

(19)



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Office européen des brevets



(11)

EP 0 775 516 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
23.10.2002 Bulletin 2002/43

(51) Int Cl.7: **B01F 7/04**

(21) Application number: **96203190.2**

(22) Date of filing: **15.11.1996**

(54) **Continuous mixer, and method and device for coating particulate material using such a mixer**

Kontinuierlicher Mischer und Verfahren und Vorrichtung zum Beschichten von Materialpartikeln unter Verwendung desselben

Mélangeur continu et procédé et dispositif pour enrober des particules de matière en l'utilisant

(84) Designated Contracting States:
AT BE DE DK ES FI FR GB GR IE IT LU NL PT SE

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(30) Priority: **27.11.1995 NL 1001751**

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(43) Date of publication of application:
28.05.1997 Bulletin 1997/22

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(56) References cited:
NL-A- 7 905 716 **US-A- 5 161 888**
US-A- 5 460 448

EP 0 775 516 B1

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Description

[0001] The invention relates to a mixing device, comprising a horizontal mixing chamber having an inlet and an outlet opening, in which chamber two shafts are disposed in a horizontal plane, while blades at least forming an angle with the shafts are disposed on said shafts, and in which the shafts are rotatable in opposite directions, in such a way that where the blades move towards each other during operation, said blades make an upward movement.

[0002] Such a mixing device is known in the form of a batchwise operating mixer from NL-A-7905716, and is intended for mixing solid matter particles which differ considerably in particle size and/or density. In such a mixer, in specific conditions as regards peripheral speed, position of the blades and filling level of the mixing chamber, a circulation of the material to be mixed is obtained wherein the material thrown upwards assumes a sort of fluidized state.

[0003] A disadvantage of the known mixer is that it can operate only batchwise. When such a mixer is incorporated as part of an essentially continuously operating process plant, storage devices have to be set up both upstream and downstream of the mixer.

[0004] It has also been found that during mixing of a sticky particulate material, for example fat-sprayed animal feed, a mix with a supplementary powdered component does not produce satisfactory results, because the powder becomes concentrated on the particulate material in certain areas. Such a product is unacceptable.

[0005] US-A-5 161 888 discloses a continuous mixer having two counter-rotatable shafts with paddles and/or beaters. The paddles can be inclined in various orientations and the beaters can be oriented in left- or right-hand patterns so as to retard or enhance downstream conveyance of the material to be mixed. The apparatus according to US-A-5 161 888 comprises various zones having paddles and/or beaters of varying orientation on both shafts.

[0006] The object of the invention is to provide a mixing device for mixing two or more components, which can be operated on a continuous basis, and with which a uniform mix is obtained.

[0007] The mixing device of the type described above according to the invention is defined in claim 1.

[0008] During operation of the mixing device according to the invention, components introduced through the inlet opening, which have to be mixed with each other or coated, are conveyed in the direction of the outlet opening by the rotating movement of the main shaft. This conveyance is supported further by the blades of the secondary shaft, which are rotating in the opposite direction, which blades form an angle $180^\circ - \beta$ with the axis of the secondary shaft. The conveyance in the main direction from the inlet opening to the outlet opening is counteracted by the rotating movement of the blades of

the secondary shaft, which form an angle β with the axis of the secondary shaft. The result of these combined forces on the materials to be mixed is a net material flow in the direction of the outlet opening. The mixing itself occurs in the zone between the main shaft and the secondary shaft, in a manner which is comparable to that in the known device.

[0009] Surprisingly, it has been found that this mixer according to the invention gives very good results as regards homogeneity of the mixture obtained not only in mixing of solid matter particles, but also in mixing of solid matter particles with liquid components and in mixing of liquids. In particular, it has been found that such a mixer is suitable for mixing or coating a sticky particulate material, such as fat-sprayed animal feed in particle form, for example for dogs, cats, fish and the like, with a powdered component.

[0010] The blades of both shafts advantageously form pairs of blades which are situated opposite each other and are fixed on the shafts by means of supports situated at right angles to the shafts, which supports of successive pairs of blades on the same shaft are preferably fixed on the shaft staggered through an angle of 90° .

[0011] The distance between the main shaft and the secondary shaft, the overlap of the blades of the two shafts, the distance between the successive pairs of blades on each shaft and the dimensions of the blades can be selected depending on the materials to be mixed and the required capacity etc. It has been found that a good net conveyance is obtained at an angle α of approximately 45° .

[0012] The angle β preferably is in the range between 60° and 80° . In particular, said angle is approximately 75° for mixing sticky particles with a powdered material. The filling level of the mixing device according to the invention and the peripheral speed of the blades preferably are at the values disclosed in NL-A-7905716 during operation of the device.

