
- afstøvningsmaskinen (1) har en støvudsugningsbeholder (9), der kun har en granulatindløbsåbning (8) samt en transportørledning, som har en gren uden for støvudsugningsbeholderen (9).

15. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at
afstøvningsmaskinens (1) styreenhed (2) har signalforbindelser til signalteknisk forbindelse med lukkeenheden (40), især til dennes styreenhed.

16. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at
afstøvningsmaskinens (1) styreenhed (2) har en kværnstyring for at tømme opsamlingsbeholderen i en kværn, hvor affaldsdele fra en sprøjtestøbemaskine kværnes, og for at tilføre den til granulatindgangsåbningen (7) af afstøvningsmaskinen (1).

17. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at
- lukkeelementet (44) af lukkeenheden (40) er et opad- og udragende element, især en lukkekegle (44), som i lukketilstanden rager opad ud af huset (41) gennem den øvre granulatindløbsåbning (42),
- lukkeelementet (44), især lukkekeglen (44), er fastgjort til en komponent, der bærer det, især til en lukkeelementbase (45), således at det kan drejes om mindst én vandret akse, bedre stadig omkring to skærende vandrette akser.

18. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at
- lukkeenhedens (40) hus (41) har periferiske vægge samt en øvre og en nedre fastgørelsesflange (41b, c), hvorpå forbindelseselementerne (49) er anbragt, og/eller
- der er en luftåbning (46) i huset (41), især i dens periferiske væg (41a), hvilken luftåbning er strømningsteknisk forbundet med et luftfilter (49), der er fastgjort især til ydersiden af hus (41).

19. Modulsystem ifølge et af de foregående krav,
kendetegnet ved, at
- lukkeenheden (40) har en styreenhed, især en elektronisk styreenhed, til lukkeelementet (44),

- hvor denne styreenhed har signaltekniske forbindelser, især til forbindelse med en anden styreenhed.

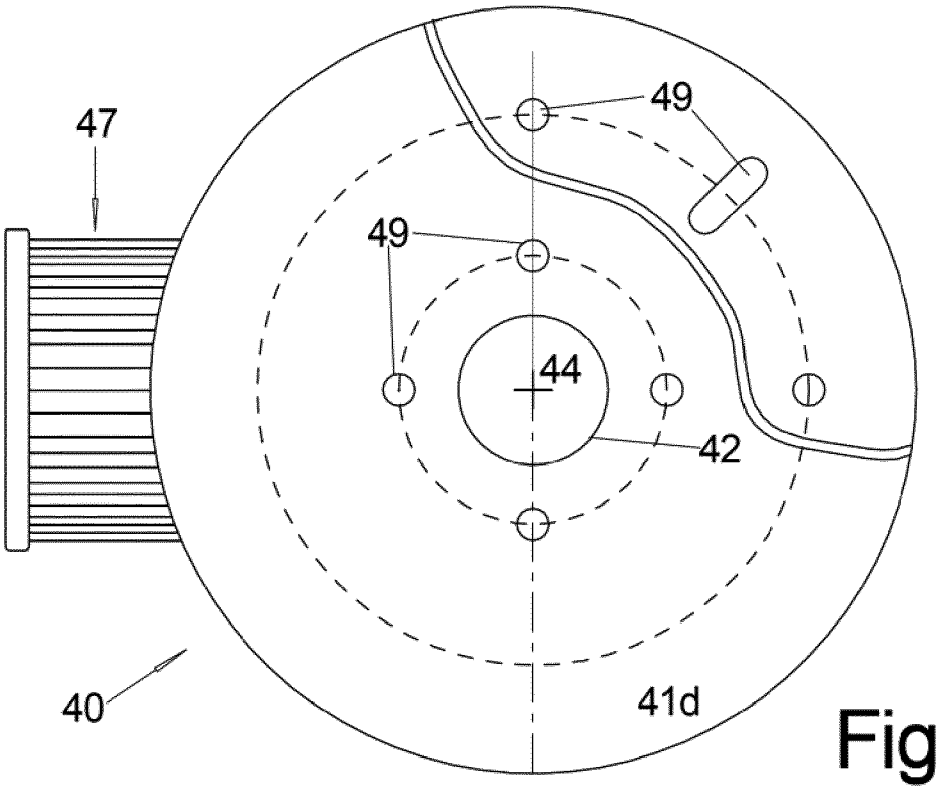
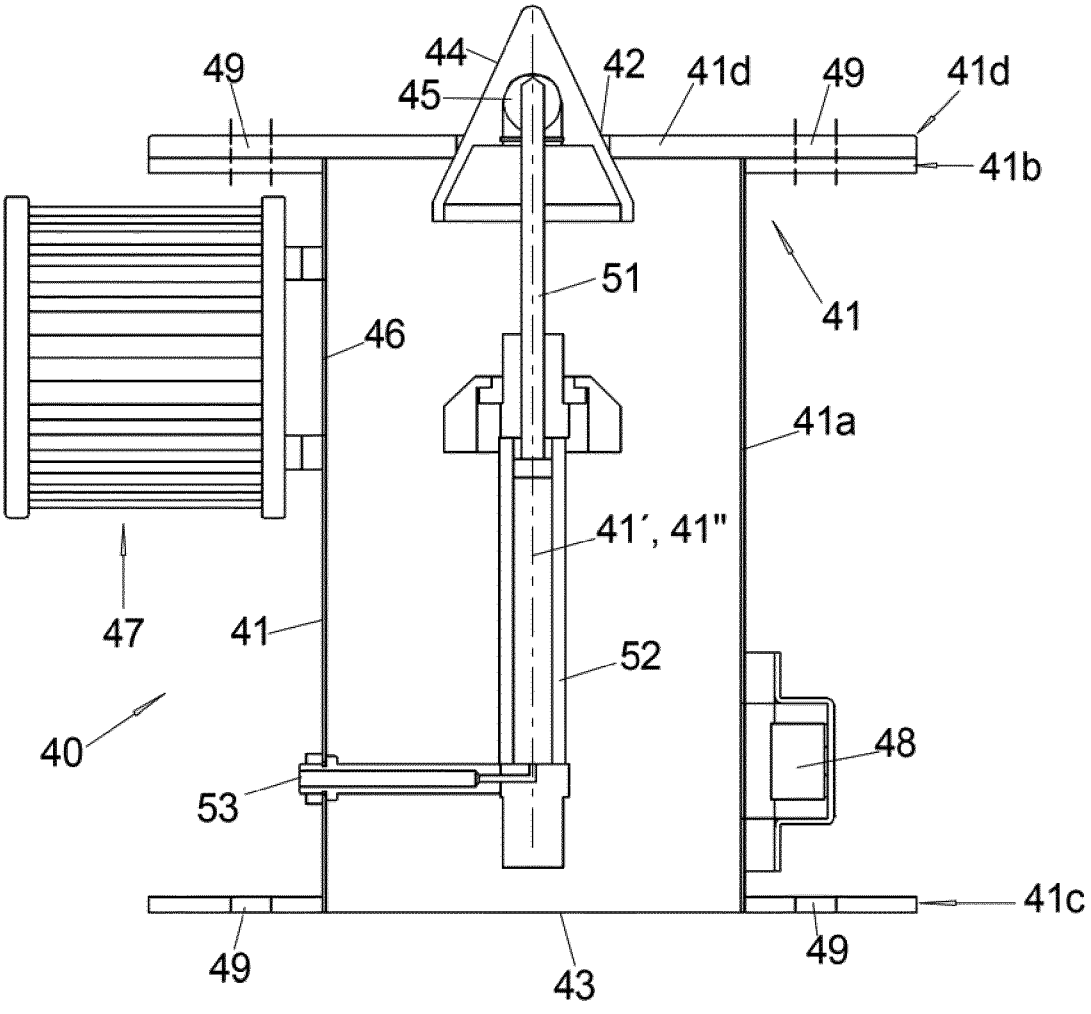

