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(54) **CENTRIFUGAL MACHINE FOR SEPARATING IMPURITIES FROM MASSES OF INCOHERENT MATERIALS AND RELATIVE METHOD**

ZENTRIFUGE ZUM TRENNEN VON VERUNREINIGUNGEN VON MASSEN AUS INKOHÄRENTEN MATERIALIEN UND ENTSPRECHENDES VERFAHREN

MACHINE CENTRIFUGE DESTINÉE À SÉPARER DES IMPURETÉS DE MASSES DE MATÉRIAUX INCOHÉRENTS ET PROCÉDÉ ASSOCIÉ

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(56) References cited:
**EP-A- 1 782 893**
**DE-A1- 10 309 292**
**DE-C- 690 702**
**DE-C- 892 266**
**GB-A- 684 891**
**GB-A- 2 105 223**
**US-A- 1 977 479**

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## Description

### FIELD OF THE INVENTION

**[0001]** The present invention concerns a centrifugal machine for separating impurities from masses of incoherent materials and the relative method.

**[0002]** In particular, the centrifugal machine according to the present invention is preferably but not only used to separate pollutant particles, for example sand or silica derivates, from powdered wood material to be sent to subsequent working steps.

### BACKGROUND OF THE INVENTION

**[0003]** In the state of the art it is known to use centrifugal machines to separate pollutant particles, for example sand or silica derivates, from powdered wood material arriving from previous working steps. Such machines comprise a separation chamber, substantially circular, inside which the mixture of powdered wood material and pollutant particles is introduced through an inlet pipe. The machines also comprise that a ventilation unit generates a flow of air that hits said mixture, making it rotate inside the separation chamber. In said chamber, due to the effect of the centrifugal force, the heavier particles of the mixture, such as sand or silica derivates, hit against the internal walls of the chamber and fall onto the bottom of it; the powdered wood material, which is lighter, is held in suspension by the flow of air and continues its travel along the walls of the circular chamber until it reaches an outlet pipe through which the powder, thus filtered, is expelled from the machine. This is then sent to subsequent working steps, for example toward a drier to eliminate the residual humidity of the powder.

**[0004]** One disadvantage of centrifugal machines like these is that they have a limited filtering power, caused by the fact that the filtering operation is performed on the mixture introduced substantially during a single pass in front of the outlet pipe. Therefore, a considerable quantity of pollutant particles comes out of the outlet pipe with the powdered wood material, and furthermore, powdered wood material remains inside the separation chamber. This causes a low productive efficiency of the machine and the risk of damage to the apparatuses used in the subsequent working steps of the powdered wood. For example, the unfiltered pollutant particles that are introduced inside driers can vitrify, thus compromising the efficiency of the driers themselves.

**[0005]** It is also known to use a vibration device, such as a hydrometric table, to separate pollutant particles from powdered wood material. In this machine, a vibratory movement imparted to a separation plane on which said mixture is disposed and a depression created by a suction system associated with the machine determine a separation of the pollutant particles according to their specific weight.

**[0006]** For this machine too, one disadvantage is the limited filtering power and the consequent limited productive efficiency.

**[0007]** In the documents DE-A-10309292, EP-A-1782893, DE-C-690702, GB-A-2105223, and DE-C-892266, a centrifugal machine for separating impurities from masses of incoherent materials having the features of the preamble of the main claims is disclosed.

**[0008]** Purpose of the present invention is therefore to achieve a centrifugal machine which increases the capacity of separating pollutant particles, consequently increasing its productive efficiency and drastically reducing the risk of damage to the apparatuses used in the subsequent working steps.

**[0009]** The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

### SUMMARY OF THE INVENTION

**[0010]** The present invention is set forth and characterized in the independent claims, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

**[0011]** In accordance with said purpose, a centrifugal machine according to the present invention is used to separate impurities from masses of incoherent materials, such as for example powdered wood material. The centrifugal machine comprises a container defining a separation chamber, inside which a mixture of impurities and masses of incoherent materials is able to be introduced, and a first fan, able to generate a flow of air to make said mixture rotate inside the separation chamber.