[0013] In order to prevent the accumulation of mixing material in the vicinity of the inlet opening and to prevent said material from sticking to the wall, both shafts are preferably provided with an additional pair of blades, adjacent to the wall of the mixing chamber situated near the inlet opening, the blades forming an angle γ and $180^\circ - \gamma$ respectively with the axis of the shaft concerned, in this case γ preferably being approximately 15° .

[0014] The invention also relates to a method for coating sticky particulate material, for example fat-containing animal feed, with a powdered material, in which the coating is carried out using a mixing device according to the invention.

[0015] According to another aspect, the invention relates to a tower device for producing particulate material, in particular particles of animal feed, with at least a coating material, said device comprising a tower of treatment units disposed in succession in the direction of flow of the material to be treated, which units comprise a pre-cooling and filtering section, a metering and weighing

section, a coating section and a cooling section, characterized in that the coating section comprises a mixing device according to the invention.

[0016] The invention is explained below with reference to the attached drawing, in which:

Fig. 1 is a side view in section of an embodiment of a mixing device according to the invention;

Fig. 2 is a view of the mixing device according to Fig. 1, in the longitudinal direction;

Figs. 3a - 3h are diagrammatic top views and corresponding side views, in which the positions of the blades of the main shaft during rotation thereof are shown;

Figs. 4a - 4h are diagrammatic top views and corresponding side views, in which the different positions of the blades of the secondary shaft during rotation thereof are shown; and

Fig. 5 is a view, partially in section, of an embodiment of a tower device according to the invention.

[0017] Fig. 1 shows an embodiment of a mixing device according to the invention. The mixing device is indicated in its entirety by reference number 1 and comprises a mixing chamber 2, and an inlet opening 3 situated at one end of the mixing chamber 2, for introducing from the top components A and B which are to be mixed or coated with one another, and also comprises an outlet opening 4 situated at the opposite end of the mixing chamber 2, for discharging the mixed or coated material. Two parallel shafts 5 and 6 are disposed in the mixing chamber 2, of which only the secondary shaft 6 can be seen in Fig. 1. The shafts extend through the entire mixing chamber 2 and are driven at one end at the same speed by means of a drive motor 7 which is known per se, while the other end is mounted in a bearing device 8. Blades, which are discussed in greater detail below, are provided on the shafts. The shafts 5 and 6 are driven in such a way that during operation the blades make an upward movement as they move towards each other.

[0018] In Fig. 2 arrows indicate the direction of rotation of the shafts 5 and 6. It can also be seen from Fig. 2 that the bottom 9 of the mixing chamber 2 is shaped according to the peripheral movement of the blades of the shafts 5 and 6, while a certain distance is maintained between said bottom and the tips of the blades, in order to ensure that the material to be treated is not broken and the blades and the bottom are not damaged.

[0019] Figs. 3a - 3h show the positions of the blades of the main shaft 5 during rotation, Figs. 3a, 3c, 3e and 3g in top view, and Figs. 3b, 3d, 3f and 3h in side view. For the sake of clarity, only the upper blades are shown in the top views. In the embodiment of the mixing device according to the invention shown, first blades 10 are disposed opposite each other in pairs on the main shaft 5, on supports 11 situated at right angles to the shaft 5. The blades are placed in such a way that they form an angle α of 45° with the axis of the shaft 5. The following

pair of second blades 12 is fixed at the same angle α on the shaft 5, but the supports 11 are staggered relative to the supports of the first pair of blades 10 through an angle of 90° . In the side view according to Fig. 3b, the pair of blades 10 situated opposite each other consists of blade 10', 10" respectively, and the pair 12 consists of blade 12', 12" respectively. As can be seen clearly from the top view according to Fig. 3a, in which blade 10' is situated in the top of the mixing chamber 2, said blade 10' forms an angle of 45° relative to the longitudinal axis of the main shaft 5. In Figs. 3c and 3d the main shaft 5 has been rotated 90° relative to Figs. 3a and 3b, so that in this case blade 12' is at the top. In Figs. 3e and 3f the main shaft 5 has again been rotated a quarter turn further, so that blade 10" is at the top, and Figs. 3g and 3h show the situation in which blade 12" is at the top. As can be seen from a comparison of Figs. 3a - 3h, the blades at the top in the situations illustrated run in the same direction. Rotation of the shaft 5 causes material introduced into the mixing chamber 2 through the inlet opening 3 to be conveyed to the outlet opening 4. This direction of flow of the product is indicated by arrow S.

[0020] Figs. 4a - 4h show the positions of the blades of the secondary shaft 6 whenever there is a rotation through 90° . A third pair of blades 13, comprising blade 13' and 13", is disposed on said secondary shaft 6 by means of supports 11. The blades 13 in this case form an angle β of 75° with the axis of the secondary shaft 6. A fourth pair of blades 14, consisting of 14' and 14", is disposed at a distance on supports 11 which are staggered at 90° , which blades form an angle of 105° with the axis of the secondary shaft 6.

