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(54) Disc roller mill

(57) The disc roller mill has a squeezing unit for squeezing granular feed raw material. The squeezing unit has two parallel rotatable disc rollers (68a, 68b), between which there is a gap, wherein the feed raw material to be squeezed can be led. The disc rollers have an axis (70a, 70b) and a number of discs (80) fitted around the axis. The discs have an inner part (84) in the direction of the normal to the surface of the axis and an outer edge (88). Between the inner part and the outer edge there is a squeezing surface (86), which substantially has the shape of a cut-off cone. The squeezing surface of the discs can be substantially smooth or it can have grooves substantially in the direction of the radius of the disc.

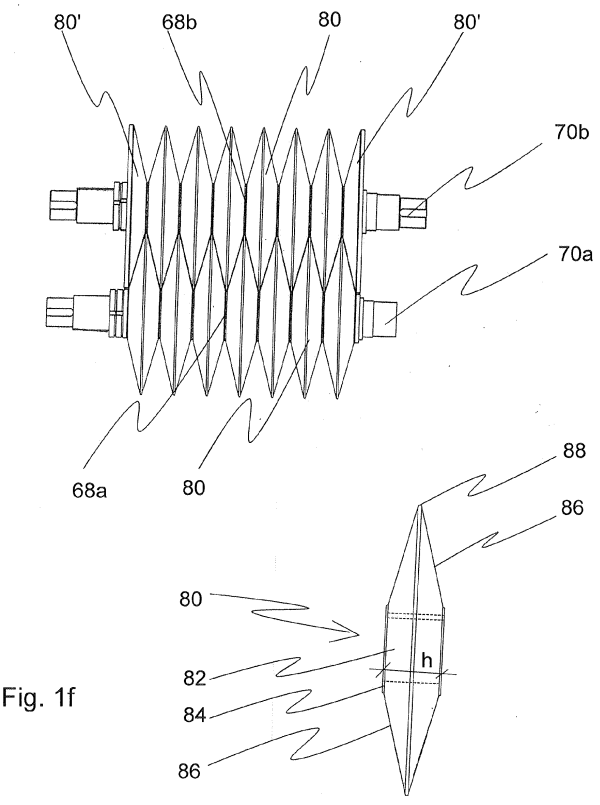

Fig. 1f

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Description

[0001] The invention relates to a disc roller mill, which has a squeezing unit for squeezing a granular feed raw material, which squeezing unit has at least two parallel rotatable rollers, between which there is a gap, into which gap the feed raw material to be squeezed can be led.

[0002] Crush preservation is generally used when preserving feed. Crush preservation is especially well suited for preserving grain crops to be used as feed, such as grains of barley, oat, wheat and triticale, and for preserving corn, peas and beans. In crush preservation the ingredients of the feed are crushed by squeezing into a feed mass, wherein a preservative is mixed. The formed feed mass is stored in an air-tight manner in a feed silo, a clamp or a plastic tube. In tube preservation the feed raw material is squeezed with a roller mill into a feed mass and the feed mass is pressed tightly into a plastic tube in subsequent work stages. The crushing and the preservation are done with a roller mill, which is equipped with a tube packing device.

[0003] For the sake of the preservability of the feed it is important that substantially all the grains or seeds of the feed plant are crushed by squeezing before the feed mass is preserved. The feed plant squeezing unit in known roller mills comprises at least two cylindrical crushing rollers, which can be rotated in opposite directions, into the gap between which rollers the feed raw material is led. In order to obtain a sufficient crushing capacity, the cylindrical crushing rollers must be made comparatively long or the number of roller pairs must be increased. This increases the size of the device and raises the material costs of the squeezing unit. Crushing rollers with different surface patterns must additionally be used in the squeezing unit when crushing different types of grain. The use of crushing rollers with different surface patterns raises the manufacturing costs of the device and makes the use of the device more difficult.

[0004] It is an object of the invention to provide an improved disc roller mill meant for manufacturing crushed feed, with which the disadvantages and flaws related to known roller mills can be reduced.

[0005] The objects of the invention are obtained with a disc roller mill, which is characterised in what is presented in the independent claim. Some advantageous embodiments of the invention are presented in the dependent claims.

[0006] The invention relates to a disc roller mill meant for manufacturing crushed feed. In manufacturing crushed feed the feed raw material, such as the grains of feed grains, peas, corn or beans, is crushed by squeezing. The disc roller mill has a squeezing unit for squeezing granular feed raw material. The squeezing unit has at least two parallel rotatable rollers, between which there is a gap, wherein the feed raw material to be squeezed can be led. The basic idea of the invention is that said rollers are disc rollers, which have an axis and a number of discs fitted around the axis. The discs have an inner part in the direction of the normal to the surface of the axis and an outer edge. Between the inner part and the outer edge there is a squeezing surface, which substantially has the shape of a cut-off cone. Advantageously at least a part of the discs of the disc roller have two squeezing surfaces, whereby the first squeezing surface is on the first side of the disc and the second squeezing surface is on the second side of the disc.

[0007] In one advantageous embodiment of the disc roller mill according to the invention the squeezing surface of said discs is substantially smooth. A smooth surface means that the surface does not have a surface shape formed with the aid of grooves, cavities or bulges. The disc advantageously has a linearly changing thickness between the inner part and the outer edge.

[0008] In a second advantageous embodiment of the disc roller mill according to the invention the squeezing surface of said discs has grooves. The grooves may be substantially straight or they may have a curved shape. Advantageously the grooves are substantially in the direction of the radius of the disc. When using the disc roller mill one of the edges of the grooves in the discs is worn, i.e. rounded, more than the other. When using symmetric grooving in the direction of the radius the worn discs can be turned the other way on the axis, whereby their crushing capacity is improved.

[0009] In a third advantageous embodiment of the disc roller mill according to the invention the edge of the squeezing surface bordering on the inner part of the disc has a transition part, where the squeezing surface changes from an substantially conical surface to an substantially cylindrical surface. The gap between the squeezing surfaces of the disc rollers is adjusted to be suitable according to the size of the grains of the feed raw material to be squeezed. Especially when squeezing small-grained feed raw material, such as small grains, a part of the raw material can fit to pass through the gap formed between the inner parts of parallel disc rollers whole. Whole un-squeezed raw material grains can thus pass into the squeezed feed raw material. With the aid of the transition part the un-squeezed passing of feed raw material through the gap between adjacent disc rollers can be substantially decreased. The radius of curvature of the surface of the transition part is advantageously less than 1 mm, more advantageously 0.8 mm.