**[0012]** According to the present invention, the centrifugal machine comprises rotor means associated with the separation chamber, able to promote the rotation of the mixture inside the separation chamber, and at least a second fan able to generate a flow of air directed in the opposite direction to the fall direction of said masses of incoherent material, in order to keep said masses of incoherent material in suspension inside the separation chamber in order to subject them to subsequent and numerous discharge passes from said separation chamber and/or to subsequent separation passes inside the separation chamber.

**[0013]** In this way, together with the centrifugal separation that is determined due to the effect of the flow of air generated by the first fan, the use of the rotor means further increases the centrifugal separation capacity of the machine. Furthermore, - the rotor means promotes the recirculation of the masses of incoherent material which are not expelled from the separation chamber, thus allowing to subject them to further separation steps and passes inside the separation chamber.

**[0014]** The flow generated by the second fan also allows to keep in suspension the masses of incoherent materials remaining inside the separation chamber, which tend to fall toward the bottom of the separation

chamber so that they can be hit by the flow of air generated by the first ventilation means and be expelled from the machine or subjected to further separation steps inside the separation chamber.

**[0015]** According to an advantageous feature of the present invention, the machine comprises an outlet pipe associated with said container, the position of which along the external wall of the container is adjustable.

**[0016]** This allows to determine the position of the outlet pipe which gives the best compromise between separation capacity of the impurities and discharge of clean incoherent material.

**[0017]** According to a variant of the present invention the centrifugal machine comprises a sieve able to achieve a first separation of the impurities from the masses of incoherent material.

**[0018]** Advantageously, said sieve is disposed in correspondence with the inlet to the separation chamber.

**[0019]** According to another variant of the present invention the centrifugal machine comprises a further sieve, disposed in correspondence with the bottom of the separation chamber, able to separate the impurities from the masses of incoherent materials which fall onto the bottom of the separation chamber.

**[0020]** These features listed above therefore allow to increase the overall separation capacity of the centrifugal machine, improving its productive efficiency and drastically reducing the risk of damage to the apparatuses used in the subsequent working steps, due to the almost total lack of impurities in the masses of incoherent materials that exit from the machine.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0021]** These and other characteristics of the present invention will become apparent from the following description of a preferential form of embodiment, given as a non-restrictive example with reference to the attached drawings wherein:

- fig. 1 is a three-dimensional view of a centrifugal machine according to the present invention;
- fig. 2 is a schematic lateral view in section of fig. 1.

## DETAILED DESCRIPTION OF A PREFERENTIAL FORM OF EMBODIMENT

**[0022]** With reference to the attached drawings, a centrifugal machine 10 according to the present invention is used preferably but not only to separate pollutant particles, for example sand or silica derivates, from powdered wood material, consisting of particles with a diameter comprised between about 0.3 mm and 0.6 mm and arriving, for example, from a sifting machine, and to be sent to subsequent working steps.

**[0023]** The centrifugal machine 10 according to the present invention comprises a supporting frame 11, made by means of metal profiles 12, able to support a snail-shaped casing 13, defining a substantially circular separation chamber 14, and a hopper 15 able to feed the separation chamber 14 with powdered wood material to be filtered.

**[0024]** The mixture of powdered wood material and pollutant particles is introduced inside the separation chamber 14 through a feed pipe 16 associated, at a first end 16a, to the bottom of the hopper and, at a second end 16b, opposite said first end 16a, to the snail-shaped casing 13, substantially in correspondence with a rectilinear pipe 17 with which said snail-shaped casing 13 is provided.

**[0025]** The centrifugal machine 10 also comprises a first fan 18 associated with said rectilinear pipe 17 and disposed axially with respect to the latter. The first fan 18 is able to generate a flow of air inside the separation chamber 14 to hit the mixture of powdered wood material and pollutant particles introduced into the separation chamber 14 and make it rotate inside the latter.