[0021] Figs. 4a, 4c, 4e and 4g show the positions of the upper blades 13' and 14', 13" and 14" respectively, in the same way as in Fig. 3. However, the forces exerted by the pairs of blades 13 and 14 respectively on the materials to be mixed are in opposite directions. While the blades 13 convey the material against the action of the blades 10 and 12 of the main shaft 5 from the outlet opening 4 back to the inlet opening 3, the blades 14 of the secondary shaft 6 work together with the blades 10 and 12 of the main shaft 5, so that a net material stream from the inlet opening to the outlet opening is produced.

[0022] The angles of the blades shown in these Figs. 3 and 4 have been found to be particularly advantageous for coating particulate animal feed, which has already been coated with a fatty substance, with a powdered material.

[0023] Figs. 3 and 4 also show pairs of blades 15 and 16 respectively, which are fixed on the main shaft 5 and the secondary shaft 6 respectively. The pair of blades 15 forms an angle γ of 15° with the main shaft, and the pair of blades 16 forms an angle of 165° with the secondary shaft. The function of these pairs of blades is to prevent the accumulation of material at the end wall of the mixing chamber 2.

[0024] Fig. 5 shows diagrammatically a tower device

according to the invention, for coating particulate material with at least one additional component.

[0025] This device of the so-called cooler-coater-cooler type comprises in the downward direction a pre-cooling and filtering unit 21, in which particulate material to be coated under heat and cooled is introduced by way of a rotating air lock 22, which prevents the entrainment of unwanted air. In this unit 21 the material is precooled by cooling air flowing in counterflow, and in this case the material also filters the cooling air and absorbs fat particles and the like coming from processing devices described below. The cooling air from the cooling unit 21 is discharged from the device by way of a valve 24. If desired, the air can also be discharged directly through bypass line 23 without flowing through device 21. Pre-cooling is desirable in particular if a low percentage of fat is being applied to the particulate material at a later stage, in order to prevent the fat from being absorbed too quickly by the material. On the other hand, the product must be maintained at a temperature higher than the solidification temperature of the fatty coating material, in order to prevent the fat from solidifying only on the external surface of the particles.

[0026] Disposed below the unit 21 is a metering and weighing device 25, such as a drop plate or weighing belt, with a stock container 26 above it. Downstream of the device 25, the material to be treated is fed to a first spray chamber 27, in which fat or oil is sprayed onto the material in metered quantities, determined on the basis of the data from the metering and weighing device 25. The fat needs some time to be incorporated in the material, and to this end the product is conveyed through a screw coating device 28 of a conventional type, which is provided with additional spray nozzles if desired. Disposed below the screw coating device 28 is a continuously operating mixing device 29 according to the invention, in which, in addition to the product from device 28, a powdered material, for example a flavouring or aromatic substance, is introduced in metered form through feed tube 30. In the mixing device the powdered material is distributed uniformly over the material, which is sticky because of the presence of the fat. It has been found that for this the angles α and β shown in Figs. 3 and 4 and a tip speed of the blades of 1.4 m/s are particularly advantageous. In a final step in cooler 31, the product treated in this way is cooled to approximately ambient temperature, so that the finished product can be packed. The cooling air flows through the bottom of the cooler 31 in the tower device and leaves the latter by way of the device 21 and the outlet of the valve 24. A mixing device according to the invention can also be used instead of the spray coating device 27.

Claims

1. Continuous mixing device (1), comprising a horizontal mixing chamber (2) having an inlet opening

(3) and an outlet opening (4), which is situated downstream of the inlet opening (3) in which mixing chamber (2) two shafts, comprising a main shaft (5) and a secondary shaft (6), are disposed in a horizontal plane, wherein blades (10, 12, 13, 14) at least forming an angle with the shafts (5, 6) are disposed on said shafts, and in which the shafts (5, 6) are rotatable in opposite directions, in such a way that where the blades (10, 12, 13, 14) move towards each other during operation, said blades make an upward movement, **characterized in that** the blades (10, 12) of the main shaft (5) are disposed at an angle α relative to the axis of the main shaft (5), in such a way that during operation said blades cause material conveyance in the direction from the inlet opening (3) to the outlet opening (4), and **in that** successive blades (13, 14) of the secondary shaft (6) are disposed at an angle β , $180^\circ - \beta$ respectively relative to the axis of the secondary shaft (6), in such a way that during operation said blades produce material conveyance in opposite directions, wherein optionally both shafts (5, 6) are provided with an additional pair of blades (15, 16), adjacent to the wall of the mixing chamber (2) situated near the inlet opening (3), the blades of the additional pair of blades (15, 16) forming an angle of approximately 15° and 165° respectively with the axis of the shafts (5, 6) such that during operation accumulation of mixing material in the vicinity of the inlet opening (3) is prevented.

