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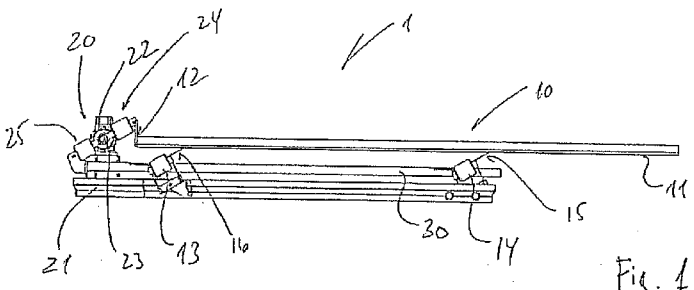

Fig. 1

(57) Abstract: Industrial sieve (1) for separation of materials in powdered, granular or other particulate form, where said industrial sieve (1) comprises a sieve (lO)arranged in a frame (11) which frame (11) comprises a side member (11', 11") on each opposing side of the sieve (10), where said side members (11', 11") are connected to a reciprocating reference mass (30) by resilient suspension means (13, 14), and where linear reciprocating means (20) for reciprocating said sieve (10) relative to the reference mass (30) is/are arranged such that the reciprocating force stemming from the reciprocating means (20) is transferred linearly and equally to each side member (11', 11").

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Industrial sieve for separation of materials

Field of the Invention

The present invention concerns an industrial sieve for separation of materials in powdered, granular or other particulate form.

Background of the Invention

In the art it is well-known to use sieves for separating different fractions of either the same or different materials. By arranging the material which is to be separated on a mesh or a plate with apertures and vibrating the mesh plate or plate with apertures up and down, back and forth or a combination, material having a particle size less than the mesh opening or the aperture opening, will fall through the sieve and thereby be separated from the material as such.

In the art there are a number of devices which may perform this separation.

Description of the Invention

The present invention is special in that it provides an industrial sieve for separation of materials in powdered, granular or other particulate form, where said industrial sieve comprises a sieve arranged in a frame which frame comprises a side member on each opposing side of the sieve, where said side members are connected via linear reciprocating means to a reciprocating reference mass, for reciprocating said sieve relative to the reference mass such that the reciprocating force stemming from the reciprocating means is transferred linearly and equally to each side member where the linear reciprocating means is mounted on a separate foundation, and where resilient suspension means are provided between the side members and the foundation and further that the reciprocating means is a linearly reciprocating drive unit, where said unit comprises a motor having a rotatable output shaft which output shaft is connected eccentrically to two radially extending load members, which load members each by means of a spring is connected to a reciprocating mass, where said reciprocating masses are slidingly arranged on a common linear axle, separated by a resonant spring, and where the side

members of the sieve is connected to one of the reciprocating masses, and the reciprocating reference mass is connected to the other reciprocating mass, and the motor and the sliding axle are mounted on a foundation.

By providing controlled and directional reciprocating movement to the sieve and especially by making sure that each side of the sieve is moved in unison a truly linear movement of the openings in the sieve is achieved. The movement of the sieve is both vertical and horizontal, and as such a particle on the sieve will be thrown upwards and forward during the separation process. In this manner it is possible to load the sieve in one end and collect the fractions or the remaining material on the sieve in the opposite end to the loading end. By furthermore making sure that the horizontal movement is larger than the vertical movement as disclosed in a further advantageous embodiment of the invention the continuous movement of material along the sieve's surface is ensured.

Furthermore, as the movement is provided as a linear movement, the particles will only be activated in one direction creating a homogenous flow along the sieve's surface thereby avoiding conglomeration of material in areas of the sieve's surface where prior art devices may have interference movements causing dead zones or especially active zones where no material at all is present.

The linear movement of the sieve back and forth will provide for a more effective separation due to the way the apertures or mesh openings appear to the particles. When the mesh is being moved back and forth and to the sides the area covered by the wires making up the mesh will effectively make the opening appear smaller whereas when the mesh is moved in one direction only the wires being arranged at an angle to this direction will move relative to the particles whereby the effective opening of the mesh appears to be larger thereby creating more effective separation on the sieve. Naturally, the sieve opening will determine which particles will be able to fall through the sieve, but it may take longer and thereby increase the process time before the particles of the determined size pass through the sieve than what is the case with the present invention.

