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(71) Applicant: **Kumera Oy**
11100 Riihimäki (FI)

(72) Inventors:
- **Mansikkaviita, Hannu**
05800, Hyvinkää (FI)
- **Shaolong, Chen**
11130, Riihimäki (FI)

(74) Representative: **Salonen, Esko Tapani et al**
Forssén & Salomaa Oy
Lautatarhankatu 8 B
00580 Helsinki (FI)

(54) **Steam dryer**

(57) The invention concerns a steam dryer for evaporating of water and/or other liquid from wet materials or evaporating of materials in a liquid state. The dryer (10) comprises a cylindrical rotatable drum (11) having a shell (12) and provided with a feed end (14) delimited by a feed end plate (15), and a discharge end (16) closed by a discharge end plate (17). A plurality of steam pipe elements (26) are inserted in the drum (11). Each steam pipe element (26) comprises axial pipes (27) parallel to a longitudinal direction of the drum (11) and interconnected by transverse intermediate pipes (28). The steam pipe elements (26) are rotatable with the drum (11). A stationary end chamber (18) and a steam distributor manifold (21) are arranged at the discharge end area of the drum (11). Conveyance means (22) are disposed at the feed end (14) of the drum (11) for supplying the wet materials or the materials in a liquid state into the steam dryer (10) for evaporating. The stationary end chamber (18) is arranged at the discharge end area of the drum (11) in the axial direction between the discharge end plate (17) and the feed end plate (15) such that the discharge end plate (17) is situated outside of the discharge end chamber (18). The discharge end chamber (18) surrounds a portion of the drum (11) and it has a lower opening (19) to discharge dried material or remaining liquid and an upper opening (20) to discharge vapour from the drum (11). The steam distributor manifold (21) is arranged at the discharge end (16) of the drum (11) outside of the discharge end plate (17) to supply the steam pipe elements (26) with steam and to remove condensate formed in the steam pipe elements (26).

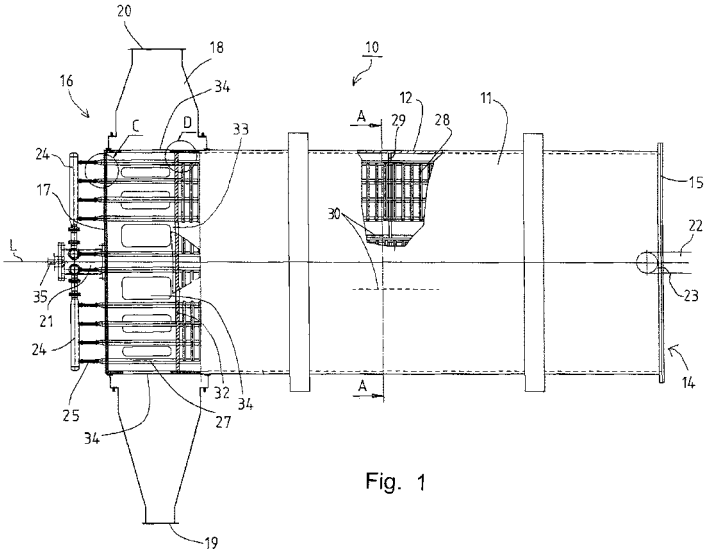


Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The invention concerns a steam dryer for evaporating of water and/or other liquid from wet materials or evaporating of materials in a liquid state, comprising:

a cylindrical rotatable drum having a shell with an inner face and an outer face and provided with a feed end structured and arranged to receive wet material or material in a liquid state into the drum the feed end being delimited by a feed end plate, and a discharge end structured and arranged to discharge vapour and dried material or remaining liquid from the drum the discharge end being equipped with a discharge end plate,

a plurality of steam pipe elements each of which comprises two axial pipes parallel to a longitudinal direction of the drum and interconnected by a plurality of longitudinally spaced transverse intermediate pipes, the steam pipe elements being structured and arranged to be inserted within the drum and being rotatable therewith,

a steam distributor manifold structured and arranged at the discharge end of the drum coaxially with said drum, and

conveyance means disposed at the feed end of the drum and structured and arranged for supplying the wet materials or the materials in a liquid state into the steam dryer for evaporating.

BACKGROUND OF THE INVENTION

[0002] In the prior art, a number of different types of dryer drums based on the use of steam are known, which drums are used, among other things, for drying of different wet materials. In steam dryers of said type, the material to be dried is introduced into the drying drum, and the steam intended for drying is made to flow in pipes fitted inside the drum. Thus, the material to be dried cannot reach direct contact with the steam. Drying drums can be divided into two main types, i.e. into batch-type dryers and, on the other hand, into continuous dryers. In batch-type dryers, of which, as one example, the dryer described in the German Patent No. 27 24 639 can be mentioned, the drying drum is filled to the desired quantity, the supply of steam is started into the set of pipes placed in the interior of the drying drum, and at the same time the drying drum starts revolving. After the material to be dried has been made sufficiently dry, the rotation of the drum is stopped, the supply of steam is switched off, and the drum is emptied. Thus, it can be considered to be a drawback of a batch-type dryer that, exactly owing to its mode of operation, the dryer cannot be used smoothly for drying of large quantities of material.