2. Mixing device according to claim 1, **characterized in that** the blades (10, 12, 13, 14) form pairs of blades (10', 10"; 12', 12"; 13', 13"; 14', 14") which are situated opposite each other and are fixed on the shafts (5, 6) by means of supports (11) situated at right angles to the shafts (5, 6).
3. Mixing device according to claim 2, **characterized in that** the supports (11) of successive pairs of blades (10, 12; 13, 14) are fixed on the shaft (5, 6) concerned, staggered through an angle of 90° .
4. Mixing device according to one of claims 1 - 3, **characterized in that** the angle α is approximately 45° .
5. Mixing device according to one of the preceding claims, **characterized in that** the angle β is in the range $60-80^\circ$, and is preferably 75° .
6. Use of a mixing device according to one of the claims 1-5, for the coating of sticky particulate material, in particular fat-containing animal feed, with a powdered material.
7. Device for coating particulate material, in particular particles of animal feed, with at least a coating material, comprising a tower of treatment units dis-

posed in succession in the direction of flow of the material to be treated, which units comprise a pre-cooling and filtering section (21), a metering and weighing section (25), a coating section (27, 28, 29) and a cooling section, **characterized in that the coating section comprises a mixing device** according to claims 1 - 5.

Patentansprüche

1. Kontinuierliche Mischvorrichtung (1), umfassend eine horizontale Mischkammer (2) mit einer Einlassöffnung (3) und einer stromabwärts der Einlassöffnung (3) befindlichen Auslassöffnung (4), wobei in der Mischkammer (2) zwei Wellen in einer horizontalen Ebene angeordnet sind, welche eine Hauptwelle (5) und eine sekundäre Welle (6) umfassen, wobei Flügel (10, 12, 13, 14), die wenigstens einen Winkel mit den Wellen (5, 6) bilden, auf den Wellen angeordnet sind, und wobei die Wellen (5, 6) in entgegengesetzte Richtungen drehbar sind, und zwar so, dass wenn sich die Flügel (10, 12, 13, 14) während des Betriebes aufeinander zu bewegen, diese eine Aufwärtsbewegung vollführen, **dadurch gekennzeichnet, dass** die Flügel (10, 12) der Hauptwelle (5) in einem Winkel α relativ zur Achse der Hauptwelle (5) angeordnet sind, und zwar derart, dass die Flügel während des Betriebes einen Materialtransport in Richtung von der Einlassöffnung (3) zur Auslassöffnung (4) bewirken, und dass aufeinander folgende Flügel (13; 14) der sekundären Welle (6) in einem Winkel β bzw. $180^\circ - \beta$ relativ zur Achse der sekundären Welle (6) angeordnet sind, und zwar derart, dass die Flügel während des Betriebes einen Materialtransport in entgegengesetzte Richtungen verursachen, wobei wahlweise beide Wellen (5, 6) mit einem zusätzlichen Paar Flügel (15, 16) versehen sind, welches der Wand der Mischkammer (2), die sich nahe der Einlassöffnung (3) befindet, benachbart ist, wobei die Flügel des zusätzlichen Flügelpaars (15, 16) einen Winkel von ungefähr 15° bzw. 165° mit der Achse der Wellen (5, 6) bilden, und zwar derart, dass während des Betriebes eine Akkumulation des Mischgutes in der Nähe der Einlassöffnung (3) verhindert wird.
2. Mischvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Flügel (10, 12, 13, 14) Paare von Flügeln (10', 10"; 12', 12"; 13', 13"; 14' 14") bilden, die sich einander gegenüber befinden und auf den Wellen (5, 6) mittels im rechten Winkel zu den Wellen (5, 6) angeordneten Stützen (11) befestigt sind.
3. Mischvorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** die Stützen (11) aufeinander folgender Paare von Flügeln (10, 12; 13, 14) auf der

betreffenden Welle (5, 6) um einen Winkel von 90° versetzt befestigt sind.

4. Mischvorrichtung nach Anspruch 1 - 3, **dadurch gekennzeichnet, dass** der Winkel α etwa 45° beträgt.
5. Mischvorrichtung nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** der Winkel β im Bereich von $60-80^\circ$ liegt und vorzugsweise 75° beträgt.
6. Verwendung einer Mischvorrichtung nach einem der vorhergehenden Ansprüche 1-5 zur Beschichtung von klebrigen Materialpartikeln, insbesondere von fetthaltigem Tierfutter, mit pulverigem Material.
7. Vorrichtung zum Beschichten von Materialpartikeln, insbesondere von Partikeln von Tierfutter, mit wenigstens einem Beschichtungsmaterial, umfassend einen Turm aus Behandlungseinheiten, welche in Aufeinanderfolge in der Flussrichtung des zu behandelnden Materials angeordnet sind, wobei die Einheiten einen Vorkühl- und Filterabschnitt (21), einen Dosier- und Wägeabschnitt (25), einen Beschichtungsabschnitt (27, 28, 29) und einen Kühlabschnitt umfassen, **dadurch gekennzeichnet, dass** der Beschichtungsabschnitt eine Mischvorrichtung nach Ansprüchen 1-5 umfasst.

