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(54) Dryer

(57) The present invention relates to a drying device (1) for drying a water-containing mixture, in which said drying device (1) comprises a conical drying chamber (2) having an inlet opening through which the water-containing mixture is supplied, said conical drying chamber (2) being designed to generate an air whirl stream from an influx of air so that the supplied water-containing mixture is dried to form dried material by the generated air whirl stream, and the drying chamber (2) furthermore comprising an outlet opening (3) for discharging the generated air whirl stream together with the dried material.

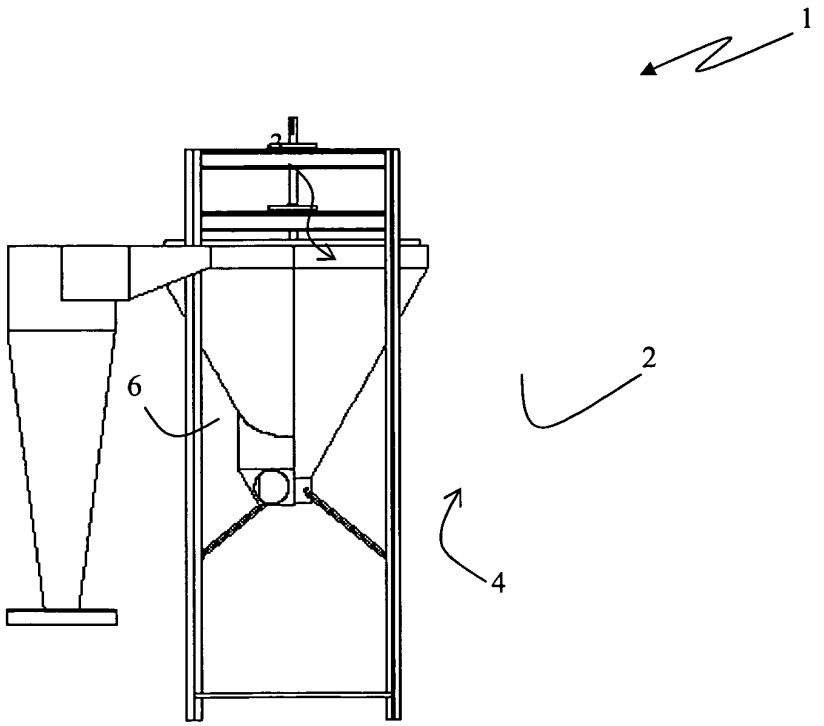

Fig. 2

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Description

[0001] The present invention relates on the one hand to a drying device for drying a water-containing mixture and on the other hand to a method for drying water-containing mixtures by means of such a drying device.

[0002] The present invention relates in particular to a drying device which is suitable for drying water-containing mixtures to form granular material or granular powder (granules).

[0003] For various reasons, as much moisture as possible has to be removed from water-containing mixtures, such as for example sludge or semi-liquid manure, sand slurries, digestate, dewatering sludge, waste sludge, etc. One of the most common systems for removing moisture from water-containing mixtures is a drying belt. Such a drying belt consists of a variable speed belt, made from plastic, which is provided with perforated apertures. The material to be dried is placed on the belt and dried by passing an air current of approximately 70°C through the apertures of the belt.

However, such a drying belt has the drawback that air currents of relatively high temperatures (> 70°C) cannot be passed through the apertures of the drying belt as there is a risk that the plastic belt could start to melt.

[0004] In order to solve this problem, a perforated vibrating plate made from stainless steel was developed. By means of such a vibrating plate, the material present on the vibrating plate can be dried using an air current having a temperature of more than 200°C.

[0005] It is now an object of the invention to provide an alternative drying device by means of which it is possible to dry water-containing mixtures in an efficient manner by means of an air current, irrespective of the temperature of this air current.

[0006] The object of the invention is achieved by providing a drying device for drying a water-containing mixture, in which said drying device comprises a conical drying chamber having an inlet opening through which the water-containing mixture is supplied, said conical drying chamber being designed to generate an air whirl stream from an influx of air so that the supplied water-containing mixture is dried to form dried material by the generated air whirl stream, and the drying chamber furthermore comprising an outlet opening for discharging the generated air whirl stream together with the dried material.

[0007] The discharged material is preferably in the form of granular material or granular powder having a solids content of between 80 and 99%, preferably of between 90 and 99%.