**[0026]** The centrifugal machine 10 also comprises a first sieve 19 disposed inside the rectilinear pipe 17, able to distribute uniformly the air generated by the first fan 18 over the whole section of the rectilinear pipe 17, before it reaches the separation chamber 14.

**[0027]** The centrifugal machine 10 also comprises a second sieve 20, disposed at inlet to the separation chamber 14, substantially in correspondence with the feed pipe 16 and having very fine mesh so as to generate a precise air front and to effect a first separation of the pollutant particles from the powdered wood material.

**[0028]** A rotor 21 is disposed inside the separation chamber 14, in this case in correspondence with the upper part of the separation chamber 14, able to promote the circulation of the mixture inside the separation chamber 14 and thus increase the separation capacity due to the centrifugal effect.

**[0029]** The centrifugal machine 10 also comprises an outlet pipe 22 for the filtered powders, associated with the snail-shaped casing 13, whose position along the external wall of the snail-shaped casing 13 is adjustable.

**[0030]** The centrifugal machine 10 also comprises a second fan 23, disposed in correspondence with the base of the supporting frame 11, associated by means of a pipe 24 to the snail-shaped casing 13, in correspondence with the bottom of the separation chamber 14, where a net 25 with fine mesh is located, able to achieve a further separation of the pollutant particles and possible powdered wood material which does not emerge from the outlet pipe 22.

**[0031]** The second fan 23 is able to generate a flow of air inside the separation chamber 14 directed substantially upward, so as to keep in suspension inside the separation chamber 14 the powdered wood material which does not emerge from the outlet pipe 22 and which reaches the bottom of the separation chamber 14, but without interfering with the deposit of the pollutant particles on the bottom of the separation chamber 14 and their expulsion through a discharge pipe 26.

**[0032]** Both fans 18, 23 are also provided with adjustment valves, of a known type and not shown in the drawings, to adjust the pressure and flow rate of the respective air flows.

**[0033]** The centrifugal machine according to the present invention functions as follows.

**[0034]** The mixture of powdered wood material and pollutant particles is introduced inside the separation chamber 14 through the hopper 15 and the feed pipe 16.

**[0035]** The mixture introduced into the separation chamber 14 is hit by the flow of air arriving from the first fan 18 in correspondence with the second sieve 20, where a first separation is achieved of the powdered wood material from the pollutant particles, which are deposited on the bottom of the separation chamber 14 in correspondence with the discharge pipe 26. The speed of the air flow in correspondence with the second sieve 20 is such as to allow the displacement of the mixture in a horizontal direction toward the internal wall of the separation chamber 14, and is such that there is the time needed for the separation of part of the pollutant particles from the mixture. The flow of air generated by the first fan 18 then makes the mixture rotate inside the separation chamber 14. The mixture is therefore subjected to a filtering action due to the centrifugal effect, in which the pollutant particles, having a greater density than that of the powdered wood material, fall toward the bottom of the separation chamber 14, whereas the powdered wood material continues its circular motion along the internal walls of the separation chamber 14 thrust by the flow of air generated by the first fan 18. The rotation of the mixture inside the separation chamber is also promoted by the rotor 21 and this increases the filtering capacity, due to the centrifugal effect, of the machine 10. The filtered powdered wood material exits from the outlet pipe 22, whose position along the external wall of the snail-shaped casing 13 allows to achieve the best compromise between capacity to separate the impurities and discharge of clean incoherent material. Any powdered wood material that is not expelled through the outlet pipe 22 tends to fall toward the bottom of the separation chamber 14 together with the pollutant particles, in correspondence with the net 25. Here another separation is achieved of the pollutant particles and the residual powdered wood material. The latter, due to the effect of the flow of air generated by the second fan 23, is thrust upward, and held in suspension inside the separation chamber 14 where, due to the effect of the flow generated by the first fan 18, it is conveyed toward the outlet pipe 22 and/or subjected to another separation step inside the separation chamber 14.