Revendications

1. Dispositif de mélange continu (1) comprenant une chambre de mélange horizontale (2) comportant une ouverture d'entrée (3) et une ouverture de sortie (4) située en aval de l'ouverture d'entrée (3), chambre de mélange (2) dans laquelle deux arbres comprenant un arbre principal (5) et un arbre secondaire (6) sont disposés dans un plan horizontal, des palettes (10, 12, 13, 14) formant au moins un angle avec les arbres (5, 6) étant disposées sur ces derniers, et les arbres (5, 6) étant aptes à tourner dans des sens opposés de telle façon que lorsque les palettes (10, 12, 13, 14) avancent en direction les unes des autres en cours de fonctionnement, elles effectuent un mouvement vers le haut, **caractérisé en ce que** les palettes (10, 12) de l'arbre principal (5) sont disposées suivant un angle α par rapport à l'axe de l'arbre principal (5) de telle façon qu'en cours de fonctionnement lesdites palettes provoquent un déplacement de matière dans la direction allant de l'ouverture d'entrée (3) vers l'ouverture de sortie (4), et **en ce que** des palettes successives (13; 14) de l'arbre secondaire (6) sont respectivement disposées suivant un angle β et $180^\circ - \beta$ par rapport à l'axe de l'arbre secondaire (6) de telle façon qu'en cours de fonctionnement lesdites palettes créent un déplacement de matière dans des di-

rections opposées, les deux arbres (5, 6) étant facultativement munis d'une paire supplémentaire de palettes (15, 16) à proximité de la paroi de la chambre de mélange (2), située près de l'ouverture d'entrée (3), et les palettes de la paire supplémentaire de palettes (15, 16) formant respectivement un angle d'approximativement 15° et 165° avec l'axe des arbres (5, 6) afin d'empêcher une accumulation de matière de mélange au voisinage de l'ouverture d'entrée (3) en cours de fonctionnement.

2. Dispositif de mélange selon la revendication 1, **caractérisé en ce que** les palettes (10, 12, 13, 14) forment des paires de palettes (10', 10"; 12', 12"; 13', 13"; 14', 14") qui sont situées les unes en face des autres et fixées sur les arbres (5, 6) au moyen de supports (11) positionnés à angle droit par rapport aux arbres (5, 6).
3. Dispositif de mélange selon la revendication 2, **caractérisé en ce que** les supports (11) de paires successives de palettes (10, 12; 13, 14) sont fixés sur l'arbre (5, 6) concerné en étant décalées d'un angle de 90° .
4. Dispositif de mélange selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** l'angle α est approximativement de 45° .
5. Dispositif de mélange selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'angle β se situe dans la plage de 60° à 80° , et est de préférence de 75° .
6. Utilisation d'un dispositif de mélange selon l'une quelconque des revendications 1 à 5 pour l'enrobage d'une matière particulière collante, en particulier d'un aliment pour animaux contenant des graisses, avec une matière en poudre.
7. Dispositif pour enrober une matière particulière, en particulier des particules d'aliment pour animaux, avec au moins un matière d'enrobage, comprenant une colonne d'unités de traitement disposées les unes à la suite des autres dans le sens d'écoulement de la matière à traiter, unités qui comprennent une partie de pré-réfrigération et de filtrage (21), une partie de mesure et de pesage (25), une partie d'enduction (27, 28, 29) et une partie de réfrigération, **caractérisé en ce que** la partie d'enduction comprend un dispositif de mélange selon les revendications 1 à 5.

