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(54) **KNIFE ASSEMBLY**

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Description

TECHNICAL FIELD

[0001] The present invention concerns a knife assembly for a size reduction machine, such as a shredder or a granulator, which comprises at least one fixed knife and a rotor with rotatable knives, arranged around the periphery of the rotor, and a sacrificial piece is arranged between the rotor and each knife for positioning and fixing of the knife.

[0002] The present invention also concerns a size reduction machine, such as a shredder or a granulator.

BACKGROUND ART

[0003] Shredders are used in many fields for size reduction of different materials, for example mixed garbage or waste from building sites. They are also used for size reduction of selected, more uniform materials, such as wood or plastics, either to make the material less bulky or to prepare it for further processing.

[0004] Shredders for plastics are often used for preparing large and/or heavy plastic parts for the production of plastic granules in a granulator mill, which requires smaller and more homogeneous parts in order to work as efficiently as possible and with as little downtime as possible. The resulting granules are often recycled in the production of new objects. Shredders work with a slower rotor speed than regular mills, and are more robust, in order to handle large or heavy pieces.

[0005] In general, a shredder or a granulator is provided with a hopper, for receiving the parts which are to be cut into smaller pieces. A pusher is provided for pushing the parts towards the rotor, which is provided with knives. The knives are in some cases arranged at two levels on the rotor. Other arrangements of the knives on the rotor are well known in the art. The knives on the rotor cooperate with fixed knives, and cut the plastics material between them.

[0006] The knives are arranged on the rotor with the aid of knife holders, which are fairly expensive, and as each knife requires a knife holder, they represent a considerable cost in the production and maintenance of the shredder. Also, the rotor itself is very expensive and difficult to exchange in case it is damaged. Protecting the rotor from damages is hence a top priority.

[0007] As the knives are often subject to considerable forces during use, the rotor, the knives, or the knife holders sometimes risk being deformed or damaged, and the knives are difficult to demount, exchange, and position without damage to the rotor. The forces on the knives during use of the shredder also contribute to wearing out the rotor after a considerable period of use.

[0008] Failures of the knives or the knife holders may lead to the breaking loose of a knife. A knife, that breaks loose during operation of the shredder, may cause considerable damage to the inside of the hopper, to the push-

er, to the rotor, or to the fixed knives. Also, a sudden stop of the rotor due to a jammed knife could damage the transmission or the motor of the shredder or granulator.

[0009] DE3228852 discloses a knife in a machine for the production of wood chips. The knife is arranged between a plate and a knife holder, with a friction-based fixation. The knife is unable to move inwards, in the direction towards the center of the rotor.

[0010] DE2932582 discloses a knife arranged between a wear part and a knife holder, which are connected. The wear part contacts the knife along a planar surface. The wear part does not position the knife.

[0011] US 1209319 discloses a knife with longitudinal ribs. A plate and a wear part contact the knife along smooth surfaces, which hold the knife by friction.

[0012] DE102012110342 discloses yet another example of knives that are held on a rotor by friction.

PROBLEM STRUCTURE

[0013] Hence a better positioning and fixing of the knives on the rotor is needed, allowing an easy demounting and exchange of the knives as they are worn out. In order to maintain the easy exchange possibilities, the rotor needs to be protected from deformation, especially at the positions where the knives are mounted.

SOLUTION

[0014] The objects forming the basis for the present invention are attained if the knife assembly mentioned in the introduction is characterized in that the sacrificial piece has a first, outer surface, which has a shape that is complementary to the shape of a seat on the rotor, and a second surface, which has a shape that is complementary to the shape of the knife, which tapers in the directions towards its center.

[0015] Regarding the shredder the objects are attained if it is characterized in that it includes said knife assembly.

[0016] Further advantages will be attained if the present invention is given one or more features from the subclaims.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

[0017] The present invention will now be described in greater detail hereinbelow, with reference to the accompanying drawings. In the accompanying drawings:

Fig. 1 shows a perspective view of a shredder according to the invention;

Fig. 2 is a section through the shredder according to Fig. 1;

Fig. 3 shows a perspective view of a rotor included in the shredder according to the invention;

- Fig. 4 is a plan view of the rotor according to Fig. 3;
- Fig. 5a is a section through the rotor according to Fig. 4;
- Fig. 5b is a section according to Fig. 5a at a different longitudinal position along the rotor;
- Fig. 6 shows a perspective view of a knife included in the knife assembly according to the invention;
- Fig. 7 is a side view of the knife in Fig. 6 with a sacrificial piece and a mounting wedge; and
- Fig. 8 shows an alternative embodiment of the knife and the sacrificial piece, mounted on a rotor.

DESCRIPTION OF PREFERRED EMBODIMENT

[0018] Fig. 1 shows a shredder 1 according to the invention. As with most shredders according to the prior art, the shredder 1 has a hopper 2 into which the plastic material, which is to be comminuted, is to be received. The shredder is also provided with a pusher 3, which pushes the material towards a rotor 4, which cuts the material into smaller pieces with the aid of knives on the rotor 4 and at least one stationary knife 22 (see fig. 2). Typically, large lumps of plastics may be cut into uniformly sized chips.

[0019] There is also an outlet 5, for evacuation of the uniformly sized chips of plastic material resulting from the cutting by the rotor 4. The outlet 5 may be connected to a conveyor, for transporting the plastic chips to a granulating mill and from there into the production of goods.