[0003] In continuous dryers, the arrangement is, as a rule, such that the drying drum is rotated constantly, and material to be dried is supplied into the interior of the drum through one end of the drum. During drying, steam is passed constantly into the pipe system provided in the interior of the drum. The drum is provided with purposeful means by which it is rotated during drying, and further, the wet material that is fed into the drum during drying is carried towards the opposite end of the drum, out of which end the material is discharged. As a rule, the drum is provided with an adjustable overflow edge or with adjustable discharge openings, and further, it is common that the position of inclination of the drum can be adjusted within certain limits so as to regulate the dwell of the concentrate material in the drum. As an example of such continuous drying drums, the steam dryer described in WO 98/02700 can be mentioned.

[0004] As regards the construction of the above-described prior-art steam drum dryers, it can be stated by way of example that quite commonly such dryers are used in which the steam pipes have been fitted as substantially parallel to the axis of the drum. In such an arrangement, in some cases, it has been noticed to be a problem that an insulating material layer is formed on the faces of the steam pipes out of the material to be dried. In such prior-art dryers in which longitudinal pipes are used, the filling degree of the devices is relatively low, i.e. of an order of 10 ... 15% of the inside volume of the drum, and such drums are not used commonly in drying of some mineral materials because of their large size and low efficiency.

[0005] A further prior-art dryer arrangement is such that in it a separate rotor is employed, which forms the heating face and around which rotor there is a stationary fixed basin placed in a horizontal plane. As a rule, the rotor consists of a number of parallel groups of pipes, which have been arranged along a central tube. Each group of pipes usually comprises a number of concentric pipe rings, and the heat transfer medium that is used can be steam or a liquid. In this prior-art solution, the system of steam pipes, which has been mounted from its ends by means of bearings and which revolves in the wet materials to be dried, imposes a restriction of size, and the size of the equipment cannot be increased economically when the amount of wet materials is increased. A considerable drawback of dryers of this type is rapid wear of the steam pipes, which causes great problems in drying of abrading minerals, because the rotor revolves in a stationary material bed, in which case the pressure applied by the concentrate to the steam pipes is high and causes intensive wear, as was mentioned above.

[0006] Still further prior art dryer construction is described in US Patent No. 6,415,527. In this patent is disclosed a steam dryer in particular intended for drying of concentrates, in which dryer abrasion has been reduced compared to previously described prior art so that abrasion does not cause similar problems. In the dryer drum of US 6,415,527 the set of pipes placed in the drum has been formed and composed of elements, which can be removed from the drum and replaced separately. So the

service life and the usability of the dryer is quite good, because, if necessary, the tube elements can be replaced quickly and easily, which reduces the standstill time of the dryer. The set of steam pipes in this prior art dryer revolves along with the drum, in which case only a low pressure and a little abrading difference in speed is formed between the material to be dried and the steam pipes, in which case abrasion of the steam pipes cause less problems than in previous dryers. However, some problems still remain and therefore there is still a need for improvements in this type of dryers.

[0007] Even though the drying efficiency and the filling degree of the drum of US 6,415,527 were considered quite acceptable at the time when the construction of said US patent was developed nowadays a demand for still better efficiency has risen. The drum of the steam dryer of US 6,415,527 has one uniform cylindrical chamber. Now, in this type drums when wet material to be dried is fed into the drum it is settled at the lower part of the drum so that only a small part of the steam pipes is in contact with said wet material. Therefore the heating area of the steam pipes is not used as efficiently as it should be. Another problem relating to the drum of US 6,415,527 lies in the construction of the combination of the steam distribution manifold and the discharge end chamber. In the drum of US 6,415,527 said steam distribution manifold with radial connection pipes, flexible hoses etc. are all located in said discharge end chamber. There they are exposed to an environment of flying dusty, moist and corrosive vapour.

OBJECTS AND SUMMARY OF THE INVENTION

[0008] The object of the present invention is to provide a steam dryer for evaporating of water and/or other liquid from wet materials or evaporating of materials in a liquid state, in which dryer the steam distributor manifold, radial connection pipes and flexible hoses are not exposed to the difficult environment of flying dusty, moist and corrosive vapour so that abrasive wear is minimized or at least it does not cause problems and that the need for maintenance has remarkably been reduced and if needed the maintenance easy to do due to the easy access to said components.

[0009] Further, another object of the present invention is to provide a steam dryer in which the contact area between the steam pipe elements and wet material is increased in order to obtain higher drying efficiency of the dryer.