47
49
49
44
42
40
41d

Fig. 1b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44
45
42
41d
49
41d
41b
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41a
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41c
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43
49

Fig. 1a

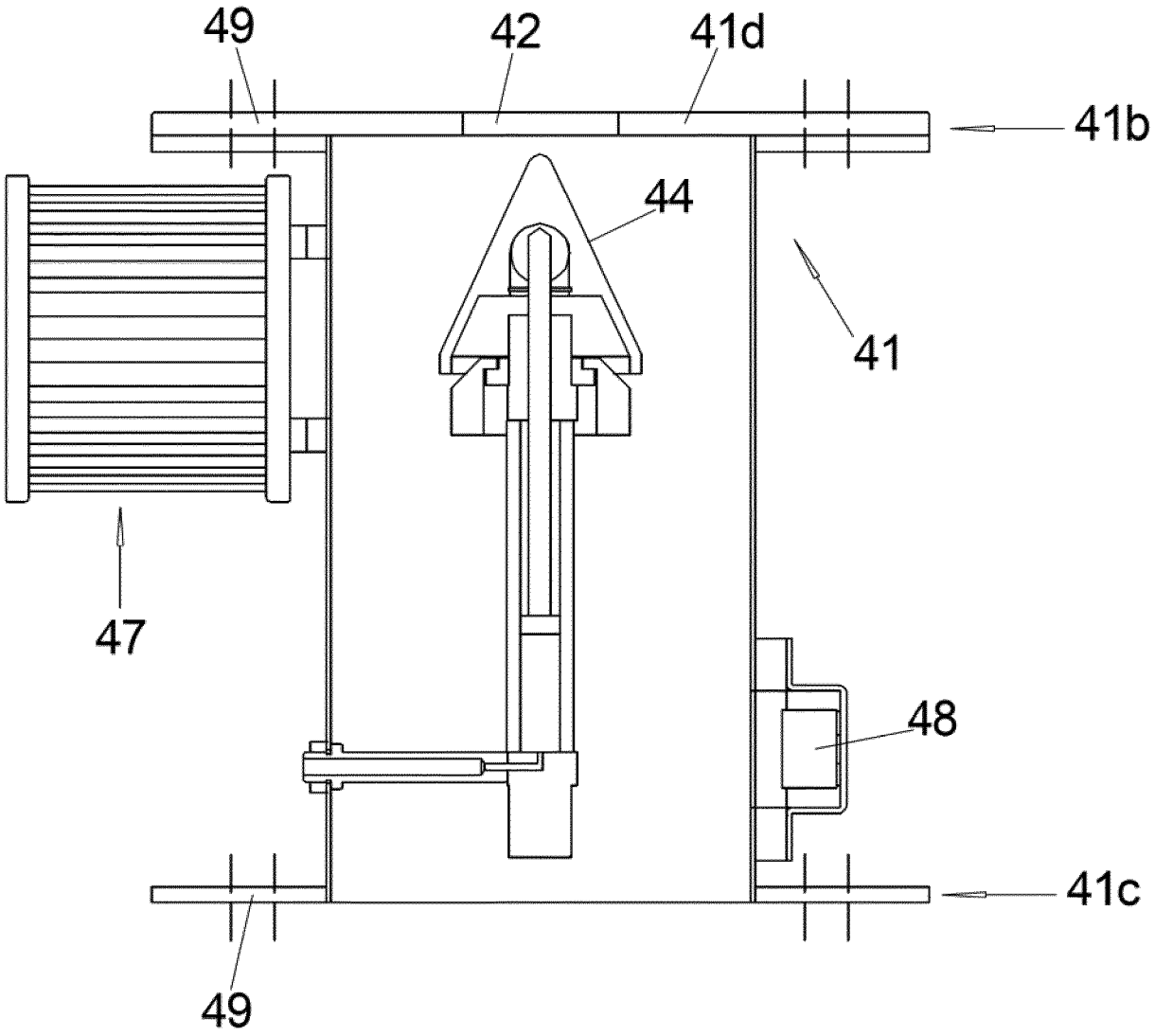
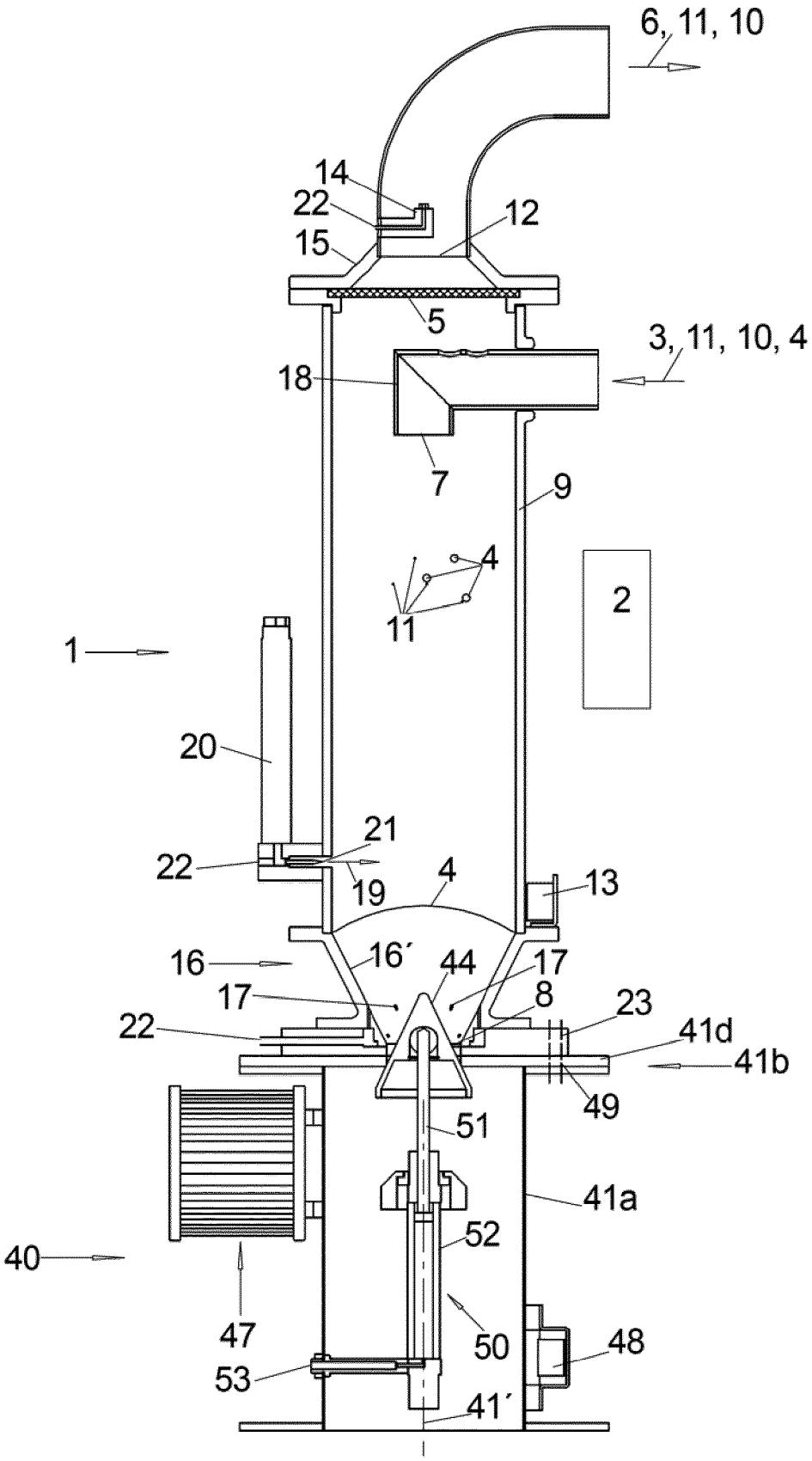


