(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 April 2009 (16.04.2009)

PCT

(10) International Publication Number
WO 2009/046719 A1

(51) International Patent Classification:
B02C 18/14 (2006.01) *B27L 11/02* (2006.01)

(21) International Application Number:
PCT/DK2008/000354

(22) International Filing Date: 10 October 2008 (10.10.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
07019901.3 11 October 2007 (11.10.2007) EP

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

[Continued on next page]

(54) **Title:** WOOD CHIPPING MACHINE WITH PERIPHERAL SIEVING AND DISINTEGRATION DEVICE

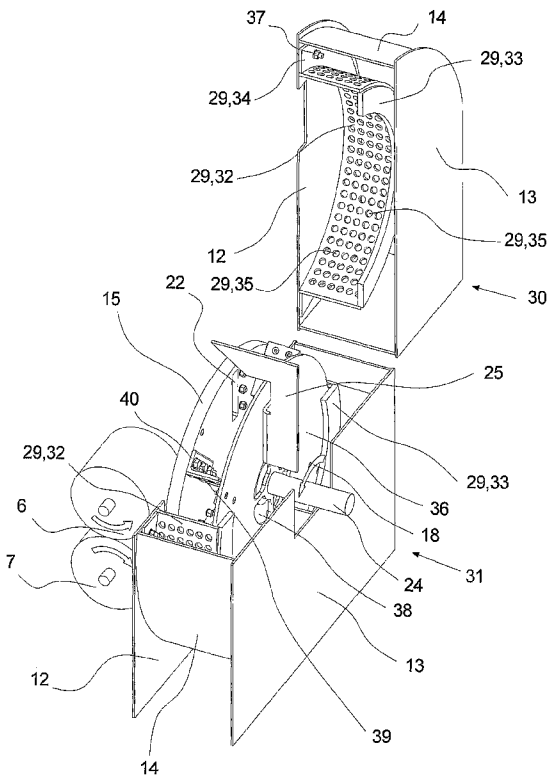


Fig. 6a

(57) **Abstract:** A wood chipping machine (1) is shown for disintegrating material (10), mainly biological material such as whole trees, branches and other forms of wooden material. The machine comprises a cutter disk (15) with one or more cutter knives (16) arranged with their cutting edges in a substantially radial plane of the disk. The cutter disk (15) is arranged in a disk housing (4) to be rotatable about its central axis and has a front side oriented towards an eccentrically positioned feed inlet of the machine. Furthermore, the machine comprises a peripheral disintegration device including one or more fixed parts that are stationary with respect to the disk housing, and one or more rotating parts that are arranged to rotate with the cutter disk during operation of the machine. The rotating parts and the fixed parts are arranged to interact with each other to sieve and disintegrate material passing towards the periphery of the disk housing.

WO 2009/046719 A1

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

WOOD CHIPPING MACHINE WITH PERIPHERAL SIEVING AND DISINTEGRATION DEVICE

The present invention relates to a wood chipping machine comprising a cutter disk arranged in a disk housing, the cutter disk comprising one or more cutter knives arranged in a substantially radial plane of the cutter disk.

BACKGROUND

Basically, there are two different principles used in wood chipping machines, both of which use a rotating rotor onto which a number of cutter knives are mounted. The rotor is driven by an external force, such as the engine of a tractor or another machine, or by an internal combustion engine or an electrical motor integrated within the wood chipping machine assembly. In both principles, the material to be chipped is fed into a feed inlet from where it is transported to the rotor either by gravitational forces ("drop feeding") or by means of a feeding device. After being chipped, the material leaves the wood chipping machine through some form of outlet pipe.

The material to be chipped is most often biological material, such as whole trees, branches or pieces of wood, but it could also be plastic, paper, ice or other materials suitable for being chipped.

Using the first principle, the rotor is formed as a cylinder with the cutter knives arranged with their cutting edges in a tangential plane of the rotor, substantially in the axially direction of the rotor. The material to be chipped is fed to the rotor in a substantially radial direction. This principle of wood chipping comprises many fine features. However, it is primarily used in very large specialized machines due to rather large construction costs.

In smaller machines, it is normal to use the second principle, in which the rotor comprises a cutter disk onto which cutter knives are mounted within or in close

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connection with chip slots formed through the disk. The material to be chipped is fed to the front side of the cutter disk in a substantially axially direction. The chipped material moves through the chip slots to the back side of the cutter disk, where a number of ejector vanes mounted on the disk make sure that the wood chips are ejected through the outlet pipe of the wood chipping machine.

Perfect wood chips are obtained when every piece of chipped material is smaller than a predefined maximum size, and there are no so-called lumps or pegs within the chipped material. Lumps and pegs are pieces of wood that are larger than the wanted maximum size of the wood chips. Contrary to a lump, which is more like a chunk of wood, a peg is oblong and often consists of a smaller branch.

In a wood chipping machine using a cutter disk, both lumps and pegs can pass through the machine without being chipped, either through a chip slot in the cutter disk or by following the front side of the cutter disk to its perimeter and passing around the edge of the disk to the back side.

US Patent no. 5,060,873 discloses a wood chipping machine having a rotating cutter disk, which comprises a plurality of fins attached to the back side of the cutter disk near the perimeter for deflecting wood chips axially away from the cutter disk. The purpose of the fins is to minimize the cross over of wood chips from the back side to the front side of the cutter disk.

An objective of the present invention is to provide a solution to the above mentioned problem of pieces of material passing through the wood chipping machine without being chipped into sufficiently small pieces.

BRIEF DESCRIPTION OF THE PRESENT INVENTION

The present invention relates to a wood chipping machine for disintegrating material, mainly biological material such as whole trees, branches and other forms of wooden material.

The wood chipping machine comprises a disk housing having an ejection opening at its periphery, a rotor arranged in the disk housing to be rotatable about its central axis and drive means for driving the rotation of the rotor. The rotor comprises a cutter disk having one or more cutter knives arranged with their cutting edges in a substantially radial plane of the cutter disk. The cutter disk has a front side oriented towards an eccentrically positioned feed inlet of the wood chipping machine. Furthermore, the rotor comprises one or more ejector vanes mounted behind the cutter disk as seen from the feed inlet, which ejector vanes extend in a substantially radial direction with respect to the cutter disk and are arranged to rotate during operation of the wood chipping machine, thus creating a centrifugal flow of air and forcing material behind the cutter disk towards the ejection opening of the disk housing.

The wood chipping machine further comprises a peripheral sieving and disintegration device including one or more fixed parts that are stationary with respect to the disk housing, and one or more rotating parts that are arranged to rotate with the rotor during operation of the wood chipping machine. The rotating parts and the fixed parts are arranged to interact with each other to sieve and disintegrate material passing towards the periphery of the disk housing on the back side of the cutter disk during operation of the wood chipping machine.

The eccentric position of the feed inlet is necessary in order to allow a drive shaft, onto which the cutter disk is mounted and by which the cutter disk is driven, to be supported by bearings at both ends, i.e. at both sides of the cutter disk, which is

crucial for making the wood chipping machine sturdy and robust enough to handle even very large pieces or chunks of wooden material, such as whole trees or branches thereof.

The term "substantially radial direction" is meant not only to include straight, radial ejector vanes but also forward curved or backward curved ejector vanes. The different shapes are all well-known from blades of centrifugal fans, giving different pressure and flow properties of the air flow produced by such fans.

Having a peripheral sieving and disintegration device is advantageous in that it prevents pieces of material from passing through the wood chipping machine to the ejection opening without being chipped into sufficiently small pieces.

Using the interaction between moving and stationary parts is a well-proven and advantageous way to disintegrate a material into smaller pieces and bits.

In a preferred embodiment of the invention, the cutting edges of the one or more cutter knives extend in a substantially radial direction with respect to the cutter disk.

Letting the cutting edges extend in a substantially radial direction is advantageous in that, when the cutter disk rotates about its central axis, the cutting edges meet the material to be chipped, which material reaches the front side of the cutter disk from the feed inlet, in a direction being substantially perpendicular to the cutting edges as well as to the feeding direction of the material.

It requires more energy to chip the material in a direction perpendicular to the feeding direction and, thereby, generally perpendicular to the grains of the wood, than it does to chip the material at a more oblique angle. Even so, a right angle is preferred due to the fact that chipping wooden material at oblique angles produces

more pegs, because the wooden material is more inclined to split, the more parallel the edges of the cutter knives are to the grains of the wood.

In a further preferred embodiment of the invention, the peripheral sieving and disintegration device comprises a sieving device and one or more cutter blades, the sieving device having a plurality of openings, and the cutter blades being arranged to interact with the edges of the openings of the sieving device to disintegrate pieces of material having too large dimensions to pass through the openings of the sieving device.

Using the interaction of a sieving device and one or more cutter blades is a well-proven and advantageous way to disintegrate a material into smaller pieces and bits.

In a preferred embodiment of the invention, the sieving device is divided into at least two parts facilitating an easy access to the rotor from a substantially radial direction.

Dividing the sieving device into at least two parts facilitates an easy access to the rotor for maintenance and repair as well as for replacement of parts that have been damaged or are simply worn out.

In an embodiment of the invention, the openings of the sieving device are placed in one or more replaceable wearing plates mounted on supports of the sieving device.

Placing the openings of the sieving device in replaceable wearing plates is advantageous in that the wearing plates can easily be replaced if they are worn out or if openings of other dimensions are wanted.

In an embodiment of the invention, the bores of the openings of the sieving device are at least partly cylindrical in shape.

Using at least partly cylindrical bores is advantageous in that circular openings can be packed closely, thus yielding a large area of flow through the plate.

In a further embodiment of the invention, the bores of the openings of the sieving device are at least partly conical in shape.

Making the bore of the openings at least partly conical is advantageous in that it improves the cutting efficiency between the cutter blades and the edges of the openings and reduces the risk of the openings getting blocked by biological material.

In preferred embodiments of the invention, the width of the openings of the sieving device is between 5 mm and 130 mm, preferably between 10 mm and 100 mm, most preferred between 15 mm and 70 mm.

The use of opening widths within the above specified ranges ensures that the dimensions of the wood chips being produced by the wood chipping machine can be held within certain predefined preferred sizes.

Also, in preferred embodiments of the invention, the total area of the openings of the sieving device is between 0.01 m^2 and 3.5 m^2, preferably between 0.05 m^2 and 0.5 m^2, most preferred between 0.1 m^2 and 0.3 m^2.

Keeping the total area of the openings within the above specified ranges makes sure that the disintegration capacity of the peripheral sieving and disintegration device is high, and that at the same time, the dividing walls of the device separating the openings can be dimensioned to be strong enough to withstand the wear that they will inevitably be subjected to during operation of the wood chipping machine.

In an advantageous embodiment of the invention, the sieving device is arranged so as to ensure that substantially all material passing towards the periphery of the disk

housing on the back side of the cutter disk during operation of the wood chipping machine is bound to pass through the sieving device.

Arranging the sieving device in a way so as to ensure that substantially all material is bound to pass through it is an advantageous and simple way of making sure that no pieces of material larger than a certain size defined by the size of the openings in the sieving device can pass through the wood chipping machine to the ejection opening.

In a preferred embodiment of the invention, at least a part of the sieving device forms at least a part of a cylindrical or conical surface.

Arranging at least a part of the sieving device to form at least a part of a cylindrical or conical surface facilitates a simple and easy interaction between the one or more cutter blades and the sieving device due to the rotational motion of the sieving device and the cutter blades relatively to each other.

In an embodiment of the invention, the sieving device is arranged to rotate with the rotor, the one or more ejector vanes are mounted near the central part of the back side of the cutter disk, and the one or more cutter blades are arranged more peripherally on the inside of the wall of the disk housing behind the cutter disk, the one or more cutter blades extending in a substantially radial direction with respect to the cutter disk.

In this case, the sieving device and the ejector vanes both rotate with the rotor during operation of the wood chipping machine, whereas the cutter blades are stationary. Therefore, it is necessary that there is a certain gap in the radial direction between the sieving device and the ejector vanes, leaving space for the cutter blades to pass between the sieving device and the ejector vanes while interacting with the sieving device as the rotor rotates.

In a preferred embodiment, the sieving device is fixed with respect to the disk housing, and the cutter blades are arranged on the back side of the cutter disk, extending in a substantially radial direction.

Using a stationary sieving device and letting the cutter blades rotate with the cutter disk is advantageous in that it enables easy solutions for replacing and repairing cutter knives, cutter blades, the sieving device, ejector vanes or other parts of the machine that might be damaged or worn out, as will be described in the detailed description below.

Again, the term "substantially radial direction" includes forward curved or backward curved cutter blades. Since the cutter blades rotating with the cutter disk will also function, at least to a certain degree, as ejector vanes forcing the material behind the cutter disk towards the sieving device and the ejection opening of the disk housing, the shape of the cutter blades can be designed according to the desired pressure and flow properties of the centrifugal air flow behind the cutter disk.

In a further preferred embodiment of the invention, the rotor further comprises a rear disk mounted behind the cutter disk as seen from the feed inlet, thus forming an internal space within the rotor between the cutter disk, the rear disk and the sieving device, the rear disk further being arranged to be rotatable with the same rotational speed as the cutter disk, parallel to and concentrically with the cutter disk.

Adding a rear disk to the rotor is advantageous in that the creation of the internal space within the rotor facilitates the flow of chipped material towards the sieving device.

In a preferred embodiment of the invention, the distance between the cutter disk and the rear disk is between 20 mm and 1000 mm, preferably between 30 mm and 350 mm, most preferred between 50 mm and 250 mm.

The distance between the cutter disk and the rear disk must be large enough to get a sufficiently large total area of the openings of the sieving device and, thus, a sufficient capacity of the sieving and disintegration device. For the same reason, the distance should at least equal the width of the openings of the sieving device. On the other hand, the distance should be kept small in order to limit the dimensions of the rotor and, thus, of the disk housing and the wood chipping machine as a whole.

The given ranges for the distance between the cutter disk and the rear disk have been found to represent good compromises with respect to the above-mentioned considerations regarding the distance.

In an advantageous embodiment of the invention, at least some of the parts of the sieving device extend in a radial direction in close proximity with the back side of the rear disk, said parts extending within the outer perimeter of the rear disk.

Letting a part of the sieving device extend in a radial direction behind the rear disk ensures that no material is leaving the internal space within the rotor by passing by the rim of the rear disk without passing through the sieving device.