[0010] In view of achieving the objectives of the invention, the first embodiment of the present invention is mainly **characterized in that** the stationary end chamber is arranged at the discharge end area of the drum in the axial direction between the discharge end plate and the feed end plate such that the discharge end plate is situated outside of the discharge end chamber, said discharge end chamber surrounding a portion of the drum and having a lower opening to discharge dried material or remaining liquid therethrough from the drum and from the discharge end chamber and an upper opening to discharge vapour therethrough from the drum and from the discharge end chamber, and that the steam distributor manifold is arranged at the discharge end of the drum outside of the discharge end plate to supply the steam pipe elements with steam intended for evaporating of water and/or other liquid from wet materials or evaporating of materials in a liquid state as said materials pass through the drum and for removing condensate formed in the steam pipe elements.

[0011] According to the second embodiment the present invention is mainly **characterized in that** an inner tube having an inner face and an outer face is fitted inside the drum coaxially therewith so that an annular space is formed between the outer face of the inner tube and the inner face of the shell of the drum, that a plurality of partition walls is arranged in the drum extending radially from the outer face of the inner tube to the inner face of the shell of the drum and longitudinally across a substantial length of the drum such that the partition walls together with the inner face of the shell of the drum and the outer face of the inner tube define compartments therebetween, and that the steam distributor manifold is arranged to supply the steam pipe elements with steam for evaporating of water and/or other liquid from wet materials or evaporating of materials in a liquid state as the materials pass through the drum and for removing condensate formed in the steam pipe elements.

[0012] In the present invention, according to the first embodiment of the invention, the drum of the steam dryer is extended in the longitudinal direction so that the end plate of the drum is moved from the inside of the discharge end chamber to the outside of it. As a result of this the flexible hoses, the radial connector pipes and the steam distributor manifold which are attached on the discharge end plate on the outside of the drum, are not exposed to the environment of flying dusty, moist and corrosive vapour. Due to this arrangement the need for maintenance is remarkably reduced and the access to these components for inspection and maintenance of the same is easy.

[0013] Further, according to the second embodiment of the invention the drum of the steam dryer is divided into a plurality of separate compartments around the axis of rotation of the drum in order to increase the contact area between the steam pipe elements and the wet material in the drum. The wet material from which water or other liquids are to be evaporated is fed into each of said compartments in which it is turned and from which it is conveyed to the discharge end of the drum when the drum is rotating. The volumetric efficiency of the drum is thereby better than in the prior art dryers.

[0014] The drum of the dryer and the set of pipes placed inside the drum are rotated during drying, and therefore the drum is provided with a mechanism of rotation suitable for this purpose. As an example of this a mechanisms described in publication WO 98/02700 or

in patent US 6,415,527 can be mentioned. Also, other types of mechanisms of rotation can be used.

[0015] The steam pipe elements placed in the drum can be removed from the drum and replaced separately. The service life and the usability of the dryer are improved, because the tube elements can be replaced quickly and easily, which reduces the standstill time of the dryer. By means of the steam dryer in accordance with the invention, high drying efficiency is obtained, because the filling degree of the drum can be made high.

[0016] The drum of the steam dryer in accordance with the invention can also be in an inclined position so as to enhance the transfer of the material to be dried and to remove the condensate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The further advantages, characteristic features and embodiments of the invention will come out in more detail in the following detailed description of the invention, in which the invention is described with reference to the figures in the accompanying drawing.

FIG. 1 is a schematic longitudinal sectional view of a steam dryer in accordance with the invention.

FIG. 2 is a schematic cross-sectional view of a steam dryer in accordance with the invention taken along line A - A of FIG. 1.

FIG. 3 is detail B taken from FIG. 2.

FIG. 4 is detail C taken from FIG. 1.

FIG. 5 is detail D taken from FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] In FIG. 1 the steam dryer is denoted generally with the reference numeral 10. The steam dryer 10 comprises a cylindrical rotatable drum 11 having a shell 12 with an inner face 12a and an outer face 12b. Steam pipe elements 26 have been fitted in the interior of the drum 11 to rotate along with the drum 11. The drum 11 is provided with a feed end 14 structured and arranged to receive wet material or material in a liquid state into said drum 11 said feed end 14 being closed by a feed end plate 15. The drum 11 is further provided with a discharge end 16 structured and arranged to discharge vapour and dried material or concentrated liquid from said drum 11 said discharge end 16 being closed by a discharge end plate 17.

[0019] A stationary end chamber 18 is structured and arranged at the discharge end 16 area of said drum 11 in the axial direction between said discharge end plate 17 and said feed end plate 15 so that the discharge end plate 17 is outside of said discharge end chamber 18. As can be seen in Fig. 1, said stationary discharge end chamber 18 surrounds a portion of the drum 11 and it is provided with a lower opening 19 for discharging dried material or remaining liquid through said lower opening 19 from said drum 11 and said discharge end chamber 18. The end chamber 18 is further provided with an upper opening 20 to discharge vapour therethrough from said drum 11 and said discharge end chamber 18.