**[0036]** The two fans 18, 23 are regulated in a dependent manner one with respect to the other by means of the adjustment valves of a known type and not shown in the drawings. The pressures and flow rates of the two fans 18, 23 are therefore varied dependently, so as to guarantee the desired speed of separation according to the quantity of mixture introduced inside the separation chamber 14, preventing unwanted overpressures or depressions from being created inside it.

**[0037]** It is clear that modifications and/or additions of parts may be made to the centrifugal machine as described heretofore, without departing from the field and scope of the present invention.

**[0038]** It is also clear that, although the present invention has been described with reference to some specific examples, a person of skill in the art shall certainly be able to achieve many other equivalent forms of centrifugal machine, having the characteristics as set forth in the claims and hence all coming within the field of protection defined thereby.

## Claims

1. Centrifugal machine for separating impurities from masses of incoherent materials, comprising a container (13) defining a substantially circular separation chamber (14) inside which a mixture of impurities and masses of incoherent materials is able to be introduced, and a first fan (18), generating a first flow of air able to hit the mass of incoherent material in said separation chamber (14) so as to displace the mixture in a horizontal direction toward an internal wall of the separation chamber (14), and then make said mixture rotate inside said separation chamber (14), the machine further comprising rotor means (21) disposed inside said separation chamber (14), able to further promote the rotation of said mixture inside the separation chamber (14), and an outlet pipe (22) provided on the external wall of said container (13) wherein at least a second fan (23) is able to generate a second flow of air directed in a direction substantially opposite the fall direction of said masses of incoherent material, so as to keep the incoherent materials that are not expelled from said outlet pipe (22) in suspension inside the separation chamber (14) in order to subject them to subsequent passes and discharge steps from said separation chamber (14) and/or separation steps inside said separation chamber (14), **characterized in that** the container (13) has a snail shape and defines the substantially circular separation chamber (14), the first fan (18) being axially associated to a rectilinear pipe (17) provided at an entrance to the container (13) opposite said internal wall, and **in that** a feed pipe (16) is provided which has a first end (16a) associated to a feed hopper (15) and a second end (16b) associated to the rectilinear pipe (17) at the entrance to the separation chamber (14) such that the incoherent material is hit by the first flow of air when being introduced into the separation chamber (14).

2. Centrifugal machine as in claim 1, **characterized in that** the position of said outlet pipe (22) is adjustable along the external wall of said container (13).

3. Centrifugal machine as in any claim hereinbefore, **characterized in that** it also comprises a sieve (20) disposed in correspondence with the inlet to said separation chamber (14).

4. Centrifugal machine as in claim 3, **characterized in that** it comprises a further sieve (25) disposed in correspondence with the bottom of the separation chamber (14), able to separate impurities from incoherent materials that fall onto the bottom of said separation chamber (14).

5. Centrifugal machine as in any claim hereinbefore, **characterized in that** the flow rate and pressure of said second fan (23) are able to be varied according to the flow rate and pressure of said first fan (18), and vice versa.

6. Method for separating impurities from masses of incoherent materials using a centrifugal machine (10) as defined in claim I, **characterized in that** it comprises at least a step in which a rotor means (21) associated with said separation chamber (14) promotes the rotation of said mixture inside the separation chamber (14), and at least a second fan (23) generates a flow of air directed in a direction substantially opposite the fall direction of said masses of incoherent material, so as to keep said masses of incoherent materials in suspension inside the separation chamber (14) in order to subject them to subsequent separation passes and steps.