[0008] Due to the specific embodiment of the drying chamber, the supplied water-containing mixture comes into contact with already partially dried or completely dried material, as a result of which (due to the structure of the already dried material) drying can be effected much more efficiently and a drying device can be produced which is much more compact than the existing drying belt.

[0009] The drying chamber is preferably made from metal and is, more particularly, made from stainless steel.

[0010] In a preferred embodiment of the drying device according to the invention, the conical drying chamber comprises an inflow opening for air which is provided in the essentially narrowest part of the drying chamber. The narrowest part of the drying chamber is situated in particular on the underside of the drying chamber. Preferably, the inflow velocity of the air is between 20 and 50 m/sec. The inflow velocity of the air depends on the product to be dried; relatively light products require a relatively low speed, while relatively heavy products require a relatively high speed.

[0011] According to a more preferred embodiment of the drying device according to the present invention, the inlet opening is connected to the periphery of the drying chamber in the vicinity of the essentially widest part of the drying chamber. The widest part of the drying chamber is preferably situated at the top of the drying chamber.

[0012] In a particular embodiment of the drying device according to the invention, the drying chamber comprises an upper wall, with the inlet opening being formed in said upper wall. The upper wall closes off the drying chamber at the top and ensures that the already dried material only leaves the drying device via the outlet opening. In a preferred embodiment of the drying device, the outlet opening is formed in a wall of the conical drying chamber, in the vicinity of the essentially widest part of the drying chamber.

[0013] According to a more particular embodiment of the drying device according to the invention, the drying device furthermore comprises a cyclone which is connected to the outlet opening and is designed to remove the dried material from the air whirl stream.

[0014] In a particularly advantageous embodiment of the drying device according to the invention, said drying device comprises a stirring and displacement device which is rotatable in the drying chamber. This device comprises in particular an Archimedean screw. The stirring and displacement device, in particular the screw, can turn clockwise as well as anticlockwise. The screw makes it possible to adjust the residence time of the mixture to be dried in the drying chamber.

[0015] In a more particular embodiment of the drying device according to the invention the stirring and displacement device furthermore comprises a scraping element which is designed to scrape the inner wall of the drying chamber.

[0016] Another subject of the present invention relates to a method for drying a water-containing mixture, in which the method comprises the following steps:

- supplying a water-containing mixture to be dried via a supply device to the inlet opening of a conical drying chamber;
- drying the water-containing mixture to form dried material by means of an air whirl stream in the conical drying chamber;
- discharging the air whirl stream via an outlet opening,

provided in the drying chamber, together with the dried material to a cyclone which is connected to the outlet opening.

[0017] The method according to the invention is in particular implemented on the above-described drying device.

[0018] In order to further explain the features of the present invention and to indicate additional advantages and details, there now follows a more detailed description of the drying device and the method for drying water-containing mixtures according to the present invention. It will be clear that nothing in the following description can be interpreted as a restriction to the scope of protection of the present invention as laid down by the claims.

[0019] In this description, reference numerals are used to refer to the attached drawings, in which:

- Fig. 1 shows a perspective view of the drying device according to the invention;
- Fig. 2 shows a front view of the drying device represented in Fig. 1;
- Fig. 3 shows the interior of the drying chamber;
- Fig. 4 shows a perspective view of an alternative drying device according to the invention.

[0020] The drying device (1) according to the present invention and as represented in the attached figures 1 and 2 is suitable for drying water-containing mixtures to form granules and comprises a conical drying chamber (2) having an inlet opening via which product to be dried, usually in the form of a wet mash, is supplied to the drying chamber (2). The drying chamber (2) is closed off at the top by an upper wall (5). The inlet opening is preferably provided in this upper wall.

[0021] Due to its specific shape (wide at the top and narrow at the bottom), the drying chamber (2) can generate an air whirl stream from an influx of air, so that the supplied wet mash is dried by the generated air whirl stream to form dried material. The inflow opening (4) for air is situated at the bottom of the drying chamber (2), in the narrowest part.

[0022] The supplied air can be ambient air which is withdrawn from the surroundings by means of ventilation means, but can also consist of waste gases from a chimney, stable air and heat from, for example, an electric group. The temperature of the supplied air depends on the source and is preferably between 10 and 250°C. The inflow velocity of the air is adjustable and is preferably between 20 and 50 m/sec.