[0020] A steam distributor manifold 21 is structured and arranged at the discharge end 16 of said drum 11 outside of said discharge end plate 17 coaxially with said drum 11. The steam distributor manifold 21 is structured and arranged to supply the steam pipe elements 26 with steam intended for evaporating of water and/or other liquid from wet materials or evaporating of materials in a liquid state as said materials pass through the drum 11 and for removing a condensate formed in said steam pipe elements 26. So steam is fed into the steam pipe elements 26 placed in the interior of the drum 11, and similarly the steam is passed out of the drum 11, through the stationary discharge end chamber 18 arranged at the discharge end 16 of the drum 11.

[0021] On the other hand, the wet materials from which water and/or other liquids are to be evaporated or the materials in a liquid state to be evaporated, are passed into the interior of the drum 11 through the feed end 14 of the drum 11. During evaporating, the material passes in the axial direction through the drum 11 and is discharged through the stationary discharge end chamber 18 arranged at the discharge end 16 of the drum 11. The wet material from which water and/or other liquids are to be evaporated or the material in a liquid state to be evaporated is introduced into the drum 11 by conveyance means 22, e.g. a belt conveyor. A conveyor of a different type can also be used and it is recommended to choose the conveyor type according to the materials to be introduced into the drum 11. For the supply of the material into the drum 11, an opening 23 has been formed into the feed end plate 15 at the feed end 14 of the drum 11, through which opening 23 the conveyance means 22 supply the material into the interior of the drum 11. The steam enters into the steam distributor manifold 21 through a rotary joint (not shown) and further therethrough to the steam pipe elements 26 placed in the interior of the drum 11.

[0022] As already explained above the steam distributor manifold 21 has been fitted in the axial direction outside of the discharge end plate 17 and so axially outside of the discharge end 16 of the drum 11. The steam distributor manifold 21 is arranged to rotate with the drum 11. The steam distributor manifold 21 is provided with a plurality of radial connector pipes 24, whose inner ends open into the interior of the steam distributor manifold 21 and whose outer ends are closed. The radial connector pipes 24 communicate with the steam pipe elements 26 in the interior of the drum 11 through flexible hoses 25 or othet suitable means.

[0023] The steam pipe elements 26 are structured and

arranged to be inserted within the drum 11 and being rotatable with said drum 11. Each steam pipe element 26 comprises two axial pipes 27 parallel to a longitudinal direction of the drum 11 and a plurality of longitudinally spaced transverse intermediate pipes 28 which interconnect said axial pipes 27. As is shown in Fig. 1, the steam pipe elements 26 or actually the axial pipes 27 of said steam pipe elements 26 can extend across the entire axial length of the drum. However, the steam pipe elements 26 may alternatively have been formed so that only a part of them extends across the entire axial length of the drum 11 while the rest of the steam pipe elements 26 extend only partially across the axial length of said drum 11 from the steam supply end, i.e. from the discharge end 16 of the drum. As a third alternative of the steam pipe elements 26 all of them may have been formed to extend only partially across the axial length of the drum 11.

[0024] A preferred embodiment of the structure and arrangement of the steam pipe elements 26 can be seen especially in Figs. 1, 2 and 3. In this embodiment each steam pipe element 26 comprises two axial pipes 27 arranged substantially equidistant from a longitudinal centre line L of the drum 11. Said axial pipes 27 are interconnected by a plurality of longitudinally spaced transverse intermediate pipes 28 as explained above. These steam pipe elements 26 can be separately mounted into and separately removed from the interior of the drum 11. In this embodiment, as shown in Fig. 2, the steam pipe elements 26 are fitted one inside the other in a radial direction of the drum at a distance from one another so that the transverse intermediate pipes 28 of an adjacent set of steam pipe elements 26 which are also placed substantially at the same distance from the longitudinal centre line L of the drum 11, form a ring-like formation parallel to the circumference of the drum 11. This naturally depends partly on the form of the intermediate pipes 28. According to another (not shown in the drawings) embodiment of the arrangement of the steam pipe elements 26 said steam pipe elements 26 are arranged within the interior of the drum 11 such that the axial pipes 27 of each steam pipe element 26 are placed at a different distance from the longitudinal centre line L of the drum 11. In the interior of the drum 11, a plurality of support constructions 29 have been arranged, to which support constructions 29 the steam pipe element 26 have been attached by fastening means, which permit movement arising from thermal expansion of the steam pipe elements 26.

