(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
19 December 2013 (19.12.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/185914 A2

(51) International Patent Classification:
A23B 4/03 (2006.01)

(21) International Application Number:
PCT/EP2013/001717

(22) International Filing Date:
12 June 2013 (12.06.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
GE2012A000056 13 June 2012 (13.06.2012) IT

(71) Applicant: **CORTINETIX PHARMA S.R.L.** [IT/IT]; Via Dante 2 - Int. 4, I- 16121 Genova (IT).

(72) Inventor: **ZIPOLI, Marco**; Via Molfino 6/40, I-16154 Genova (IT).

(74) Agent: **FORATTINI, Amelia**; INTERNATIONALE BREVETTI INGG. ZINI, MARANESI & C. S.R.L., Piazza Castello 1, I-20121 Milano (IT).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) **Title**: METHOD AND APPARATUS FOR DRYING FOOD PRODUCTS.

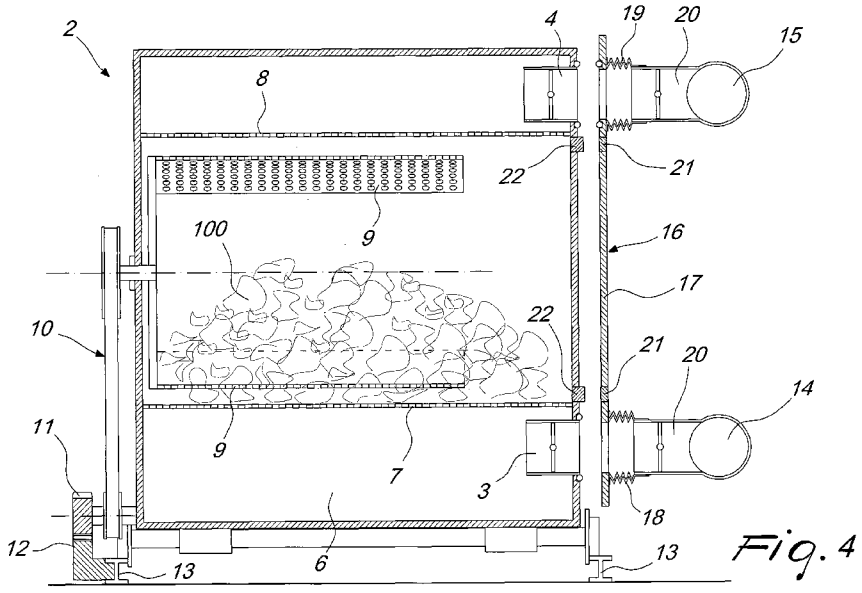

Fig. 4

(57) **Abstract**: A system for drying foods, preferably officinal plants, by the use of a controlled atmosphere with inert gas, preferably nitrogen, having a low action temperature, 35°C to 40°C, and a humidity of less than 5%. The invention also relates to a modular drying apparatus with carriages that is fully automated and provides computerized management of the degree of drying.

WO 2013/185914 A2

METHOD AND APPARATUS FOR DRYING FOOD PRODUCTS

The present invention relates to a method and an apparatus for drying food products, such as officinal plants.

As is known, foods, and particularly officinal plants, can be dried in order to inhibit the alterations that generally lead to a variation of the context and content of the active ingredients and of the organoleptic features of the plants.

Drying allows to inhibit the growth of enzymes and other microorganisms that are responsible for the putrefaction of the product and that proliferate in the humid portions of the product. Removing the humidity from the product prevents those microorganisms from multiplying and prevents other pathogenic microbes from forming, that are very dangerous for the consumer's health.

As regards in particular enzyme activities, it is known that biochemical processes continue to occur in tissues even long after the plant has been picked.

Since enzymes in general, and hydrolase in particular, require water in order to react, those activities are greatly slowed when the water content in the product is lower than 5%.

In addition to the best-known agents of deterioration of officinal plants, one can also find browning and rancidity.

Browning is caused by oxidation reactions that lead to the forming of colored products and simultaneously to an alteration of the organoleptic characters and of the activity of the product.

Such type of alteration is facilitated by the oxygen and by relatively high temperatures.

An alteration of such type occurs in leaves during drying, in which chlorophyll, in the presence of the acids of cell juices, is transformed into dark-colored feochlorophyll.

Rancidity is a typical alteration of fats that occurs during preservation.

The rancidity is caused by complex reactions which lead, among other things, to a variation in the odor, taste, and at the same time in the biological activity.

Some products of rancidity, for example peroxides, are in fact highly reactive and are such as to alter even the active ingredients with which they are in direct contact.

Two types of rancidity can be distinguished: hydrolytic rancidity and oxidation rancidity.

Hydrolytic rancidity occurs due to enzymes known as lipases; as a consequence of their action an increase in free acidity is observed in fat or in oil.

Lipases, in order to perform the hydrolysis reactions, require water and are considerably accelerated by the increase in temperature from 40°C to 50°C.

Oxidation rancidity can be enzyme-based (lipoxidase) and/or spontaneous, facilitated by external activators such as heat, light, oxygen, metallic catalysts.