This type of reciprocating drive unit has earlier been used in linear transport mechanisms, but due to the special movement of the reciprocating drive unit special advantages as described above and as will be evident below are achieved by implementing this device in an industrial sieve unit.

In a further advantageous embodiment of the invention the resilient suspension means are leaf springs which are flexible in one direction and firm in the perpendicular direction. Therefore, by arranging the leaf springs such that they will flex in the linear direction of the reciprocating means the flexibility in that direction is ensured whereas the movement in a perpendicular direction, i.e. direction across the sieve is avoided whereby the advantages already mentioned above is safeguarded.

The resilient suspension means in the shape of leaf springs may either be separate leaf springs arranged one in each side connecting the side members to the foundation or may be one single leaf spring arranged such that it connects with both side members and the foundation.

In this connection it should also be understood that the side members may be integral with the sieve such that for example a large number of apertures may be provided in a bottom section of a closed pipe where the rest of the wall of the pipe not being provided with apertures has the function of the side members, i.e. to convey the linear oscillating movement from the vibration generating unit to the sieve. Naturally, also half open pipes, i.e. pipes having a bottom and side surfaces whether they are circular or U-shaped, may also be interpreted within the scope of the present invention as being a sieve integrating the side members.

In a further advantageous embodiment of the invention the reciprocating means comprises two units, one unit coupled to each side member of the sieve, and where a controlling unit is provided, which controlling unit synchronises the two units to provide identical action to the respective side members.

By having two units working synchronously a relatively large force may be imparted to the side members and thereby to the sieve. In this connection it is important to control the units such that the two units are synchronized and thereby provide identical action to the respective side members.

In a still further advantageous embodiment of the invention the reciprocating means is a single unit, which unit is mechanically coupled to each side member, such that corresponding reciprocating action is transferred to each side member. Naturally, it is easier to control a single unit and for example by axle means transfer the reciprocating force to the side members of the sieves whereby a uniform reciprocating action is created in the side members due to the action of the single reciprocating unit. The axle, however, has to be relatively stiff in order to ensure that a transfer of power from the single unit is substantially identical to the two side members which impart the movement to the sieve. Also for sieves designed for large quantities and loads, a two unit solution as described above may be advantageous.

In a still further advantageous embodiment of the invention the sieve comprises a section with a plate bottom and a section downstream from the plate bottom comprising apertures or one or more mesh sections. The plate bottom shall in this connection be understood as a closed bottom, for example just a plate member/surface without apertures or mesh where any product placed on this will not be able to fall through the bottom but will be transferred to the mesh section or the bottom section comprising apertures whereby separation, i.e. sieve action will again be possible.

These sections having a plate bottom may be utilized in order to provide special work procedures, for example if the objects to be separated on the sieve are vegetables the plate bottom section will allow washing of the vegetables where it is possible to retain the water around the vegetables for a certain period of time before the water is drained off during the mesh/aperture sections of the bottom.

In this manner the sieve provides a number of advantages in addition to the effective separation as already discussed above.

In a still further advantageous embodiment of the invention the industrial sieve comprises two sieves; a first sieve arranged above a second sieve, where said first sieve is arranged connected to said side members, and where said second sieve is part of or constitutes said reference mass and where said second sieve is further connected to and agitated by said reference mass, and where optionally a collection tray or conveyor is arranged below said second sieve.

As the unit which generates the reciprocating action is connected between the sieve and a reciprocating reference mass and mounted on a foundation, the replacement of the reciprocating reference mass by a further sieve either completely or partly creates extra sieve action/capability with the same energy consumption.

Naturally, if the second sieve is not heavy enough or if the second sieve is lighter than the first sieve, additional weight compensation may be added or subtracted from one of the other sieves in order to achieve a weight balance creating the optimal reciprocating action between the two "masses" comprised by the sieves.

For this embodiment as for all the embodiments within the invention a bottom tray or conveyor may be provided below the sieve or sieves in order to collect any material which passes through the sieves and/or transport it away from the industrial sieve installation for further processing or to be discarded, reworked, or any other purpose.

In a further advantageous

In a still further advantageous embodiment the sieve or sieves are arranged substantially horizontally. Due to the linear movement generated by the reciprocating drive unit any material placed on the sieve's surface will be pushed forward and upwards and therefore when the sieve moves in one direction the particles on the sieve's surface will be thrown into the air in a forward direction and while the particles are in the air the sieve will reciprocate and move back whereby the particles will land further down the sieve's surface relative to where they started. Therefore, it is not necessary to provide the sieve's surface with a slant which is otherwise common practice in the industry.