[0025] In the embodiment shown in the attached drawing the steam dryer 10 according to the invention comprises a cylindrical rotatable drum 11 having a shell 12 with an inner face 12a and an outer face 12b as explained above. Inside said drum 11 an inner tube 30 is fitted said inner tube 30 having an inner face 30a and an outer face 30b. The inner tube 30 is fitted inside said drum 11 coaxially therewith so that an annular space is formed between the outer face 30b of said inner tube 30 and the inner face 12a of the shell 12 of the drum 11. A plurality of partition walls 31 are arranged in the drum 11 such that said partition walls 31 extend radially from the outer face 30b of the inner tube 30 to the inner face 12a of the shell 12 and longitudinally across a substantial length of the drum 11 so that the partition walls 31 together with the inner face 12a of the shell 12 and the outer face 30b of the inner tube 30 define compartments therebetween. In this embodiment the steam pipe elements 26 are inserted within said compartments whereby they are rotatable with the drum 11.

[0026] According to another embodiment (not shown in the drawing) of the steam dryer 10 the drum 11 is formed without any inner tube or partition walls so that the inner face 12a of the shell 12 of the drum 11 defines an open space delimited by the feed end plate 15 and the discharge end plate 17 of the drum 11. The steam pipe elements 26 are arranged to be inserted within said space. As in the previous embodiment the steam pipe elements 26 can be separately mounted into and separately removed from the interior of the drum 11.

[0027] As can best be seen in Fig. 1 a dam plate 32 is structured and arranged in the drum 11 at the discharge end 16 area of the drum 11. Said dam plate 32 is mounted at a distance from said discharge end plate 17. The dam plate 32 has at least one opening 33 formed therein through which opening 33 dried material, remaining liquid and vapour are discharged from the drum 11 into the stationary end chamber 18. The discharge end plate 17 and the dam plate 32 have holes 17a, 32a formed therein through which holes the axial pipes 27 of the steam pipe elements 26 are led. Fig. 1 further shows that the transverse intermediate pipes 28 of the steam pipe elements 26 are arranged in the drum 11 in the area between the dam plate 32 and the feed end plate 15 but not in the area between dam plate 32 and the discharge end plate 17. In the shell 12 of the drum 11 openings 34 are formed in the area between the dam plate 32 and the discharge end plate 17. Dried material and/or remaining liquid are discharged through these shell openings 34 from the drum 11 to the discharge end chamber 18.

[0028] In the arrangement in accordance with the present invention, through-flow of steam in the steam pipe elements 26 has not been employed, but each of the steam pipe elements 26 forms a closed space for the steam. This has been arranged so that one end of the axial pipes 27 has been closed. As was already described above, the axial pipes 27 extend through the dam plate 32 and the discharge end plate 17 of the drum 11 at the discharge end area of the dryer 10, where they communicate with the radial connector pipes 24 through flexible hoses 25, for example steel hoses. At the other end, i.e. at the feed end area of the dryer the axial pipes 27 are closed. In such a case, when steam is fed into the steam distributor manifold 21, the steam is carried from said manifold 21 through the radial connector pipes 24 and through the flexible hoses 25 into the axial pipes 27 and into the transverse intermediate pipes 28 which intercon-

nect said axial pipes 27. When the steam condenses, the condensate liquid flows along the same route back into the steam distributor manifold 21, from which it is drained away by means of a siphon pipe 35 into a condensate discharge pipe. The removal of condensate can be enhanced by inclining the steam dryer 10.

[0029] Vapour and dried material or remaining liquid is/are discharged from the steam dryer 10 through the discharge end 16 of the drum 11. For this purpose, as already explained above, openings 34 are formed in the shell 12 of the drum 11 in the area between the dam plate 32 and the discharge end plate 17. Dried material and remaining liquid are discharged through these shell openings 34 from the drum 11 to the discharge end chamber 18.

[0030] When the drum 11 and the steam pipe elements 26 rotate, the wet material from which water or other liquids are to be evaporated or materials in a liquid state to be evaporated pass through the drum 11, and the dried material and/or remaining liquid is/are discharged through openings 34 formed in the shell 12 of the drum 11 into the discharge end chamber 18 and therefrom for further use and/ or further prosecution.

[0031] The mechanism of rotation of the drum 11 and the mechanism of inclination of the drum 11 are not shown in the figures in the drawing, but, as was already stated above, as the mechanism of rotation and as the mechanism of inclination, it is possible to use, for example, the same type of arrangement described in International publication WO 98/02700 or in US Patent No. 6,415,527. In such a case, by means of the angle of inclination of the drum 11 and the adjustable speed of rotation, the time the wet materials from which water or other liquids are to be evaporated or materials in a liquid state to be evaporated, stay in the steam dryer 10 can be regulated.

[0032] Above, the invention has been described by way of example with reference to the exemplifying embodiment illustrated in the figures in the accompanying drawing. The invention is, however, not confined to the exemplifying embodiment shown in the figures alone, but different embodiments of the invention may show variation within the scope of the inventive idea defined in the accompanying patent claims.