**Patentansprüche**

1. Zentrifugenmaschine zum Abtrennen von Verunreinigungen aus Mengen von inkohärenten Materialien, die über einen Behälter (13), der eine im Wesentlichen kreisförmige Trennkammer (14) bildet, in der eine Mischung von Verunreinigungen und Mengen von inkohärenten Materialien einführbar ist, und über ein erstes Gebläse (18) verfügt, das einen ersten Luftstrom erzeugt, der dazu eingerichtet ist, die Menge von inkohärentem Material in der Trennkammer (14) zu beaufschlagen, um die Mischung in eine horizontalen Richtung in Richtung einer Innenwand der Trennkammer (14) zu verschieben und anschließend die Mischung in der Trennkammer (14) rotieren zu lassen, wobei die Maschine weiterhin in der Trennkammer (14) angeordnete Rotormittel (21), die die Rotation der Mischung in der Trennkammer (14) fördern, und ein Auslassrohr (22) aufweist, das an der Außenwand des Behälters (13) vorgesehen ist, wobei wenigstens ein zweites Gebläse (23) dazu eingerichtet ist, einen zweiten Luftstrom zu erzeugen, der in eine Richtung ausgerichtet ist, die im Wesentlichen der Fallrichtung der Mengen von inkohärentem Material gegenüberliegt, um die inkohärenten Materialien, die nicht aus dem Auslassrohr (22) ausgeführt sind, in der Trennkammer (14) in der Schwebe zu halten, um sie weiteren Durchläufen und Abführschritten aus der Trennkammer (14) und/oder Trennschritten in der Trennkammer (14) zu unterwerfen, **dadurch gekennzeichnet, dass** der Behälter (13) schneckenförmig ist und die im Wesentlichen kreisförmige Trennkammer (14) bildet, wobei das erste Gebläse (18) axial mit einem geraden Rohr (17) verbunden ist, das an einem Einlass zu dem Behälter (13) gegenüber der Innenwand eingerichtet ist, und dass ein Zuführrohr (16) vorgesehen ist, das über ein erstes Ende (16a), das mit einem Zuführtrichter (15) verbunden ist, und über ein zweites Ende (16b) verfügt, das mit dem geraden Rohr (17) an dem Einlass zu der Trennkammer (14) verbunden ist, so dass das inkohärente Material durch den ersten Luftstrom beaufschlagt ist, wenn es in die Trennkammer (14) eingeführt ist.

2. Zentrifugenmaschine nach Anspruch 1, **dadurch gekennzeichnet, dass** die Position des Auslassrohrs (22) entlang der Außenwand des Behälters (13) einstellbar ist.

3. Zentrifugenmaschine nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** sie weiterhin ein Sieb (20) aufweist, das in Beziehung zu dem Einlass zu der Trennkammer (14) angeordnet ist.

4. Zentrifugenmaschine nach Anspruch 3, **dadurch gekennzeichnet, dass** sie ein weiteres Sieb (25) aufweist, das in Beziehung zu der Unterseite der Trennkammer (14) angeordnet und dazu eingerichtet ist, Verunreinigungen von inkohärenten Materialien zu trennen, die auf den Boden der Trennkammer (14) fallen.

5. Zentrifugenmaschine nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** der Durchflussstrom und der Druck des zweiten Gebläses (23) entsprechend dem Durchflussstrom und dem Druck des ersten Gebläses (18) und umgekehrt variabel einstellbar sind.

6. Verfahren zum Abtrennen von Verunreinigungen aus Mengen von inkohärenten Materialien mit Verwendung einer wie in Anspruch 1 definierten Zentrifugenmaschine (10), **dadurch gekennzeichnet, dass** es wenigstens einen Schritt aufweist, bei dem ein mit der Trennkammer (14) verbundenes Rotormittel (21) die Rotation der Mischung in der Trennkammer (14) fördert und wenigstens ein zweites Gebläse (23) einen Luftstrom erzeugt, der in eine Richtung ausgerichtet ist, die im Wesentlichen der Fallrichtung der Mengen von inkohärentem Material gegenüberliegt, um die Mengen von inkohärenten Ma-

terialien in der Trennkammer (14) in der Schwebe zu halten, um sie weiteren Trenndurchläufen und Schritten zu unterwerfen.