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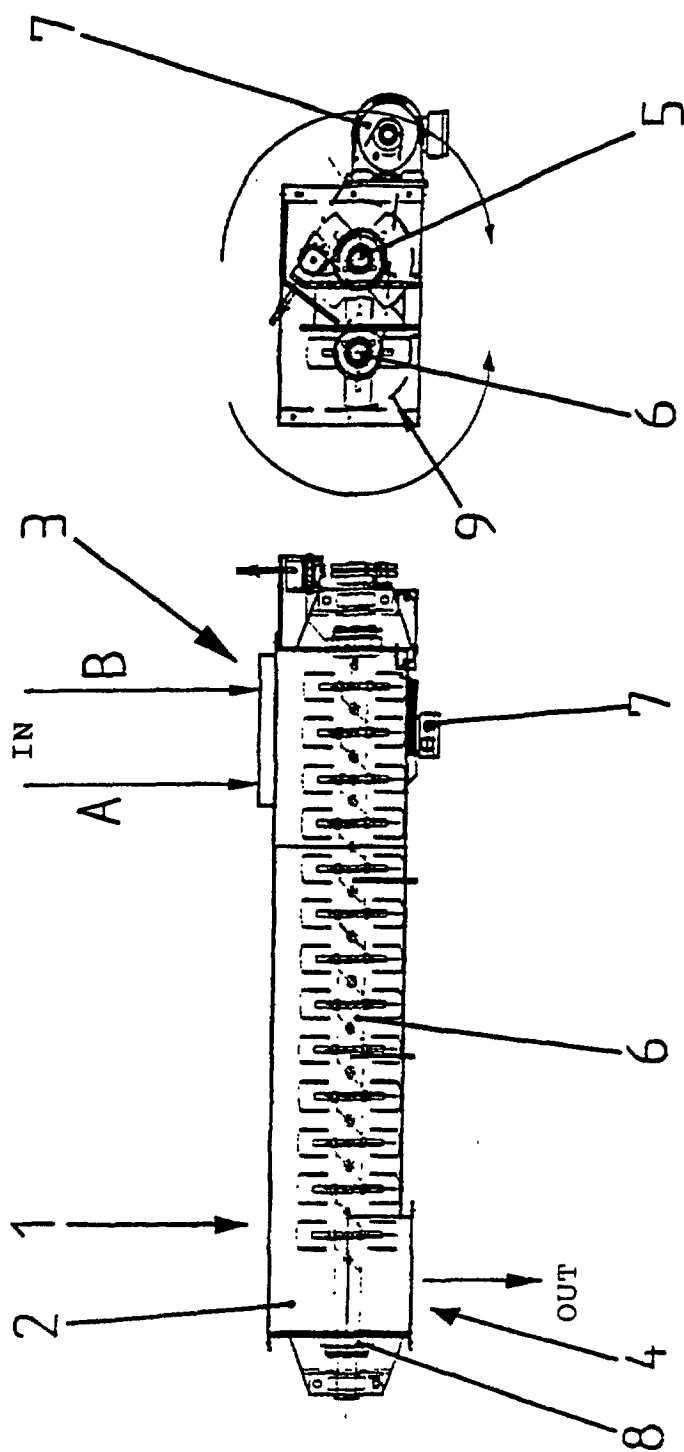