Claims

1. A steam dryer for evaporating of water and/or other liquid from wet materials or evaporating of materials in a liquid state, comprising:

a cylindrical rotatable drum (11) having a shell (12) with an inner face (12a) and an outer face (12b) and provided with a feed end (14) structured and arranged to receive wet material or material in a liquid state into the drum (11) the feed end (14) being delimited by a feed end plate (15), and a discharge end (16) structured and arranged to discharge vapour and dried material or remaining liquid from the drum (11) the discharge end (16) being equipped with a discharge end plate (17),

a plurality of steam pipe elements (26) each of which comprises two axial pipes (27) parallel to a longitudinal direction of the drum (11) and interconnected by a plurality of longitudinally spaced transverse intermediate pipes (28), the steam pipe elements (26) being structured and arranged to be inserted within the drum (11) and being rotatable therewith,

a stationary end chamber (18) structured and arranged at the discharge end area of the drum (11),

a steam distributor manifold (21) structured and arranged at the discharge end (16) of the drum (11) coaxially with said drum (11), and

conveyance means (22) disposed at the feed end (14) of the drum (11) and structured and arranged for supplying the wet materials or the materials in a liquid state into the steam dryer (10) for evaporating,

characterized in

that the stationary end chamber (18) is arranged at the discharge end area of the drum (11) in the axial direction between the discharge end plate (17) and the feed end plate (15) such that the discharge end plate (17) is situated outside of the discharge end chamber (18), said discharge end chamber (18) surrounding a portion of the drum (11) and having a lower opening (19) to discharge dried material or remaining liquid therethrough from the drum (11) and from the discharge end chamber (18) and an upper opening (20) to discharge vapour therethrough from the drum (11) and from the discharge end chamber (18), and

that the steam distributor manifold (21) is arranged at the discharge end (16) of the drum (11) outside of the discharge end plate (17) to supply the steam pipe elements (26) with steam intended for evaporating of water and/or other liquid from wet materials or evaporating of materials in a liquid state as said materials pass through the drum (11) and for removing condensate formed in the steam pipe elements (26).

2. A steam dryer for evaporating of water and/or other liquid from wet materials or evaporating of materials in a liquid state, comprising:

a cylindrical rotatable drum (11) having a shell (12) with an inner face (12a) and an outer face (12b) and provided with a feed end (14) structured and arranged to receive wet material or material in a liquid state into the drum (11) the

feed end (14) being delimited by a feed end plate (15), and a discharge end (16) structured and arranged to discharge vapour and dried material or remaining liquid from the drum (11) the discharge end (16) being equipped with a discharge end plate (17),
a plurality of steam pipe elements (26) each of which comprises two axial pipes (27) parallel to a longitudinal direction of the drum (11) and interconnected by a plurality of longitudinally spaced transverse intermediate pipes (28), the steam pipe elements (26) being structured and arranged to be inserted within the drum (11) and being rotatable with the drum (11),
a steam distributor manifold (21) structured and arranged at the discharge end (16) of the drum (11) coaxially with said drum (11), and
conveyance means (22) disposed at said feed end (14) of the drum (11) and structured and arranged for supplying the wet materials or the materials in a liquid state into the steam dryer (10) for evaporating,
characterized in
that an inner tube (30) having an inner face (30a) and an outer face (30b) is fitted inside the drum (11) coaxially therewith so that an annular space is formed between the outer face (30b) of the inner tube (30) and the inner face (12a) of the shell (12) of the drum (11),
that a plurality of partition walls (31) is arranged in the drum (11) extending radially from the outer face (30b) of the inner tube (30) to the inner face (12a) of the shell (12) of the drum (11) and longitudinally across a substantial length of the drum (11) such that the partition walls (31) together with the inner face (12a) of the shell (12) of the drum (11) and the outer face (30b) of the inner tube (30) define compartments therebetween, and
that the steam distributor manifold (21) is arranged to supply the steam pipe elements (26) with steam for evaporating of water and/or other liquid from wet materials or evaporating of materials in liquid state as the materials pass through the drum (11) and for removing condensate formed in the steam pipe elements (26).

3. The steam dryer according to claim 2, **characterized in that** a stationary end chamber (18) is arranged at the discharge end area of the drum (11) in the axial direction between the discharge end plate (17) and the feed end plate (15) such that the discharge end plate (17) is situated outside of the discharge end chamber (18), said discharge end chamber (18) surrounding a portion of the drum (11) and having a lower opening (19) to discharge dried material or remaining liquid therethrough from the drum (11) and from the discharge end chamber (18) and an upper opening (20) to discharge vapour therethrough from the drum (11) and from the stationary end chamber (18).