In a further embodiment of the invention the angle of the sieve's surface is variable. By being able to change the slant of the surface on which the material is transported it is possible to increase or decrease the time the material spends on the sieve and thereby the sieving action, i.e. allowing more time to achieve a full separation of materials or for other materials separating easily, achieve a faster process time, and thereby increased production. These features are dependent on the type of material which is to be separated on the sieve. For example when treating ground spices which may be in powder form, a relatively long separation time is necessary whereby it may be advantageous to be able to slant the surface of the sieve thereby reducing the forward movement of the particle on the sieve's surface. For other applications such as for example the one already mentioned above where vegetables are being separated the relatively coarse appearance of the vegetables usually renders them easy to separate and as such a relatively higher separation speed and thereby travelling speed of the objects along the sieve may be used in order to achieve the effective separation.

The means for changing the angle of the sieve's surface may be any suitable means such as for example telescopic cylinders which may be controlled independently for each sieve or there may be fixed mechanical installations such that the sieve is arranged in a given angle and fixated in this angle whereafter the sieving process is carried out. Other manners in which to alter the angle of the sieves may also be contemplated without departing from the inventive scope.

In a still further advantageous embodiment of the invention the linear reciprocating means for reciprocating said sieve(s) relative to the reference mass or further sieve is/are arranged such that the reciprocating force stemming from the reciprocating means is transferred having a horizontal force component and a vertical force component, where the horizontal force component is larger than the vertical force component.

The advantages of being able to control the horizontal and vertical components respectively have already been discussed above, and it is clear that by being able to control these the movement of the particles on the sieve may be controlled and thereby the

separation speed and the overall production speed may be adjusted in order to achieve the highest possible acceptable separation speed.

Description of the Drawing

The invention will now be explained with reference to the accompanying drawing wherein

figure 1	illustrates an industrial sieve for separation of materials,
figure 2	illustrates the sieve in figure 1 is seen from behind
figure 3	illustrates a further embodiment of the sieve
figure 4	illustrates an embodiment of the invention with sieves being enclosed in a housing
figure 5	illustrates a drive unit
figure 6	illustrates a cross-section through an embodiment of the invention
figure 7a and b	illustrate constructions where the sieve is an integrated section of a tubular member 34
figure 8	illustrates a further embodiment where the sieve structure comprises a first sieve and a second sieve
figure 9	illustrates a further embodiment of the invention where two sieves are arranged superposed each other

Detailed Description of the Invention

In the figures two specific embodiments of the invention are illustrated, but it should be noted that other embodiments may be conceived within the scope of the appended claims.

In figure 1 is illustrated an industrial sieve for separation of materials. The materials may be any type of material and may be provided on the sieve in any shape such as powder, granular or other particulate form. The sieve's surface will naturally be designed to handle that particular type of material which it is desired to separate, such that for example for powder the mesh size on the sieve will be very small whereas for more granular particulate matter the sieve sizes will be larger, i.e. the mesh size will be larger.

The industrial sieve 1 comprises a sieve 10 arranged in a frame 11 which frame 11 comprises a frame member 11', 11'', see figure 3 on each opposing side of the sieve 10. The side members 11', 11'' are in turn connected, in this embodiment by a bar 12 via linear reciprocating means 20 to a reciprocating reference mass 30. The linear reciprocating means 20 transfers the reciprocating actions linearly and equally to each side member due to the linear reciprocating means' 20 connection to the bar 12 which in turn is connected to the side members 11', 11''.

The linear reciprocating means 20 is mounted on a separate foundation 21 onto which resilient suspension means 13, 14 also are mounted. The resilient suspension means 13, 14 are arranged between the side members 11', 11'' and the foundation 21.

The linear reciprocating means 20 is in an embodiment illustrated with reference to figure 1, 2 and 3 a linear reciprocating drive unit, said unit comprising a motor 22, said motor having an output shaft 23 which is eccentrically connected to two radially extending load members 24, 25. A schematic illustration of the linear reciprocating drive unit is illustrated with reference to figure 5. The load members 24, 25 are slidingly arranged on a common linear axle 26 separated by a resonance spring 27. The load members 24, 25 are also connected to the output shaft by axles incorporating springs 28, 28'.