Oxidation rancidity is typical of fats/oils constituted by unsaturated fatty acids; it occurs due to the enzymes known as lipoxidases and is facilitated by external activators such as heat, light, oxygen and the presence of traces of metallic substances.

This enzyme phenomenon consists of two steps: primary self-oxidation, in which oxidation in an allyl position to the double bond occurs, forming hydroperoxides, and secondary self-oxidation, in which the products formed in the first step (hydroperoxides) undergo a further degradation, giving rise to species of the aldehyde and ketone type, which give the oil and fat the typical acrid rancid odor.

Not least, but not less important, are parasites, micro organisms, bacteria, molds and spores that are present in the environment and on the picked product. These pathogens are not eliminated in currently known drying processes and lead to a degradation of the product with dangers for human health.

The drying methods, particularly of an officinal plant, are currently of three types: at ambient temperature, by heat, by freeze-drying.

Drying at ambient temperature is the most widely used method and the oldest. It is performed in well-ventilated rooms and far from sunlight. The officinal plant, generally cut into small pieces so as to increase the drying surface, is arranged on adapted frames or is hung. This method requires time and the speed of the process depends on the fragmentation of the officinal plant as well as on the temperature and, most of all, on the volume and the type of air, dry or humid, that passes over the product to be dried.

It is evident that this drying process does not solve the problems described earlier, because the long drying time, the variability of the temperature, the humidity of

the air, the presence of oxygen and the possible presence of parasites, molds and bacteria, both already present on the product and in the environment, cause a considerable loss of active ingredient and a high risk of deterioration of the product to be dried.

Heat drying considerably affects the drying rate, but it must be suitably controlled, because it can also cause other unwanted effects, such as the increase in enzyme activities and the deactivation of certain thermolabile active ingredients.

As regards in particular enzyme reactions, it has been noted that an increase in temperature, up to 40-50°C, considerably increases the rate of enzyme reactions, while at higher temperatures the enzymes are inactive.

However, at those values, the thermolabile substances can alter and, also, oxidation, polymerization and racemization reactions can occur more easily and also lead to an alteration of the active ingredients, as explained above.

The temperature of such drying method is generally 55°C to 65°C, but unfortunately, during the preheating step, when the product goes from ambient temperature to a temperature of 55-65°C, the product falls through the above temperature band, between 40° and 50°C, in which the reaction rate of the enzymes is increased considerably. Although the time period is limited, this causes a significant loss of the active ingredients.

With respect to the ambient drying method, heat drying reduces drying times but does not completely solve the problems described earlier.

DE102007037605 discloses a heat drying method comprising the use of superheated steam in a housing.

WO9514201 discloses a drying apparatus for drying food including a primary drying chamber and a secondary drying chamber, transfer means for transferring the material from the primary chamber to the secondary chamber, supply means for supplying a gaseous drying medium through the drying chambers, and heating means for heating the drying medium supplied to the drying chambers.

Drying by lyophilization, or freeze-drying, is a system that has become particularly important over the last decades and is used especially when the officinal

plant is valuable and contains thermolabile active ingredients.

With freeze-drying, all alterations are blocked, because such method operates at low temperature and low pressure.

With freeze-drying, the product is frozen rapidly and is subjected to a high vacuum.

In these conditions, the ice that is formed sublimes and its vapors are aspirated by adapted pumps and subsequently made to condense in cold walls.

With the freeze-drying process, a dehydrated material is obtained which has not undergone alterations, because it has been subjected to temperatures below 0°C. The freeze-dried product is a product that is generally sponge-like but however easily tends to absorb water to return to the initial conditions.

For this reason, the product subjected to freeze-drying has to be carefully preserved in an anhydrous environment.

It is evident that freeze-drying solves all of the previous problems but, because of its high production cost, due to the rapid freezing and by the extraction of water by using vacuum, it can be used only for high-value products.

Another drawback of the freeze-drying method is that the resulting product must be preserved in an anhydrous environment and therefore it is difficult to use it for herbal products such as for example tisanes, herb blends, et cetera.

The aim of the present invention is to provide a method and an apparatus for drying food products, particularly for officinal plants, that overcome the drawbacks of the cited prior art.

Within the scope of this aim, an object of the present invention is to provide a method and an apparatus that allow a product to dry without losing its active ingredients, or in any case with a very low loss thereof, and a sterilization of the dried product without using antiparasitic and bactericidal agents.

An object of the present invention is to provide an apparatus which, by virtue of its particular constructive characteristics, is capable of giving the greatest assurances of reliability and safety in use.

This aim and these and other objects that will become better apparent hereinafter

are achieved by a method for drying food products characterized in that it comprises subjecting a food product to a flow of substantially inert gas at a temperature not higher than approximately 35°C-40°C and having a humidity lower than 5%, in an environment that is completely lightless and substantially without oxygen.

This aim and these and other objects that will become better apparent hereinafter are also achieved by an apparatus for drying food products characterized in that it comprises one or more carriages, each of said one or more carriages constituting a body that can be closed hermetically and is adapted to contain an amount of product to be dried; said carriage comprising an intake port and a discharge port respectively for introducing and extracting substantially inert gas; said intake port being arranged in the lower part of said carriage and being provided with an automatic closure system; said intake port being connected to a lower compartment formed by a perforated lower panel inside said carriage; said perforated lower panel uniformly distributing said gas through said product, arranged on said perforated lower panel; said carriage comprising a mesh filter arranged above said product; said gas passing through said mesh filter after passing through said product to exit through said discharge port; said discharge port being provided with an automatic closure system.

