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(54) AN APPARATUS FOR REMOVING ADHERED SUBSTANCE FROM PARTICULATE MATERIAL OR FOR CRUSHING MATERIAL

(57) An apparatus (1) for removing adhered substance from particulate material, such as cement paste from particulate material of recycled concrete aggregate, or for crushing material, comprises a housing (2) including an inlet (3) for introducing untreated particulate material into the housing (2) and an outlet (4) for discharging treated particulate material from the housing (2). The inlet (3) and the outlet (4) are located at a distance from each other. The apparatus also comprises a shaft (5) which is mounted to the housing (2) and rotatable with respect to the housing (2) about an axis of rotation (6), a driving member (7, 8) for driving the shaft (5) about its axis of rotation (6), a plurality of circular disks (9) which are each eccentrically mounted on the shaft (5) and located behind

each other inside the housing (2). The centre of each successive circular disk (9) is shifted with respect to the centre of its preceding circular disk (9) in a rotational direction about the axis of rotation (6). The apparatus (1) comprises a plurality of non-circular disks (11) which are each provided with a cam (12) on its outer circumference. The non-circular disks (11) are mounted on the shaft (5) and located behind each other inside the housing (2). The cam (12) of each successive non-circular disk (11) is shifted with respect to the cam (12) of its preceding non-circular disk (11) in a rotational direction about the axis of rotation (6) such that the cams (12) form a helical shape about the axis of rotation (6).

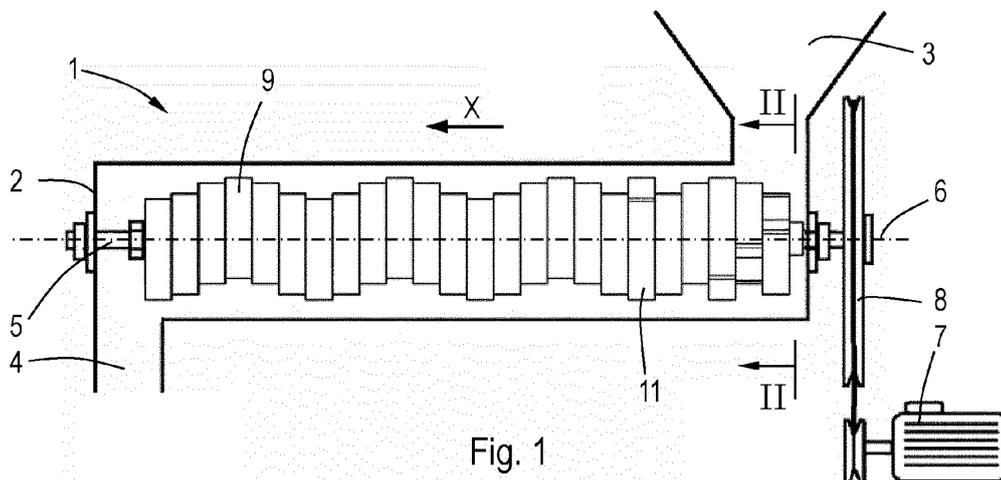


Fig. 1

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Description

[0001] The present invention relates to an apparatus for removing adhered substance from particulate material, such as cement paste from particulate material of recycled concrete aggregate, or for crushing material, comprising a housing including an inlet for introducing untreated particulate material into the housing and an outlet for discharging treated particulate material from the housing, wherein the inlet and the outlet are located at a distance from each other, a shaft which is mounted to the housing and rotatable with respect to the housing about an axis of rotation, a driving member for driving the shaft about its axis of rotation, a plurality of circular disks which are each eccentrically mounted on the shaft and located behind each other inside the housing, wherein the centre of each successive circular disk is shifted with respect to the centre of its preceding circular disk in a rotational direction about the axis of rotation.

[0002] Such an apparatus is known from EP 3 725 411. Due to increasing environmental awareness concrete recycling gains importance because it conserves natural resources by using the readily available concrete as an aggregate source for new concrete or other applications. Concrete recycling reduces the need for gravel mining, water, coal, oil and gas. It also eliminates the need for transporting concrete aggregate collected from demolition sites to landfill for disposal. It is known to put collected concrete aggregate through a crushing machine. Crushed recycled concrete aggregate can be used as the aggregate for brand new concrete if it is mainly free of contaminants. Adding a portion of recycled concrete aggregate instead of natural aggregate into the new concrete mixture creates a sustainable product.