[0010] In a fourth advantageous embodiment of the disc roller mill according to the invention the squeezing unit has a first disc roller and a second disc roller, which are arranged to be parallel, so that there is a substantially evenly wide zigzag-shaped gap between the squeezing surfaces of the discs. Due to the zigzag shape, the length of the gap between the disc rollers is significantly greater than the length of the disc rollers.

[0011] In a fifth advantageous embodiment of the disc roller mill according to the invention the first disc roller is attached to the squeezing unit in a stationary manner and the second disc roller is attached to the squeezing unit in a mobile manner. The mobility of the second disc

roller makes possible the adjustment of the width of the gap between the disc rollers to be suitable for different feed plants.

[0012] A sixth advantageous embodiment of the disc roller mill according to the invention further comprises a funnel for receiving the feed raw material and a compartment feeding device for dosing the feed raw material from the funnel into the squeezing unit.

[0013] It is an advantage of the invention that the same squeezing unit's disc roller is suitable for use with all feed plants. The disc rollers do thus nut need to be changed as the type of grain or feed plant changes, which makes the use of the device easier and decreases the operating costs of the device.

[0014] It is further an advantage of the invention that the disc rollers provide a significantly larger squeezing surface area than cylindrical rollers of the same length. The crushing capacity of the roller mill according to the invention is thus significantly larger than in known roller mills.

[0015] It is further an advantage of the invention that it provides crushed feed, which has a good quality with regards to structure and properties. The good quality of the crushed feed is a result of the rubbing properties of the disc rollers of the squeezing unit, which is caused by the fact that the speed of the squeezing surface of the discs is higher close to the outer edge of the disc than close to the inner part of the disc.

[0016] It is still an advantage of the invention that the size of the disc rollers can easily be adjusted as desired by changing the number of discs to be on the axis of the roller. The manufacture of disc rollers constructed from several discs fitted onto the same axis is additionally technically simpler than the construction of one cylindrical roller.

[0017] In the following, the invention will be described in detail. In the description, reference is made to the appended drawings, in which

Figure 1a shows as an example a disc roller mill according to the invention seen from the side,

Figure 1b shows a compartment feeding device of the disc roller mill seen diagonally from above,

Figure 1c shows the compartment feeding device of the disc roller mill as a cross-sectional view,

Figure 1d shows a squeezing unit of the disc roller mill as a cross-sectional view,

Figure 1e shows the squeezing unit of the disc roller mill seen diagonally from above,

Figure 1f shows disc rollers in the squeezing unit of the disc roller mill,

Figure 1g shows an advantageous embodiment of a disc of the disc roller in the squeezing unit of the disc roller mill,

Figure 1h shows a cross-section of the disc of the disc roller shown in Figure 1g and

Figure 1i shows a tube packing device belonging to the disc roller mill.

[0018] Figure 1 a shows as an example a disc roller mill according to the invention seen from the side. The disc roller mill is a device for manufacturing crushed feed, which device is placed on top of a mobile towing base 12. In the first end of the towing base there is a tow bar 14 and on the sides of the towing base there are wheels 16. In the free end of the tow bar there is a towing eyelet 18 for attaching to the towing hook of a work machine, such as a tractor (the tractor is not shown in the figure). On the lower surface of the free end of the tow bar there is a support 20, which can be lifted. The disc roller mill is an apparatus ready for operation, which can be moved by towing with a work machine to a desired place for manufacturing crushed feed.

[0019] The disc roller mill includes a funnel 30 reminiscent of an upside-down pyramid, which funnel is supported with the aid of support beams 32 on the towing base above the towing base. The funnel is a container, where the granular raw material of the crushed feed, such as the feed grains, peas, corn or beans, are poured as the manufacture of crushed feed starts. Below the downwards pointing end of the funnel there is a compartment feeding device 40 and below it on top of the towing base 12 a squeezing unit 60. In the downward pointing end of the funnel there is a hole, through which the raw material of the crushed feed can flow into the compartment feeding device, which doses the raw material further in suitable doses into the squeezing unit 60. In the squeezing unit the raw materials are crushed by squeezing into a feed mass. From the squeezing unit the feed mass moves along a transfer duct between the edge beams of the towing base to the tube packing device 90, which presses the feed mass into a plastic tube (the transfer duct and the plastic tube are not shown in the figures). The disc roller mill further includes a rotatable pivot axis 22, which is supported on bearings to the towing base, which pivot axis is attached by its first end to the squeezing unit by means of a power transmission mechanism. The second end of the pivot axis can be attached to an external power source, for example the take-off axis of a tractor. The squeezing unit gets its driving force from the rotation movement of the pivot axis.

[0020] Figure 1b shows the compartment feeding device 40 of the disc roller mill seen diagonally from above and Figure 1c shows the same compartment feeding device as a cross-sectional view. The compartment feeding device has a frame casing 42, on the first side of which there is a rectangular feeding opening 44 and on the second side of which there is an outlet opening 46. The com-

partment feeding device is placed in the roller mill below the end of the funnel 30, so that the opening in the end of the funnel is aligned with the feeding opening. Inside the frame casing there are two substantially parallel compartment axes, a first compartment axis 48a and a second compartment axis 48b, the first ends of which extend in the first end of the frame casing through the wall of the frame casing to the outside of the frame casing. There is a cogwheel 50 at the first end of each compartment axis. The cogs of the cogwheels settle to interlace with each other, so that rotating the first compartment axis makes the second compartment axis rotate in the opposite rotation direction. In the second end of the frame casing, in the second end of the first compartment axis, there is a hydraulic motor 52, by means of which the first compartment axis can be rotated with a desired speed. The hydraulic motor has a hydraulic tube, which can be connected to the hydraulic system of a work machine, such as a tractor. The hydraulic motor thus gets its driving force from the hydraulic system of the work machine.

[0021] On the outer surfaces of both compartment axes there are six wings 54 placed in the direction of the radius of the axis. The wings are arranged in the compartment axes so that when the compartment axes rotate, chambers 56 of an substantially standard volume are formed between them (Figure 1c), through which chambers the granular raw material of the crushed feed is dosed toward the outlet opening 46. As the compartment axes rotate, these chambers are first open in the direction of the feeding opening, whereby feed raw material can flow into the chamber. As the compartment axes turn further, the chambers first close on the side toward the feeding opening, whereafter - as the rotation movement of the compartment axes still continues - the chambers open on the side toward the outlet opening, whereby the feed raw material flows through the outlet opening into the squeezing unit 60. The compartment feeding device thus doses crushed feed raw material to the squeezing device in the amount that fits into the chamber 56 at a time. The compartment feeding device can be equipped with a rotation counter for the compartment axes, whereby the volume of feed raw material dosed into the squeezing unit can easily be calculated, when the volume of the chamber is known. Inside the frame casing there is a magnet 58 between the compartment axes and the outlet opening, to which magnet possible ferrous parts, such as nails, in the feed raw material adhere.