Returning to figure 1 the sieve 10 will when the motor is activated be exposed to reciprocating action due to the coupling of the side members 11 via the bar 12 to the mass 24 and move back and forth very quickly. The resilient means 13, 14 which typically will incorporate leaf springs 15, 16 will ensure that the movement of the sieve is linear, i.e. back and forth without a sideways component. Therefore, any material placed on the sieve will be exposed to a reciprocating force created by the drive unit 20.

Looking in detail to the actual movement of the sieve 10 the leaf springs will when the sieve 10 is moved to the right in figure 1 bend whereby the sieve 10 will be slightly lowered. During this movement any particles on the sieve will be accelerated towards the right and become airborne due to the movement of the sieve. At the same time, while the particles are airborne the reciprocating means will cause the sieve 10 to move

in the opposite direction, i.e. towards the left, and thereby relative to the airborne particle which is moving forward the sieve will be moved towards the left whereby the particle will land further to the right on the sieve relative to the position of the particle before the movement of the sieve.

Turning to figure 2 the sieve in figure 1 is seen from behind such that it is clear that resilient suspension means 13', 13'' (and not visible 14', 14'') are arranged on either side of the sieve 1 thereby connecting the side members 11', 11'' to the foundation 21. This is in order to ensure that a true linear movement of the sieve is achieved without any movement twisting the sieve thereby creating vibrations perpendicular to the longitudinal direction of the sieve.

In figure 3 is illustrated a special embodiment of the sieve 10 where the surface of the sieve in a first section 10' is solid, i.e. without apertures, mesh openings and the like and further downstream is provided with a mesh or apertures in the section 10''.

This configuration combines two advantageous features, namely that in the solid section 10' it is possible to carry out other procedures than separation of the materials placed on the sieve. For example for vegetables, fruits etc. it is possible to sort, wash, wax or otherwise treat the materials/objects before they arrive at the sieve section 10'', where the materials/objects may be graded and/or debris sorted away either manually or through the sieve.. Where for example it is desirable to wash vegetables in the section 10', the water will not drain away until it reaches the section 10'' provided with mesh or apertures.

Turning to figure 4 an embodiment of the invention is illustrated being enclosed in a housing 50 where the reference mass 30 instead of being a reference mass is a second sieve 31 arranged beneath the first sieve 10. The first sieve 10 is illustrated by the dots (fastening points of the sieve to the inner side of the housing) , whereas the second sieve 31 is only illustrated by the housing's shape.

However, turning to figure 1 it is clear that if the counter mass 30 was replaced by a second sieve 31, material passing through the upper sieve 10 would arrive on the lower

sieve 31. Any material being smaller than the mesh size on the second sieve 31 (31 in figure 4) would fall through that sieve 31 and arrive on the foundation 21. However, in practice as illustrated in figure 4 the material passing the second sieve 31 will be collected by a tray or a conveyor and transported to further processing.

The sieve structure illustrated in figure 4 is provided with an inlet 60 and as two sieves 10, 31 are provided, two outlets 61, 62 are provided, one for each end of each sieve. In this manner it is possible to introduce material through the inlet 60 and have it separated into three fractions i.e. a fraction on the upper sieve 10 which will be collected at the outlet 61, a second fraction passing through the first sieve and arriving on the second sieve 31 and collected through the outlet 62 and a third fraction arriving in the bottom tray 32 which may either be collected after the sieving process is finished by removing the bottom tray 32 or where the bottom tray is provided with a conveyor, may continuously be conveyed away for further processing.

In figure 6 is illustrated a cross-section through an embodiment of the invention corresponding to the view described with reference to figure 2. The same reference numbers which were used with reference to figures 1, 2 and 3 are applied to the embodiment illustrated in figure 6. The sieve 10 is arranged between two side members 11', 11'' and resilient suspension means in the shape of a single rather large leaf spring 13, 14 is arranged connecting the side members of the sieve to the foundation 21. With this construction it may be achieved that substantially identical spring characteristics are provided for both side members and therefore for the entire sieve construction without having to adjust the leaf springs. Furthermore, it is avoided that one leaf spring may be slightly out of plane thereby creating a twisting movement in the sieve which would otherwise be the case where leaf springs are arranged separately in each side of the sieve.