[0020] Fig. 2 shows a section of the shredder according to Fig. 1. From the section it is clear how the hopper 2 funnels down into a narrower, lower part 2a, wherein the pusher 3 operates in order to make sure that all the material reaches the rotor 4, and is eventually cut into smaller pieces. These smaller pieces are fed into the outlet 5, which is next to the rotor 4, as can be seen in Fig. 2.

[0021] Fig. 3 is a perspective view of the rotor 4. The rotor is, in the present embodiment, provided with a screen 6, which is perforated. The screen is arranged on that side of the rotor 4 which faces away from the lower part 2a of the hopper 2. When the plastic chips, resulting from the cutting operation, are small enough to pass through the holes in the screen 6, they will proceed to the outlet 5, as described above.

[0022] The uncovered side of the rotor 4 may be discerned in Fig. 3. The rotor 4 is, in this embodiment, provided with annular ridges 7 and valleys 8. A number of knives 9 are arranged on the ridges 7 as well as in the valleys 8, which will be clearer in Fig. 4, which is a plan view of the rotor 4.

[0023] The knives 9 are arranged spaced around the rotor 4 in two sets in the embodiment shown. One set of

knives 9 are arranged on the ridges 7 in a V-shaped formation, which extends over approximately half the periphery of the rotor 4. The other set of knives 9 are arranged in the valleys 8 in a similar formation, extending over the other half of the periphery.

[0024] The arrangement of the knives 9 is known as such in the prior art, and serves to distribute the reaction forces from the cutting, so that the operation of the shredder 1 will run as smoothly and efficiently as possible. Also, the distribution allows the material, which is to be cut, to advance in small steps towards the rotor 4, each time the rotor 4 has rotated half a turn, as the knives 9 are alternatingly arranged at an outer level of the rotor 4, on the ridges 7, on the first half and at an inner level, in the valleys 8, on the second half.

[0025] Fig. 5a shows a section through the rotor 4 at one of the ridges 7. A knife 9 is secured in a recess 12 in the ridge 7, with the aid of a fastening screw 10. The fastening screw 10 extends approximately radially through a bore 20 in a mounting wedge 18, which acts as a holder for the knife 9, and into a threaded bore 19 in the rotor 4. The mounting wedge 18 is arranged in close contact with the knife 9, and the oblique, contacting surfaces on the wedge 18 and the knife 9, respectively, ensure that the knife 9 is pushed towards the sacrificial piece 11 and the seat on the rotor 4, as the fastening screw 10 is tightened.

[0026] The diameter of the bore 20 through the wedge 18 is slightly larger than the diameter of the fastening screw 10. Hence there is usually no contact between the inner surface of the bore 20 in the mounting wedge 18 and the exterior of the fastening screw 10. However, the inner surface of the bore 20 is threaded in the preferred embodiment. This thread is of a larger dimension than the thread of the fastening screw 10, and the two threads are not intended to interact when the fastening screw 10 is screwed through the bore 20 in the wedge 18. The purpose of the larger thread in the bore 20 is to provide a means for fastening a larger bolt in the event of deformation or displacement of the wedge 18. By fastening a larger bolt in the bore 20, the wedge 18 may be pulled out of the recess 12, where it may be accidentally stuck, due to the deformation or displacement.

[0027] The wedge 18 will be pressed against the knife 9 with its slanting surface 21. At its opposite end, the wedge 18 is in contact with one of the inner walls of the recess 12 of the rotor 4. The depth of the recess 12 is large enough to allow for a maximum pressure on the knife 9 from the wedge 18, as the wedge 18 is forced downwards by the fastening screw 10. The wedge 18 is unable to reach the bottom of the recess 12, since the size and shape of the knife 9, in contact with the slanting surface 21 on the wedge 18, will be the limiting factor of how deep into the recess the wedge 18 may be forced. The space between the wedge 18 and the bottom of the recess 12 also ensures a secure fixation even when the parts have become worn with use or in cases of minor deficiencies in manufacture.

[0028] A sacrificial piece 11 is arranged between the knife 9 and the rotor 4 in the recess 12. The sacrificial piece 11 has a shape which on at least one, first surface is complementary to the shape of the recess 12, i. e. the seat of the rotor. On at least one other surface the sacrificial piece 11 is complementary to the shape of the knife 9.

[0029] The sacrificial piece 11 is manufactured from a softer material than the materials of the rotor 4, the wedge 18, and the knife 9, respectively. When the knife 9 is subjected to excessive forces, possibly in a direction which was not intended, neither the knife 9 nor the rotor 4, nor the wedge 18, will be the primary target of deformation, but instead the sacrificial piece 11 will be deformed. The sacrificial piece 11 is fairly cheap to manufacture and easy to exchange, while especially the rotor 4 is a more expensive components of a higher-grade material. Hence the more expensive parts of the shredder 1 are protected, and the downtime for repairs and maintenance is kept to a minimum.

[0030] A number of additional knives 9, which are also arranged in corresponding recesses 12 in the ridges 7 beyond the section of Fig. 5a, can be seen along the periphery of the rotor 4.

[0031] Fig. 5b shows a section through the rotor 4 at one of the valleys 8. There is a recess 13 in each valley 8 for securing a knife 9 and a sacrificial piece 11 with the aid of a fastening screw 10 and a wedge 18, similar to the recesses 12 in the ridges 7. The result is that a number of knives 9 are secured in different positions, extending over at least half the periphery of the rotor 4.