4. The steam dryer according to claim 1 or 3, **characterized in that** a dam plate (32) is structured and arranged in the drum (11) at the discharge end area of the drum (11) at a distance from the discharge end plate (17), the dam plate (32) having an opening (33) formed therein through which opening (33) dried material, remaining liquid and vapour are discharged from the drum (11) into the stationary end chamber (18), the discharge end plate (17) and the dam plate (32) being provided with holes (17a, 32a) through which the axial pipes (27) of the steam pipe elements (26) are led.

5. The steam dryer according to claim 4, **characterized in that** the transverse intermediate pipes (28) of the steam pipe elements (26) are arranged in the drum (11) in the area between the dam plate (32) and the feed end plate (15), whereby the area between the dam plate (32) and the discharge end plate (17) is free from the transverse intermediate pipes (28).

6. The steam dryer according to any of the preceding claims, **characterized in that** openings (34) are formed in the shell (12) of the drum (11) in the area between the dam plate (32) and the discharge end plate (17), through which shell openings (34) dried material and remaining liquid are discharged from the drum (11) to the stationary end chamber (18).

7. The steam dryer according to any of the preceding claims, **characterized in that** the steam pipe elements (26) are structured and arranged within the interior of the drum (11) such that the axial pipes (27) of each steam pipe element (26) are placed substantially equidistant from a longitudinal centre line (L) of the drum (11).

8. The steam dryer according to any of claims 1 to 6, **characterized in that** the steam pipe elements (26) are structured and arranged within the interior of the drum (11) such that said axial pipes (27) of each steam pipe element (26) are placed at a different distance from a longitudinal centre line (L) of the drum (11).

9. The steam dryer according to any of the preceding claims, **characterized in that** a plurality of radial connector pipes (24) are fitted within the steam distributor manifold (21) and connected to the axial pipes (27) of the steam pipe elements (26) through a plurality of flexible hoses (25) for supplying steam from the steam distributor manifold (21) into the steam pipe elements (26).

10. The steam dryer according to any of the preceding claims, **characterized in that** the axial pipes (27) of the steam pipe elements (26) are fully closed at their end opposite to the steam supply end.

11. The steam dryer according to claim 10, **characterized in that** a siphon pipe (35) is structured and arranged within the steam distributor manifold (21) such that condensate water drained out of the steam pipe elements (26) is withdrawn from the steam distributor manifold (21) through said siphon pipe (35).

12. The steam dryer according to any of the preceding claims, **characterized in that** the steam pipe elements (26) have been formed to extend substantially across the entire axial length of the drum (11).

13. The steam dryer according to any of claims 1 to 11, **characterized in that** a part of the steam pipe elements (26) has been formed to extend across the entire axial length of the drum (11) while the rest of the steam pipe elements (26) extend from the steam supply end partially across the axial length of the drum (11).

14. The steam dryer according to any of claims 1 to 11, **characterized in that** the steam pipe elements (26) have been formed to extend from the steam supply end partially across the entire axial length of the drum (11).

15. The steam dryer according to any of the preceding claims, **characterized in that** a plurality of support constructions (29) are structured and arranged within the interior of the drum (11) for supporting the steam pipe elements (26), to which support constructions (29) the steam pipe elements (26) are attached by fastening means permitting thermal expansion.