It is also to be noted that in embodiments where a single sieve is arranged the counter mass 30, may be arranged as two separate masses superposed (under) the sieve, in order to allow material passing the sieve, not to come into contact with the countermass.

Turning to figures 7a and 7b constructions are illustrated where the sieve 10' is an integrated section of as illustrated with reference to figure 7a a tubular member 34. In this embodiment the tubular member 34 at least over a section is provided with apertures 35 in a bottom section of the tubular member 34. In the longitudinal direction there will be a section in the beginning of the tube without apertures 35 in order to transfer the reciprocating movement equally to the entire tubular member 34. In this embodiment the side members are an integrated part of the construction.

In figure 7b the same reasoning applies in that a bottom section of the sieve 10' is provided with apertures 35 and the upstanding sides forming the U-shape of the cross-section constitutes the side members 11', 11''.

In figure 8 is illustrated a further embodiment where the sieve structure comprises a first sieve 10 and a second sieve 31 arranged as already discussed with reference to figure 4. However, in this embodiment each sieve 10, 31 is provided with an actuator 41, 42 in one end of the sieves 10, 31 and mounted on a hinge-like structure 43, 44 in the opposite end such that by activating one or both of the actuators 41, 42 the angles relative to a horizontal plane of the sieves 10, 31 may be positioned at any desired angle, naturally depending on the abilities of the actuators 41, 42. For reasons of clarity all features not having to do with the principle of being able to vary the angle of the sieves 10, 31 are not illustrated.

In figure 9 is illustrated a further embodiment of the invention where two sieves 10, 31 are arranged superposed each other where each sieve is provided with an outlet 61, 62. Furthermore, at endless conveyor 51 is arranged below the two sieves 10, 31 such that any material which falls through the second sieve 31 is collected on the conveyor 51 and may be transported to a collection bin or the like.

Although not illustrated it is also foreseen that the sieve(s) and/or counter mass can be suspended from a frame structure or ceiling. Such an arrangement allows for great flexibility with respect to the manner in which the materials are handled after having passed the sieves. Also vibrations stemming from the sieves may easier be isolated away from the rest of the structures or immediate vicinity of the installation.

The invention has now been explained with reference to the accompanying drawings wherein particular embodiments of the invention have been described, but variations of the embodiments may be contemplated without departing from the scope of the appended claims.

CLAIMS

1. Industrial sieve for separation of materials which materials are provided in powdered, granular or other particulate form, where said industrial sieve comprises a sieve arranged in a frame which frame comprises a side member on each opposing side of the sieve, where said side members are connected via linear reciprocating means to a reciprocating reference mass, for reciprocating said sieve relative to the reference mass such that the reciprocating force stemming from the reciprocating means is transferred linearly and equally to each side member where the linear reciprocating means is mounted on a separate foundation, and where resilient suspension means are provided between the side members and the foundation, and further that the reciprocating means is a linear reciprocating drive unit, where said unit comprises a motor having a rotatable output shaft which output shaft is connected eccentrically to two radially extending load members, which load members each by means of a spring is connected to a reciprocating mass, where said reciprocating masses are slidingly arranged on a common linear axle, separated by a resonant spring, and where the side members of the sieve is connected to one of the reciprocating masses, and the reciprocating reference mass is connected to the other reciprocating mass, and the motor and the sliding axle are mounted on a foundation.

2. Industrial sieve according to claim 1 wherein the resilient suspension means are leaf springs.

3. Industrial sieve according to claim 1 or 2 wherein the reciprocating means comprises two units, one unit coupled to each side member of the sieve, and where a controlling unit is provided, which controlling unit synchronises the two units to provide identical action to the respective side members.

4. Industrial sieve according to claim 1 or 2 wherein the reciprocating means is a single unit, which unit is mechanically coupled to each side member, such that corresponding reciprocating action is transferred to each side member.

5. Industrial sieve according to any preceding claim wherein the sieve comprises a section with a plate bottom and a section downstream from the plate bottom comprising apertures or one or more mesh sections.

6. Industrial sieve according to any preceding claim wherein the industrial sieve comprises two sieves; a first sieve arranged above a second sieve, where said first sieve is arranged connected to said side members, and where said second sieve is part of or constitutes said reference mass and where said second sieve is further connected to and agitated by said reference mass, and where optionally a collection tray or conveyor is arranged below said second sieve.