In yet an advantageous embodiment of the invention, the one or more ejector vanes are mounted on the back side of the rear disk, at least a part of which ejector vanes extends in a substantially radial direction.

Mounting the ejector vanes on the back side of the rear disk and, thus, outside the sieving device facilitates the creation of a sufficient centrifugal air flow to force the chipped material towards and out through the ejection opening of the disk housing.

In an even more advantageous embodiment of the invention, one or more parts of the one or more ejector vanes further extend in a substantially axial direction being substantially parallel to the outer surface of the sieving device.

If a part of the ejector vanes extend in an axial direction parallel to the sieving device, a sweeping or pushing function of the ejector vanes is added to the centrifugal air flow forcing the chipped material towards the ejection opening.

In another aspect of the invention, it relates to a method for producing wood chips with no dimensions exceeding certain predefined maximum dimensions. This method comprises the steps of

feeding material to the front side of a rotating cutter disk of a wood chipping machine as described above, where the cutter knives of said cutter disk chip the material, and the chipped material thereupon is transported to the back side of the cutter disk through chip slots extending through the cutter disk, and

directing any material passing from the back side of the cutter disk towards the ejection opening of the disk housing through the peripheral sieving and disintegration device, where pieces of material too large to pass through the peripheral sieving and disintegration device are disintegrated.

In yet another aspect of the invention, it relates to the use of a wood chipping machine according to any of the above mentioned embodiments to produce wood chips with no dimensions exceeding certain predefined maximum dimensions.

BRIEF DESCRIPTION OF THE FIGURES

A few embodiments of the invention will be described in the following with reference to the figures in which

fig. 1 illustrates an overview of the main parts of a wood chipping machine,

fig. 2 illustrates an overview of the main parts of the feeding device and the disk housing of a wood chipping machine as known from the art,

fig. 3a illustrates a cutter disk of a wood chipping machine as seen from the front side,

fig. 3b illustrates a cutter disk of a wood chipping machine as seen from the back side,

fig. 4a illustrates a sectional view of the feeding device and the disk housing of a wood chipping machine as known from the art,

fig. 4b illustrates an enlargement of a central part of the sectional view of the feeding device and the disk housing of a wood chipping machine as shown in fig. 4a,

fig. 5a illustrates a partial sectional view of a cutter disk with a knife mounted in recesses on the front side,

fig. 5b illustrates a partial sectional view of a cutter disk with a knife mounted in a slot inside the disk,

fig. 6a illustrates an opened disk housing of a wood chipping machine according to the present invention,

fig. 6b illustrates the same opened disk housing as fig. 6a as seen from another angle,

fig. 7 illustrates the same opened disk housing as fig. 6a with some parts of the disk housing and the rotor cut away,

figs. 8a-8j is a series of illustrations showing an example of how the rotor can be assembled and arranged in the disk housing,

fig. 9 illustrates the path of wood chips passing through the disk housing of a wood chipping machine according to the present invention,

fig. 9a is an enlargement of a part of fig. 9, illustrating the path of the wood chips through the cutter disk,

fig. 9b is an enlargement of another part of fig. 9, illustrating the path of the wood chips through the sieving device,

fig. 10a illustrates a sieving device divided into an upper and a lower part having supports for wearing plates,

fig. 10b illustrates five wearing plates for a sieving device,

fig. 10c illustrates an assembly of the sieving device in fig. 10a and the wearing plates in fig. 10b,

fig. 11a illustrates a cylindrical bore through a sieving plate or wearing plate of a sieving device,

fig. 11b illustrates a conical bore through a sieving plate or wearing plate of a sieving device,

fig. 11c illustrates a partly conical, partly cylindrical bore through a sieving plate or wearing plate of a sieving device, and

fig. 11d illustrates a double-conical bore through a sieving plate or wearing plate of a sieving device.

The appended figures are provided for illustrating an embodiment of the present invention and are not intended to limit the scope of protection as defined by the claims. For instance, the present invention is not limited to wood chipping machines comprising only a single cutter disk.

DETAILED DESCRIPTION

In the following is disclosed a few embodiments of the present invention of a wood chipping machine comprising a cutter disk having one or more cutter knives arranged with their cutting edges in a substantially radial plane of the cutter disk and a peripheral sieving and disintegration device including fixed as well as rotating parts.

Fig. 1 illustrates a generalized overview of a wood chipping machine 1 comprising a feed inlet 2, a feeding device 3, a disk housing 4 and an outlet pipe 5.

During operation of the wood chipping machine 1, material 10, such as whole trees, branches or pieces of wood, which is to be disintegrated into wood chips 26, is fed into a feed inlet 2. The feeding device 3 behind the feed inlet 2 catches the material 10 and drags it towards the disk housing 4, inside which the knives 16 on a rotating cutter disk 15 chip the fed material 10 into wood chips 26. By means of ejector vanes 25 mounted behind the cutter disk 15, the wood chips 26 are expelled from the wood chipping machine 1 through the outlet pipe 5.

Fig. 2 illustrates a generalized overview of the main parts of the feeding device 3 and the disk housing 4 of a wood chipping machine 1 as known from the art.

The feeding device comprises two feed-in rollers 6, 7 rotating in opposite directions 8, 9 about parallel axes of rotation. When material 10 to be disintegrated is caught between the feed-in rollers 6, 7, the rotation 8, 9 of the rollers 6, 7 drags the material 10 in a direction 11 towards the disk housing 4. In the shown embodiment, the rotational axes of the feed-in rollers 6, 7 are horizontal. It should be noted, however, that the axes can also be vertical or form any angle with the horizontal plane as long as they are parallel.

The disk housing 4 basically comprises a front sheet 12, a back sheet 13 and a disk casing 14, enclosing a cutter disk 15 along its front side, its back side and its rim, respectively. The cutter disk 15 comprises a number of cutter knives 16 arranged with their cutting edges in a substantially radial plane on the front side of the disk 15, which is arranged with its axial direction substantially parallel to the feed-in direction 11 of the feeding device 3. In the shown embodiment, the disk housing 4 further comprises a backstop 17 arranged to hold the material 10 in position while it is being chipped by the cutter knives 16 during rotation 18 of the cutter disk 15.

Furthermore, the disk housing 4 comprises an ejector shielding 19, which is a kind of extra disk casing covering the ejection opening 20 through which the wood chips 26 are ejected 21 from the disk housing 4. The ejector shielding 19 covers the ejection opening 20 in front of the cutter disk 15 and over the rim of the disk 15 but leaves the ejection opening 20 open behind the cutter disk 15. Thus, the ejector shielding 19 ensures that material 10 on the front side of the cutter disk 15, that has not yet been disintegrated, cannot be ejected from the disk housing 15, whereas wood chips 26 on the back side of the cutter disk 15, that has already been disintegrated, is ejected through the ejection opening 20.

Fig. 3a and 3b show a cutter disk 15 as seen from the front side and the back side, respectively. In connection with each cutter knife 16, there is a chip slot 22 formed through the disk 15, through which the wood chips 26 pass from the front side to the back side of the disk 15 after being cut by a knife 16. The purpose of the edge blades 23 is to break the otherwise circular periphery of the cutter disk 15 and clean out the area between the rim of the cutter disk 15 and the disk casing 14 in order to avoid that any material 10 gets stuck in this area, where it can get very hot and even catch fire due to the friction between the stuck material 10 and the rotating cutter disk 15.

Normally, the diameter of cutter disks as known from the art are within a range from around 300 mm to around 1400 mm with the most typical diameter being around 1000 mm, but even larger cutter disks can be seen in large industrial wood chipping machines.

The cutter disk 15 is mounted on and driven by a drive shaft 24, which is again driven by some kind of drive means for driving the rotation of the rotor. These drive means may comprise an external force, such as the engine of a tractor or another machine, or an internal combustion engine or an electrical motor integrated within the wood chipping machine assembly 1. On the back side of a cutter disk 15 as known from the art, there are a number of ejector vanes 25 which, due to the rotation of the cutter disk 15, eject the wood chips 26 through the ejection opening 20 as the chips reach the back side of the disk 15 through the chip slots 22.

Cutting the material requires a relatively large force and, therefore, a certain rotational speed of the rotor. For this reason, a so-called "revolution guard" is preferably installed within the wood chipping machine 1. The "revolution guard" is an electronic device monitoring the number of revolutions per minute of the rotor and disabling the function of the feeding device 3, if the number of resolutions gets too low. This is done in order to avoid "choking" of the machine or engine driving the rotation of the rotor, because it is very difficult to start up the wood chipping

machine 1 again, if it is filled up with material 10 to be chipped. As soon as the number of revolutions is back to normal, the function of the feeding device 3 is enabled again, and the machine 1 resumes working normally.

The operational principle of a wood chipping machine 1 as known from the art using a cutter disk 15 is illustrated in figs. 4a and 4b, where fig. 4b is an enlargement of a central part of fig. 4a. The material 10 to be disintegrated is drawn into the wood chipping machine 1 by the feed-in rollers 6, 7 of the feeding device 3 towards the cutter disk 15. When the material 10 has reached the cutter disk 15, the end of the material 10 is chipped by one of the cutter knives 16 rotating with the cutter disk 15, the material 10 being held in position by the backstop 17.

The material 10 that has been chipped off and has now become wood chips 26 is forced through the chip slot 22 behind the knife 15 by the cutting force of the knife 15 and ends up at the back side of the cutter disk 15, from where it is ejected from the wood chipping machine 1 by being shovelled out by the ejector vanes 25. The small arrows in fig. 4a illustrate the flow of material 10, 26 through the machine.

Fig. 5a and fig. 5b illustrates two different principles of mounting the cutter knives 16 on the cutter disk 15. Basically, the size of the wood chips 26 is defined by the cutting height 28, i.e. the height of the edge of the knife 16 over the surface of the cutter disk 15. However, other factors can also affect the size of the wood chips 26. If, for instance, the material 10 to be disintegrated is drawn too slowly towards the cutter disk 15 by the feeding device 3, so that it does not reach the front surface of the disk 15 before it is chipped by a knife 16, the wood chips will be smaller than the maximum size defined by the cutting height 28.

In fig. 5a, a cutter knife 16 is mounted in a recess on the front side of the cutter disk 15 with the blade of the knife 16 arranged in a plane that is parallel to the front plane

of the disk 15. If needed, a spacer 27 can be mounted between the cutter knife 16 and the cutter disk 15 for adjustment of the cutting height 28.

Using the other principle, as shown in fig. 5b, the cutter knife 16 is mounted within the chip slot 22 through the cutter disk 15 along a wall of the slot 22 that is angled with respect to the radial plane of the cutter disk 15. In this case, the cutting height 28 is adjusted by sliding the knife 16 along the wall of the chip slot 22 onto which the knife 16 is mounted.

During the use of wood chipping machines 1 using a cutter disk 15 as known from the art, pieces of material 10 sometimes pass through the chip slots 22 from the front side to the back side of the cutter disk 15 without being chipped into suitable sized wood chips 26 by the cutter knives 16. This is particularly a problem with end pieces of the material 10, which can be dragged through the chip slot 22 by the knife 16 instead of being cut, because they are too short to be held in position by the backstop 17 when they are met by the edge of a knife 16.

The maximum width of a piece of material 10 passing through a chip slot 22 equals the radial width of the chip slot 22, and the maximum height of such a piece of material 10 equals the distance between the edge of the cutter knife 16 and the opposite edge of the associated chip slot 22. The maximum length of a piece of material passing through a chip slot 22 depends on the cutting height 28, the speed with which the material 10 is fed towards the cutter disk 15 by the feeding device 3 and, only if the cutter disk 15 rotates very slowly, of the rotational speed of the cutter disk 15.

In a wood chipping machine as known from the art, oversized pieces of material 10 do not only travel from the front side to the back side of the cutter disk 15 through the chip slots 22. Also, some pieces of material 10 are seen travelling along the front side of the cutter disk 15 to its periphery and passing by the rim of the cutter disk 15

to its back side. Obviously, the material 10 is not supposed to move this way around the cutter disk 15, but it is very difficult to avoid that at least a limited amount of material 10 passes along the front side of the cutter disk 15 towards the rim because of the gap between the cutter disk 15 and the front sheet 12 of the disk housing 4. This gap is necessary to make room for the cutter knives 16 which extend at least the cutting height 28 from the front side of the cutter disk 15. Also, a certain tolerance between the cutter knives 16 and the front sheet 12 is needed.

It should be noted, that it is not a workable solution just to blank off the periphery of the cutter disk 15, since this will simply cause the space between the front side of the cutter disk 15 and the front sheet 12 of the disk housing 4 to be filled up with material 10 very quickly.

A preferred embodiment of the present invention, comprising a sieving device 29 fixed to the front sheet 12 of the disk housing 4, represents a solution to the problem of oversized pieces of material 10 passing to the back side of the cutter disk 15, whether the pieces of material 10 pass through chip slots 22 or by the rim of the cutter disk 15. This embodiment, which causes all material 10 on the back side of the cutter disk 15 to pass through the sieving device 29 before it reaches the ejection opening 20 of the disk housing 4, is described in details with references to the following figures.

Figs. 6a and 6b illustrate an opened disk housing 4 of a wood chipping machine 1 according to the above-mention embodiment of the invention as seen from two different angles.

As can be seen from the figures, the disk housing 4 is divided into an upper part 30 and a bottom part 31. The same is true for the sieving device 29, which consists of three parts, namely a sieving plate 32, a sealing plate 33 and a mounting plate 34, each of which three parts are divided into an upper and a bottom part. Dividing the

disk housing 4 and the sieving device 29 into upper and bottom parts facilitates an easy access to the rotor for maintenance and repair as well as for replacement of parts that have been damaged or are simply worn out. In other embodiments of the invention, the disk housing 4 and/or the sieving device 29 can be undivided, or they can be divided into more than two parts each for easy access to the interior of the disk housing 4.

It should be noted, that in order to enable the disassembly of the sieving device 29 into its upper and bottom parts, the rotor should be rotated 90° as compared to the figure to get the ejector vane 25 out of the way.

The main part of the sieving device 29 is the sieving plate 32 containing the openings 35 of the sieving device 29. The sieving plate 32 is also the part of the sieving device 29 forming a cylindrical surface.

The sealing plate 33 is the part of the sieving device 29 that extends in a radial direction within the outer perimeter of the rear disk 36 in close proximity with the back side of the rear disk 36.

In stead of extending along the back side of the rear disk 36, the sealing plate 33 can also be placed in a recess along the back side edge of the rear disk 36, if the thickness of the rear disk 36 is large enough to leave space for such a recess.