[0032] In the preferred embodiment shown, the knives 9 that are mounted in the valleys 8 are arranged at an inner level, i. e. at a level closer to the center, of the rotor 4, while the knives 9 at the ridges 7 are arranged at an outer level. The two levels of knives 9 will enable the pusher 3 to push the plastic material to be shredded forward towards the rotor 4 in small steps, where it will alternately be cut by the knives 9 at the outer level and the inner level, respectively.

[0033] Fig. 6 shows the knife 9 according to the invention in greater detail in a perspective view. The knife 9 has four sharp edges 15, which extend transversally to the intended direction of movement, when the knife 9 is mounted and rotating on the rotor 4, as seen e. g. in figures 5a and 5b.

[0034] The knife 9 has several symmetry planes in its preferred embodiment. A first symmetry plane is a plane to which the intended direction of movement is a normal. This symmetry ensures that the knife 9 may be turned with the opposite surface facing forward, still fitting closely to the sacrificial piece 11, able to be positioned thereby.

[0035] A second symmetry plane extends in parallel with the top and bottom surfaces (as shown in Fig. 6) of the knife 9. This symmetry ensures that the knife 9 may be turned upside down, e. g. turned around the direction of movement, in order to arrange another sharp edge 15 in a cutting position, while the surface facing the sacrificial

piece 11 still fits closely thereto and is still able to be positioned thereby.

[0036] A third symmetry plane is arranged in parallel with the side end surfaces of the knife 9. This symmetry ensures that all of each sharp edge 15 is able to cooperate with the fixed knives during operation of the shredder 1, in order to provide an efficient cutting of the plastic material.

[0037] The sharp edges 15 are arranged at the upper and lower surfaces, where the knife is widest. The knife 9 tapers in the directions towards its center, resulting in an angle 16 near the middle portion of the knife 9. This angle 16 functions mainly for the secure positioning of the knife 9, as the tapering surfaces on the knife cooperate with the sacrificial piece 11 on one side and with the wedge 18 on the other side. Depending on the acuteness of the angle 16, it may function as an indication of fracture in the event of a failure during operation of the shredder. If the knife 9 breaks along the indication of fracture, only a limited part of the knife 9 will be let loose inside the shredder 1, and the risk of severe damages to the shredder 1 is low.

[0038] The side edges 17 of the knife 9 are beveled, which reduces the risk of breakage of the outer ends of the sharp edge 15. Also, the compact design of the knife 9, without any bores or threads through the knife 9, provides a greater resistance to cracks and breakage thereof.

[0039] In Fig. 7, the knife 9 and the sacrificial piece 11 are shown from the side with a close fit, corresponding to their mounted state. The shape of a second surface of the sacrificial piece 11 is, as mentioned earlier, complementary to the shape of the knife 9, which means that their respective surfaces are in close contact, and a well defined positioning of the knife 9 is attained. When one sharp edge 15 of the knife 9 is worn down, the symmetry of the knife 9 will allow the knife 9 to be turned into another position with a retained close fit and well defined positioning, and with another sharp edge 15 facing forward for cutting the material.

[0040] The close fit will result in a transfer of forces on the knife 9 to the sacrificial piece 11. In combination with the soft material, the close fit will protect the knife 9 and the rotor 4 from damages, since excessive forces on the knife 9 will result in a deformation of the sacrificial piece 11, not damages to the knife 9 nor to the rotor 4. If only the sacrificial piece 11 has been deformed, demounting the knife 9 will be less problematic than if the knife 9 itself or parts of the rotor 4 around it have been deformed.

[0041] Another advantage of the close fit is that the risk of material getting stuck between the knife 9 and the rotor 4 or the sacrificial piece 11 is greatly reduced. Cleaning of the shredder 1, e. g. between batches of different material, will be easier and quicker, and the downtime will be reduced.

[0042] In Fig. 7 the knife 9 and the sacrificial piece 11 are also seen with the fastening screw 10 and the wedge 18 mounted. The knife 9 and the sacrificial piece 11 act

as a stable unit, with the fastening screw 10 pulling the wedge 18 downwards, towards the center of the rotor 4, and being long enough to be able to extend into the threaded bore 19 in the rotor 4. As the wedge is pulled downwards, the knife 9 and the sacrificial piece 11 are pressed together so that they together will form the unit which is securely mounted in one of the recesses 12, 13 directly in the rotor 4. The screw 10 extends some distance through the rotor 4, which results in a secure fit of the knife 9, and helps reducing the risk that the knife 9 is displaced from its position, when it is subjected to great forces during cutting.

ALTERNATIVE EMBODIMENTS

[0043] In an alternative embodiment, the shape of the knife 9 may be varied. It would still be possible to mount the modified knife in the same recesses 12, 13 in the rotor 4, as long as corresponding modifications are made to the sacrificial piece 11, so that the close fit is maintained, and the outer shape of the unit of the knife 9 and the sacrificial piece 11 is the same.

[0044] In another embodiment, shown in fig. 8, the recesses 12, 13 are arranged for a different configuration of the fastening screw 10. The fastening screw 10 extends approximately parallel to a tangential direction of the rotor 4, through a part of the rotor 4 as well as through through-going bores 14 in the knife 9 and the sacrificial piece 11, respectively. In still another embodiment, the rotor may not be provided with a screen 6, as was described above for the preferred embodiment. Not all applications of the invention on a shredder 1 or a granulator will need a screen, and the presence of a screen is not necessary for the functionality of the knives 9.