## Revendications

1. Machine centrifuge destinée à séparer des impuretés de masses de matériaux incohérents, comprenant un récipient (13) définissant une chambre de séparation (14) sensiblement circulaire à l'intérieur de laquelle un mélange d'impuretés et de masses de matériaux incohérents peut être introduit, et un premier ventilateur (18), générant un premier flux d'air capable de frapper la masse du matériau incohérent dans ladite chambre de séparation (14) de manière à déplacer le mélange dans une direction horizontale vers une paroi interne de la chambre de séparation (14), et ensuite faire tourner ledit mélange à l'intérieur de ladite chambre de séparation (14), la machine comprenant en outre des moyens de rotor (21) disposés à l'intérieur de ladite chambre de séparation (14), capables de développer davantage la rotation dudit mélange à l'intérieur de la chambre de séparation (14), et une conduite de sortie (22) prévue sur la paroi externe dudit récipient (13) dans laquelle au moins un deuxième ventilateur (23) est capable de générer un second flux d'air dirigé dans une direction sensiblement opposée à la direction de chute desdites masses de matériau incohérent, de manière à conserver les matériaux incohérents qui ne sont pas expulsés de ladite conduite de sortie (22) en suspension dans la chambre de séparation (14) afin de les soumettre à des passages suivants et à des étapes d'évacuation de ladite chambre de séparation (14) et / ou à des étapes de séparation à l'intérieur de ladite chambre de séparation (14), **caractérisée en ce que** le récipient (13) présente une forme d'escargot et définit la chambre de séparation (14) sensiblement circulaire, le premier ventilateur (18) étant axialement associé à une conduite rectiligne (17) prévue au niveau d'une entrée dans récipient (13) opposée à ladite paroi interne, et **en ce qu'**une conduite d'alimentation (16) est prévue, laquelle présente une première extrémité (16a) associée à une trémie d'alimentation (15) et une seconde extrémité (16b) associée à la conduite rectiligne (17) au niveau de l'entrée de la chambre de séparation (14) de telle sorte que le matériau incohérent est frappé par le premier flux d'air lors de son introduction dans la chambre de séparation (14).

2. Machine centrifuge selon la revendication 1, **caractérisée en ce que** la position de ladite conduite de sortie (22) est réglable le long de la paroi externe dudit récipient (13).

3. Machine centrifuge selon l'une quelconque des revendications précédentes, **caractérisée en ce qu'**elle comprend en outre un tamis (20) disposé en correspondance avec l'orifice d'entrée de ladite chambre de séparation (14).

4. Machine centrifuge selon la revendication 3, **caractérisée en ce qu'**elle comprend un autre tamis (25) disposé en correspondance avec le fond de la chambre de séparation (14), capable de séparer les impuretés des matériaux incohérents qui tombent sur le fond de ladite chambre de séparation (14).

5. Machine centrifuge selon l'une quelconque des revendications précédentes, **caractérisée en ce que** le débit et la pression dudit second ventilateur (23) peuvent être modifiés en fonction du débit et de la pression dudit premier ventilateur (18), et vice versa.

6. Procédé destiné à séparer des impuretés de masses de matériaux incohérents en utilisant une machine centrifuge (10) telle que définie dans la revendication 1, **caractérisé en ce qu'**il comprend au moins une étape dans laquelle des moyens de rotor (21) associés à ladite chambre de séparation (14) développent la rotation dudit mélange à l'intérieur de la chambre de séparation (14), et au moins un deuxième ventilateur (23) génère un flux d'air dirigé dans une direction sensiblement opposée à la direction de chute desdites masses de matériau incohérent, de manière à maintenir lesdites masses de matériaux incohérents en suspension à l'intérieur de la chambre de séparation (14) afin de les soumettre à des passages et à des étapes de séparation ultérieurs.