The mounting plate 34 is used for fixing the sieving device 29 to the front sheet 12 of the disk housing 4. In the embodiment shown, the mounting plate 34 is fixed to the disk housing 4 by means of a number of bolts 37. This is advantageous because it makes it possible to replace the sieving device 29, either because of wear or because another size of openings 35 is wanted. If the mounting plate 34 were welded directly to the disk housing 4, such a replacement would not be possible without also replacing the whole front sheet 12 of the disk housing 4.

The rear disk 36 is provided with a number of air passages 38 formed through the disk 36 near its centre. These air passages 38 constitute the main inlet for the air being blown out through the ejection opening 20 and the outlet pipe 5 during operation of the wood chipping machine 1. Due to the centrifugal properties of the air flow within the rotor, which air flow forces the wood chips 26 between the cutter disk 15 and the rear disk 36 to move towards the sieving device 29, placed at the periphery of the disks 15, 36, and due to the direction of the motion of the air being sucked into the rotor through the air passages 38, the wood chips 26 are not inclined to leave the rotor through the air passages 38 during operation of the machine 1. Anyhow, the air passages 38 can be formed as a plurality of small openings, or they can be covered by a mesh in order to ensure that no material leaves the rotor this way.

In the embodiment shown in fig. 6a, the rear disk 36 has substantially the same diameter as the cutter disk 15, thus facilitating the use of a sieving plate 32 shaped as a cylindrical surface as also shown in the figure. If, instead, the rear disk 36 is chosen to have a smaller diameter than the cutter disk 15, the use of a sieving plate 32 shaped as a conical surface is facilitated. Technically, such a solution is more complicated, but it has the advantage that the wood chips 26 passing through the sieving device 29 are directed towards the back of the disk housing 4 and, thus, towards the ejector vanes 25 and the ejection opening 20 of the disk housing 4.

The cutter blades 39 are mounted between the back side of the cutter disk 15 and the front side of the rear disk 36 by means of supports 40, which serve two purposes. Apart from supporting the cutter blades 39 and keeping them in the right positions to interact properly with the sieving device 29, the supports 40 also contribute to the formation of a centrifugal flow of air within the rotor forcing the wood chips 26 towards the sieving device 29.

The cutter blades 39 interact with the edges of the openings 35 of the sieving device 29 to disintegrate the wood chips 26, until the wood chips 26 have been divided into pieces small enough to pass through the openings 35. In order to achieve a proper disintegration between the cutter blades 39 and the sieving device 29, it is necessary to keep a rather tight tolerance between the cutter blades 39 and the sieving device 29.

In another embodiment of the invention, the cutter blades 39 extend towards the feed inlet 2 of the wood chipping machine 1 through recesses cut out from the rim of the cutter disk 15. In this way, also the part of the sieving plate 32 surrounding the rim of the cutter disk 15 can be used for disintegrating and sieving the wood chips 26.

Also, an ejector vane 25 extending in two directions perpendicular to each other is shown in figs. 6a and 6b, mounted to the back side of the rear disk 36. The reason for the shown ejector vane 25 to be cut of in an oblique angle is to make room for reinforcement of the connection between the sieving plate 32 and the mounting plate 34 of the sieving device 29, should it be necessary.

The cutter knives 16 are mounted in a plane parallel to the radial plane of the cutter disk 15, each in close proximity with a chip slot 22.

Fig. 7 illustrates the same opened disk housing as shown in fig. 6a, only with some parts of the disk housing 4, the sieving device 29 and the rotor cut away. First and foremost, this makes the interaction between the cutter blades 39 and the sieving plate 32 visible, but also the mounting of the cutter blades 39 on their supports 40 and the mounting of the supports 40 between the cutter disk 15 and the rear disk 36 are more easily seen than in fig 6a.

Figs. 8a-8j is a series of illustrations showing an example of how the rotor can be assembled and arranged in the disk housing 4.

Figs. 8a and 8b illustrate a cutter disk 15 as known from the art as seen from the front side and from the back side, respectively. The cutter disk 15, which is mounted on a drive shaft 24, comprises cutter knives 16, chip slots 22 and edge blades 23.

In fig. 8c, the supports 40 for the cutter blades 39 have been bolted to the back side of the cutter disk 15, and in fig. 8d, the cutter blades 39 have been bolted to their respective supports 40.

In fig. 8e, the rear disk 36 has been mounted to the free ends of the cutter blade supports 40, and in fig. 8f, the ejector vanes 25 have been mounted to the back side of the rear disk 36.

Fig. 8g illustrates the two parts of the sieving device 29, each comprising a part of the sieving plate 32, the sealing plate 33 and the mounting plate 34.

In fig. 8h, the two parts of the sieving device 29 have been mounted to the corresponding parts of the front sheet 12 of the disk housing 4, and the two parts 12, 29 have been assembled around the rotor.

Finally, in fig. 8i, the upper and bottom parts of the disk casing 14 has been mounted, leaving open the ejection opening 20 of the disk housing 4, and in fig. 8j, the two parts of the back sheet 13 of the disk housing 4 has been mounted to close the disk housing 4.

Fig. 9 illustrates a disk housing 4 with some parts cut away to show the path of wood chips 26a, 26b passing through the disk housing 4 of a wood chipping machine 1 according to the present invention.

Figs. 9a and 9b are enlargements of parts of fig. 9, illustrating the path of the wood chips 26a, 26b through the cutter disk 15 and through the sieving device 29, respectively.

It should be noted that in figs. 9, 9a and 9b, the reference number 26, generally referring to wood chips, has been split up into two reference numbers 26a and 26b, referring to wood chips 26a containing oversized pieces and perfect wood chips 26b with no oversized pieces, respectively.

In fig. 9a, it is seen how wood chips 26a pass through a chip slot 22 from the front side to the back side of the cutter disk 15 after having been chipped by a cutter knife 16. Furthermore, this figure clearly shows the bolts 41 with which the cutter knives 16 are mounted to the cutter disk 15.

Figure 9b similarly illustrates how oversized pieces of wood chips 26a are disintegrated between a cutter blade 39 and the sieving plate 32, whereupon they pass through openings 35 of the sieving device 29, now being referred to as perfect wood chips 26b. Furthermore, this figure clearly shows the bolts 42 with which the cutter blade supports 40 are mounted to the back side of the cutter disk 15, and the bolts 43, with which the cutter blades 39 are mounted to the supports 40.

The small arrows in the figures illustrate the flow direction of material 10, 26a, 26b passing through the disk housing 4.

Figs. 10a-10c illustrate another embodiment of a sieving device 29, in which the sieving plate 32 is replaced by of a number of replaceable wearing plates 45 mounted on supports 44 placed between the sealing plate 33 and the mounting plate 34 of the sieving device 29.

Fig. 10a illustrates a sieving device 29 divided into an upper and a lower part without the wearing plates 45, fig. 10b illustrates five wearing plates 45, and fig. 10c illustrates the assembled sieving device 29 with the wearing plates 45 mounted on the supports 44 by means of countersunk bolts 46.

Since the segments 32-34 of the sieving device 29 are relative expensive and, furthermore, rather cumbersome to replace, a solution like the one illustrated in figs. 10a-10c with replaceable wearing plates 45 mounted on a number of supports 44 is very advantageous in that the wearing plates can easily be replaced when needed.

Because the wear only takes place along one side of the openings 35 during operation of the wood chipping machine 1, the wearing plates 45 can be turned around once, if the design allows so, when the edges on one side of the openings 35 are worn down.

It is easy to change the dimensions of the openings 35 of the sieving device 29, or the wearing plates 45 can simply be omitted, leaving the sieving device 29 without a sieving plate 32, if a larger capacity of the wood chipping machine 1 is desired. This, of course, will result in a lower quality of the wood chips 26 produced.

The wearing plates 45 can be made from a material that can be hardened, which will prolong the lifetime of the plates and make it possible to use thinner plates due to the higher strength provided by the hardening.

It is much easier to replace the wearing plates 45, when they are worn out, than to replace all the larger segments 32-34 of a sieving device 29 without replaceable wearing plates 45.

The cutting efficiency between the cutter blades and the edges of the openings 35 of the sieving device 29 depends on a number of factors, among which are the shape of

the openings 35, the thickness of the sieving plate 32 or the wearing plate 45, and the shape of the bore of the openings 35 through the sieving plate 32 or the wearing plate 45.

As for the shape of the openings 35, it has been found that circular openings 35 are to be preferred for a number of reasons: they can be packed closely, thus yielding a large area of flow through the plate 32, 45 in a small place, they are stronger than openings 35 with corners, in which cracks tend to be formed, and they can be sharpened by use of a drill, leaving the openings 35 a little bit larger than before the sharpening.

The thinner the plate 32, 45, the sharper and the weaker it will be. Even if a very thin plate 32, 45 is very sharp when it is new, the edges of the openings 35 will soon be deformed and the efficiency will be reduced.

Figs. 11a-11d illustrate different shapes of the bore of the openings 35 through the sieving plate 32 or wearing plate 45 of a sieving device 29.

By bevelling the edges of the openings 35 all the way from the back side to the front side of the plate 32, 45, i.e. from the side turning away from the cutter blades 39 to the side turning against the cutter blades 39, a normal cylindrical bore as illustrated in fig. 11a will be changed to a conical bore as illustrated in fig. 11b.

Conical bores have at least two advantages: due to the shape, the bores will be less likely to be blocked by biological material, and the edges with which the cutter blades 39 interact will be sharper, thus increasing the cutting efficiency. The sharper the edge, the better the cutting efficiency, but also the larger the tendency to deformation and general weakness along the edges.

When using thicker plates 32, 45, a part of the bores can be left cylindrical, as illustrated in fig. 11c, in order to avoid overlaps between the openings 35 on the back side of the plates 32, 45 without having a very large distance between the openings 35.

Fig. 11d illustrates a double-conical bore giving both the advantage of a sharp edge for increasing the cutting efficiency and the advantage of a conical bore reducing the risk of blockage by biological material without getting very large openings 35 on the back side of the plate 32, 45.

REFERENCE LIST

In the drawings, the reference numbers refer to:

1. Wood chipping machine
2. Feed inlet
3. Feeding device
4. Disk housing
5. Outlet pipe
6. Upper feed-in roller
7. Lower feed-in roller
8. Rotational direction of upper feed-in roller
9. Rotational direction of lower feed-in roller
10. Material to be disintegrated
11. Feed-in direction of material to be disintegrated
12. Front sheet of disk housing
13. Back sheet of disk housing
14. Disk casing
15. Cutter disk
16. Cutter knife

17. Backstop
18. Rotational direction of cutter disk
19. Ejector shielding
20. Ejection opening
21. Ejection direction for wood chips
22. Chip slot through cutter disk
23. Edge blade on cutter disk
24. Drive shaft for cutter disk
25. Ejector vane
26. Wood chips
26a. Wood chips containing oversized pieces
26b. Perfect wood chips with no oversized pieces
27. Spacer for adjustment of cutting height
28. Cutting height
29. Sieving device
30. Upper part of disk housing
31. Bottom part of disk housing
32. Sieving plate
33. Sealing plate for sieving device
34. Mounting plate for sieving device
35. Opening of sieving device
36. Rear disk
37. Bolt for fixing sieving device
38. Air passage through rear disk
39. Cutter blade
40. Support for cutter blade
41. Bolt for mounting cutter knife
42. Bolt for mounting support for cutter blade
43. Bolt for mounting cutter blade
44. Support for replaceable wearing plates

45. Replaceable wearing plate for sieving device
46. Bolt for mounting replaceable wearing plate

CLAIMS

1. A wood chipping machine (1) for disintegrating material (10), mainly biological material such as whole trees, branches and other forms of wooden material, comprising

a disk housing (4) having an ejection opening (20) at its periphery,

a rotor, arranged in the disk housing to be rotatable about its central axis, the rotor comprising

a cutter disk (15) having one or more cutter knives (16) arranged with their cutting edges in a substantially radial plane of the cutter disk, the cutter disk having a front side oriented towards an eccentrically positioned feed inlet (2) of the wood chipping machine, and

one or more ejector vanes (25) mounted behind the cutter disk as seen from the feed inlet, which ejector vanes extend in a substantially radial direction with respect to the cutter disk and are arranged to rotate during operation of the wood chipping machine, thus creating a centrifugal flow of air and forcing material behind the cutter disk towards the ejection opening of the disk housing, and

drive means for driving the rotation of the rotor,

characterized in that

the wood chipping machine further comprises a peripheral sieving and disintegration device (29, 32-35, 39-40) including

one or more fixed parts that are stationary with respect to the disk housing, and

one or more rotating parts that are arranged to rotate with the rotor during operation of the wood chipping machine,

the rotating parts and the fixed parts of the peripheral sieving and disintegration device being arranged to interact with each other to sieve and disintegrate material passing towards the periphery of the disk housing on the back side of the cutter disk during operation of the wood chipping machine.

2. A wood chipping machine according to claim 1, wherein the cutting edges of the one or more cutter knives extend in a substantially radial direction with respect to the cutter disk.

3. A wood chipping machine according to claim 1 or 2, wherein the peripheral sieving and disintegration device comprises a sieving device (29) and one or more cutter blades (39), the sieving device having a plurality of openings (35), and the cutter blades being arranged to interact with the edges of the openings of the sieving device to disintegrate pieces of material (10, 26, 26a) having too large dimensions to pass through the openings of the sieving device.

4. A wood chipping machine according to claim 3, wherein the sieving device is divided into at least two parts facilitating an easy access to the rotor from a substantially radial direction.

5. A wood chipping machine according to claim 3 or 4, wherein the openings of the sieving device are placed in one or more replaceable wearing plates mounted on supports of the sieving device (45).

6. A wood chipping machine according to any of claims 3-5, wherein the bores of the openings of the sieving device are at least partly cylindrical in shape.

7. A wood chipping machine according to any of claims 3-6, wherein the bores of the openings of the sieving device are at least partly conical in shape.

8. A wood chipping machine according to any of claims 3-7, wherein the width of the openings of the sieving device is between 5 mm and 130 mm, preferably between 10 mm and 100 mm, most preferred between 15 mm and 70 mm.

9. A wood chipping device according to any of claims 3-8, wherein the total area of the openings of the sieving device is between 0.01 m^2 and 3.5 m^2, preferably between 0.05 m^2 and 0.5 m^2, most preferred between 0.1 m^2 and 0.3 m^2.