Further characteristics and advantages will become better apparent from the description of preferred but not exclusive embodiments of the invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a schematic perspective view of an embodiment of a drying apparatus according to the present invention;

Figure 2 is a perspective view of a carriage in a condition in which it is not connected to the system for conveying the inert gas;

Figure 3 is a view, similar to the preceding one, of the carriage in the condition in which it is connected to the inert gas conveyance system;

Figure 4 is a transverse sectional elevation view of the carriage in the condition in which it is not connected to the inert gas conveyance system;

Figure 5 is an elevation view, similar to the preceding one, of the carriage in the condition in which it is connected to the inert gas conveyance system.

The method for drying food products according to the invention comprises subjecting a food product to a flow of inert gas at a temperature that is not higher than 35°C in an environment that is completely lightless and substantially without oxygen.

According to the invention, a flow of inert gas, preferably nitrogen, is emitted below a support, on which the product to be dried is arranged.

The flow of inert gas is emitted at the temperature of 35°C and with a humidity of less than 2%.

The inert gas passes through the product, removing humidity, and is subsequently conveyed into a condenser, which cools the gas, dehumidifying it, so as to be able to introduce it again after returning it to the temperature of 35°C.

An automatic oxygen control system maintains the oxygen percentage in the gas within 2% and, if the oxygen exceeds this threshold, the gas is diverted to a nanofiltration system, or to another oxygen suppression system, to remove and eliminate the oxygen, and is then returned immediately to the cycle.

This operation achieves three important results: the first one is that it is possible to perform drying at a low temperature and in the absence of light, thus preventing chlorophyll photosynthesis and thus reducing the action of enzymes.

The second and more important result is that oxygen is eliminated and therefore oxidation reactions are prevented.

The third result is the prevention of the life and propagation of parasites, bacteria, microorganisms and molds, because of the absence of oxygen.

Two drying control systems allow to control the amount of water that is still contained in the product, allowing to suspend drying at the most appropriate time.

One system is located at the output of the inert gas, preferably nitrogen, and calculates the absolute humidity thereof.

The data reach a computerized system that determines the degree of drying of the product from them.

The second system is the control of the volume or weight of the water extracted by the dehumidification of the inert gas.

Officinal plants, depending on the harvesting period, contain different quantities

of water; a sample thereof is taken, weighed, dried a high temperature and weighed again subsequently in order to determine the ratio between the green product and the dry product.

These data are introduced in the computerized system that determines the amount of liquid to be extracted from the product, in order to perform adequate drying.

With reference to the cited figures, the apparatus for drying food products according to the invention, generally designated by the reference numeral 1, comprises at least one carriage, designated by the reference numeral 2, which constitutes a body that can be closed hermetically and is adapted to contain a certain quantity of green product to be dried, for example approximately 1000 kg.

Each carriage 2 has an intake port 3 and a discharge port 4, respectively for introducing and extracting the inert gas, preferably nitrogen.

The carriage has a door 5 for introducing the green product and for subsequently discharging the dried product at the end of the process.

The intake port 3 is arranged in the lower part of the carriage and is provided with an automatic butterfly-type closure system with external electromagnetic activation.

The intake port 3 allows to introduce the gas at a lower compartment 6 that is formed by a perforated lower panel 7.

The perforated lower panel 7 uniformly distributes the gas over the entire surface of the product 100 arranged on the perforated lower panel itself.

The gas rises through the product 100 until it reaches the upper part of the carriage 2, where a mesh filter 8 retains any solid parts of the product, entrained by the gas.

After passing through the filter 8, the gas exits from the discharge port 4, which also is provided with an automatic butterfly-type closure system with external electromagnetic activation.

Advantageously, the carriage 2 has a product stirring device 100.

According to a preferred embodiment, the stirring device is constituted by a rotating member 9 that is actuated by a transmission 10, for example of the belt type, that is actuated by a pinion 11 driven by a rack 12.

The rack 12 runs parallel to one of the tracks 13 on which the carriage 2 slides.

The inert gas is conveyed into the carriage 2 by means of an intake duct 14 and an extraction duct 15, which run parallel to the tracks 13 and have one or more coupling devices 16.

The coupling device 16 has a bracket 17 that supports an intake bellows tube 18 and a discharge bellows tube 19.

Both tubes are connected to the respective intake duct 14 and extraction duct 15 by virtue of butterfly valves 20.

The coupling device 16 has a system for coupling to the carriage that is actuated magnetically and is constituted, in this embodiment, by magnets 21 that are inserted in the bracket 17, and corresponding magnets 22 associated with the carriage 2.

The system for coupling to the inert gas intake and extraction ducts by means of the butterfly valves 20 prevents the escape of inert gas and oxygen contamination in the system.

The magnets inserted in the carriages and the electromagnets inserted in the bracket, which moves the bellows tubes, allow the coupling and uncoupling in a stable manner of the ducts, using the reversal of the magnetic field of the electromagnet.