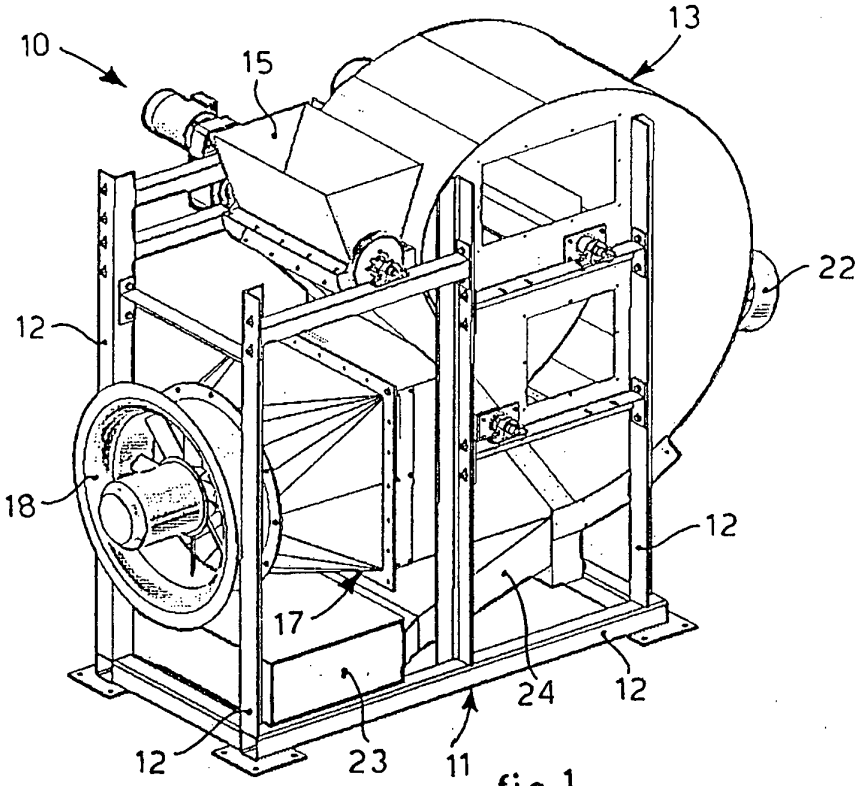

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fig. 1

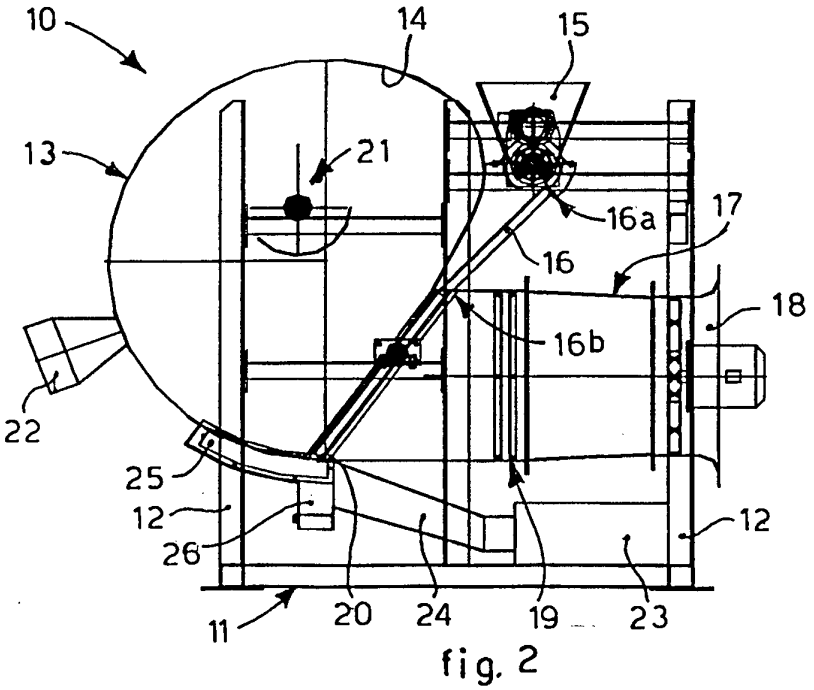

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fig. 2

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- DE 10309292 A **[0007]**
- EP 1782893 A **[0007]**
- DE 690702 C **[0007]**
- GB 2105223 A **[0007]**
- DE 892266 C **[0007]**