10. A wood chipping machine according to any of claims 3-9, wherein the sieving device is arranged so as to ensure that substantially all material passing towards the periphery of the disk housing on the back side of the cutter disk during operation of the wood chipping machine is bound to pass through the sieving device.

11. A wood chipping machine according to any of claims 3-10, wherein at least a part of the sieving device forms at least a part of a cylindrical or conical surface (32).

12. A wood chipping machine according to any of claims 3-11, wherein the sieving device is arranged to rotate with the rotor, the one or more ejector vanes are mounted near the central part of the back side of the cutter disk, and the one or more cutter blades are arranged more peripherally on the inside of the wall (13) of the disk housing behind the cutter disk, the one or more cutter blades extending in a substantially radial direction with respect to the cutter disk.

13. A wood chipping machine according any of claims 3-11, wherein the sieving device is fixed with respect to the disk housing, and the cutter blades are arranged on the back side of the cutter disk, extending in a substantially radial direction.

14. A wood chipping machine according to claim 13, wherein the rotor further comprises a rear disk (36) mounted behind the cutter disk as seen from the feed inlet, thus forming an internal space within the rotor between the cutter disk, the rear disk and the sieving device, the rear disk further being arranged to be rotatable with the same rotational speed as the cutter disk, parallel to and concentrically with the cutter disk.

15. A wood chipping device according to claim 14, wherein the distance between the cutter disk and the rear disk is between 20 mm and 1000 mm, preferably between 30 mm and 350 mm, most preferred between 50 mm and 250 mm.

16. A wood chipping machine according to claim 14 or 15, wherein at least some of the parts (33) of the sieving device extend in a radial direction in close proximity with the back side of the rear disk, said parts extending within the outer perimeter of the rear disk.

17. A wood chipping machine according to any of the claims 14-16, wherein the one or more ejector vanes are mounted on the back side of the rear disk, at least a part of which ejector vanes extends in a substantially radial direction.

18. A wood chipping machine according to claim 17, wherein one or more parts of the one or more ejector vanes further extend in a substantially axial direction being substantially parallel to the outer surface of the sieving device.

19. A method for producing wood chips with no dimensions exceeding certain predefined maximum dimensions, the method comprising the steps of

feeding material to the front side of a rotating cutter disk of a wood chipping machine according to any of claims 1-18, where the cutter knives of said cutter disk chip the material, and the chipped material thereupon is transported to the back side of the cutter disk through chip slots extending through the cutter disk, and

directing any material passing from the back side of the cutter disk towards the ejection opening of the disk housing through the peripheral sieving and disintegration device, where pieces of material too large to pass through the peripheral sieving and disintegration device are disintegrated.

20. The use of a wood chipping machine according to any of claims 1-18 to produce wood chips with no dimensions exceeding certain predefined maximum dimensions.