Fig. 2

Fig. 1

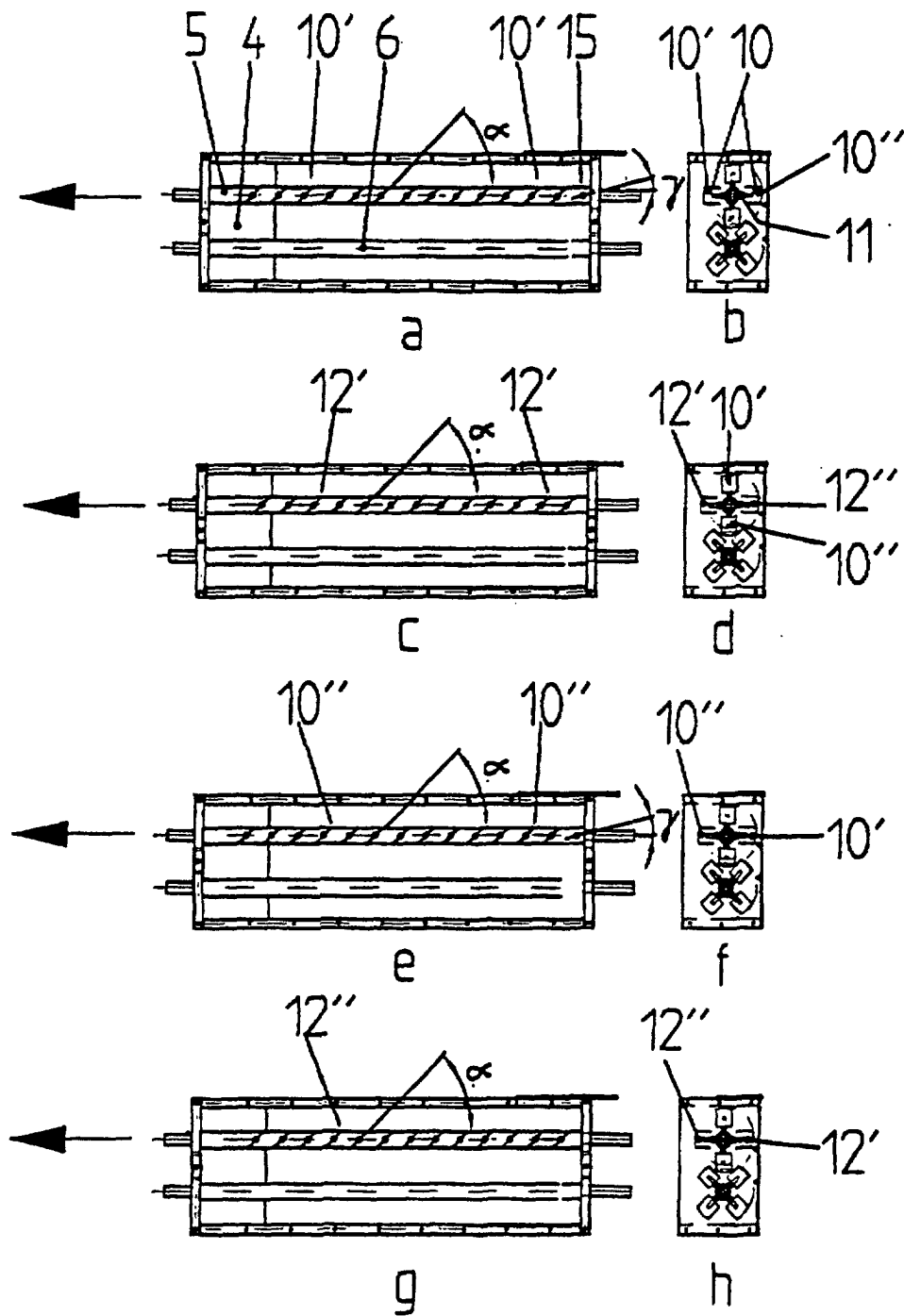


Fig. 3