7. Industrial sieve according to any of claims 1 to 6 wherein the sieve(s) are arranged substantially horizontally.

8. Industrial sieve according to any of claims 1 to 6 wherein the angle of the sieve(s) surface is variable with respect to horizontal.

9. Industrial sieve according to any of claims 1 to 8 wherein the linear reciprocating means for reciprocating said sieve(s) relative to the reference mass or further sieve is/are arranged such that the reciprocating force stemming from the reciprocating means is transferred having a horizontal force component and a vertical force component, where the horizontal force component is larger than the vertical force component.

10. Industrial sieve according to any of claims 1 to 9 wherein the one or more sieves or countermass are suspended from a frame structure or ceiling.

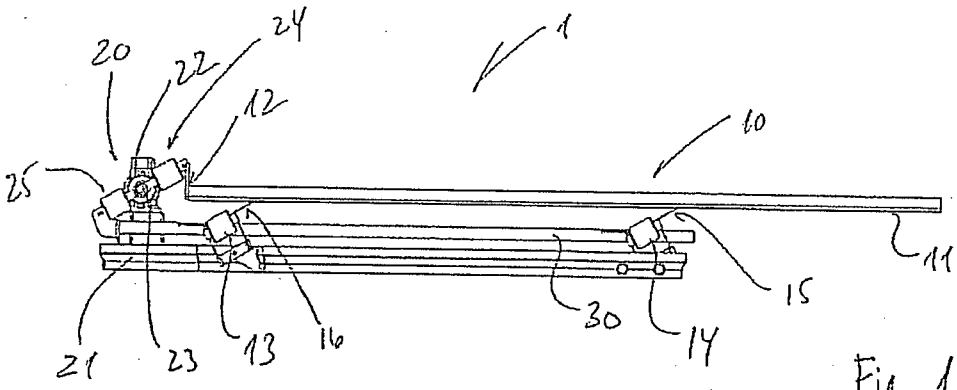

Fig. 1

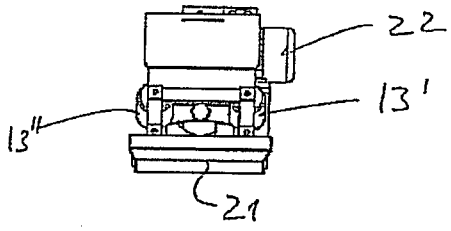

Fig. 2

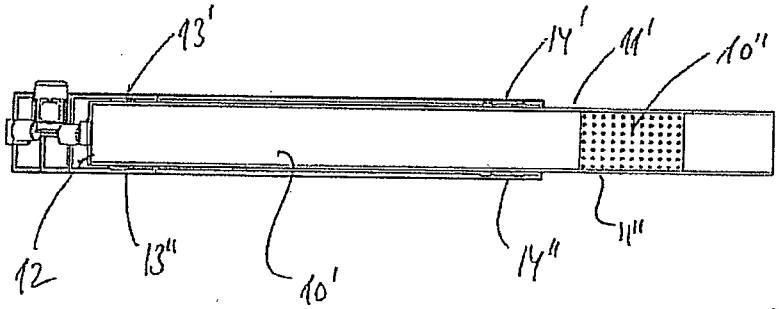

Fig. 3

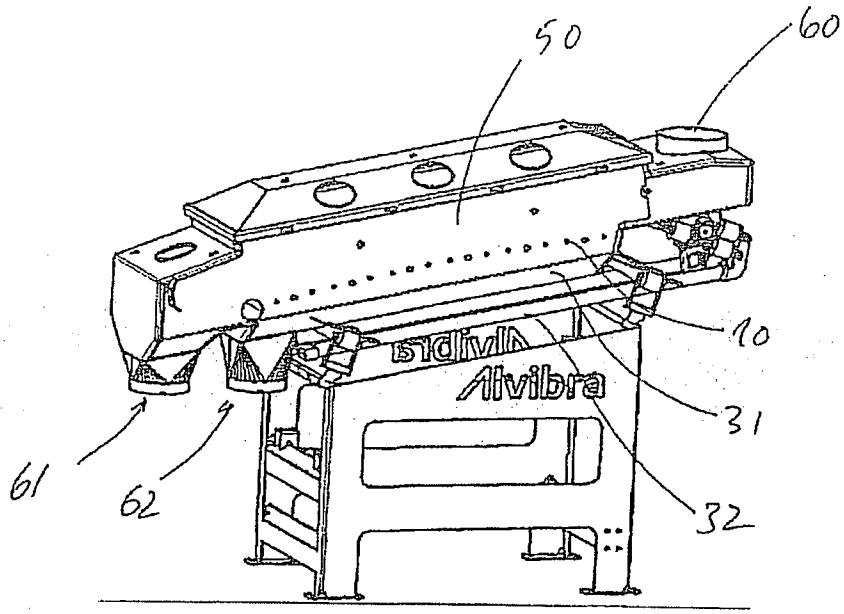

Fig. 4