[0022] Figure 1d shows as an example a squeezing unit 60 belonging to a disc roller mill according to the invention as a cross-sectional view and Figure 1e shows the same squeezing unit seen diagonally from the front and above. The squeezing unit has a case-like outer shell 62, which has an upper side 64 and a lower side 65 and a first end wall 66 and a second end wall 67. Figure 1e shows only the first end wall. The second end wall is a mirror image of the first end wall and thus contains substantially all the same parts as the first end wall. On the upper side there is an inlet hole 75, through which the feed raw material coming from the compartment feeding device arrives in the squeezing unit. The inlet hole is fitted directly below the outlet opening of the compartment feeding device 40. Correspondingly, on the lower side there is an outlet hole 79, through which the squeezed feed raw material exits from the squeezing unit to the feeding duct and along the feeding duct further to the tube packing device 90 (the feeding duct is not shown in the figure). On the inside of the outer shell there is a steering funnel 77, which steers the feed raw material coming from between the disc rollers to the outlet hole.

[0023] The squeezing unit further includes two substantially parallel disc rollers, a first disc roller 68a and a second disc roller 68b (Figure 1 d). The disc rollers have axes 70a, 70b, the first end of which extends through the first end wall to outside the outer shell and the second end of which extends through the second end wall to outside the outer shell. On the outer surfaces of the end walls there are attaching plates 74a, 74b, into the holes of which the ends of the axes are mounted on bearings.

[0024] The first attaching plates 74a, where the ends of the axis 70a of the first disc roller 68a is mounted on bearings, are attached in place on the outer shell with a screw attachment to be stationary. The second attaching plates 74b, where the ends of the axis 70b of the second disc roller are mounted on bearings, are attached to the outer shell of the squeezing unit with a sliding attachment. The sliding attachment is realized so that there are two slide tracks 72 at a distance from each other on the end walls 66, 67, on which tracks the second attaching plates are attached to be mobile in the direction of the slide tracks. By moving the second attaching plates the distance between the first disc roller and the second disc roller can be altered, whereby the width of the gap remaining between the disc rollers changes. Both end walls have adjustment cylinders 76 for moving the second attaching plates. The adjustment cylinders are attached by their first end to the end wall and by their second end to the second attaching plate. The second attaching plates can be moved as desired by changing the length of the adjustment cylinders. The first and second attaching plates have adjustment surfaces 78, which are fitted to settle against each other, when the second attaching plates are moved along the slide tracks. When the adjustment surfaces settle against each other, no gap remains between the disc rollers. By setting a suitably thick adjustment plate between the adjustment surfaces, the gap between the disc rollers can be adjusted to be suitable (the adjustment plate is not shown in the figure). For example a 1.5 mm thick adjustment plate can be used for oat, a 2 mm thick adjustment plate for barley and a 3 mm thick adjustment plate for corn.

[0025] The first disc roller is attached by its second end to the first end of the pivot axis 22 of the roller mill (the attachment of the pivot axis is not shown in the figure). The first disc roller thus gets its rotational force from the rotation movement of the pivot axis. Cogwheels can be

arranged in the ends of the axes of the first and second disc roller, so that rotating the first disc roller makes the second disc roller rotate in the opposite direction. The second disc roller can also be left to rotate freely, whereby the rotation movement of the first disc roller is not transmitted to the second disc roller with cogwheels or any other power transmission mechanism. The rotational force is thus transmitted to the second disc roller via the feed raw material led between the disc rollers.

[0026] Inside the outer shell there are further peeling knives 73a, 73b. The peeling knives are plate-like parts, which have a wider base part and which narrow in a wedge-like manner when moving toward the tip. The shape of the peeling knife corresponds to the shape of the free space remaining between adjacent discs. The peeling knives are fitted between adjacent discs 80, so that their narrow tip settles close to the axis of the disc roller. In the squeezing unit according to the invention two peeling knives are arranged in connection with each disc roller. The first peeling knives 73a are placed above the axes of the disc rollers and are supported by their wider end to the upper side 64 of the outer shell. The purpose of the first peeling knives is to steer all the feed raw material coming into the squeezing unit into the gap between the disc rollers. The second peeling knives are placed below the axes of the disc rollers and are supported by their wider end to the walls of the steering funnel 77. The purpose of the second peeling knives is to scrape squeezed feed raw material, which has possibly adhered to the surface of the disc, off the surface of the disc, whereby the feed raw material can fall into the steering funnel.

[0027] Figure 1f shows as an example the disc rollers 68a, 68b belonging to the above-described squeezing unit seen from above and diagonally from the front and one disc 80 of the disc roller. The disc rollers are constructed from axes 70a, 70b, around which a number of discs 80 have been fitted in a parallel manner, which discs are case hardened and manufactured from steel. In Figure 1f the second disc roller 68b has six whole discs and two "split" half discs 80', which are placed at the ends of the roller as the outermost discs. The first disc roller 68a has seven discs, which are all the same. The length of the disc roller can be formed as desired by selecting the number of discs to be set on the axis to be suitable. The individual discs are circular parts, in the middle of which there is an axis hole 82 for the passing through of the axis. In the middle of the disc there is a circular inner part 84 in the direction of the normal to the axis, which inner part is surrounded by a ring-shaped squeezing surface 86. By the inner part the disc has a standard thickness h. Advantageously the thickness h of the inner part of the disc is in the range 50-100 mm. The diameter of the inner part can be selected as desired. At its smallest the diameter of the inner part can be substantially as large as the axis hole 82 in its centre. Thus the discs do not practically have any inner part in the direction of the normal to the axis, but the squeezing surface begins directly at the edge of the axis hole.

[0028] In the squeezing surface part the thickness of the discs decreases linearly in the direction of the radius of the disc toward the outer edge 88 of the disc, so that a sharp edge is formed in the outer edge of the disc, i.e. the thickness of the disc right at the outer edge is zero. The squeezing surface thus has the shape of a cut-off cone. Right at the outer edge of the disc there is a small rounding of the edge surface. The diameter of the discs can be selected. Advantageously the diameter of the disc is in the range 250-420 mm.

[0029] The whole discs are symmetric in relation to their central line, i.e. there is an inner part and a squeezing part surrounding it on both sides of them. The angle between the inner part and the surface of the squeezing part is also substantially the same on both sides of the disc. In the split discs one side of the disc is flat all over. The discs are set to be parallel around the axis, so that the inner parts of adjacent discs settle against each other. In the squeezing unit the disc rollers 68a, 68b are set to be parallel in the manner shown in Figure 1f, so that the discs of the first and the second disc roller settle in an interlacing manner, whereby a zigzag-shaped evenly wide gap is formed between their squeezing surfaces 86. The width of the gap can be adjusted as desired with the aid of the adjustment cylinders in the manner described above.