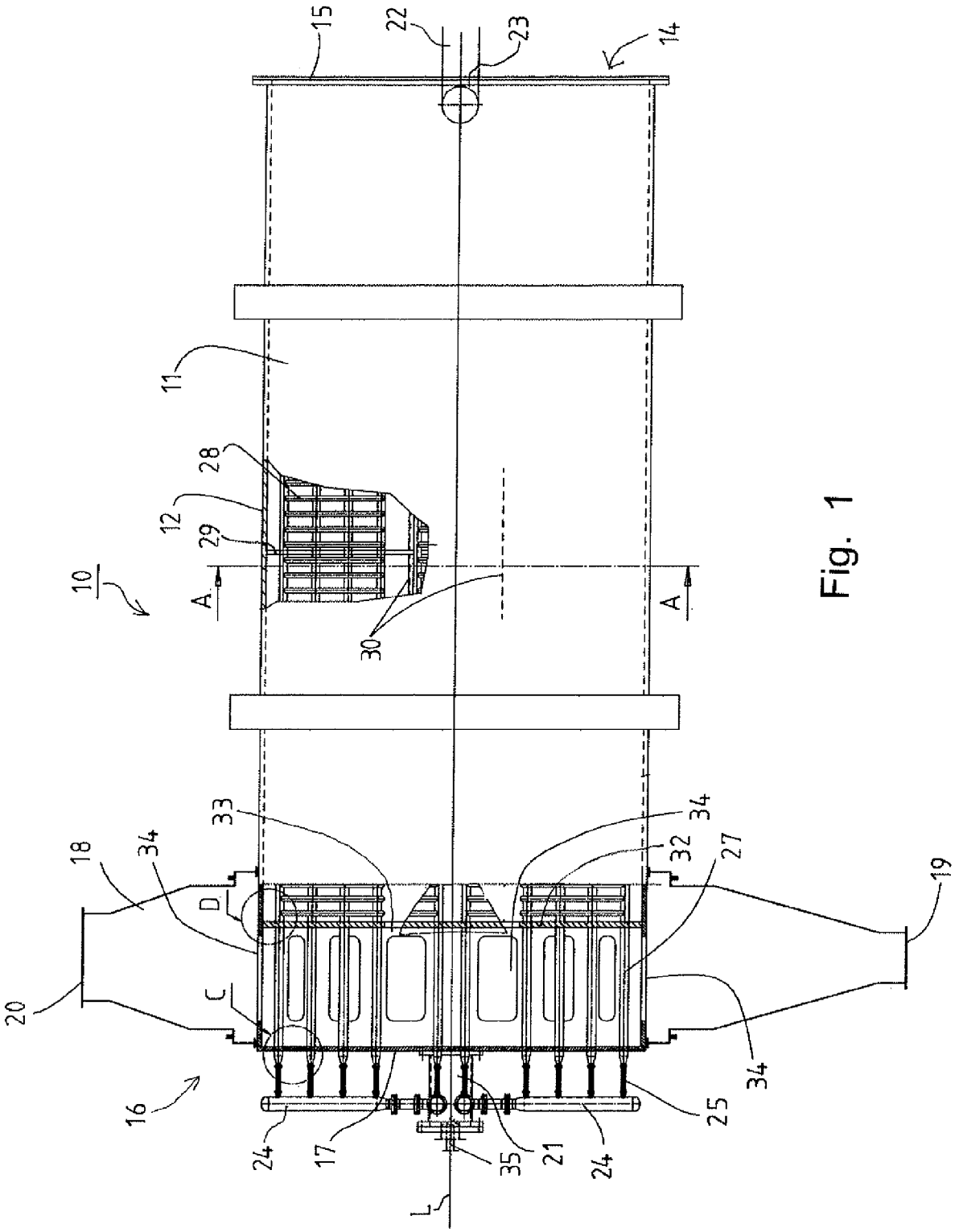

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Fig. 1

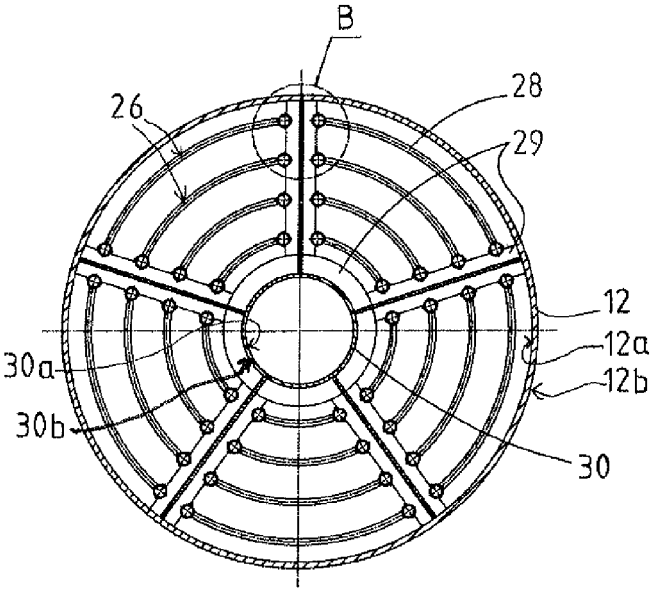


Fig. 2

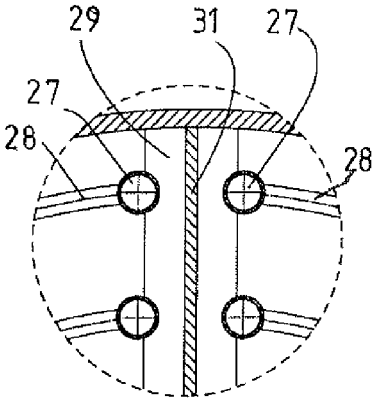


Fig. 3

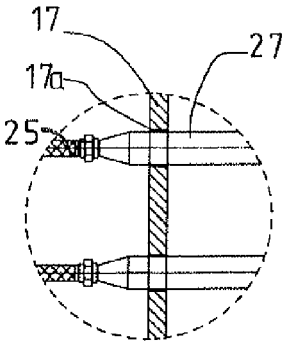


Fig. 4

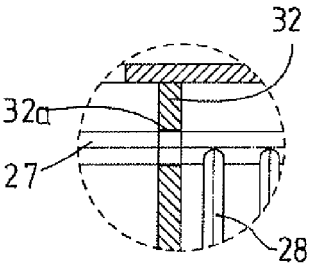


Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 09 15 9735

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	9 October 2009	Silvis, Henk

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