[0023] The wet mash is supplied to the top of the drying chamber (2) via a supply device (not shown), usually a conveyor belt. In order to be able to feed the supplied mash to the drying chamber (2) in a controlled manner, a sluice is preferably arranged above the inlet opening. It will be obvious that other devices which are suitable for a controlled supply can also be used. Since the inlet opening is connected to the periphery of the drying chamber (2), the supplied mash will move downwards along the walls of the drying chamber (2) on account of the force of gravity.

[0024] During the downward movement of the wet mash, the latter will be dried, on the one hand, by the generated air whirl stream and, on the other hand, by coming into contact with already dried material. The wet mash is dried to form granular material or granular powder with a solids content between 80 and 99%.

[0025] Depending on the composition of the supplied wet mash, it is sometimes necessary to adjust the residence time in the drying chamber (2). This can be effected by placing a rotatable stirring and displacement device (7) in the drying chamber (2), as is illustrated in Fig. 3. The stirring and displacement device (7) is in particular designed as an Archimedean screw which can be turned both in the clockwise and the anticlockwise direction. In this way, it is possible to impart an upward movement to mixtures which are relatively heavy, e.g. sand slurries, by means of the Archimedean screw in order to be able to remove them from the drying chamber (2) more easily. In the case of the relatively light mixtures, e.g. mixtures which contain wood fibres, the Archimedean screw will rotate in the other direction in order to create a downward movement and thus to allow the mixture to remain in the drying chamber (2) for longer.

[0026] The residence time can be influenced further by providing the stirring and displacement device (7) with one or more screen elements which extend at right angles to the length direction of the stirring and displacement device (7). The screen is interrupted across part of its surface as a result of which an opening is formed. Such a screen ensures that the air current comprising the dried material can only flow further to an outlet opening (3) when it has reached the interrupted portion. The screen is situated essentially halfway up the drying chamber. The presence of the screen creates additional resistance, as a result of which it will be more difficult for the material to leave the device. If desired, the screen can be provided with additional perforated fine holes across its surface.

[0027] The stirring and displacement device (7) is furthermore provided with a scraper element (8) in order to remove any encrusted remains of material from the inner walls of the drying chamber (2).

[0028] The dried material leaves the drying chamber (2) together with the generated air current via the top by means of an outlet opening (3) which is formed in the wall of the conical drying chamber (2).

The composition of the dried material can be adjusted by adjusting the inflow velocity of the air, for example by making the air flow more quickly, more moist product will be entrained and leave the drying chamber (2) via the outlet opening (3). At a slower inflow velocity, less moist product will be entrained.

[0029] After leaving the drying chamber (2), the air current comprising dried material ends up in the cylindrical part of a cyclone (6) (dust remover). In the cyclone (6), the dried material is removed from the air current. The

dried material will leave the cyclone (6) via an opening at the end of the conical part.

[0030] Fig. 4 shows an alternative embodiment of the drying device (1) according to the present invention. The illustrated drying device (1) comprises a conical drying chamber (2) with an inlet opening (9) via which the product to be dried is supplied to the drying chamber (2), usually in the form of a wet mash. The drying chamber (2) is closed off at the top by an upper wall (5). The inlet opening (9) is provided in this upper wall.

[0031] With the drying device (1) illustrated in Fig. 4, the entire inflow opening (4) for air is situated at the bottom of the drying chamber (2), in the conical end of the drying chamber (2). In this conical end, the air supply to the rest of the installation is closed off by a perforated plate. This prevents any product to be dried from entering the air supply. Such a perforated plate can also be provided in the devices illustrated in Figs 1 to 3.

[0032] The dried material leaves the drying chamber (2), together with the generated air current, at the top via an outlet opening (3) which is formed in the upper wall (5) of the conical drying chamber (2). In this embodiment, the outlet opening is situated substantially opposite the inflow opening (4). After leaving the drying chamber (2), the air current comprising dried material ends up in the cylindrical part of a cyclone (6) (dust remover).

Claims

1. Drying device (1) for drying a water-containing mixture, **characterized in that** said drying device (1) comprises a conical drying chamber (2) having an inlet opening through which the water-containing mixture is supplied, **in that** said conical drying chamber (2) is designed to generate an air whirl stream from an influx of air so that the supplied water-containing mixture is dried to form dried material by the generated air whirl stream, and **in that** the drying chamber (2) furthermore comprises an outlet opening (3) for discharging the generated air whirl stream together with the dried material.