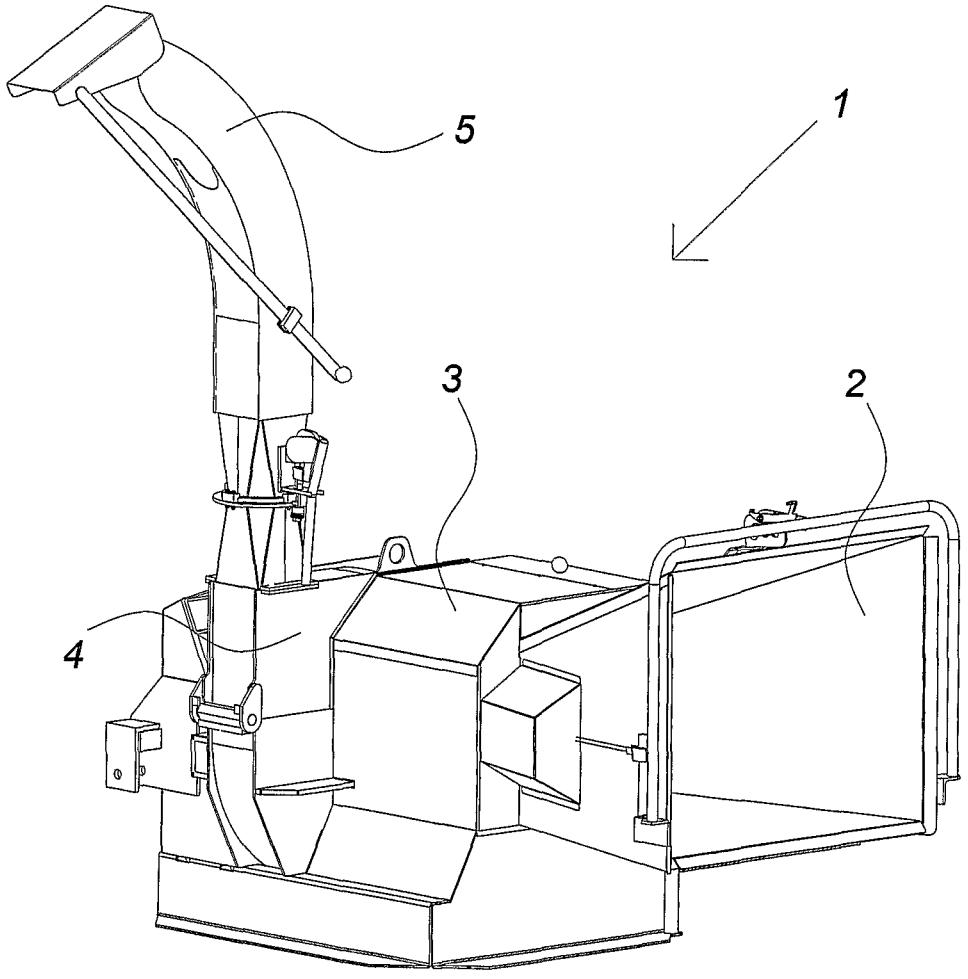


Fig. 1

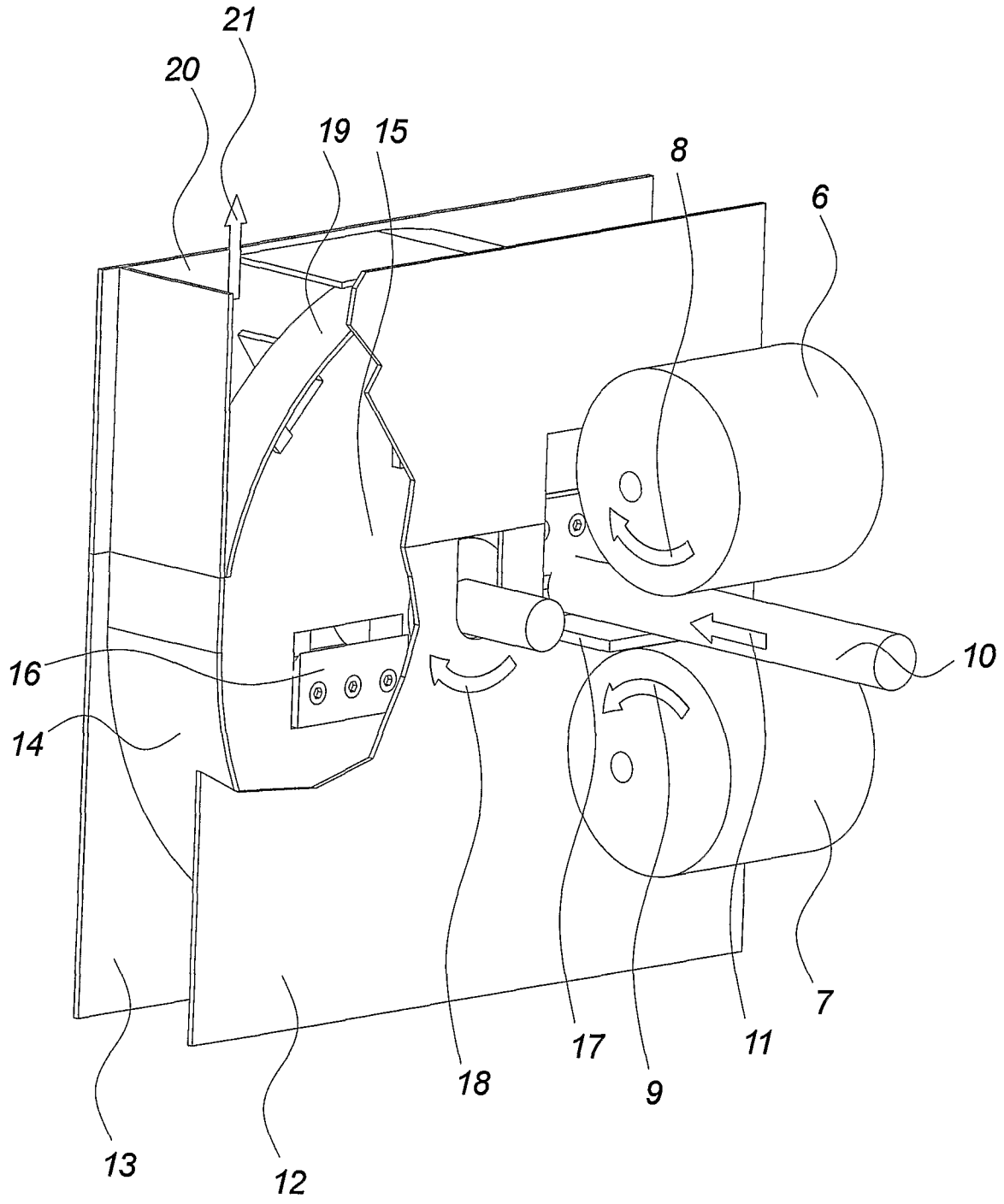


Fig. 2

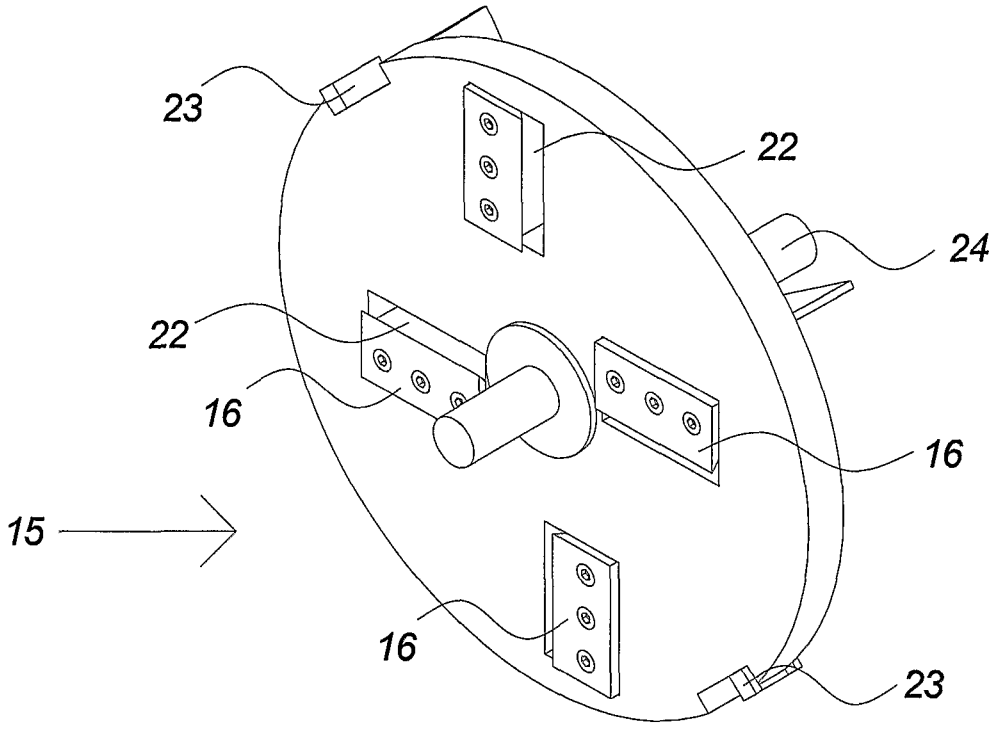


Fig. 3a

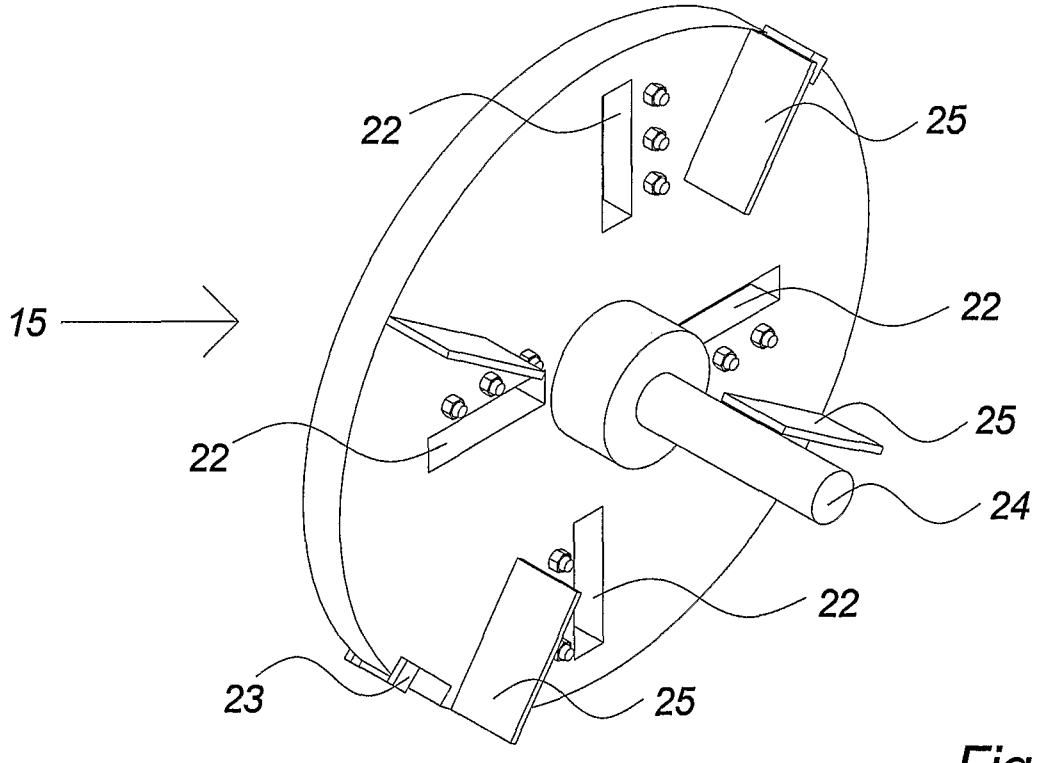


Fig. 3b

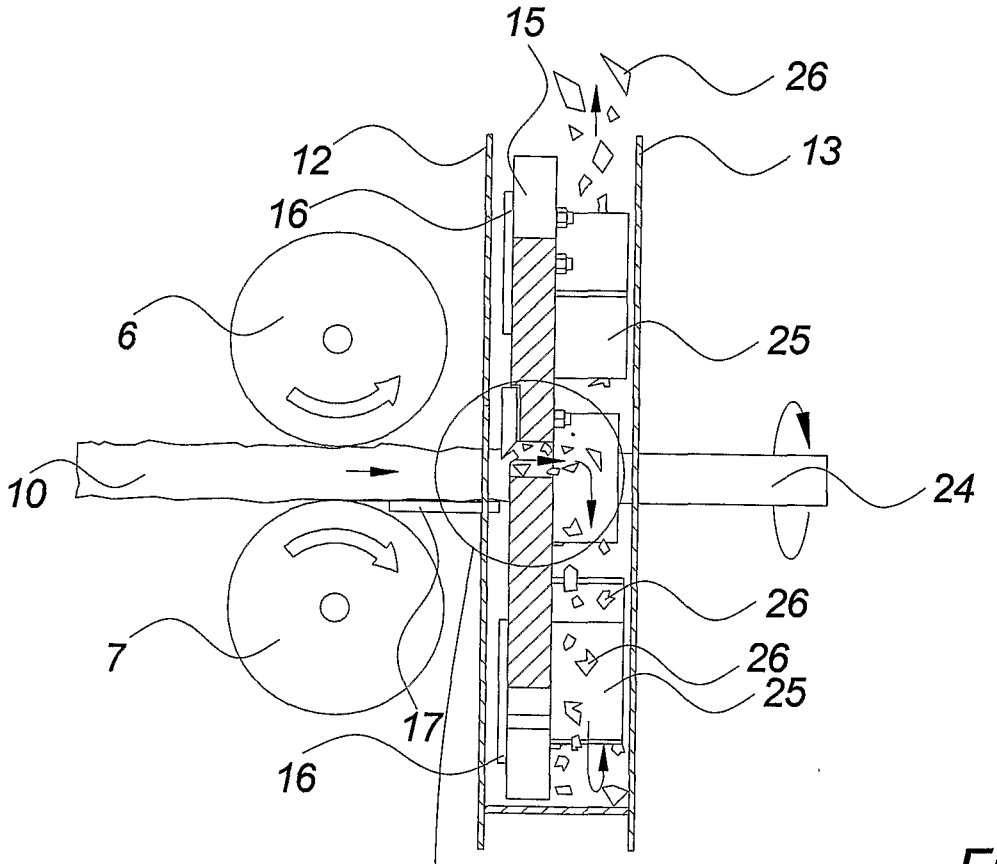


Fig. 4a

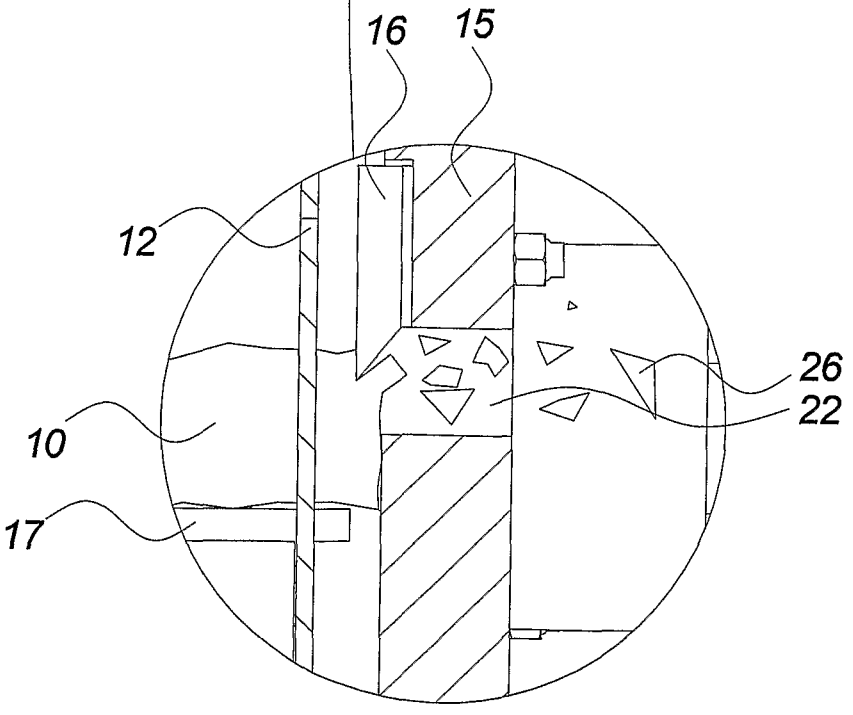


Fig. 4b

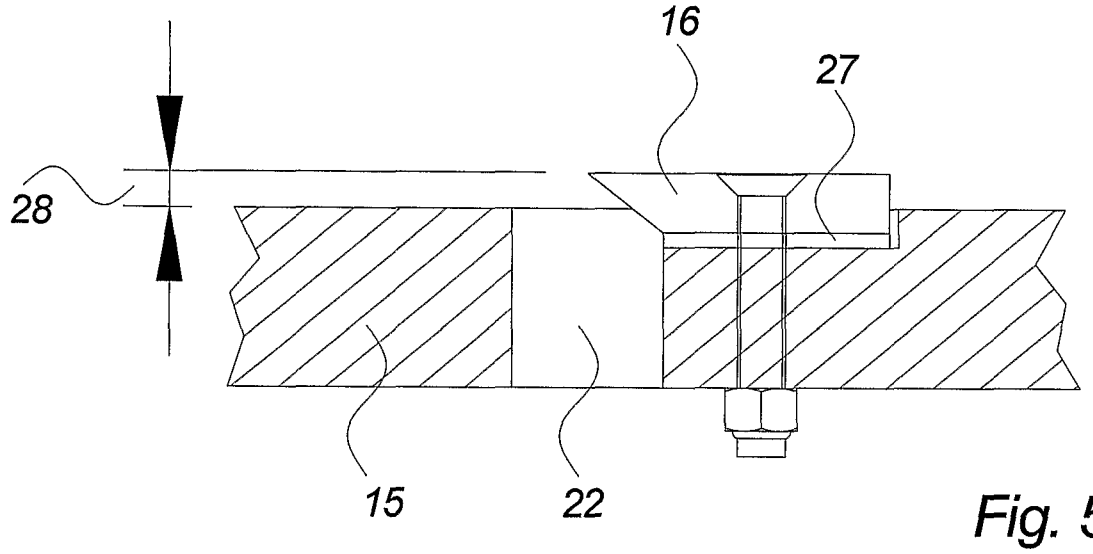


Fig. 5a

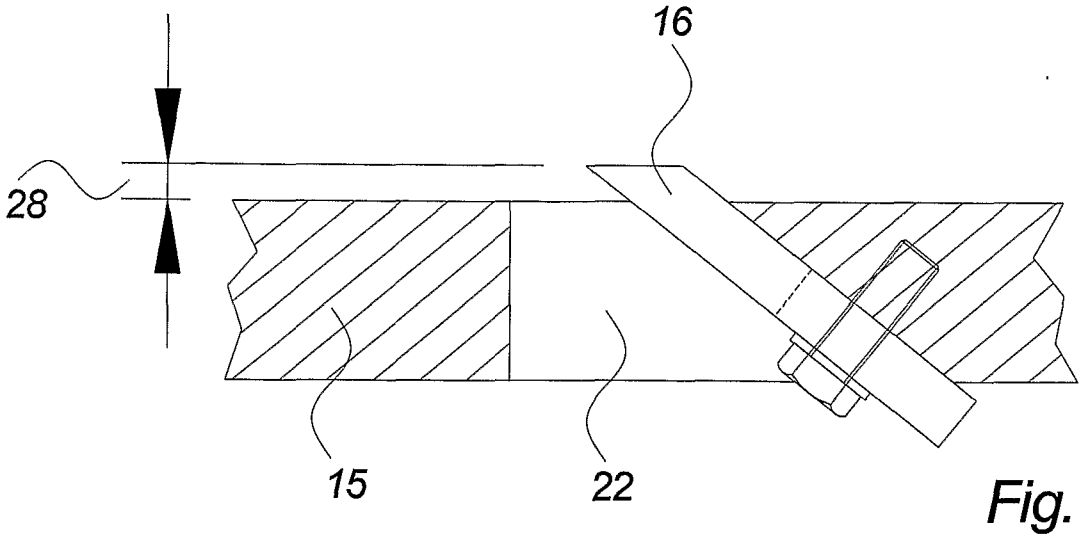


Fig. 5b

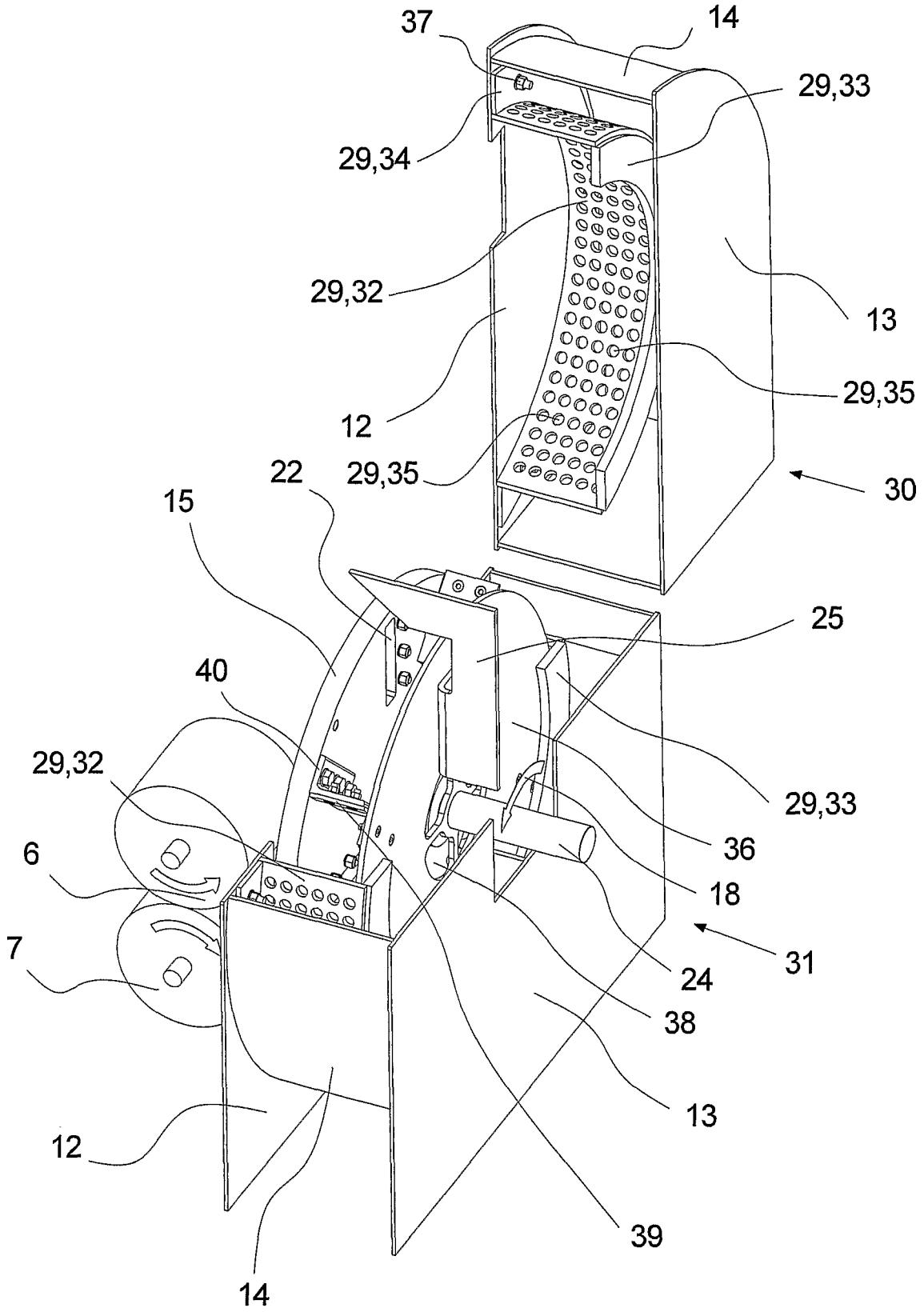

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Fig. 6a

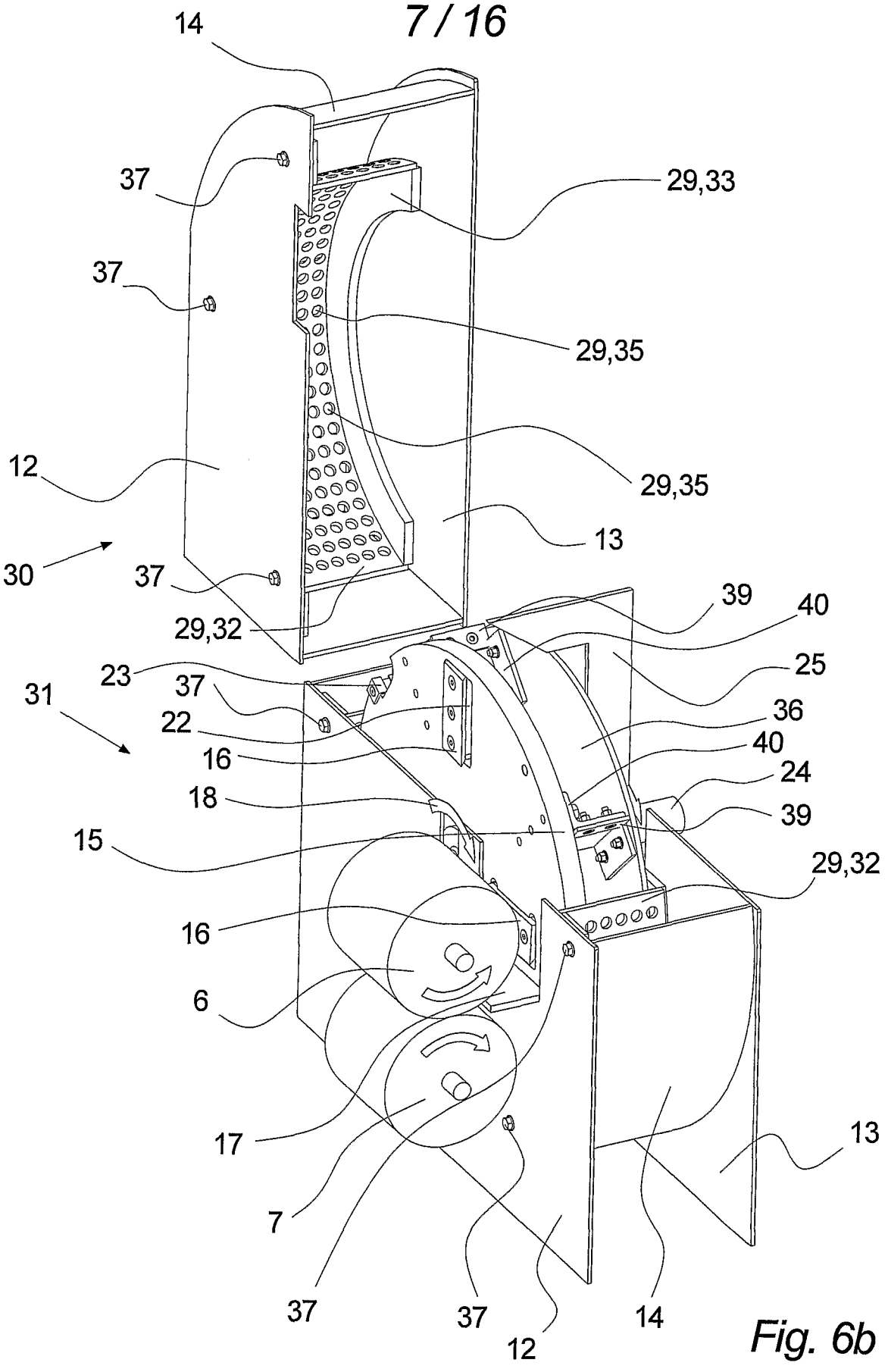

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Fig. 6b

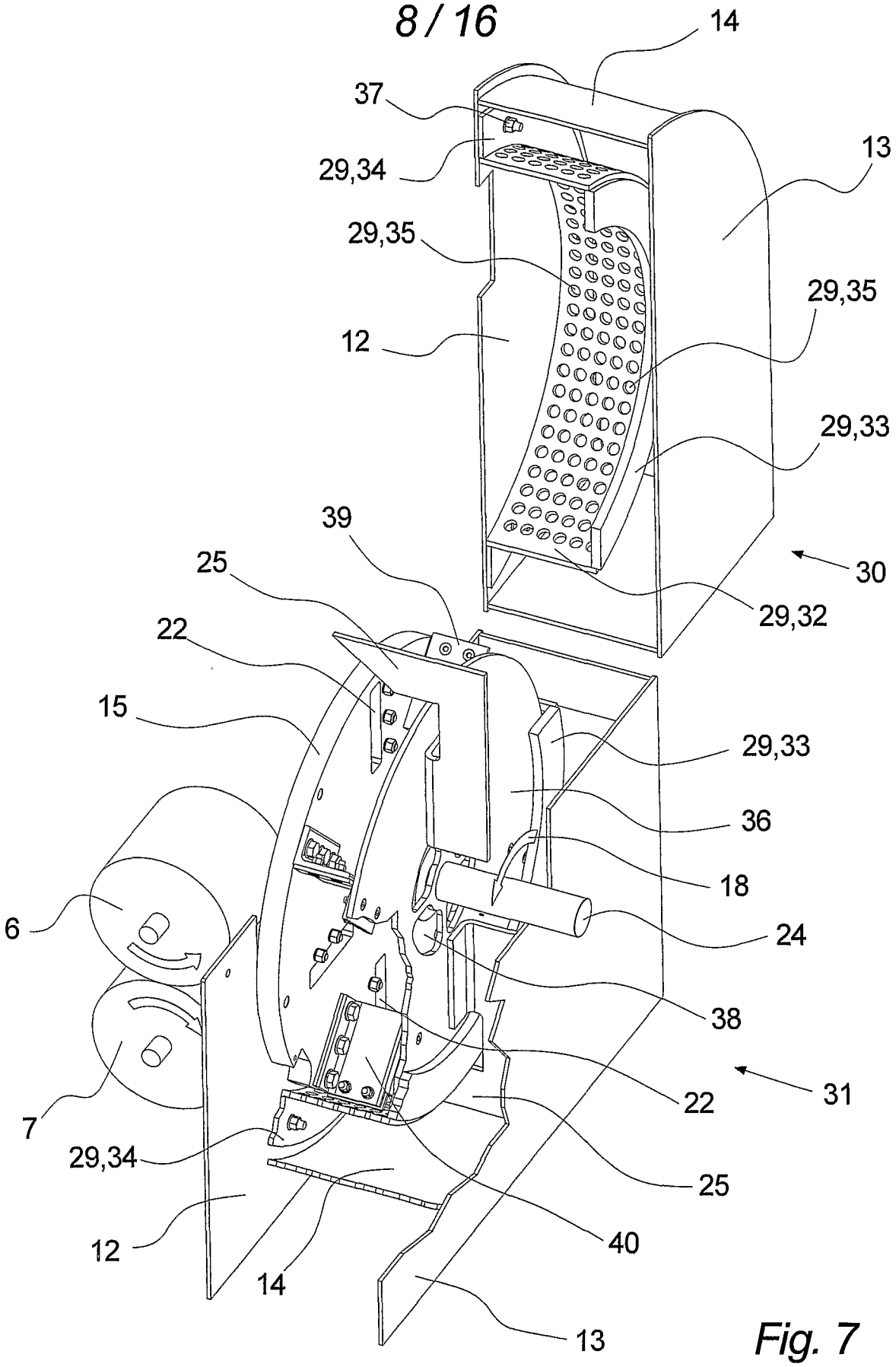

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Fig. 7

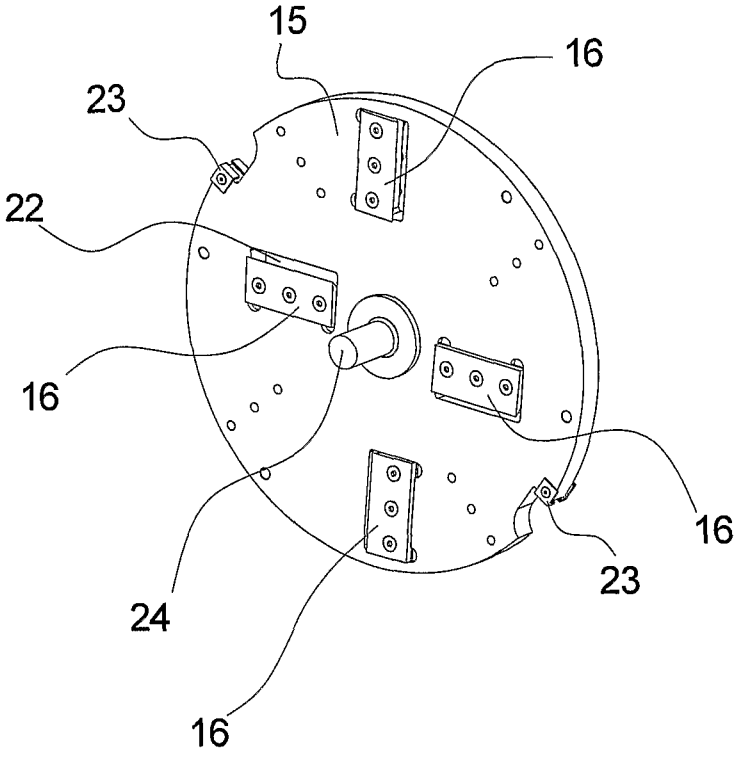


Fig. 8a

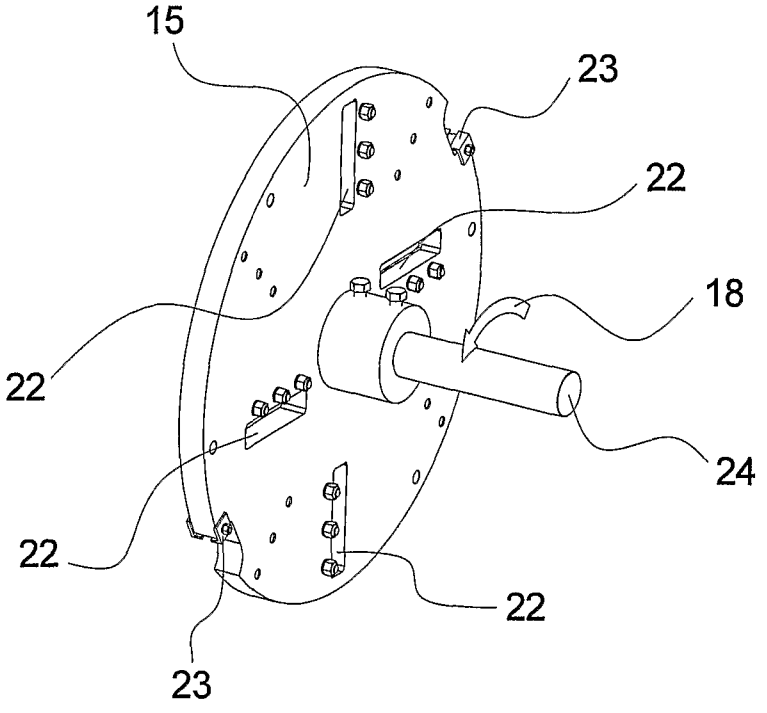


Fig. 8b

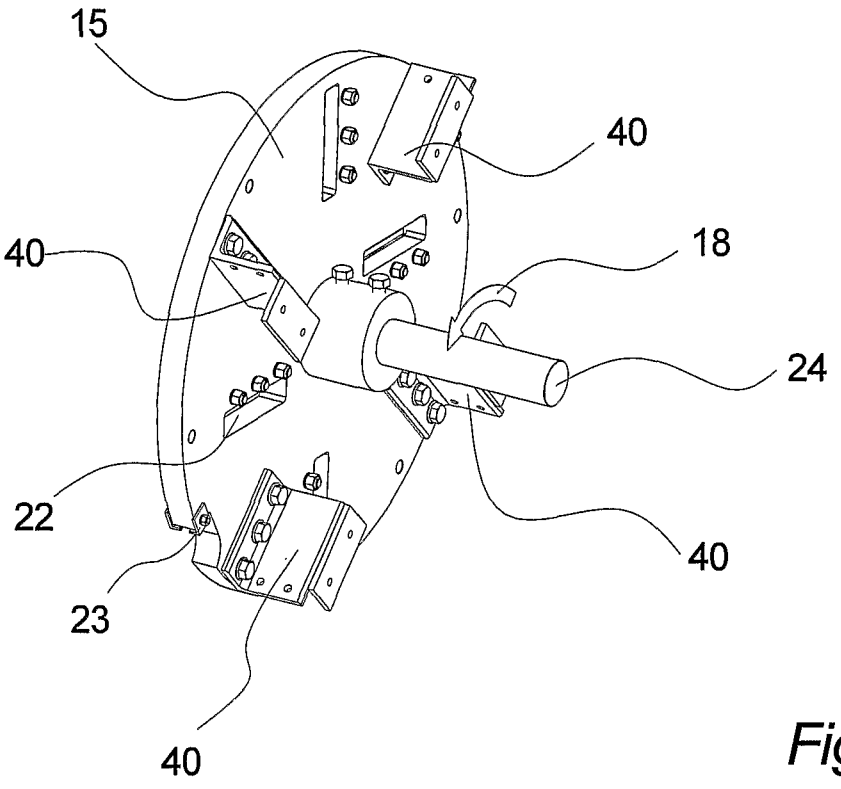


Fig. 8c

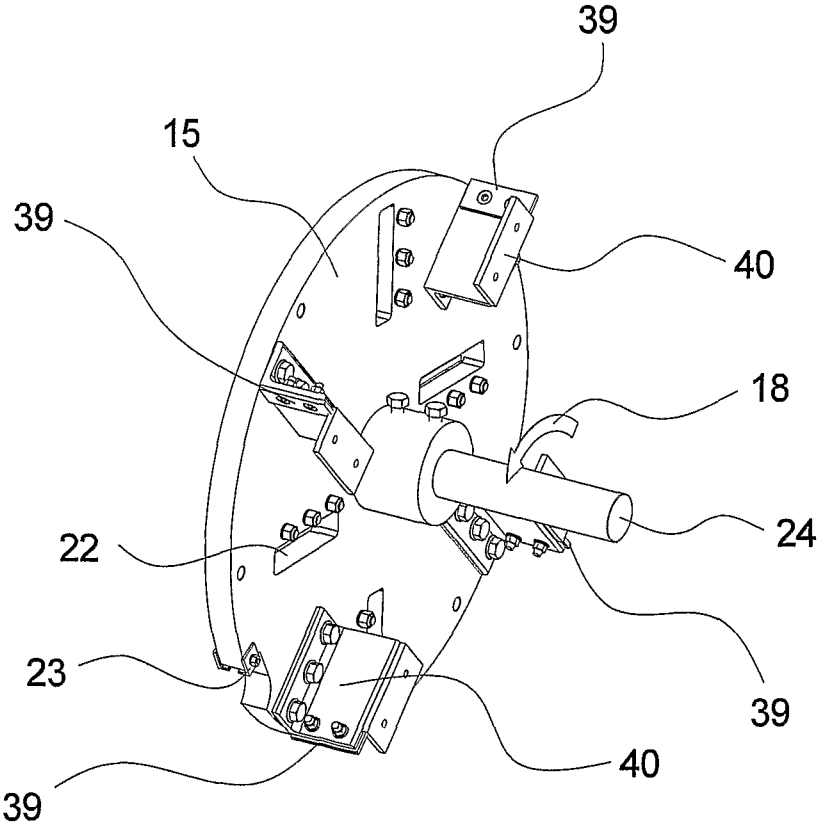


Fig. 8d