[0045] The annular ridges 7 and valleys 8, forming a rotor 4 with knives 9 at two different levels, is not compulsory for the invention. Alternative embodiments where all knives 9 are arranged in a single level, at a uniform distance from the center of the rotor 4, are conceivable.

[0046] Further, there are alternatives to arranging the knives 9 in V-shaped formations. Some alternatives are knives 9 in spiral-shaped formations, or knives 9 arranged on alternating quarters of the rotor 4.

[0047] The invention may be further modified within the scope of the claims.

Claims

1. Knife assembly for a size reduction machine, such as a shredder or a granulator (1), which comprises at least one fixed knife (22) and a rotor (4) with rotatable knives (9), arranged around the periphery of the rotor (4), a sacrificial piece (11) is arranged between the rotor (4) and each knife (9) for positioning and fixing of the knife (9), **characterized in that** the sacrificial piece (11) has a first, outer surface, which has a shape that is complementary to the shape of

a seat on the rotor (4), and a second surface, which has a shape that is complementary to the shape of the knife (9), which tapers in the directions towards its center.

2. Knife assembly according to any of claims 1, **characterized in that** the shape of the knife (9) has at least one symmetry plane, so that the knife (9) is reversible.
3. Knife assembly according to claim 2, **characterized in that** the knife (9) is provided with at least four cutting edges (15).
4. Knife assembly according to any of claims 1 to 3, **characterized in that** a wedge (18) with a fastening screw (10) is arranged to hold the knife (9) in place on the rotor (4).
5. Knife assembly according to any of claims 1 to 3, **characterized in that** the knife (9) and the sacrificial piece (11) have respective through-going bores (14), for a fastening screw (10).
6. Knife assembly according to claim 5, **characterized in that** the through-going bores (14) in the knife (9) and the sacrificial piece (11) are arranged to align with corresponding bores in the rotor (4).
7. Size reduction machine, such as a shredder or a granulator (1) including the knife assembly according to any of claims 1 to 6.

Patentansprüche

1. Messeranordnung für eine Zerkleinerungsmaschine, wie zum Beispiel einen Shredder oder eine Schneidmühle (1), die wenigstens ein festes Messer (22) und einen Rotor (4) mit drehbaren Messern (9) umfasst, die um den Umfang des Rotors (4) angeordnet sind, wobei ein Opferstück (11) zwischen dem Rotor (4) und jedem Messer (9) angeordnet ist, um das Messer (9) zu positionieren und zu fixieren, **dadurch gekennzeichnet, dass** das Opferstück (11) eine erste Außenfläche, die eine Form aufweist, die auf die Form eines Sitzes an dem Rotor (4) abgestimmt ist, und eine zweite Fläche aufweist, die eine Form aufweist, die auf die Form des Messers (9) abgestimmt ist, die sich in die Richtungen zu ihrem Mittelpunkt hin verjüngt.
2. Messeranordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Form (9) wenigstens eine Symmetrieebene aufweist, so dass das Messer (9) umschaltbar ist.
3. Messeranordnung nach Anspruch 2, **dadurch ge-**

- kennzeichnet, dass** das Messer (9) mit wenigstens vier Schneidkanten (15) versehen ist.
4. Messeranordnung nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** ein Keil (18) mit einer Befestigungsschraube (10) so angeordnet ist, dass er das Messer (9) an Ort und Stelle an dem Rotor (4) hält. 5
 5. Messeranordnung nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** das Messer (9) und das Opferstück (11) jeweils Durchgangsbohrungen (14) für eine Befestigungsschraube (10) aufweisen. 10
 6. Messeranordnung nach Anspruch 5, **dadurch gekennzeichnet, dass** die Durchgangsbohrungen (14) in dem Messer (9) und dem Opferstück (11) so angeordnet sind, dass sie in einer Linie mit entsprechenden Bohrungen in dem Rotor (4) angeordnet sind. 20
 7. Zerkleinerungsmaschine, wie zum Beispiel ein Shredder oder eine Schneidmühle (1), die die Messeranordnung nach einem der Ansprüche 1 bis 6 enthält. 25
 5. Ensemble de couteaux selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** le couteau (9) et la pièce sacrificielle (11) ont des alésages traversants respectifs (14), pour une vis de fixation (10).
 6. Ensemble de couteaux selon la revendication 5, **caractérisé en ce que** les alésages traversants (14) dans le couteau (9) et la pièce sacrificielle (11) sont disposés de sorte à s'aligner avec des alésages correspondants dans le rotor (4).
 7. Machine de réduction de taille, telle qu'une déchiqueteuse ou un broyeur (1), comprenant l'ensemble de couteaux selon l'une quelconque des revendications 1 à 6.

Revendications

1. Ensemble de couteaux pour une machine de réduction de taille, telle qu'une déchiqueteuse ou un broyeur (1), qui comprend au moins un couteau fixe (22) et un rotor (4) avec des couteaux rotatifs (9), disposés autour de la périphérie du rotor (4), une pièce sacrificielle (11) étant disposée entre le rotor (4) et chaque couteau (9) pour positionner et fixer le couteau (9), **caractérisé en ce que** la pièce sacrificielle (11) a une première surface externe qui a une forme complémentaire à la forme d'un siège sur le rotor (4), et une seconde surface, qui a une forme complémentaire à la forme du couteau (9), qui s'effile dans les directions vers son centre. 30
2. Ensemble de couteaux selon la revendication 1, **caractérisé en ce que** la forme du couteau (9) a au moins un plan de symétrie, de sorte que le couteau (9) soit réversible. 45
3. Ensemble de couteaux selon la revendication 2, **caractérisé en ce que** le couteau (9) est pourvu d'au moins quatre tranchants (15). 50
4. Ensemble de couteaux selon l'une quelconque des revendications 1 à 3, **caractérisé en ce qu'un** coin (18) avec une vis de fixation (10) est disposé pour maintenir le couteau (9) en place sur le rotor (4). 55