2. Drying device (1) according to Claim 1, **characterized in that** the conical drying chamber (2) comprises an inflow opening (4) for air which is provided in the essentially narrowest part of the drying chamber (2).

3. Drying device (1) according to Claim 1 or 2, **characterized in that** the inlet opening is connected to the periphery of the drying chamber (2) in the vicinity of the essentially widest part of the drying chamber (2).

4. Drying device (1) according to one of the preceding claims, **characterized in that** the drying chamber (2) comprises an upper wall (5), with the inlet opening being formed in said upper wall (5).

5. Drying device (1) according to one of the preceding claims, **characterized in that** the outlet opening (3) is formed in a wall of the conical drying chamber (2) in the vicinity of the essentially widest part of the drying chamber (2).

6. Drying device (1) according to one of the preceding claims, **characterized in that** the inflow velocity of the air is between 20 and 50 m/sec.

7. Drying device (1) according to one of the preceding claims, **characterized in that** the drying device (1) furthermore comprises a cyclone (6) which is connected to the outlet opening (3) and is designed to remove the dried material from the air whirl stream.

8. Drying device (1) according to one of the preceding claims, **characterized in that** said drying device (1) comprises a stirring and displacement device (7) which is rotatable in the drying chamber (2).

9. Drying device (1) according to Claim 8, **characterized in that** said stirring and displacement device (7) comprises an Archimedean screw.

10. Drying device (1) according to Claim 8 or 9, **characterized in that** the stirring and displacement device (7) furthermore comprises a scraping element (8) which is designed to scrape the inner wall of the drying chamber (2).

11. Method for drying a water-containing mixture, **characterized in that** the method comprises the following steps:

    - supplying a water-containing mixture to be dried via a supply device to the inlet opening of a conical drying chamber (2);
    - drying the water-containing mixture to form dried material by means of an air whirl stream in the conical drying chamber (2);
    - discharging the air whirl stream via an outlet opening (3), provided in the drying chamber (2), together with the dried material to a cyclone (6) which is connected to the outlet opening.