[0030] In the discs of the apparatus according to the invention shown in Figure 1f, the surface of the disc is at the part of the squeezing surface smooth all over, i.e. the squeezing surface does not have surface patterns formed with the aid of grooves or bulges. It has by testing been noticed that the granular feed raw material of crushed feed, such as grains, peas, corn and beans, move well into the gap between the rollers, even if the squeezing surfaces are smooth all over. The disc rollers can also make use of discs, in which the part of the squeezing surface has a surface shape, which deviates from a smooth one, for example comprising grooves and/or bulges.

[0031] Figure 1g shows as an example an advantageous embodiment of a disc 180 of a disc roller in the squeezing unit of a disc roller mill. In this embodiment of the disc the squeezing surface 186 has grooves 187, which extend in the direction of the radius of the disc from the inner edge of the squeezing surface, i.e. close to the inner part 184 of the disc, to close to the outer edge 188 of the disc. The grooves have been discovered to promote the passing of the grains into the gap between the disc rollers, i.e. they speed up the passing of the grains through the gap between the disc rollers. The grooves on the squeezing surfaces of the discs thus increase the squeezing efficiency of the disc roller mill and decrease the heating up of the discs during use. The number, shape and depth of the grooves can be selected as desired. The squeezing surface can for example have 24-36 grooves and their depth and width can be 2-4 mm. There can be grooves either on both the squeezing surfaces of

the disc or only on one squeezing surface.

[0032] Figure 1h shows the disc 180 shown in Figure 1g as a cross-sectional view. In this advantageous embodiment of the disc the juncture between the squeezing surface and the inner part 184 is different than in the disc shown in Figure 1f. The squeezing surface approaching the edge of the inner part turns into a surface in the direction of the wall of the axis hole 182 passing through the disc, so that the squeezing surface has a cylindrical shape at the juncture between the inner part and the squeezing surface. The squeezing surface and the inner part thus form an substantially right angle at their juncture. The squeezing surface changes from a conical surface to a cylindrical surface over a very short ring-shaped transition part 189. The radius of curvature of the surface of the transition part between the conical part and the cylindrical part of the squeezing surface is very small. The radius of curvature is advantageously less than 1 mm, more advantageously 0.8 mm.

[0033] Figure 1i shows as an example a tube packing device belonging to the roller mill according to the invention seen diagonally from behind. The tube packing device has a pressure cone 92, onto which a folded tube-like plastic packing bag is set. The pressure cone comprises side plates 94, which are attached to the frame of the tube packing device to be mobile in a sideways direction. Due to the mobile side plates the width of the pressure cone can be adjusted in the range of 2.0-2.4 meters. The width adjustment occurs so that locking screws 96 of the side plates are first loosened, after which the side plates can be pushed or pulled to a desired width. Finally the locking screws are tightened, whereby the side plates are attached in place. Due to the possibility of adjusting the width, packing bags of different sizes can be fitted onto the same pressure cone. To its other parts the tube packing device represents common prior art, which is not described further in this context.

[0034] The apparatus according to the invention further comprises dosing devices for preservative for the crushed feed, which devices are not shown in the figures. These devices are not within the scope of the present invention, thus they are not described further in this context.

[0035] The disc roller mill according to the invention is used in the following manner: The disc roller mill is towed with a work machine to a desired place for manufacturing feed, such as a field. The disc roller mill gets all its required driving force from the take-off axis and hydraulic system of the work machine, so the feed manufacturing place can be selected freely. At the feed manufacturing place a granular feed raw material is dosed into the funnel 30 and the disc roller mill is started. The compartment feeding device thus doses feed raw material into the squeezing unit, where it is crushed by squeezing into a feed mass. A preservative is added to the feed mass, after which the feed mass is pressed with a tube packing device into an airtight plastic tube. The roller mill according to the invention can be used to manufacture crushed feed from all of the most common feed plant grains and seeds, such as barley, oat, wheat, triticale, peas, corn and beans.

[0036] Some advantageous embodiments of the disc roller mill according to the invention have been described above. The invention is not limited to the embodiments described above, but the inventive idea can be applied in different ways within the scope of the claims.

Claims

1. A disc roller mill, which has a squeezing unit (60) for squeezing granular feed raw material, which squeezing unit has at least two parallel rotatable rollers, between which there is a gap, into which gap the feed raw material to be squeezed can be led, **characterised in that** said rollers are disc rollers (68a, 68b), which have an axis (70a, 70b) and a number of discs (80, 180) fitted around the axis, which discs have an inner part (84, 184) in the direction of the normal to the surface of the axis, and an outer edge (88, 188), an a squeezing surface (86, 186) between the inner part and the outer edge, which surface has substantially the shape of a cut-off cone.

2. The disc roller mill according to claim 1, **characterised in that** at least a part of the discs (80, 180) of the disc roller (68a, 68b) have two squeezing surfaces (86, 186), whereby the first squeezing surface is on the first side of the disc and the second squeezing surface on the second side of the disc.

3. The disc roller mill according to claim 1 or 2, **characterised in that** the squeezing surface (86) of said discs (80) is substantially smooth.

4. The disc roller mill according to claim 1 or 2, **characterised in that** the squeezing surface (186) of said discs (180) has grooves (187).

5. The disc roller mill according to claim 4, **characterised in that** the grooves (187) are substantially in the direction of the radius of the disc (180).

6. The disc roller mill according to any of the claims 1-5, **characterised in that** the disc (80, 180) has a substantially linearly changing thickness between the inner part (84, 184) and the outer edge (88, 188).

7. The disc roller mill according to any of the claims 1-6, **characterised in that** the edge of the squeezing surface (186) bordering on the inner part (184) of the disc (180) has a transition part (189), where the squeezing surface changes from an substantially conical surface to a substantially cylindrical surface.

8. The disc roller mill according to claim 7, **characterised in that** the radius of curvature of the surface of the transition part (189) is less than 1 mm, advantageously 0.8 mm.

9. The disc roller mill according to any of the claims 1-8, **characterised in that** the squeezing unit (60) comprises a first disc roller (68a) and a second disc roller (68b), which are arranged to be parallel, so that there is an substantially evenly wide zigzag-shaped gap between the squeezing surfaces (86, 186) of the discs (80, 180).