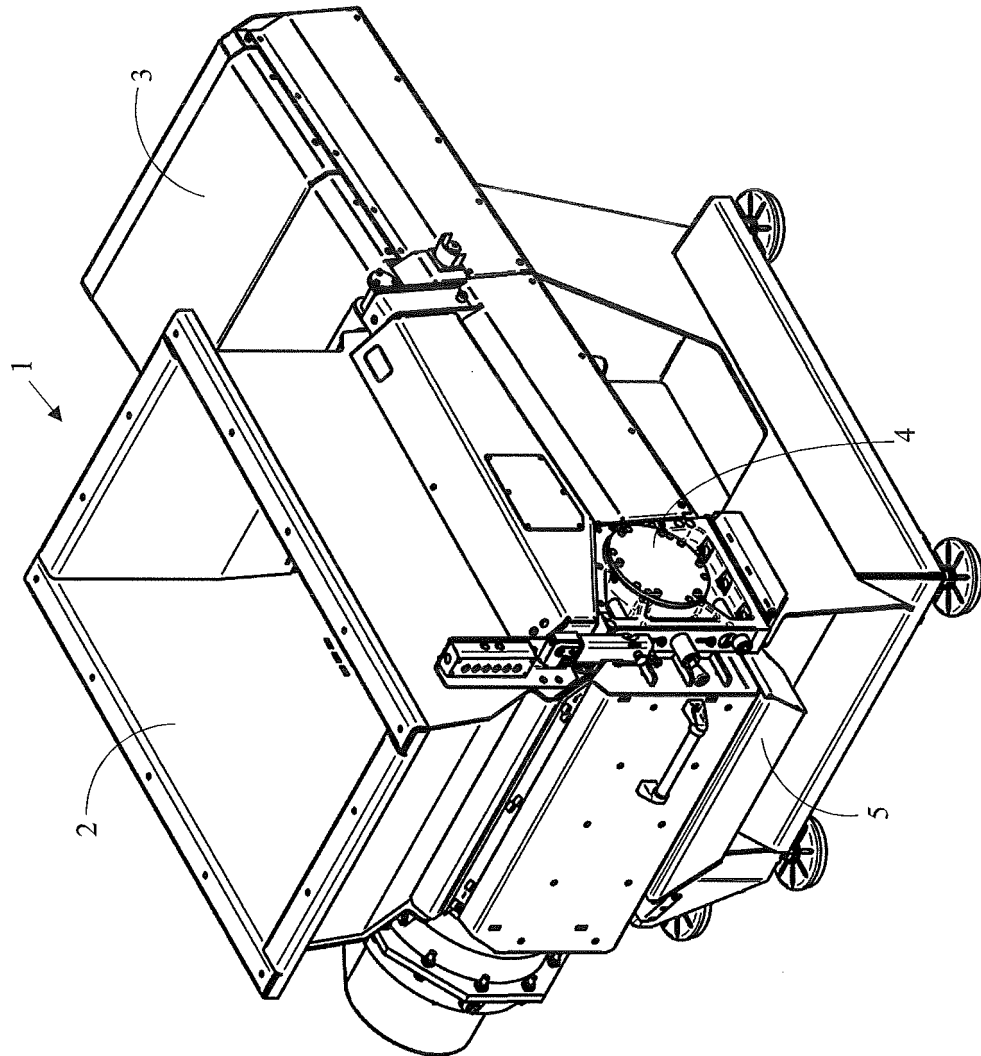
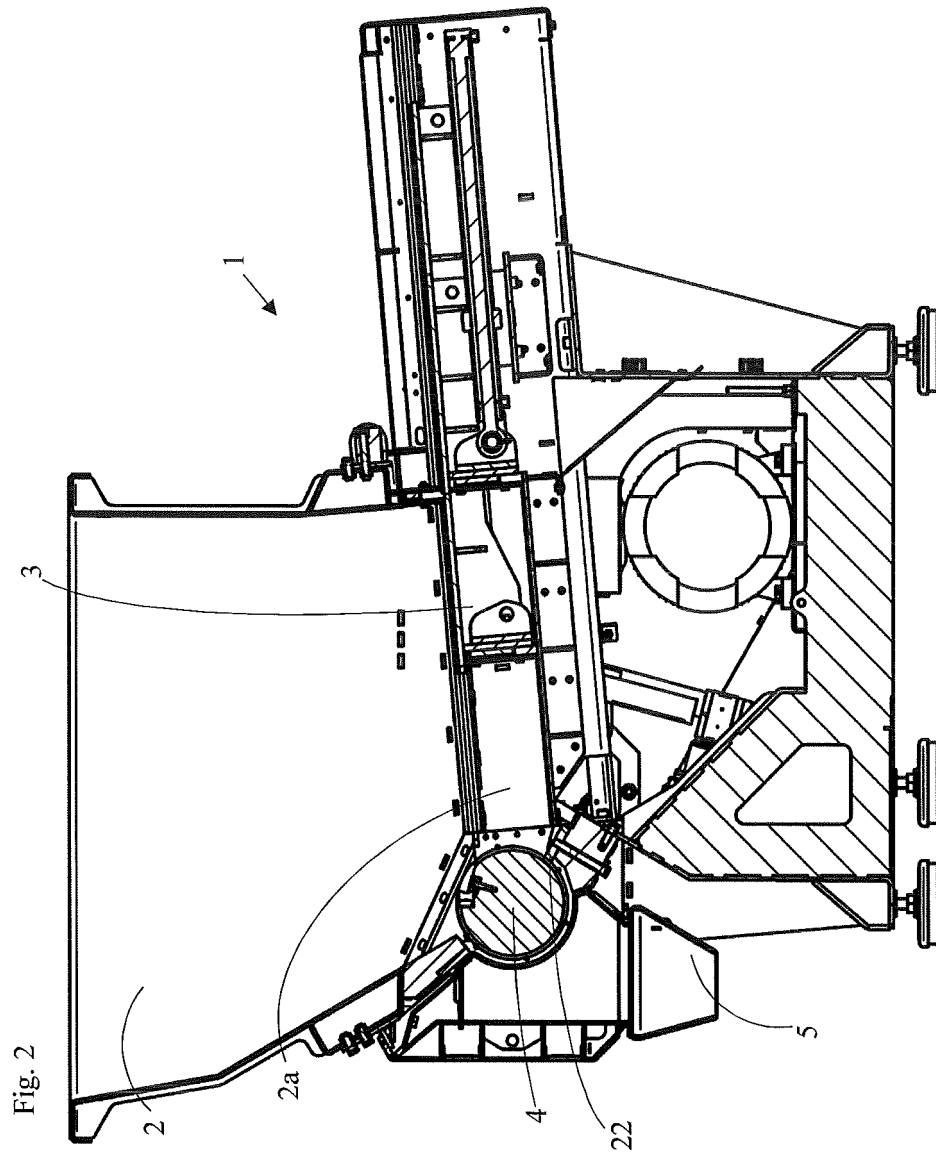