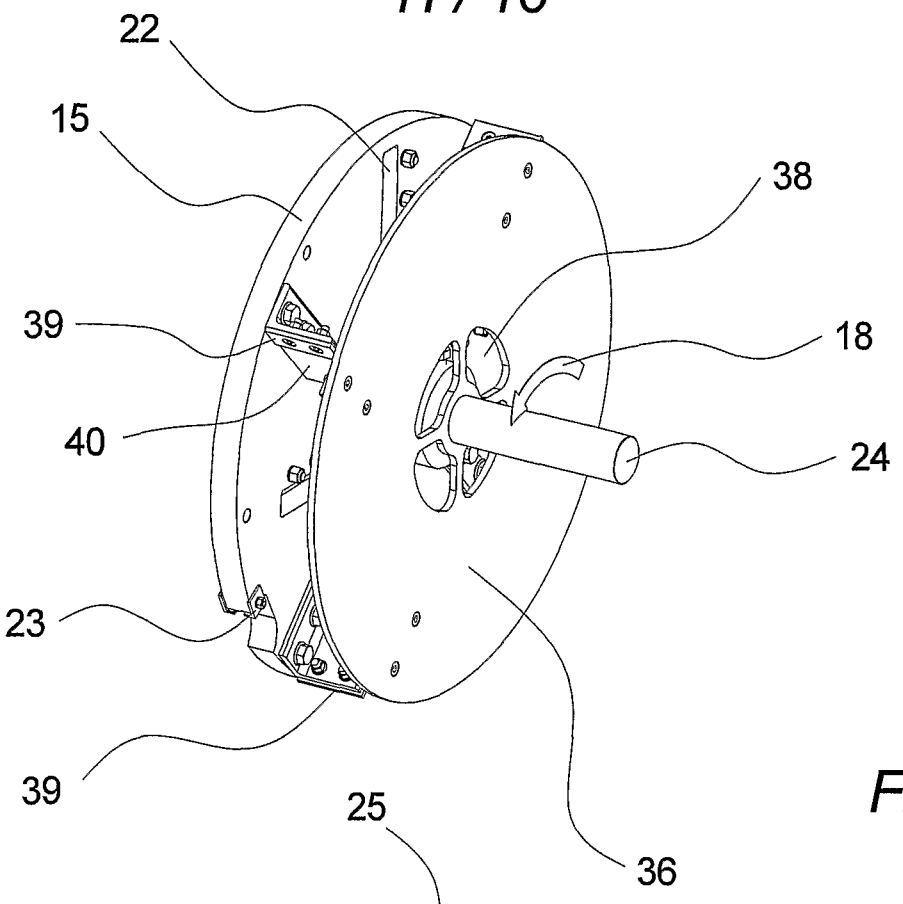


Fig. 8e

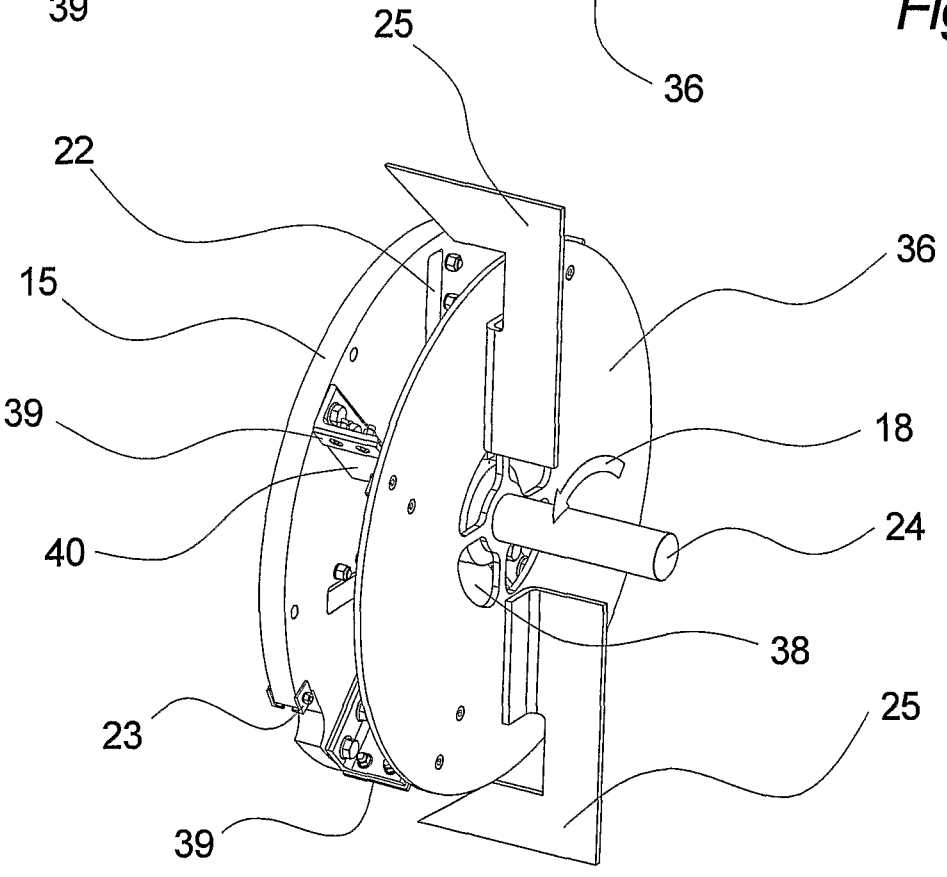


Fig. 8f

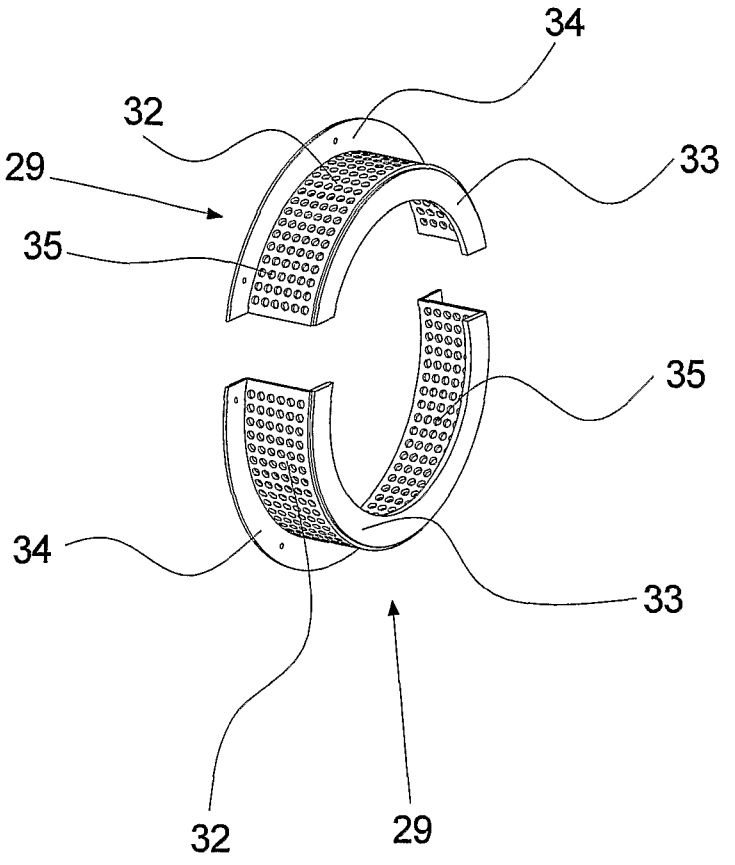

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Fig. 8g

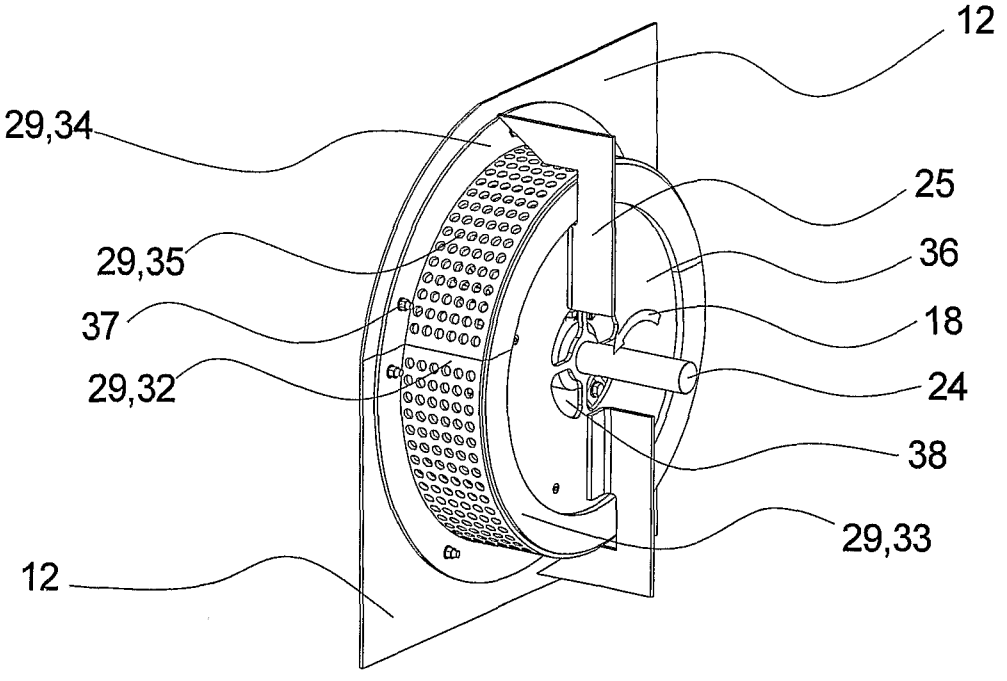

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Fig. 8h

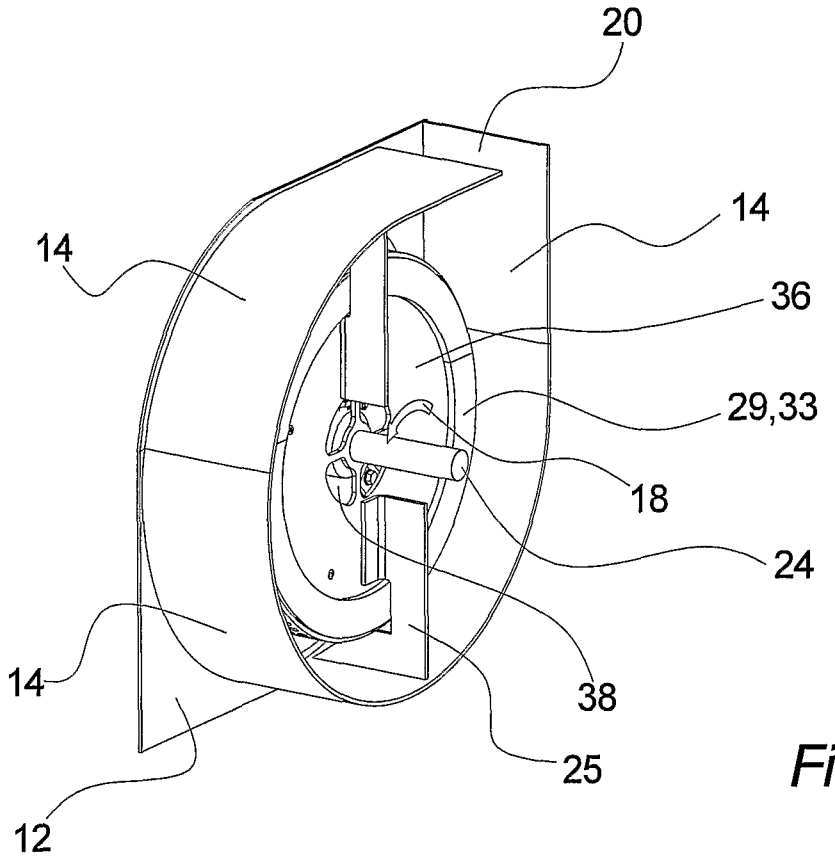


Fig. 8i

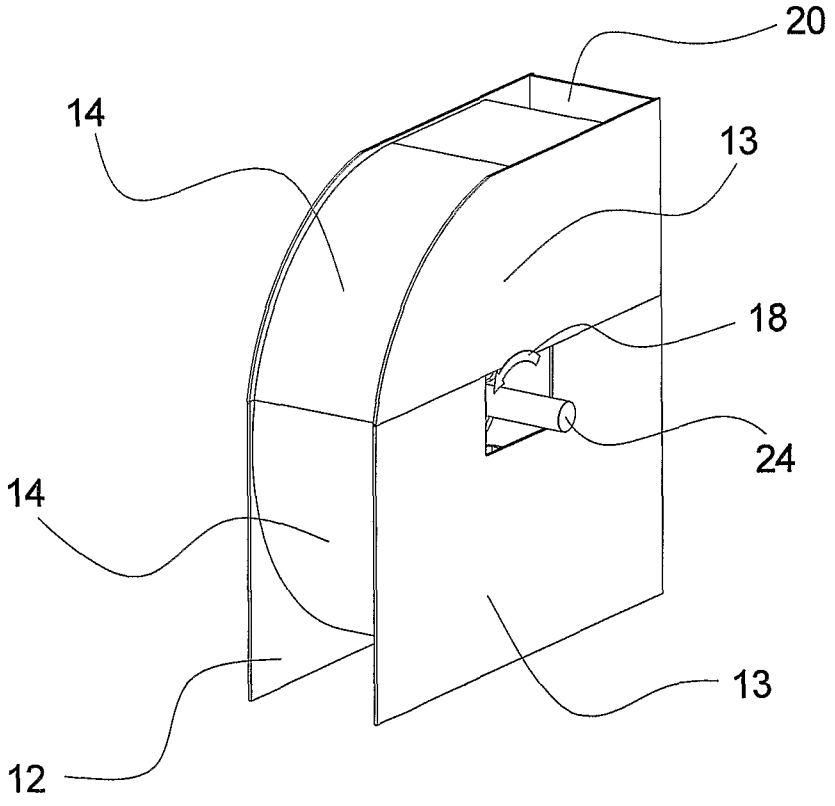


Fig. 8j

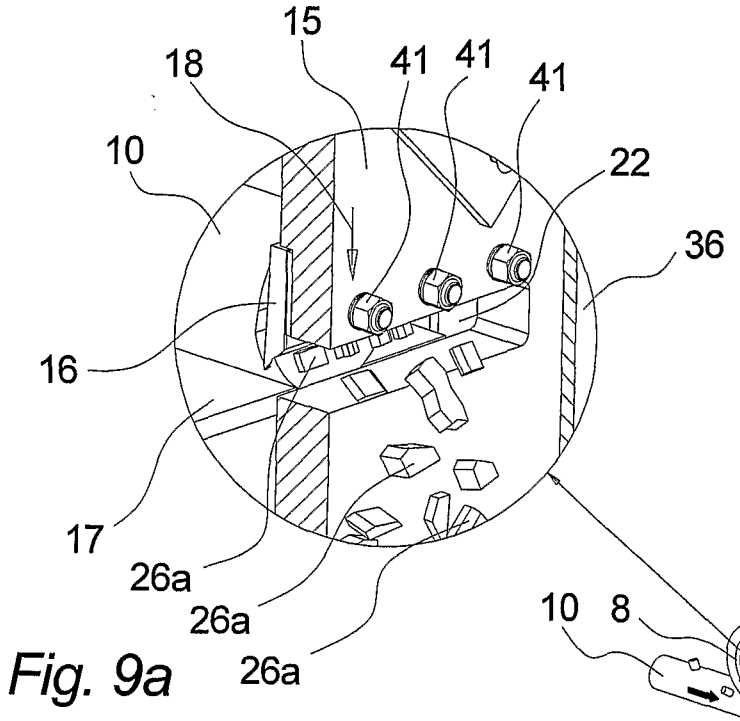


Fig. 9a

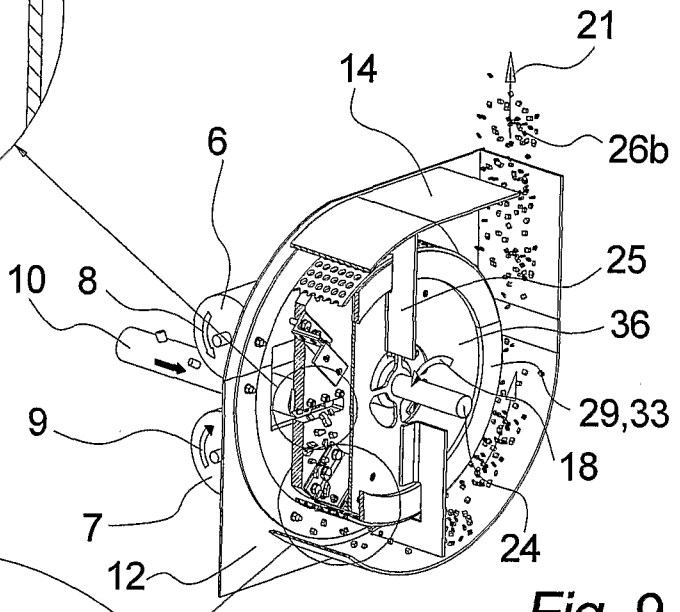


Fig. 9

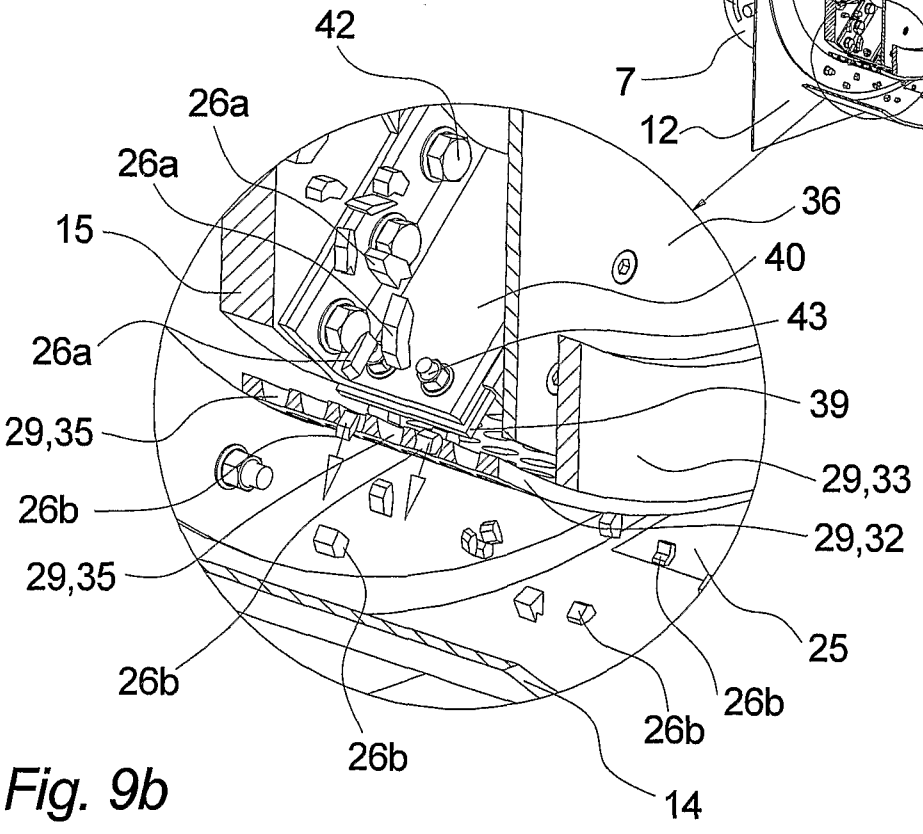


Fig. 9b

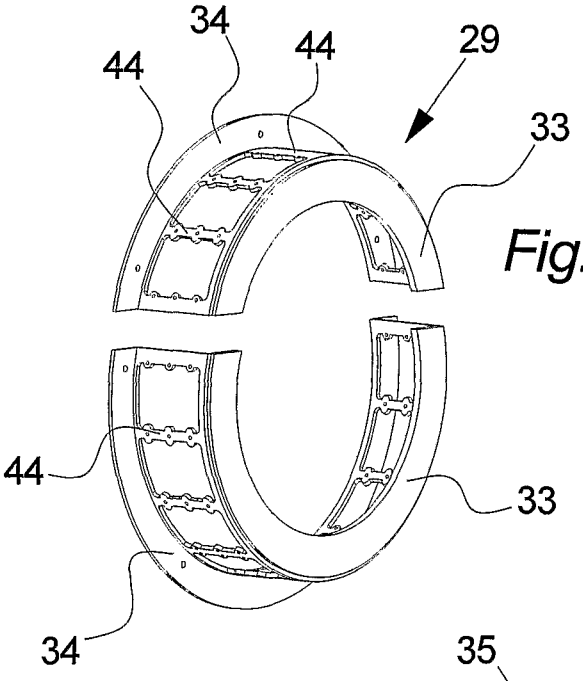


Fig. 10a

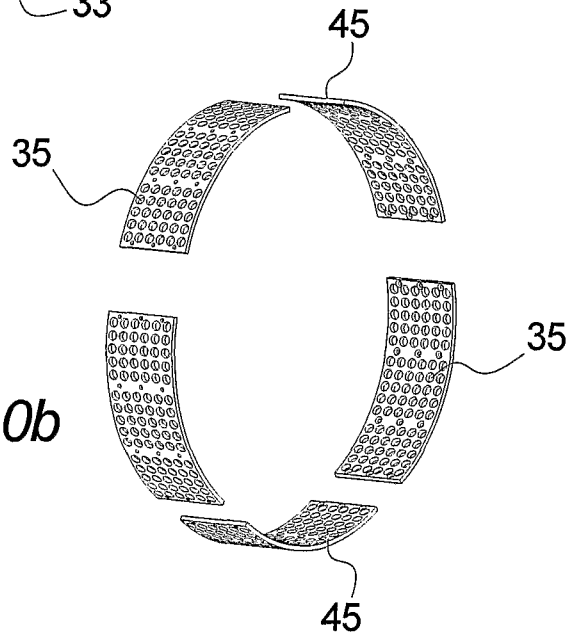


Fig. 10b

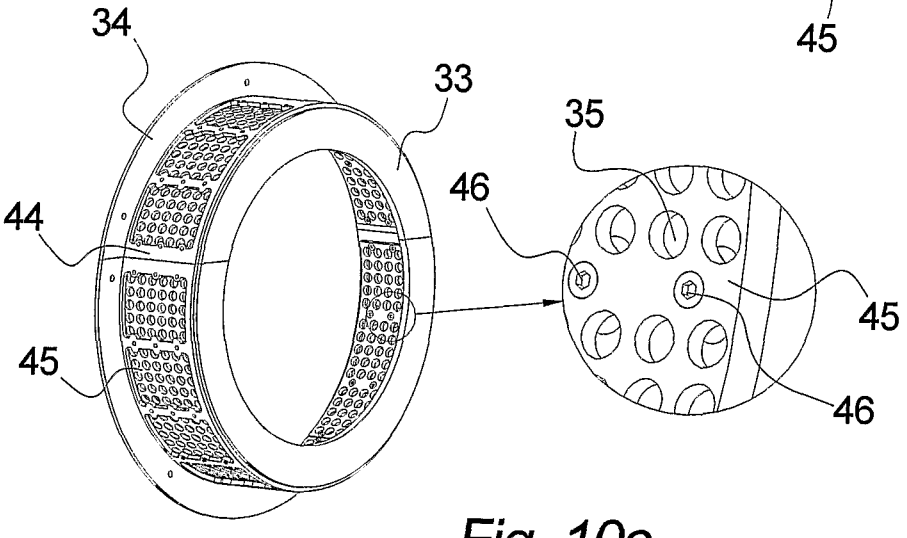


Fig. 10c

Fig. 11a

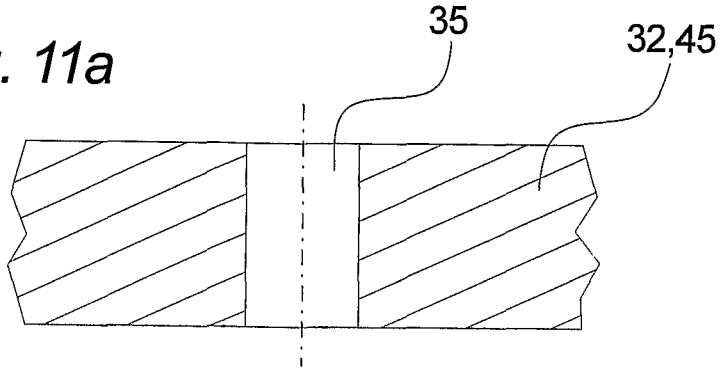


Fig. 11b

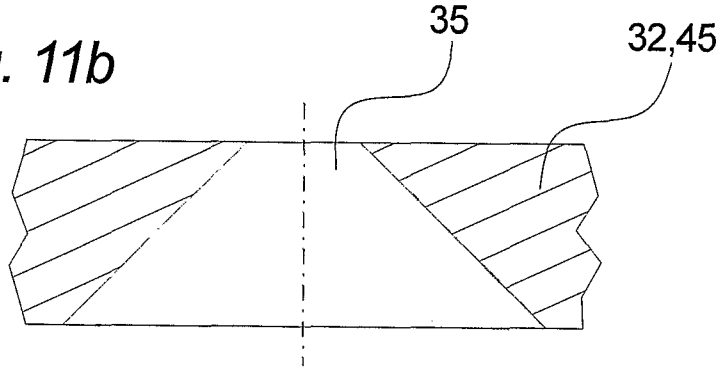


Fig. 11c

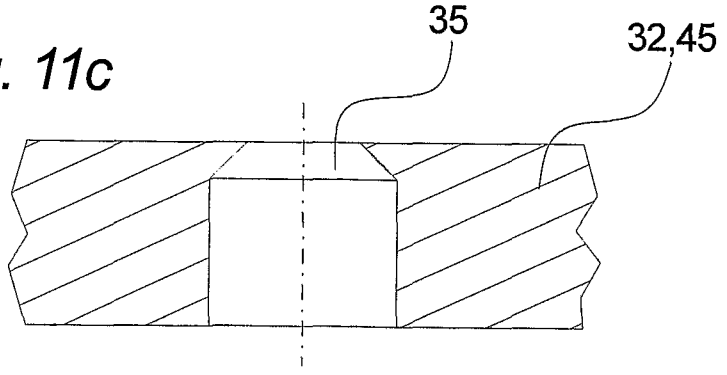
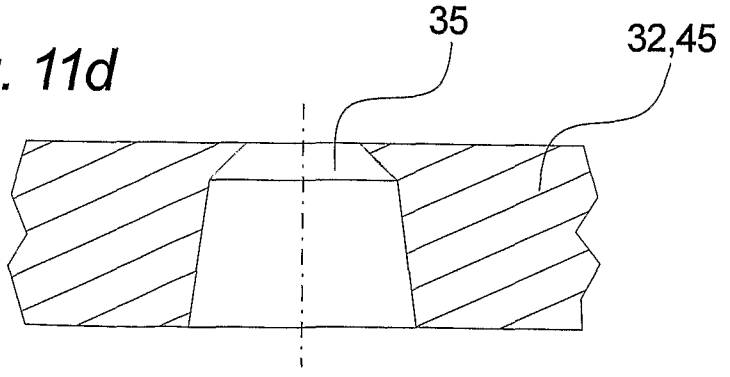


Fig. 11d