10. The disc roller mill according to claim 9, **characterised in that** the first disc roller (68a) is attached to the squeezing unit (60) in a stationary manner and the second disc roller (68b) is attached to the squeezing unit in a mobile manner.

11. The disc roller mill according to any of the claims 1-10, **characterised in that** it further comprises a funnel (30) for receiving the feed raw material and a compartment feeding device (40) for dosing the feed raw material from the funnel into the squeezing unit (60).

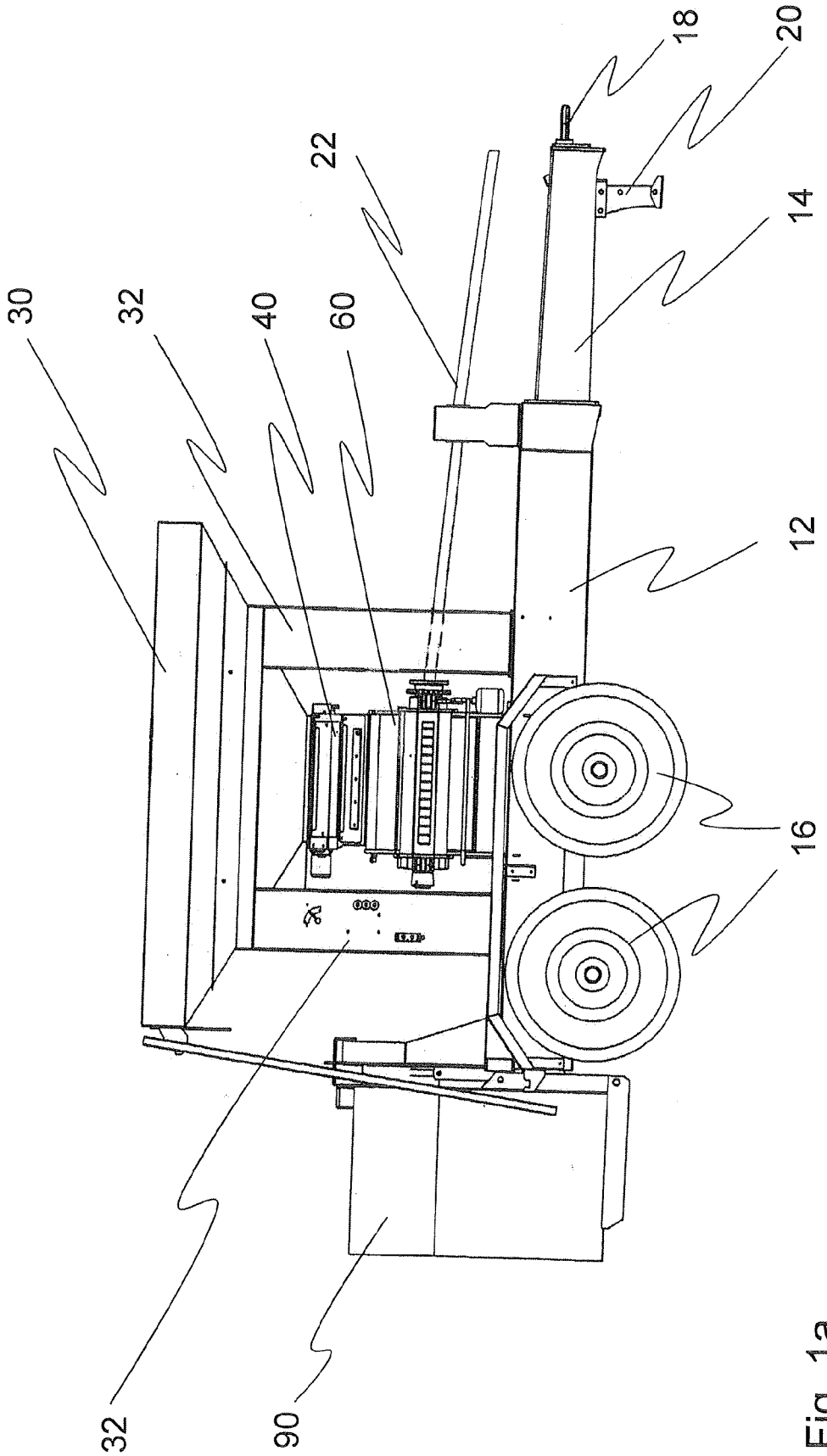


Fig. 1a

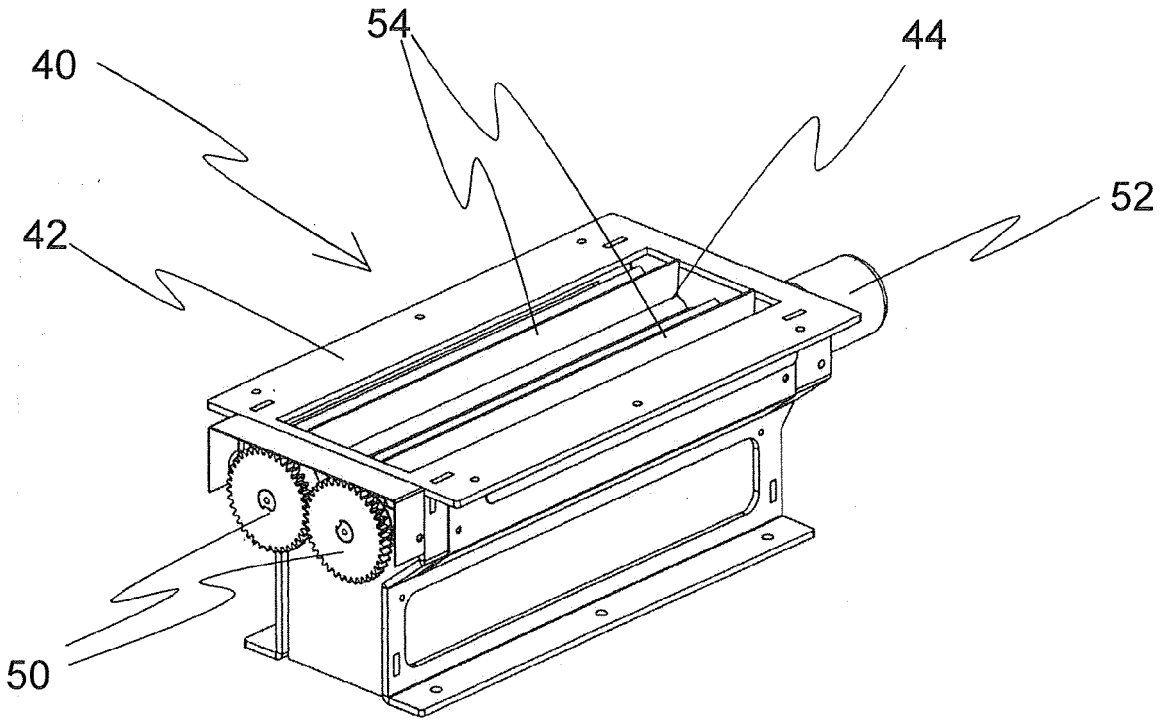


Fig. 1b

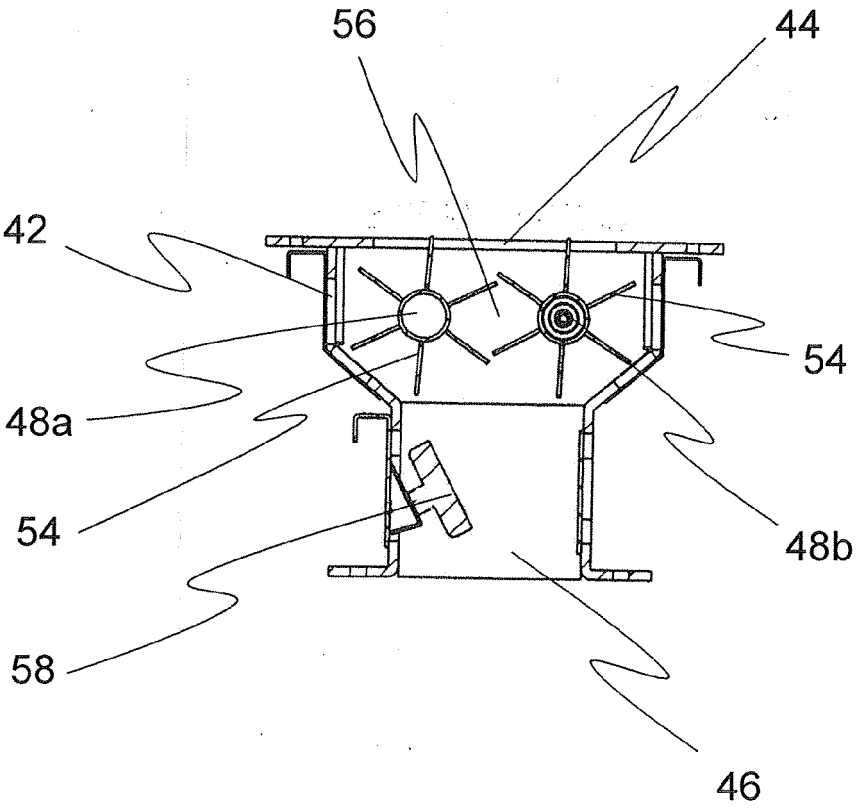
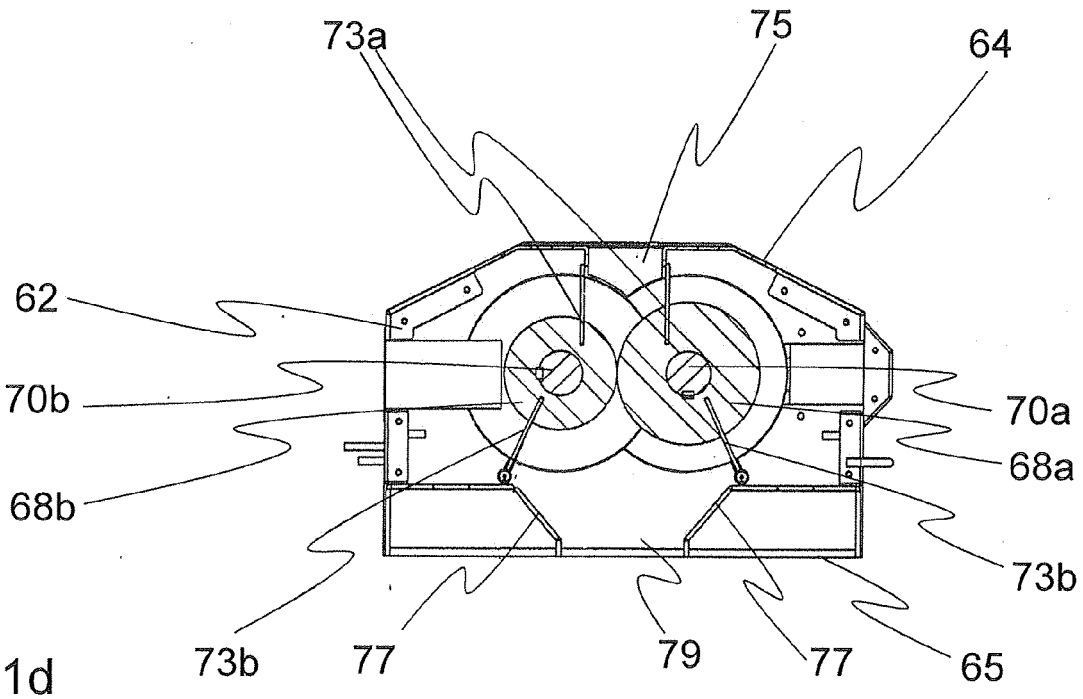


Fig. 1c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68b
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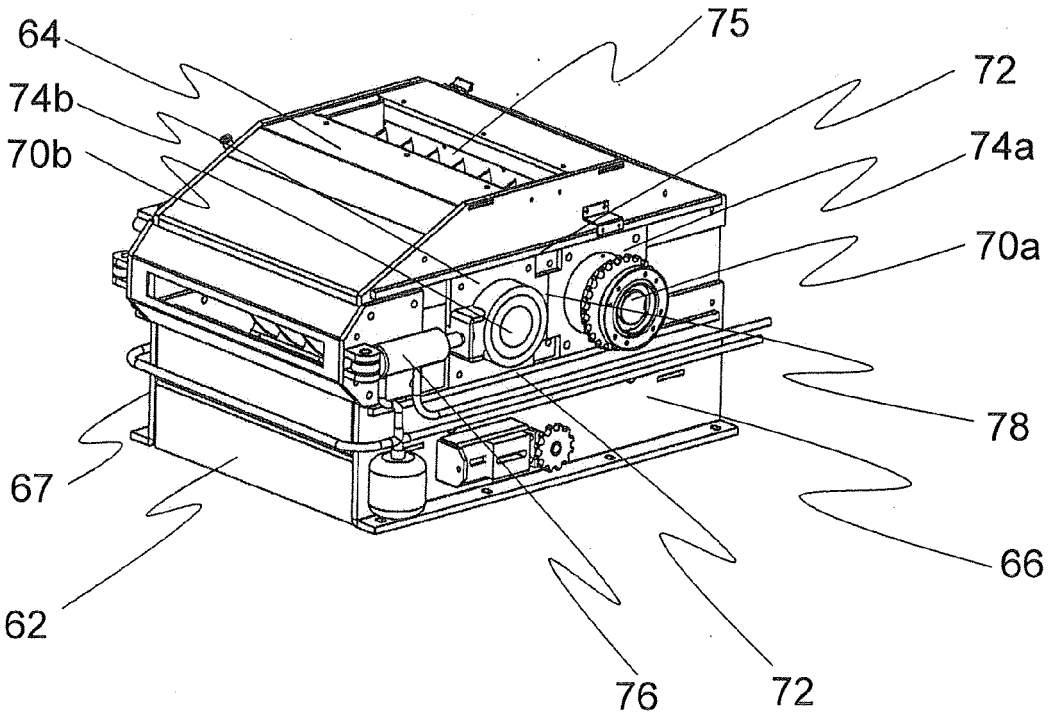
77
79
77
65