Fig. 1c


6, 11, 10
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12
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3, 11, 10, 4
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21
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16
16´
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41d
41b
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41a
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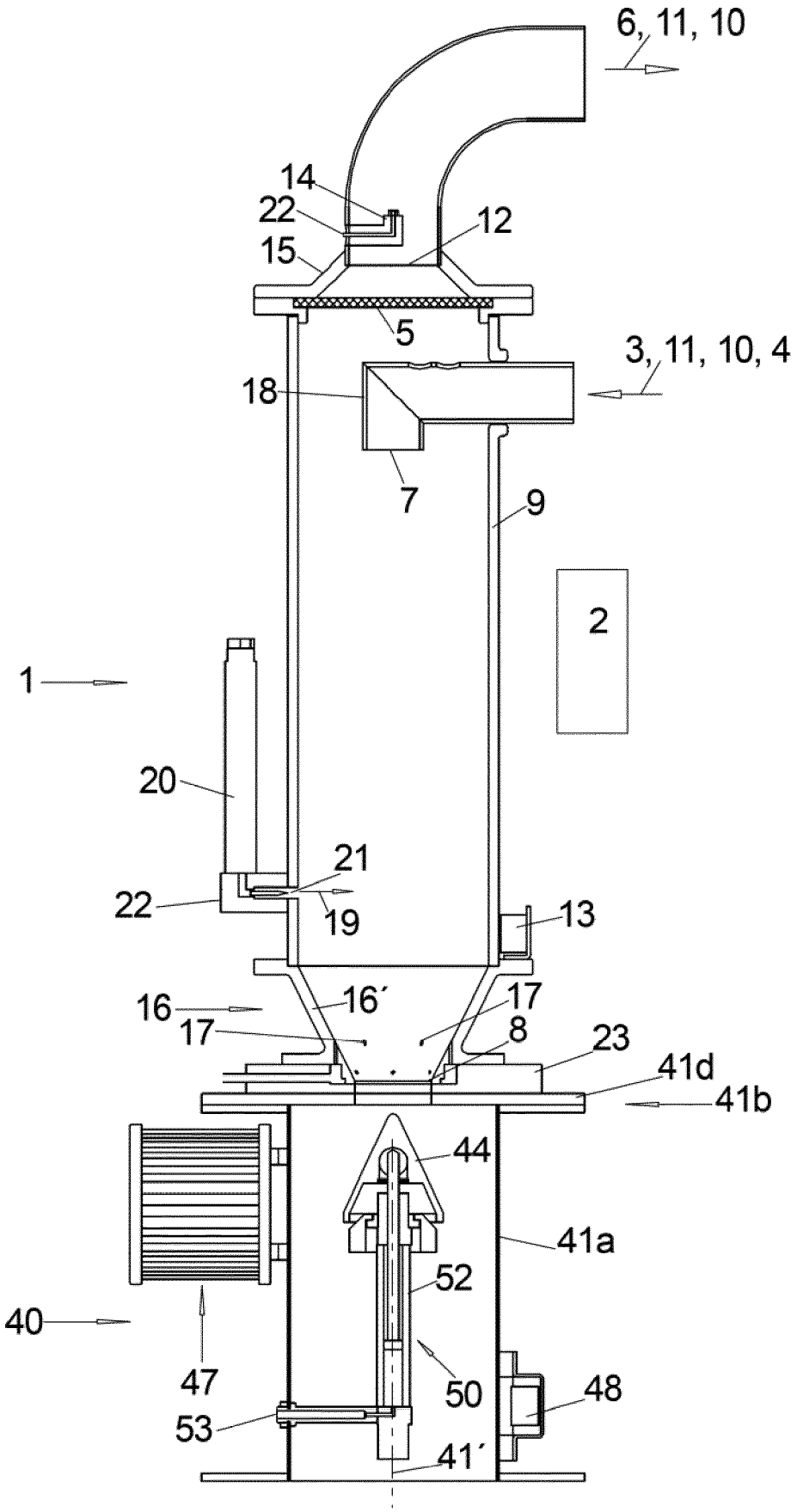
41´