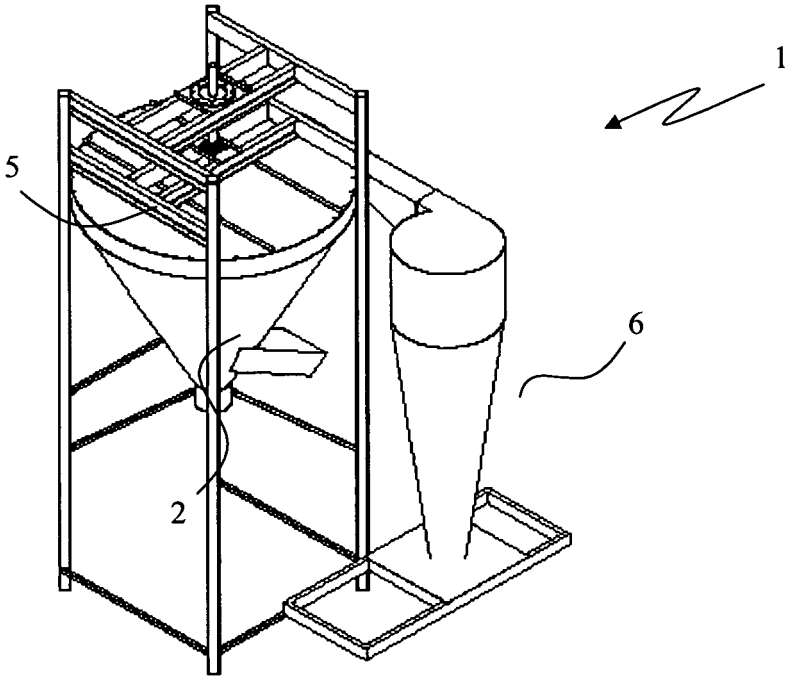

Fig. 1

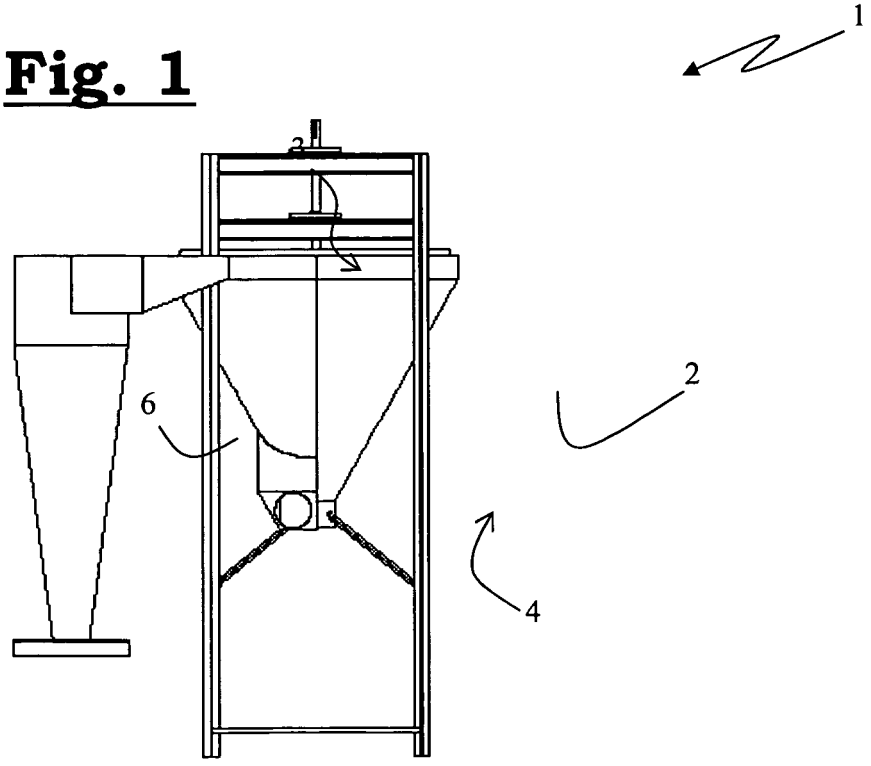

Fig. 2