Fig. 1d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66
62
76
72

Fig. 1e

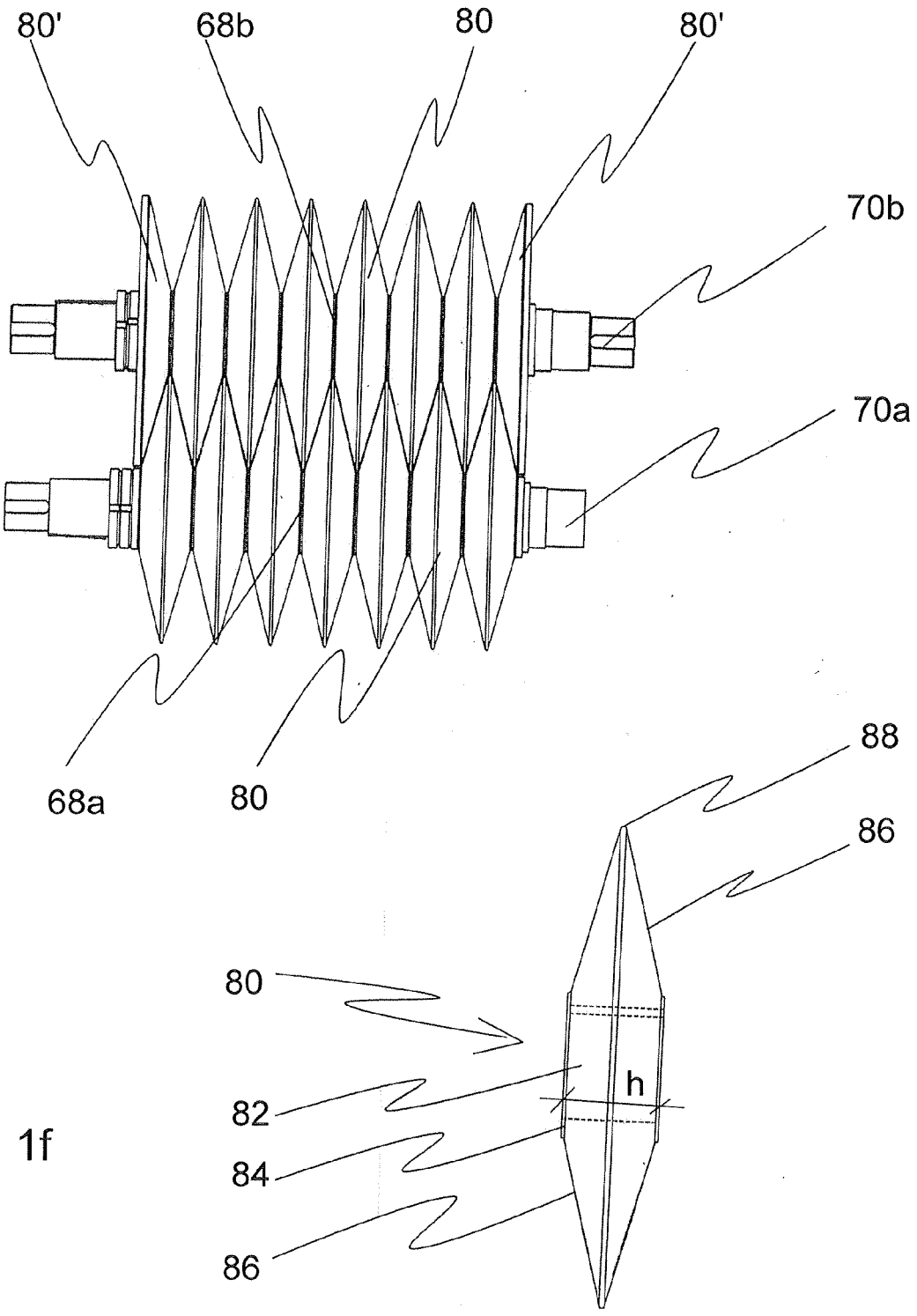

Fig. 1f