Fig. 2a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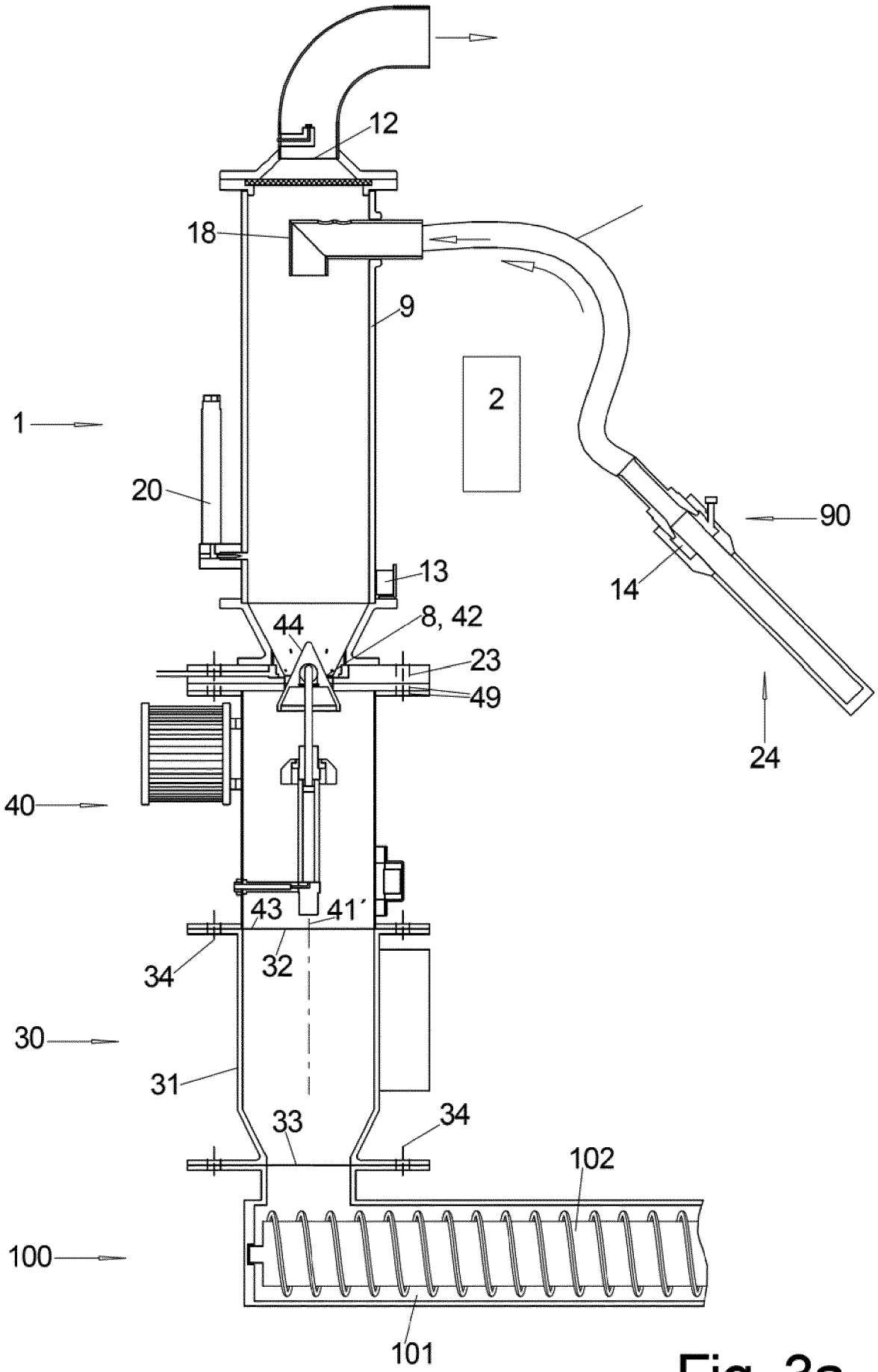
41´

Fig. 2b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8, 42
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100
101