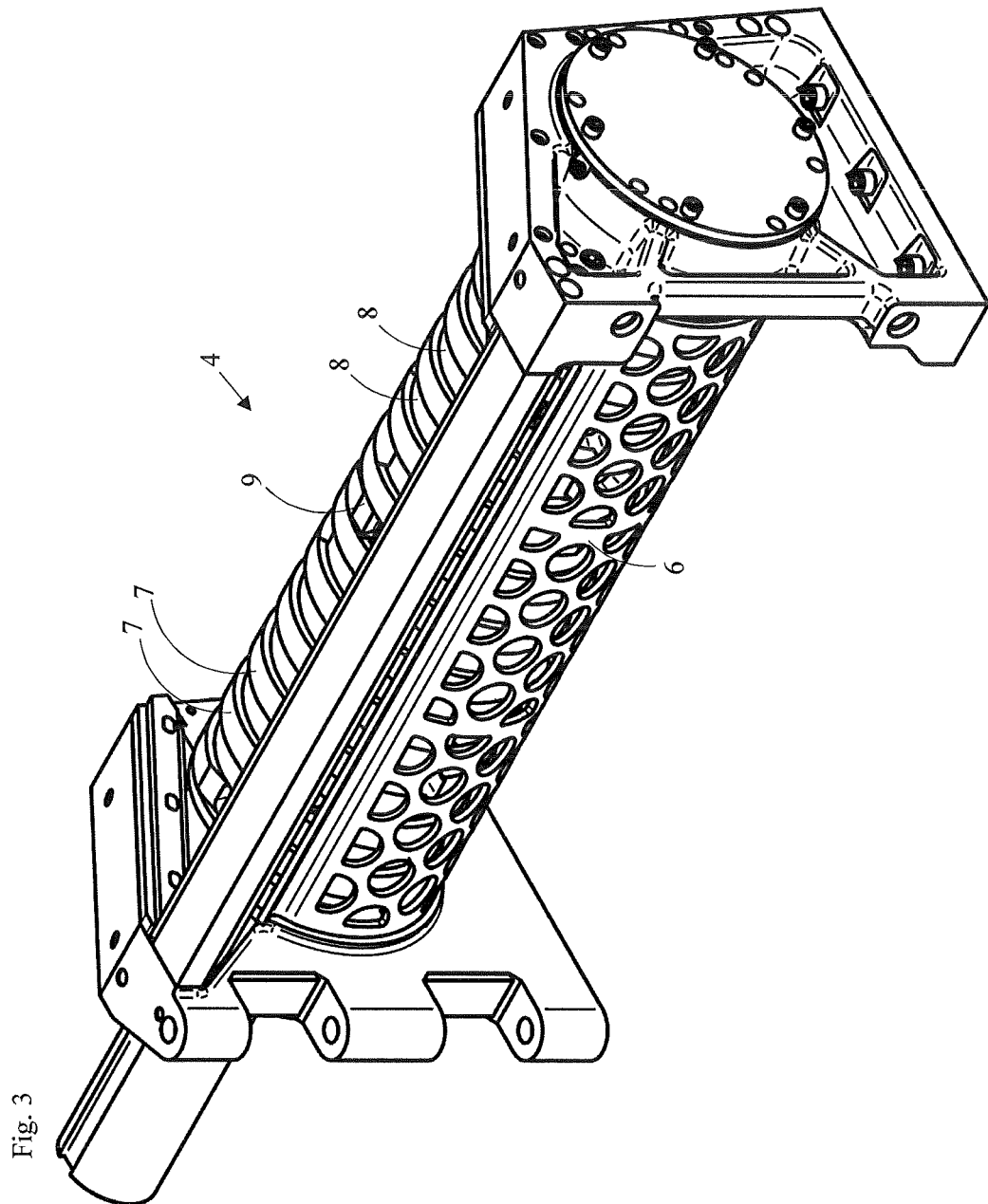