INTERNATIONAL SEARCH REPORT

International application No
PCT/DK2008/000354

A. CLASSIFICATION OF SUBJECT MATTER
INV. B02C18/14 B27L11/02

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)
B27L B27G A01G B02C

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 practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	AT 361 762 B (BUCHMANN & CO) 25 March 1981 (1981-03-25)	1-3, 7-11,13, 20
Y	page 2, line 1 - line 9 page 2, line 22 - line 24 page 3, line 11 - line 30 page 3, line 38 - line 41 figures 1-3	4-6,12, 19

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

[X] See patent family annex.

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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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Date of the actual completion of the international search	Date of mailing of the international search report
7 January 2009	05/02/2009

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	Hamel, Pascal

INTERNATIONAL SEARCH REPORT

International application No
PCT/DK2008/000354

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CH 625 390 A5 (SCHERZ & CO MASCHINEN UND KRAF [AT]) 30 September 1981 (1981-09-30)	1
Y	abstract page 2, line 67 - line 76 page 3, line 20 - line 21 page 3, line 98 - line 127 page 4, line 15 - line 39 page 4, line 109 - line 118 page 5, line 6 - line 11 figures	6

Y	DE 15 07 525 A1 (FELLNER & ZIEGLER GMBH) 17 July 1969 (1969-07-17)	4
A	page 1, line 1 - line 5 page 5, line 11 - page 6, line 15 figure 1	1

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A	abstract page 1, line 3 - line 6 page 2, line 24 - page 3, line 3 figure 4	1

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Y	page 1 page 2, line 8 - line 15 page 3, line 9 - line 19 page 4, line 7 - line 9 page 5, line 16 - line 17 figures	19

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