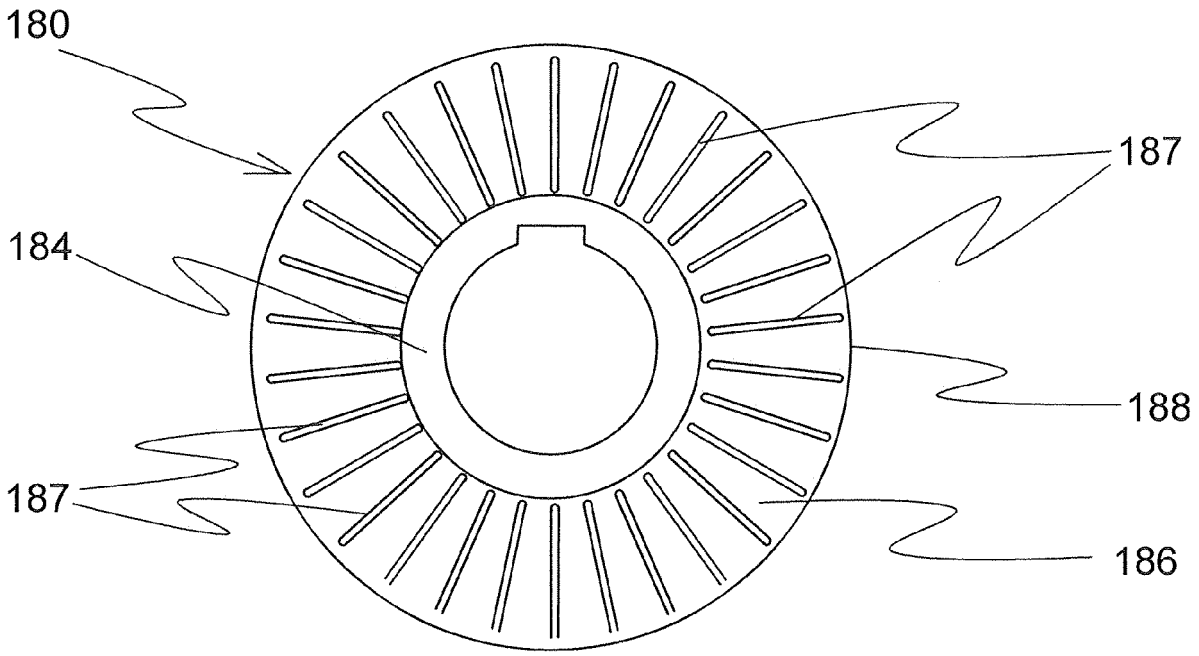

Fig. 1g

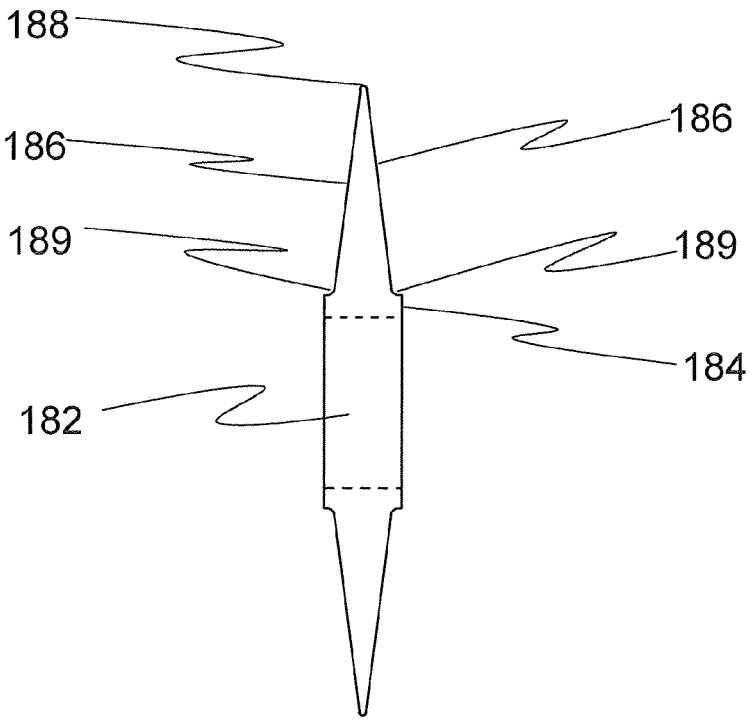

Fig. 1h

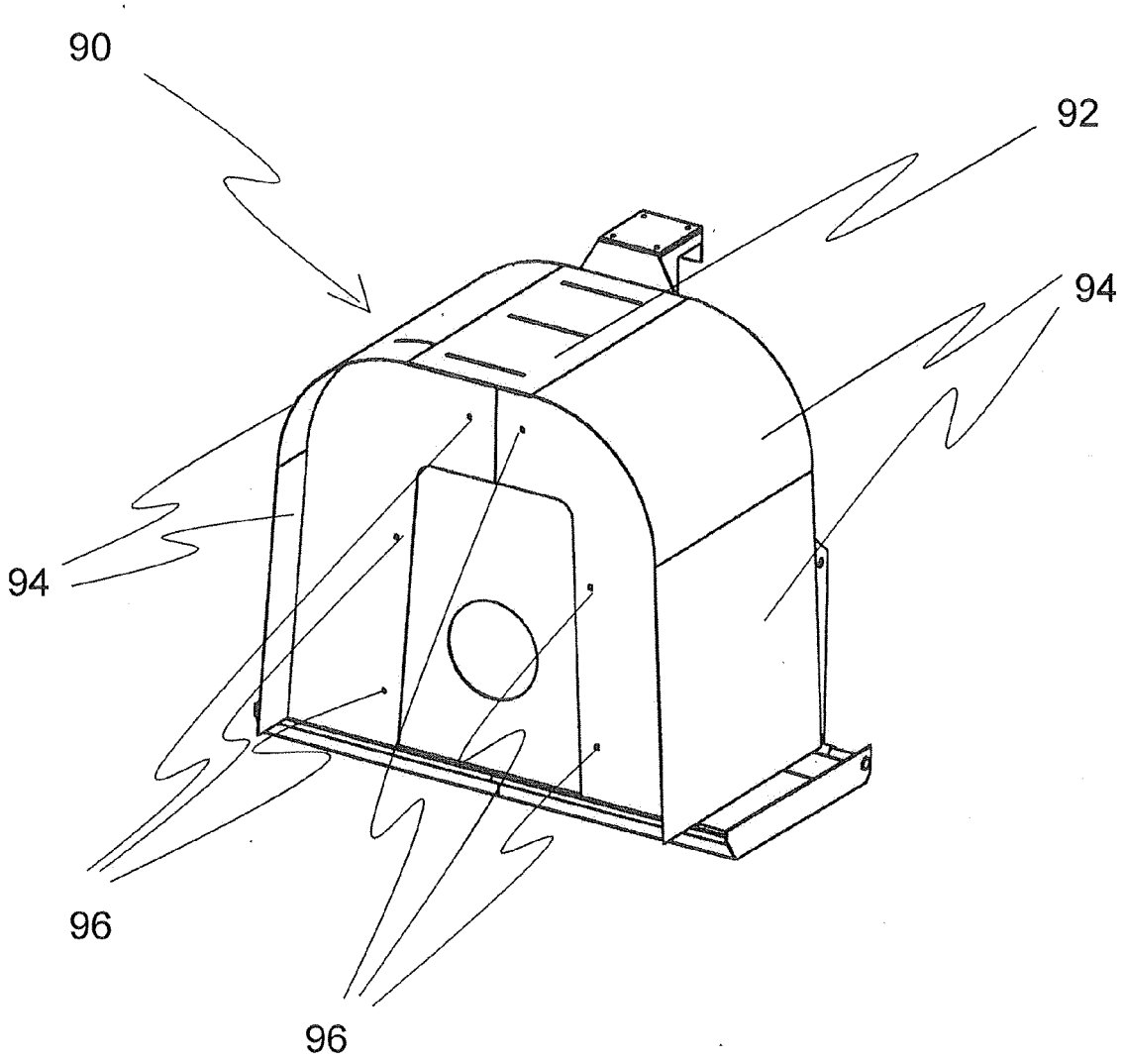

Fig. 1i