Fig. 3a

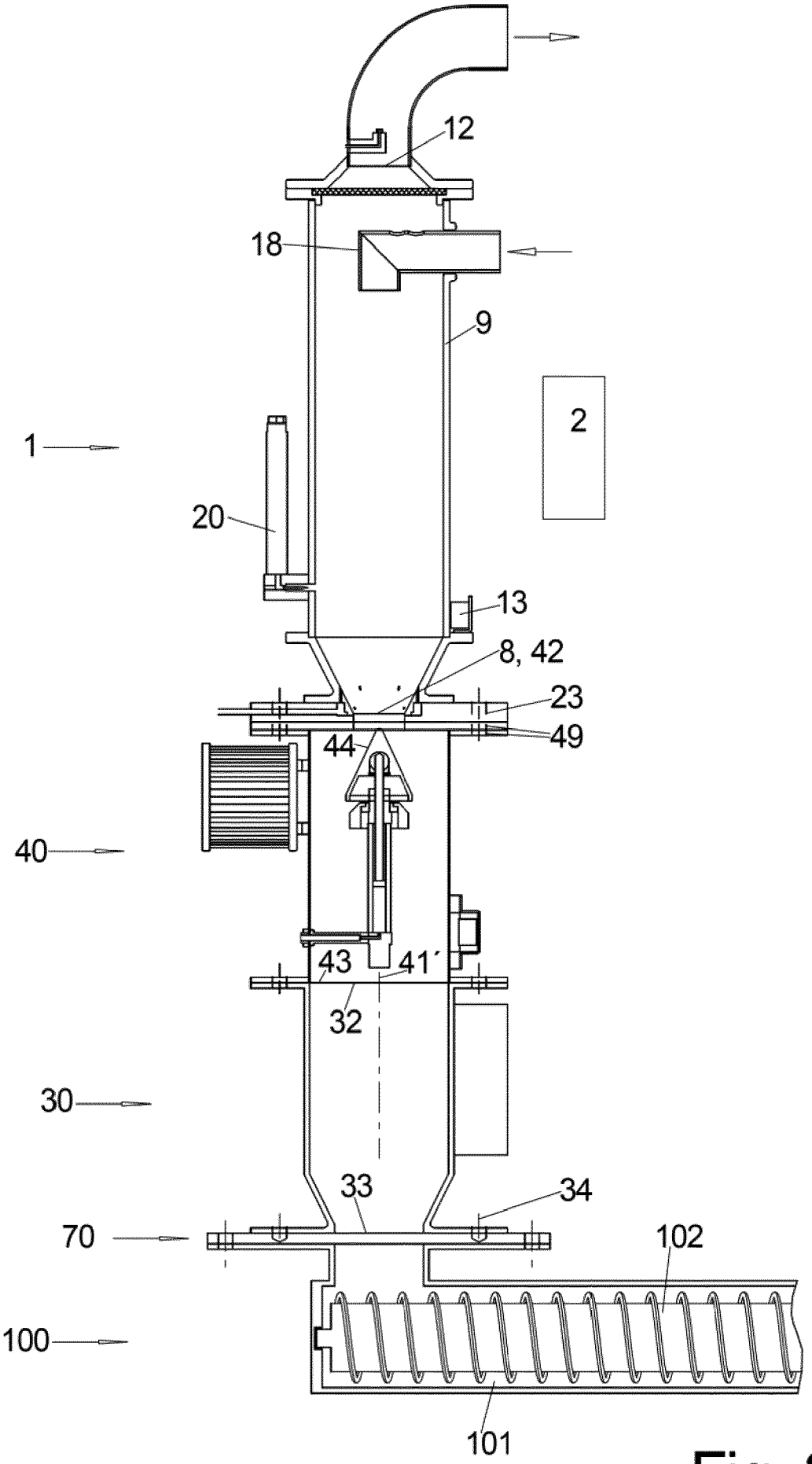

Fig. 3b