A second set of electromagnets acts on the opening and closing of the butterfly valves inserted in the ducts of the carriage, allowing to close the valves before disconnecting the tube, thus avoiding the contamination of the inert gas by the oxygen during the carriage movement step.

The apparatus is constituted by a number “n” of carriages that slide along the tracks and are automatically positioned at the coupling devices 16.

Before being inserted in the line, the carriages are arranged at an adapted station, optionally constituted by a coupling device 16, for introducing the inert gas, which eliminates the air inside the carriage.

After being loaded with inert gas and arranged at the beginning of the line, the carriage 2 is weighed by an automatic balance that determines the amount of product loaded; this data item is sent to the central computer, which calculates the amount of liquid expected according to the requested type of drying.

The carriages are pushed automatically from one position to the next according to times that are set by the computerized system on the basis of the set drying program.

The number of carriages inserted on the line, and therefore the dimension of the apparatus, depends on the amount of product that must be dried each day.

When the carriage, which slides along the tracks, is arranged at a coupling device 16, the electromagnetic activation system connects the carriage and at the same time opens the intake and discharge ports, allowing the gas to circulate.

When the carriage is moved from one position to the next, the rack 12 transmits the motion to the system for stirring the product inside the carriage, as described above, allowing better drying and avoiding the stratification of the green product.

Control of the humidity of the various intake ports and the calculation of the extracted liquid determine the retention time of the carriage in each station.

The first carriage of the row contains dried product according to the expected characteristics; the carriage is then unloaded and automatically returned to the loading point by means of return tracks.

The different dehumidification capacity and the rate of the gas that is introduced in the intake port allows a reduction or an increase of the drying times, adjusting the process according to the quantity of expected dry product.

In practice it has been found that the invention achieves the intended aim and objects, a drying system for food products, particularly for officinal products and the like, having been provided which allows drying without the loss of active ingredients or in any case with an extremely reduced loss thereof and a sterilization of the dried product without the use of antiparasitic and bactericidal agents which, if used, would be entrained inevitably into the finished product.

By virtue of the combination of a cold drying process, with a maximum temperature of 35°C, and of the use of an inert gas, preferably nitrogen, instead of air, it is possible to obtain a finished product with chemical characteristics that are similar to the green product without any alteration in color and without external pathogens.

The use of a controlled atmosphere with at least 98% inert gas, preferably nitrogen, kills automatically germs, bacteria, molds, viruses and parasites, which

generally settle on the outer part of the plant, while the enzymes and other bacteria that are inside the product, suspended in the liquid, are eliminated and then killed in the step for dehydration and drying of the product.

In the last drying step, when the humidity that is present inside the product is less than 7%, the action of the inert atmosphere, preferably nitrogen, with a content of more than 98%, allows the almost total elimination of the last traces of microorganisms that are present inside the product.

The product obtained by means of the method and the apparatus according to the present invention is then sterilized, thus allowing a better preservation of the chemical and organoleptic characteristics of the product.

Another significant advantage of the present invention is the possibility to reuse the vegetable water extracted from the product, approximately three times the weight of the dried product, appropriately filtered by using ultrafiltration methods, which eliminate any microorganisms that are still present.

This water can be reused productively in the subsequent processes for extracting active ingredients, since the vegetable water that is extracted from the product during the dehydration step is certainly the best polar solvent, differently from the mineral water that can be used.

A further advantage of the present invention is the use, as an inert gas for dehumidification, of nitrogen, which is present abundantly in the atmosphere and can be separated easily by using hollow-fiber modules.

The apparatus is constituted by one or more modules containing hollow fibers, in which the separation of the oxygen from the nitrogen occurs by filtration with the action of a pressure of approximately 10 bars, generated by a compressor that draws the inert gas/air, still containing oxygen, from the drying cells, raising the purity of the nitrogen to 99%.

This application claims the priority of Italian Patent Application No. GE2012A000056, filed on June 13, 2012, the subject matter of which is incorporated herein by reference.

CLAIMS

1. A method for drying food products, characterized in that it comprises subjecting a food product to a flow of substantially inert gas at a temperature not higher than approximately 35°C-40°C and having a humidity lower than 5%, in an environment that is completely lightless and substantially without oxygen.

2. The method according to claim 1, characterized in that said substantially inert gas comprises nitrogen.

3. The method according to claim 1, characterized in that said substantially inert gas is diffused through said product from the bottom and is collected at the top.

4. The method according to one or more of the preceding claims, characterized in that said product is stirred while it is crossed by said substantially inert gas.

5. The method according to one or more of the preceding claims, characterized in that it comprises checking the percentage of oxygen that is present in said substantially inert gas and maintaining said percentage of oxygen below 2%.

6. An apparatus for drying food products, characterized in that it comprises one or more carriages, each of said one or more carriages constituting a body that can be closed hermetically and is adapted to contain an amount of product to be dried; said carriage comprising an intake port and a discharge port respectively for introducing and extracting substantially inert gas; said intake port being arranged in the lower part of said carriage and being provided with an automatic closure system; said intake port being connected to a lower compartment formed by a perforated lower panel inside said carriage; said perforated lower panel uniformly distributing said gas through said product, arranged on said perforated lower panel; said carriage comprising a mesh filter arranged above said product; said gas passing through said mesh filter after passing through said product to exit through said discharge port; said discharge port being provided with an automatic closure system.