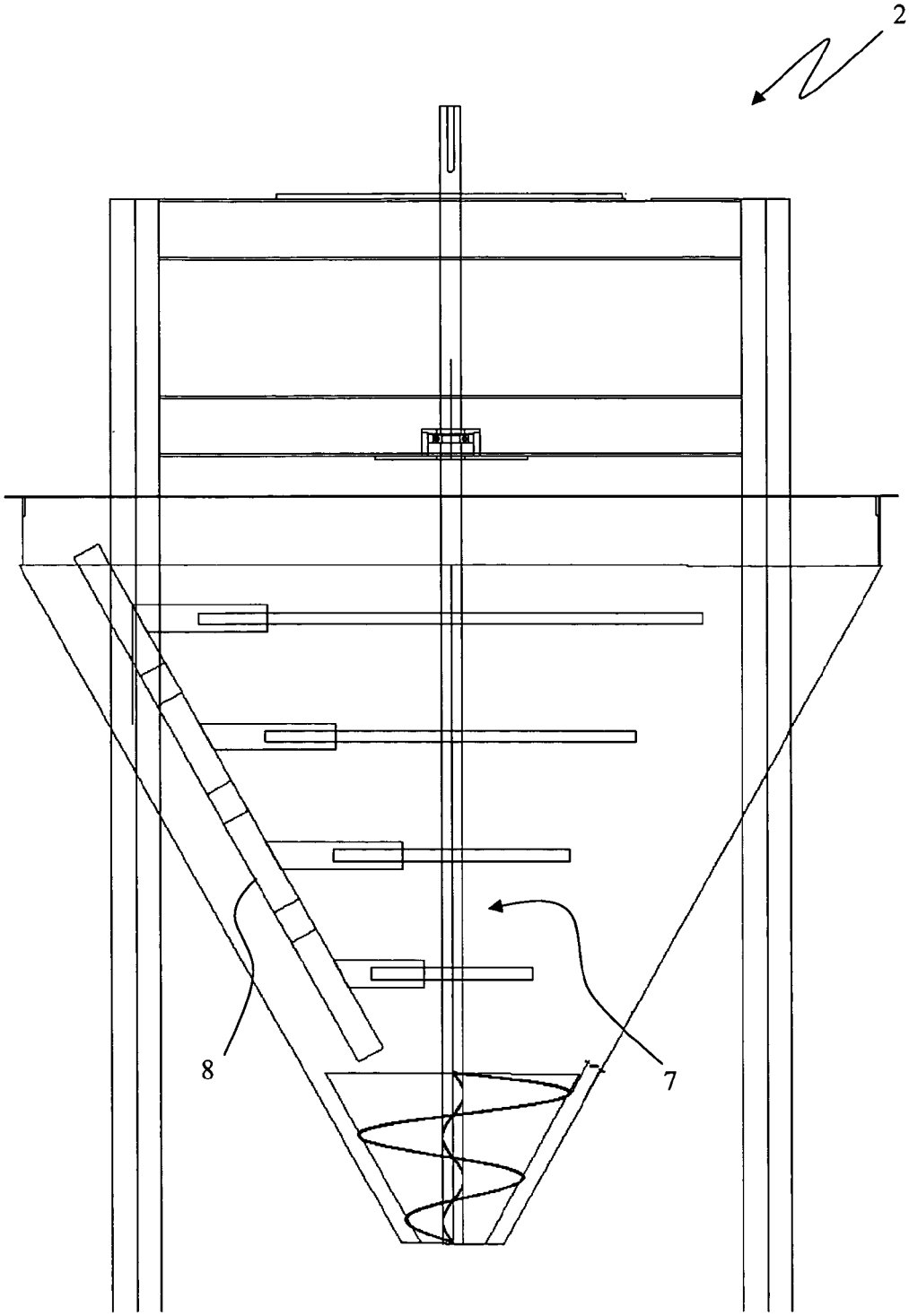

Fig. 3

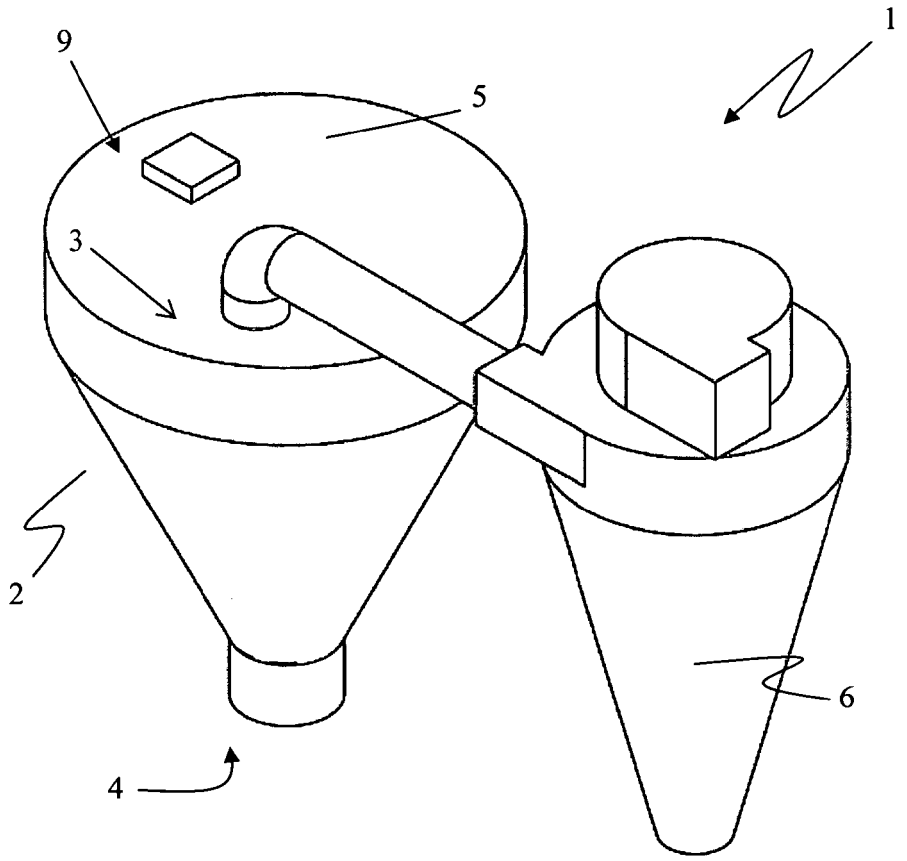

Fig. 4