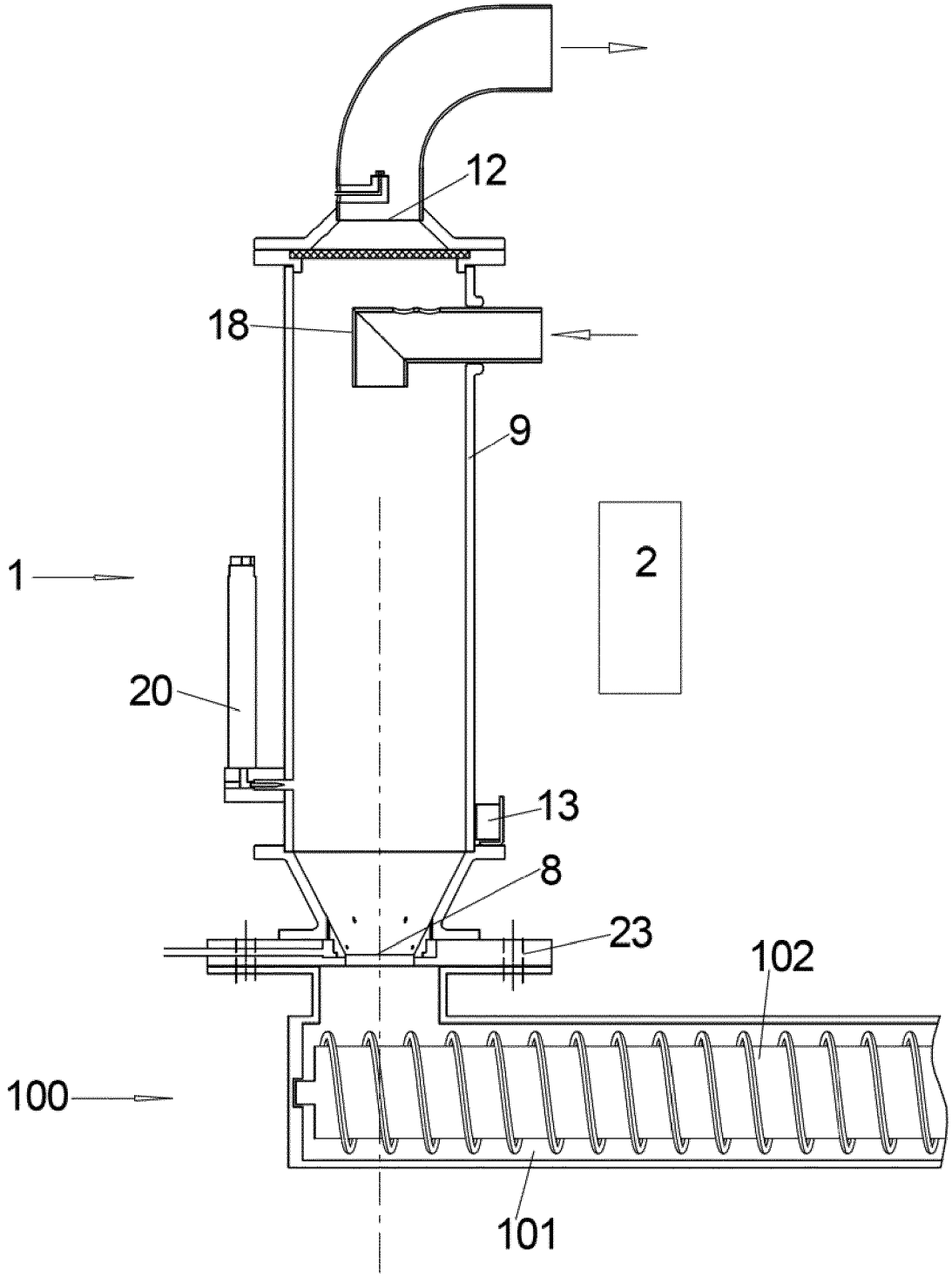

Fig. 4a

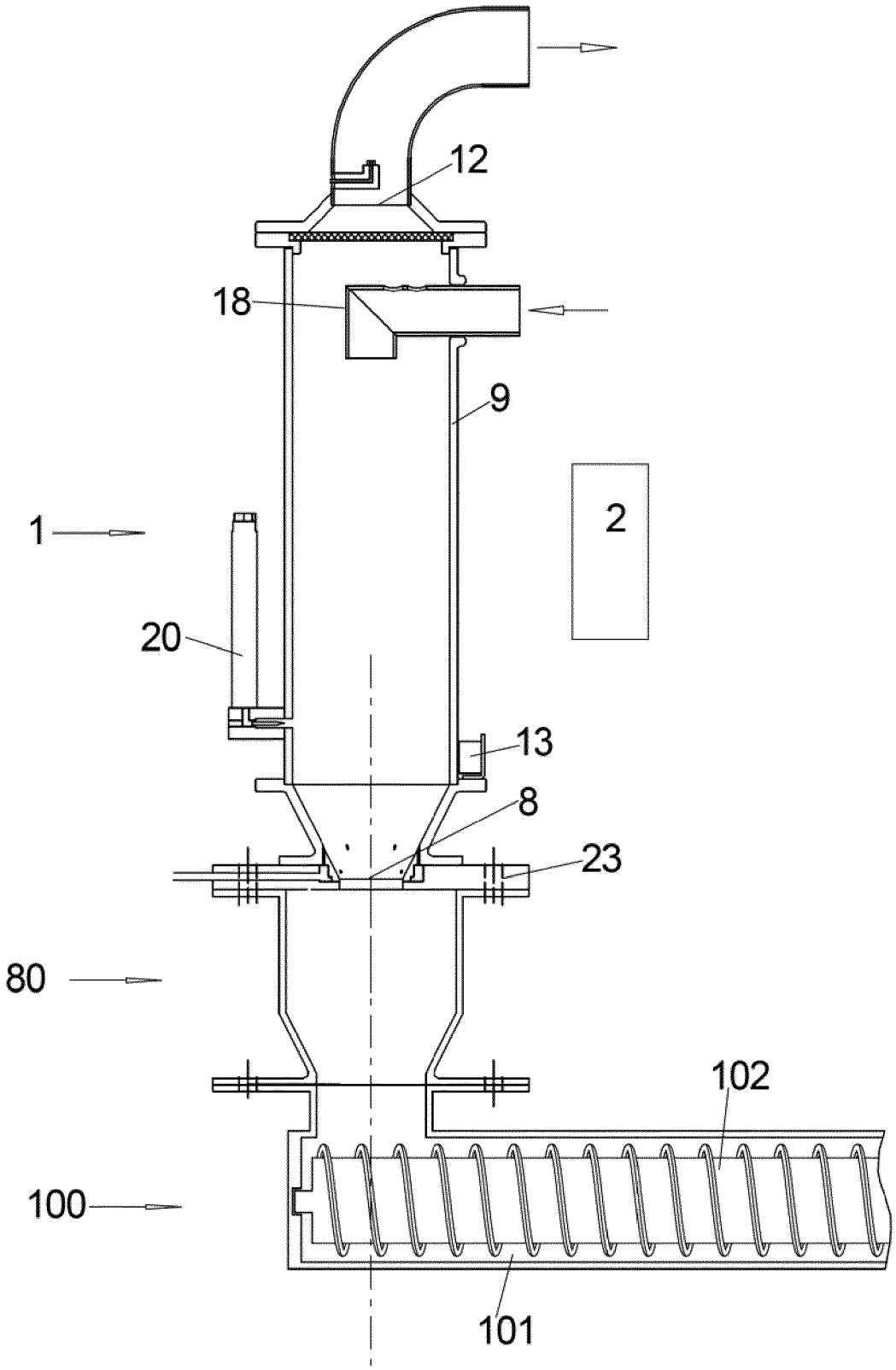