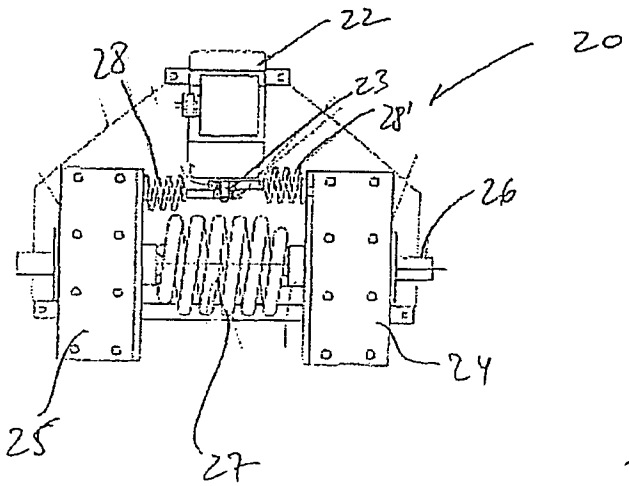

Fig 5

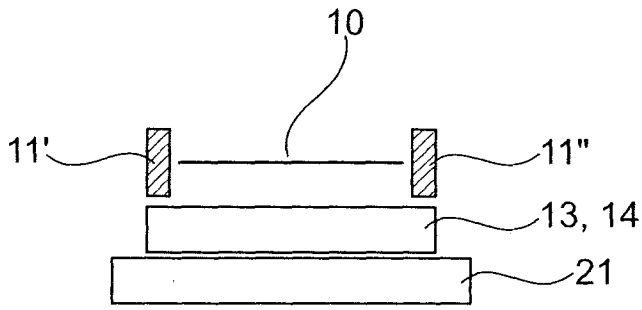

Fig. 6

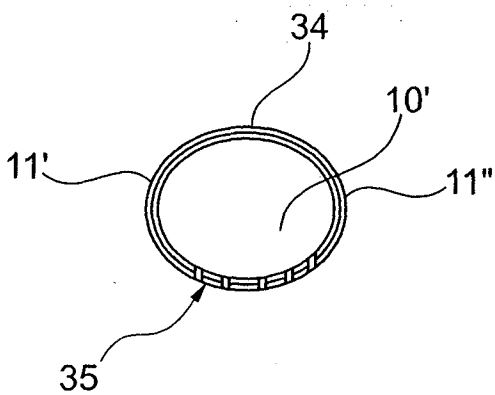

Fig. 7a

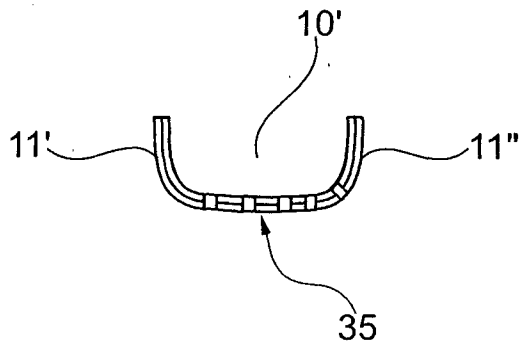

Fig. 7b

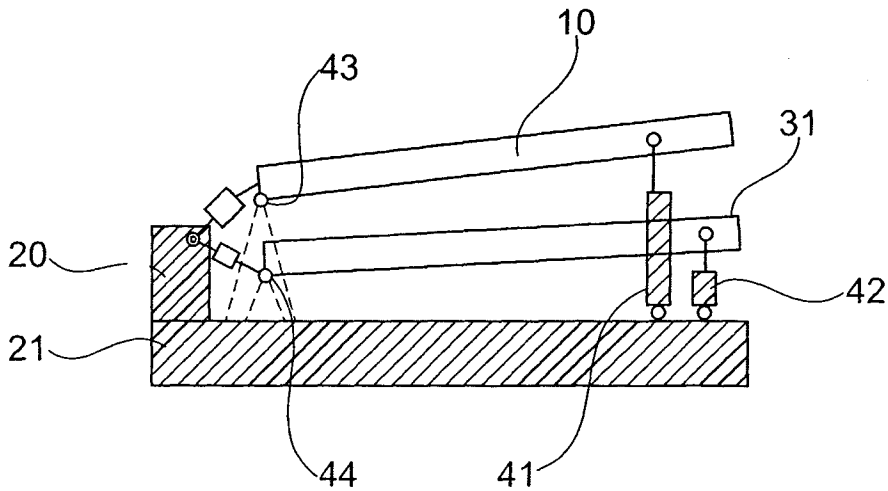

Fig. 8

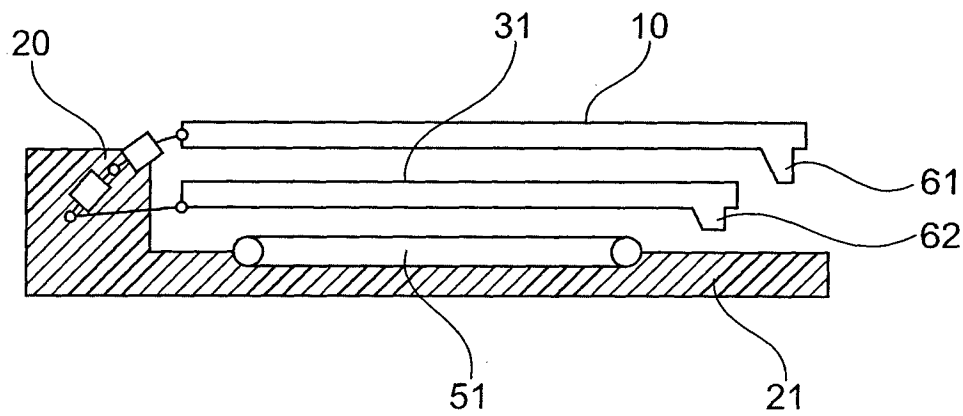

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/DK2013/050129

A. CLASSIFICATION OF SUBJECT MATTER
INV. B07B1/28 B07B1/42
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B07B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2 279 742 A (OVERSTROM GUSTAVE A ET AL) 14 April 1942 (1942-04-14) page 4, column 1, line 4 - line 7 page 4, column 1, line 23 - line 61 page 3, column 2, line 67 - line 73 page 4, column 2, line 54 - page 5, column 1, line 3 figure 2	1-10

Y	DE 11 87 897 B (SCHUECHTERMANN & KREMER) 25 February 1965 (1965-02-25) column 3, line 52 - column 4, line 5 figure 1	1-10

A	GB 816 847 A (FUR UNTERNEHMUNGEN DER EISEN U) 22 July 1959 (1959-07-22) page 2, line 49 - line 79 figure 1	1-10

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 August 2013	05/09/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Posten, Katharina

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INTERNATIONAL SEARCH REPORT

International application No
PCT/DK2013/050129

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 798 287 A (KLOECKNER HUMBOLDT DEUTZ AG) 16 July 1958 (1958-07-16) page 2, line 4 - line 40 figure 2	1-10
A	GB 500 695 A (JOSEF WOLZ; WESTFALIA DINNENDAHL GROEPPEL) 14 February 1939 (1939-02-14) page 1, line 82 - line 84 figure 1	1-10
A	GB 781 073 A (REDLER CONVEYORS LTD) 14 August 1957 (1957-08-14) page 2, lines 2-23 page 2, line 1 - line 3 page 1, line 14 - line 18 figure 1	1-10

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/DK2013/050129

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2279742 A	14-04-1942	NONE	
DE 1187897 B	25-02-1965	BE 669615 A	28-08-2013
		DE 1187897 B	25-02-1965
		GB 1085813 A	04-10-1967
		NL 6503195 A	12-04-1966
GB 816847 A	22-07-1959	NONE	
GB 798287 A	16-07-1958	NONE	
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