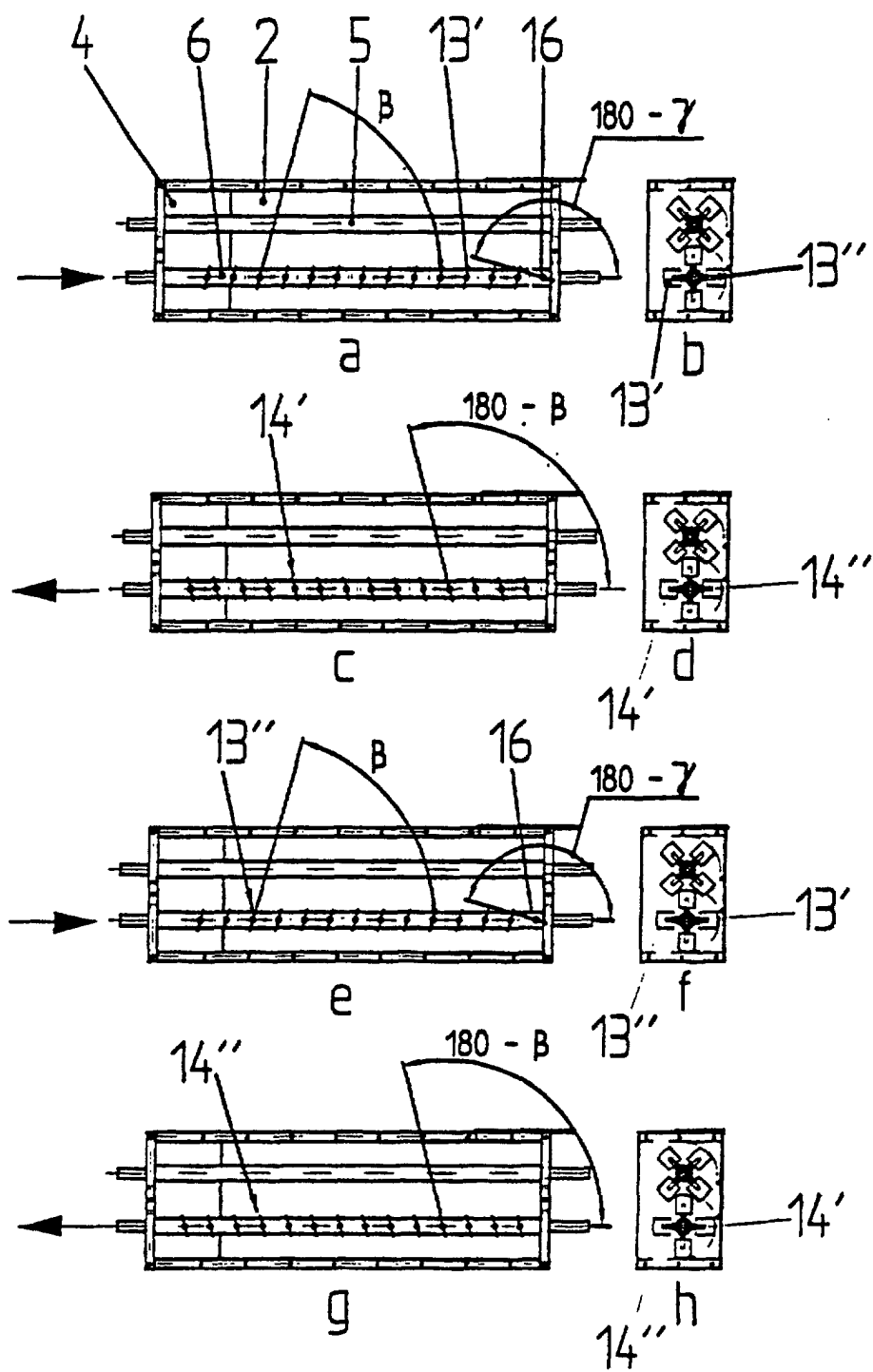


Fig. 4

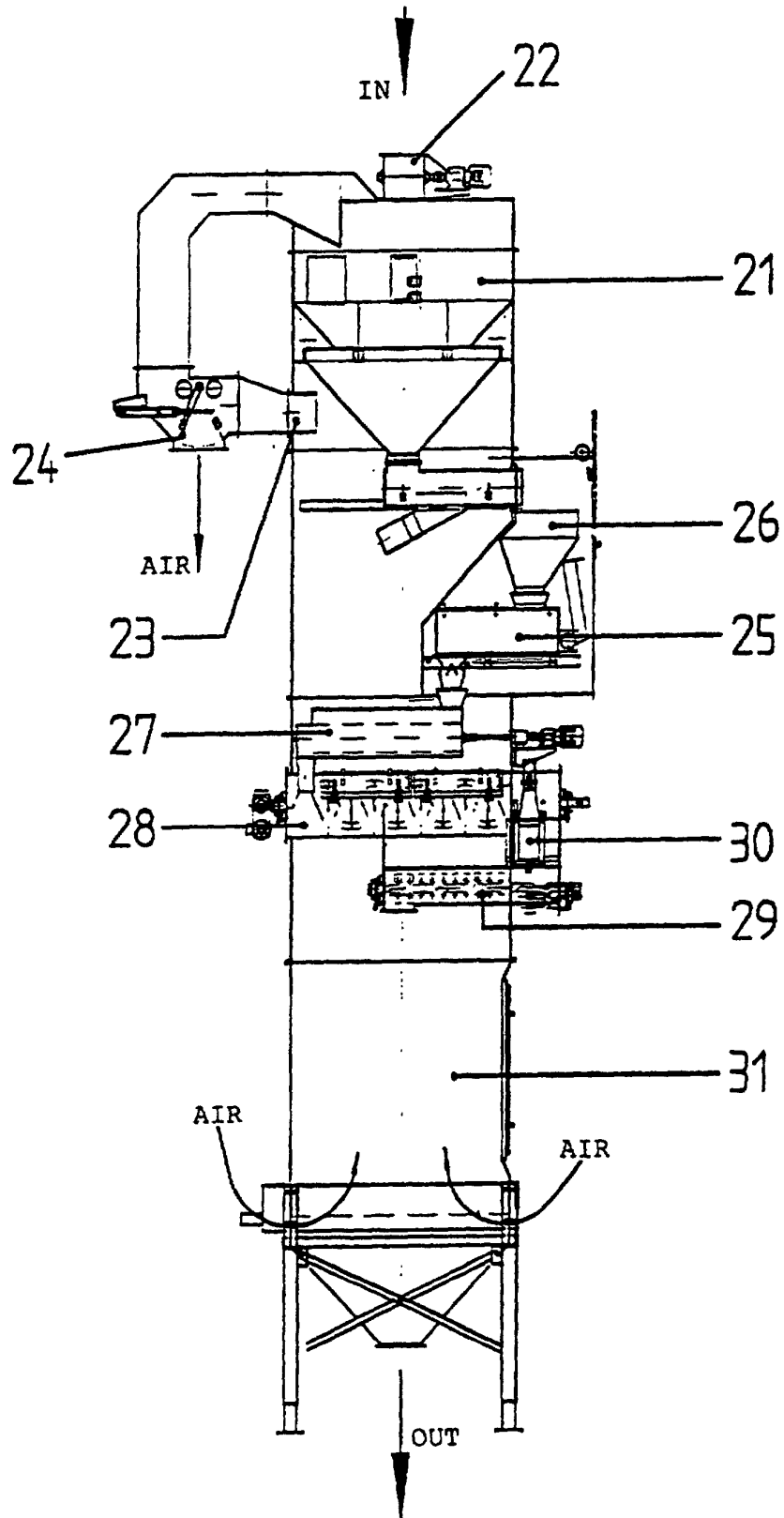


Fig. 5