7. The apparatus according to claim 6, characterized in that said carriage comprises a product stirring device.

8. The apparatus according to claim 7, characterized in that said product stirring device comprises a rotating member driven by a transmission actuated by a pinion that

draws its motion from a rack; said rack running parallel to tracks along which said carriage slides.

9. The apparatus according to claim 6, characterized in that it comprises a conveyor means for conveying said substantially inert gas into said one or more carriages; said conveyor means comprising inlet ducts and extraction ducts, which run parallel to tracks along which said one or more carriages slide; said conveyor means comprising one or more coupling devices for mutually coupling said ducts and said carriages.

10. The apparatus according to claim 9, characterized in that said coupling device comprises a bracket, which supports an inlet bellows tube and an outlet bellows tube; said tubes being both connected to said respective inlet duct and outlet ducts by means of valves; said coupling device comprising a magnetically actuated system for coupling to said carriage.

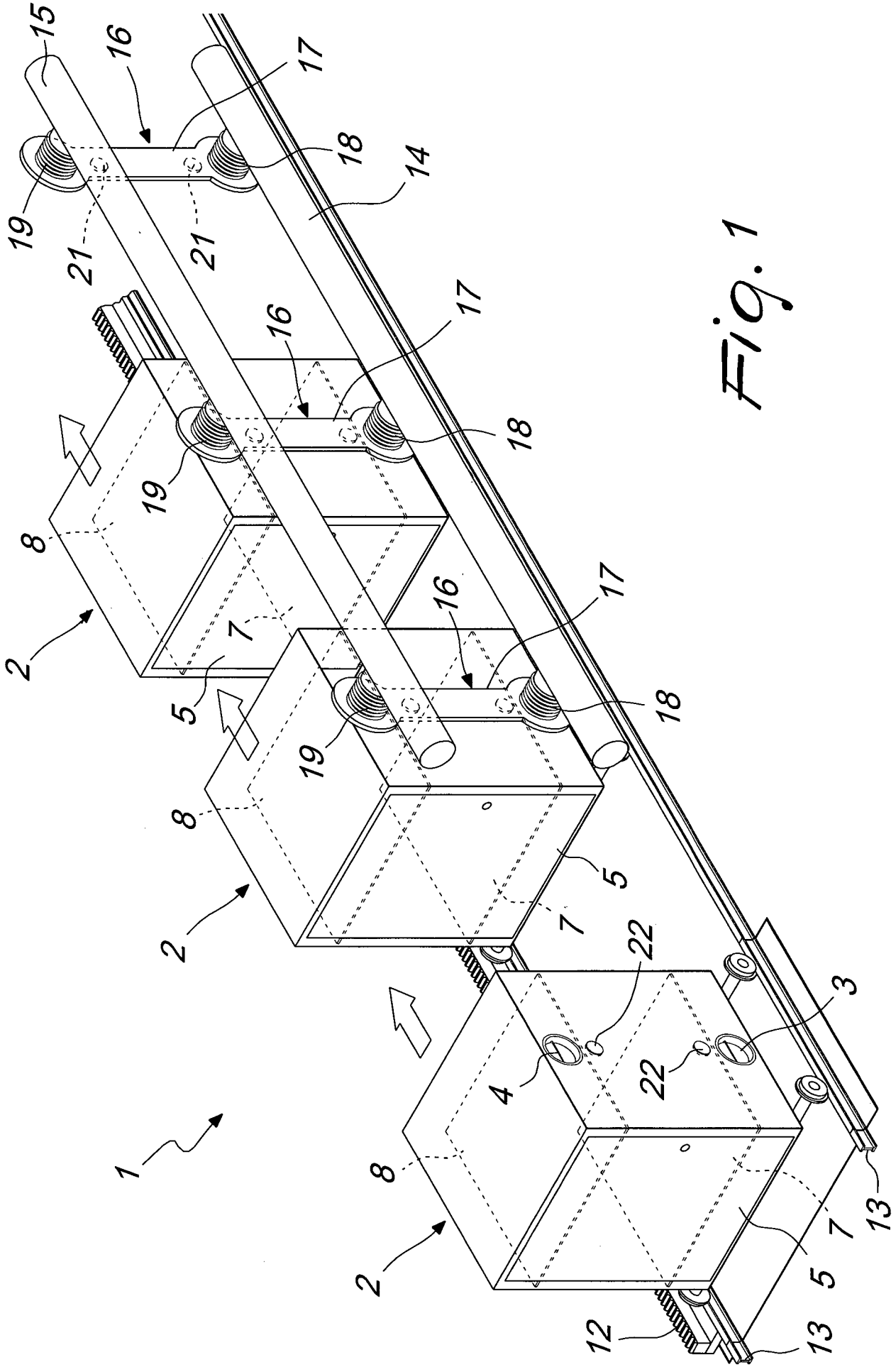

Fig. 1

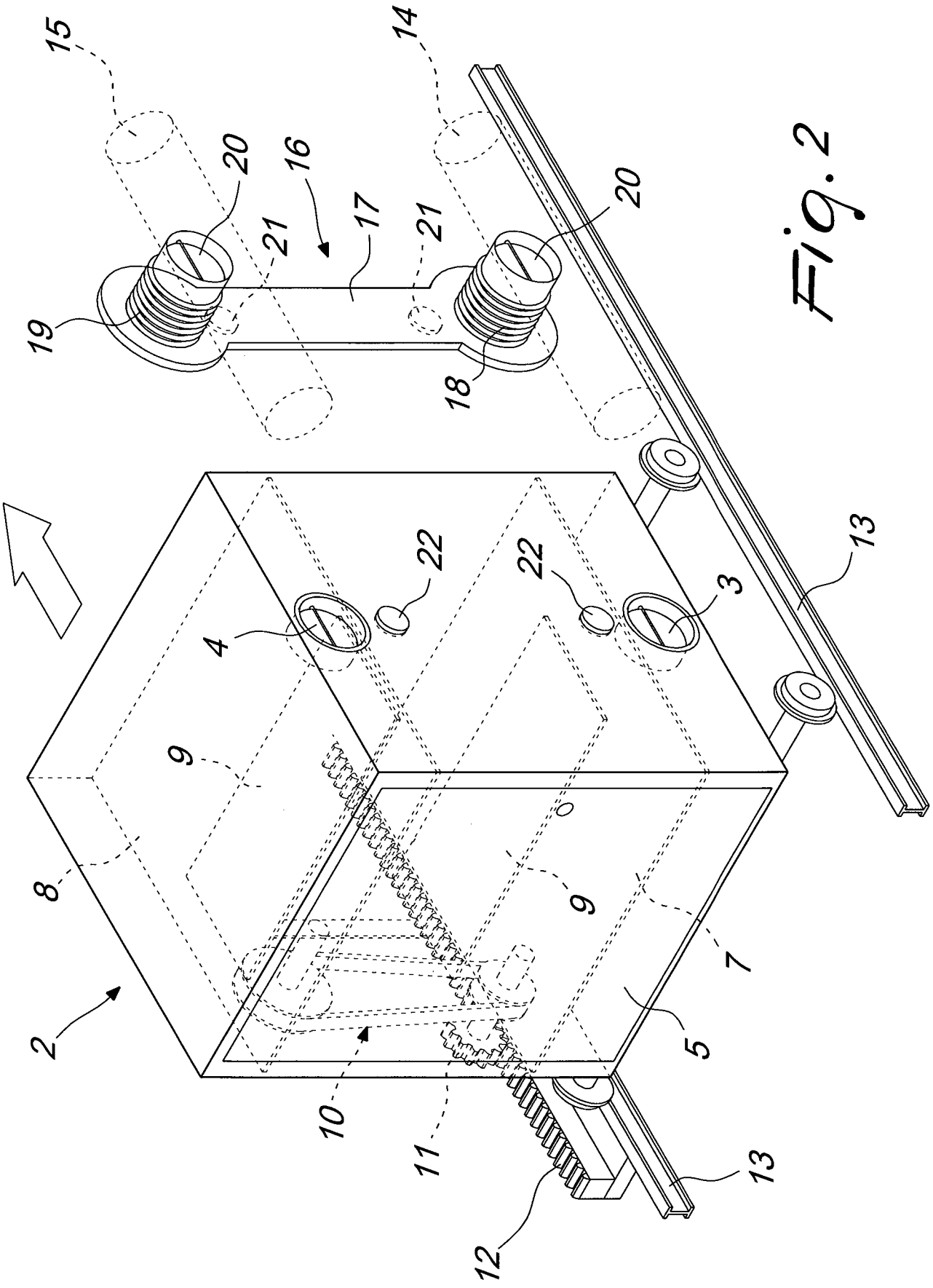

Fig. 2

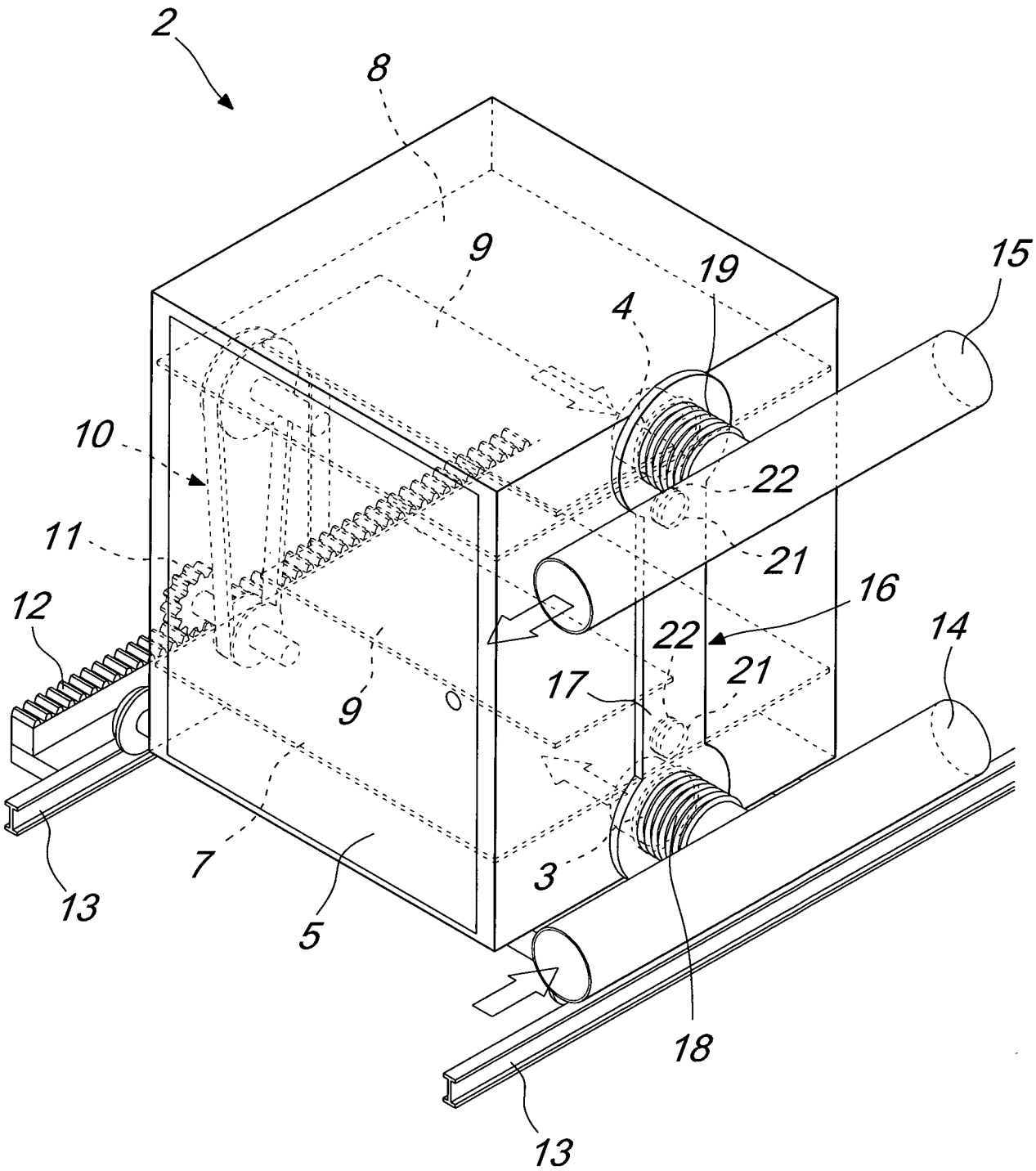

Fig. 3

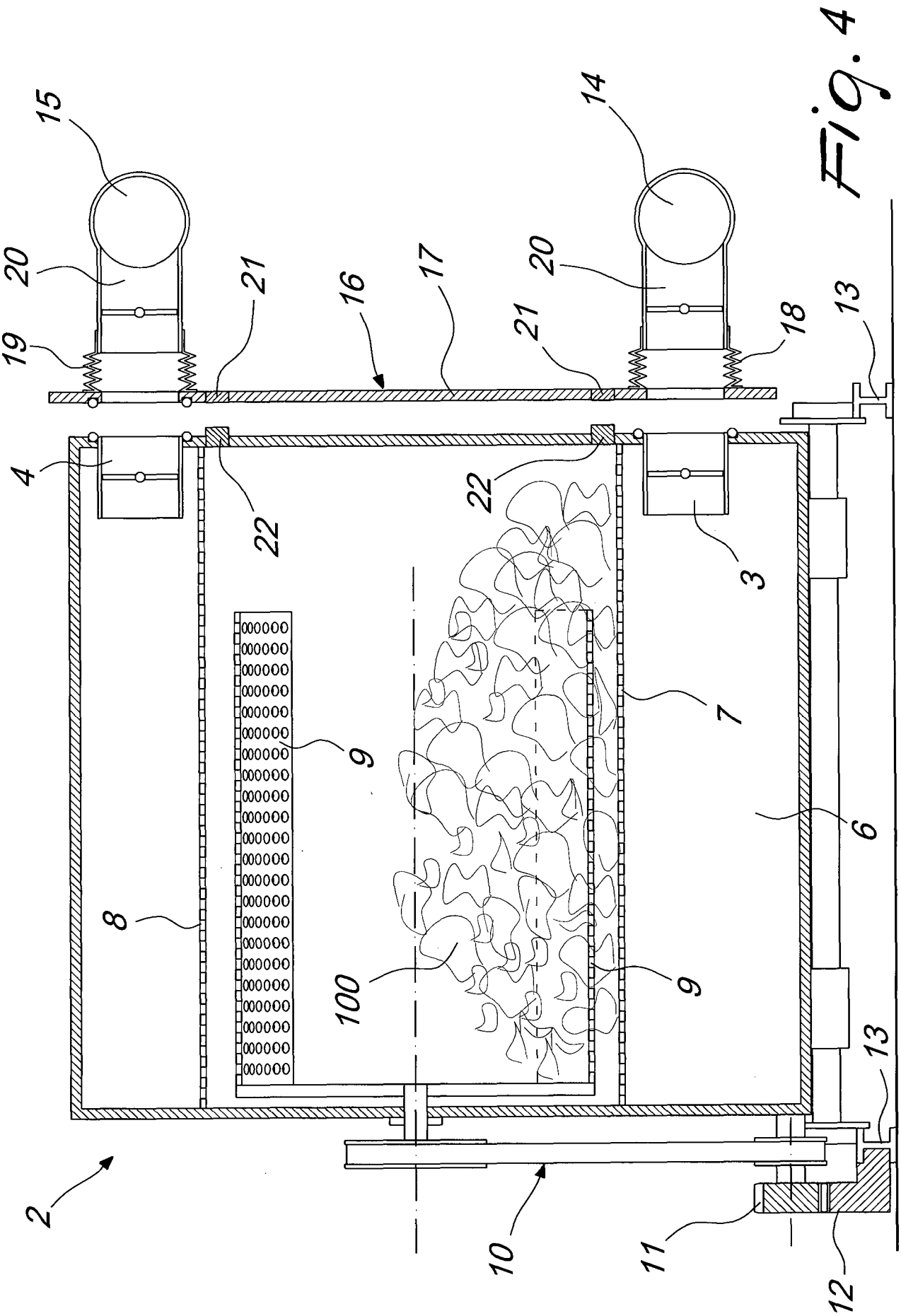

Fig. 4

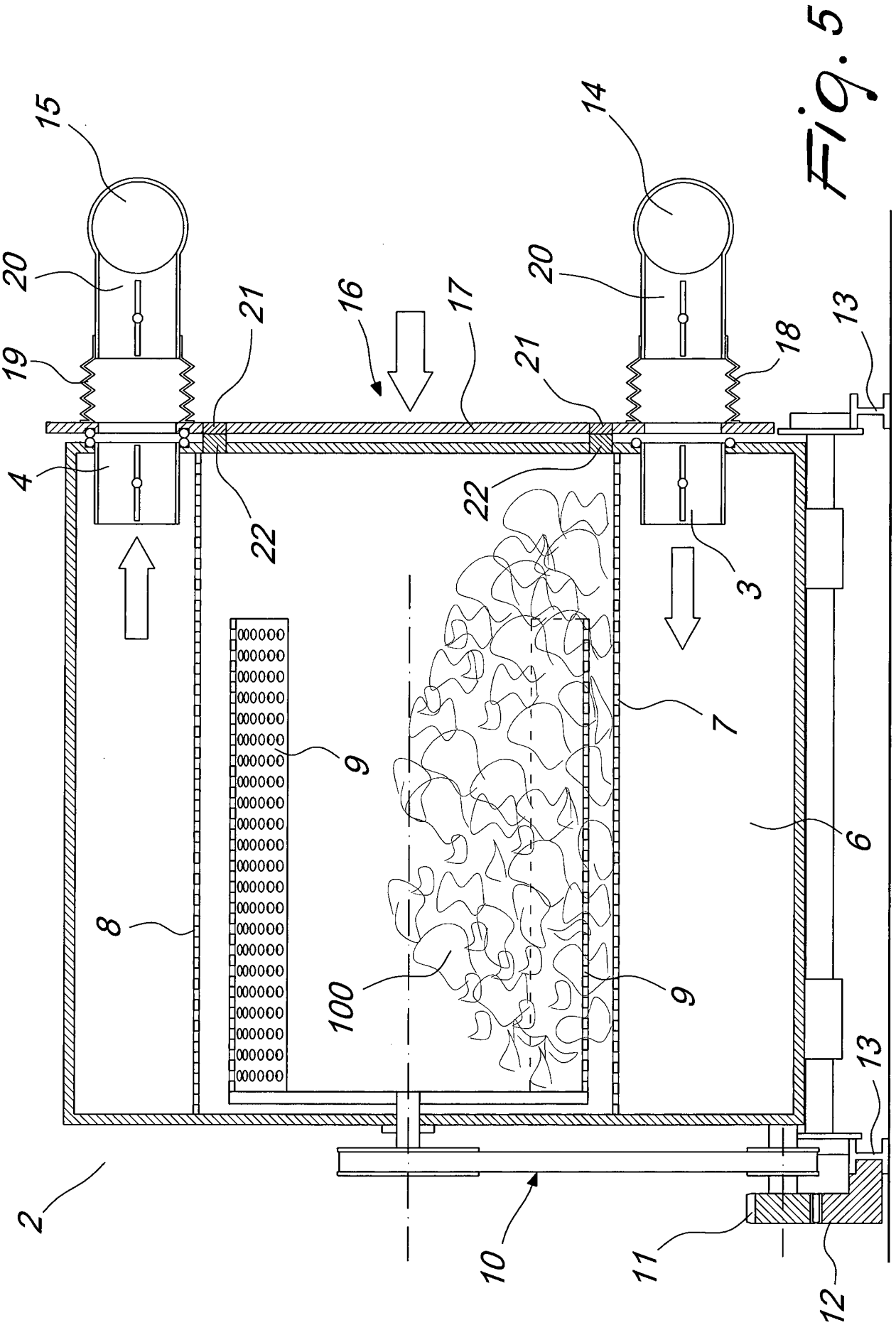

Fig. 5