Fig. 1





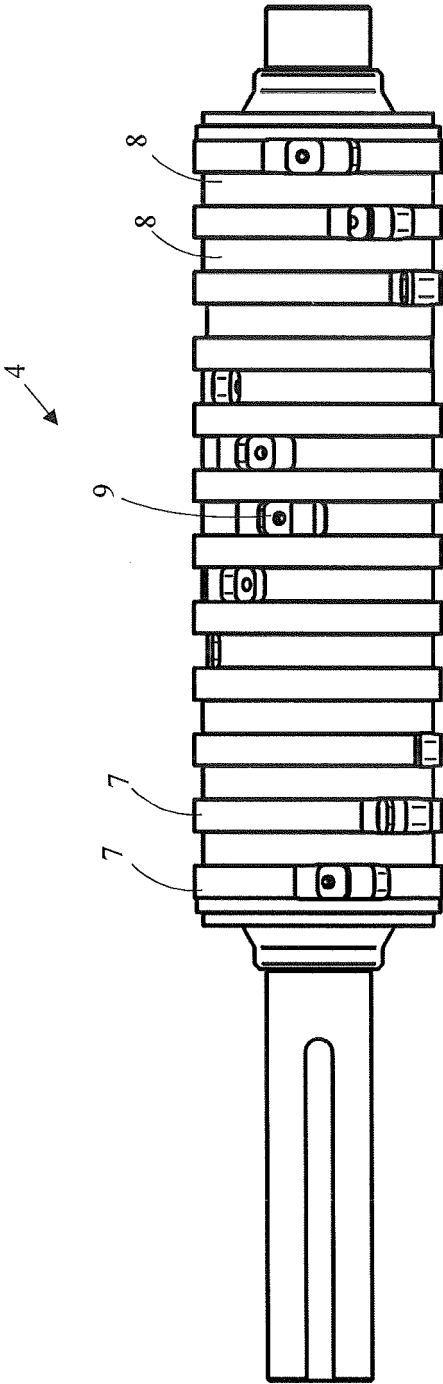


Fig. 4

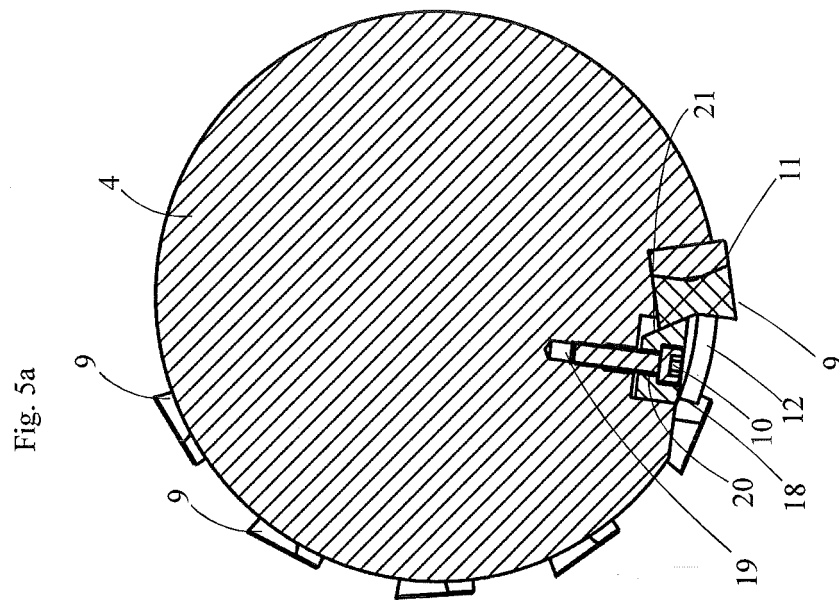
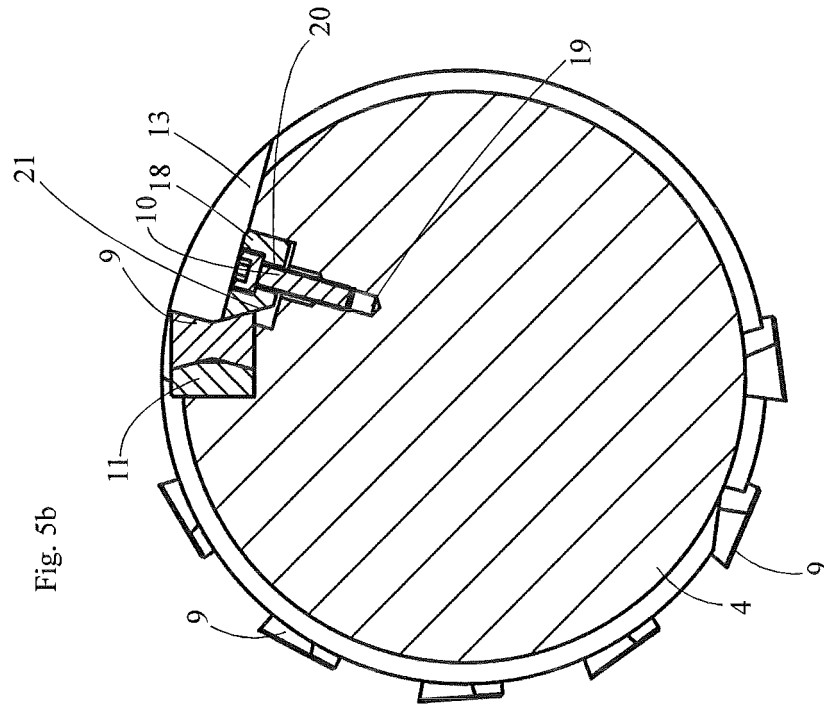