Fig. 4b

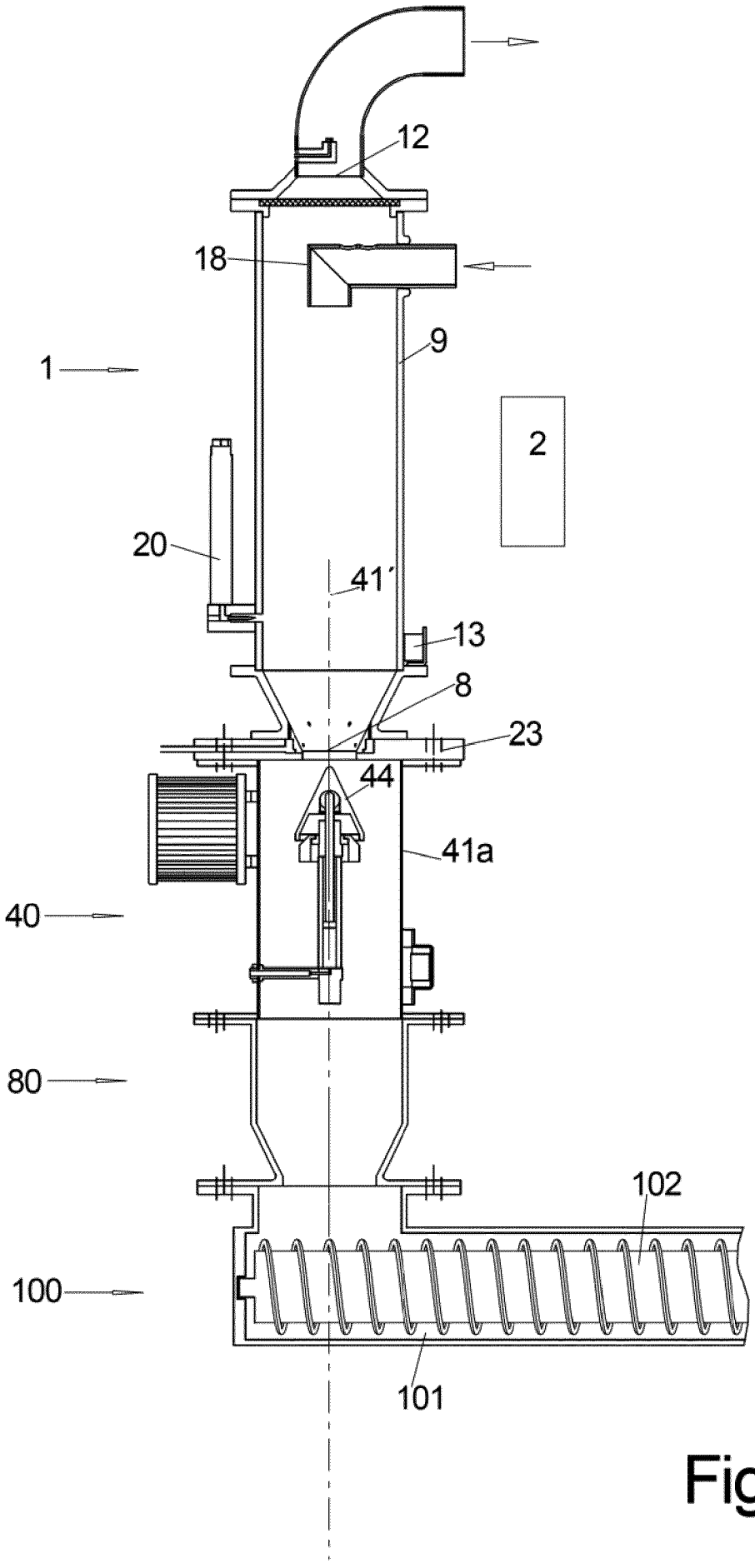

Fig. 4c