Fig. 6

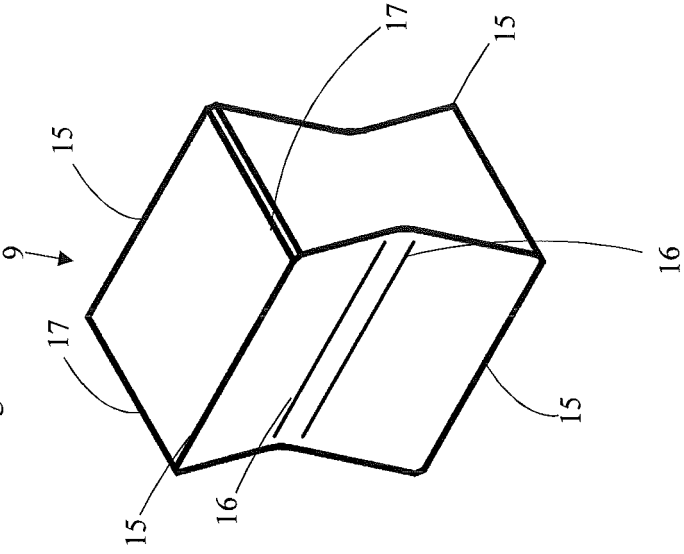
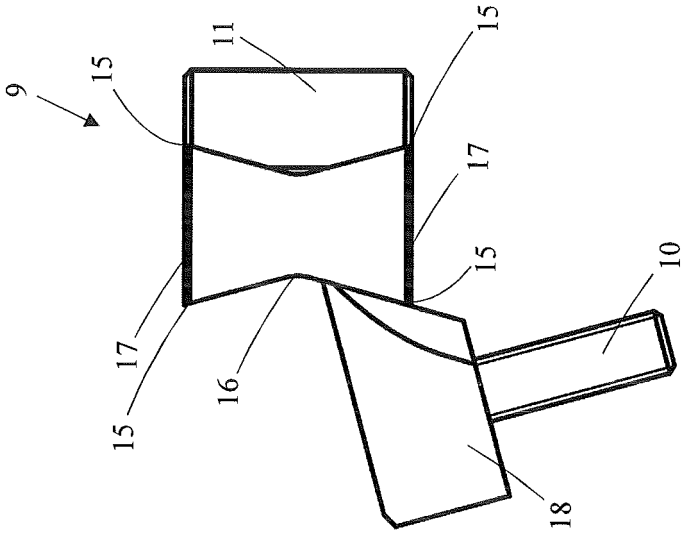


Fig. 7



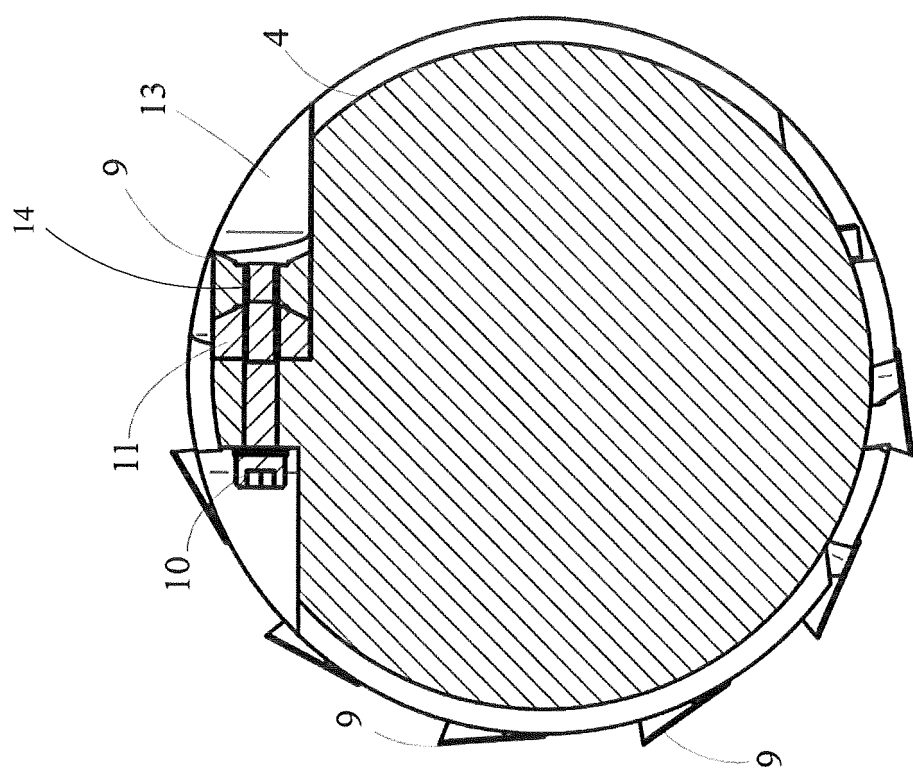


Fig. 8

REFERENCES CITED IN THE DESCRIPTION

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