[0003] Recycled concrete aggregates may perform differently when used in new concrete than natural aggregates. Residual adhered mortar or cement paste on aggregate is a main factor affecting the properties of density, porosity, and water absorption of recycled concrete aggregates. The maximum allowable amount of replacement of recycled coarse aggregate in concrete in order to obtain a durable concrete product depends on the quality of recycled aggregate.

[0004] The known apparatus provides good performance for removing adhered substance from particulate material due to its configuration.

[0005] An object of the invention is to provide an improved apparatus.

[0006] This object is accomplished with the apparatus according to the invention, wherein the apparatus comprises a plurality of non-circular disks which are each provided with a cam on its outer circumference, wherein the non-circular disks are mounted on the shaft and located behind each other inside the housing, wherein the cam of each successive non-circular disk is shifted with respect to the cam of its preceding non-circular disk in a rotational direction about the axis of rotation such that the cams form a helical shape about the axis of rotation.

[0007] Due to the helical shape of the successive cams the apparatus forces the material to be treated through the housing under operating conditions in an efficient way.

5 **[0008]** The apparatus is also suitable for crushing or pulverizing material rather than removing adhered substance from particulate material. The apparatus is also suitable for treating other materials than mentioned here-
10 inbefore, for example asphalt, tar contaminated asphalt types, concrete, concrete sand, bottom ash from AEC (waste to energy plant), bricks, limestone, etc.

[0009] The cam of each non-circular disk may have a height which is more than 20% or even more than 30% of the radius of each of the circular disks.

15 **[0010]** Preferably, the plurality of circular disks are located downstream of the plurality of non-circular disks as seen from the inlet to the outlet in order to maintain a driving force on the material to be treated.

[0011] The plurality of non-circular disks may be lo-
20 cated at the inlet.

[0012] The shaft may have a horizontal orientation, since a vertical orientation for forcing the material through the housing by gravity is not necessary.

25 **[0013]** In an embodiment the contours of the non-circular disks together form a circular projection in axial direction of the shaft, which substantially coincides with the contours of the circular disks which together form a circular projection in axial direction of the shaft.

[0014] The housing may comprise a circular cylindrical
30 inner side.

[0015] In an advantageous embodiment the shaft has a polygonal cross-section and each circular disk and non-circular disk has a through-hole in which the shaft fits at different discrete angular positions with respect to the
35 corresponding circular disk and non-circular disk, since the circular disks and non-circular disks are locked on the shaft in rotational direction thereof. The circular and non-circular disks can be mounted onto the shaft by stabbing the shaft through their through-holes.

40 **[0016]** A portion of the shaft where the circular disks are mounted and a portion of the shaft where the non-circular disks are mounted may be shaped and dimensioned similarly. In that case the shaft can have a continuous circumference in its longitudinal direction along
45 both portions.

[0017] At least one of the shaft, the circular disks, the non-circular disks and an inner side of the housing may be made of metal, for example steel.

50 **[0018]** The minimum distance between the housing and the circular and non-circular disks, as measured in radial direction of the axis of rotation, may be smaller than each of the diameters of the circular disks.

[0019] The angle by which the cam of each successive non-circular disk is shifted with respect to the cam of its
55 preceding non-circular disk in the rotational direction about the axis of rotation may be smaller than 90°, preferably smaller than 70°. A smaller angle may provide more efficient driving force of the material through the

housing.

[0020] The helical shape may have at least one winding. More windings may provide a higher driving force of material through the housing.

[0021] In an embodiment a flexible element is provided between each of the circular disks and the shaft and/or between each of the non-circular disks and the shaft. This provides flexibility to the apparatus, for example when a hard piece gets stuck between the housing and a circular and/or a non-circular disk, hence minimizing the risk of damage to the apparatus.

[0022] The flexible element may comprise a ring, preferably made of rubber.

[0023] At least one of the circular and non-circular disks may be made of two parts which are fixed to each other about the shaft, which parts may be adapted such that they can be mounted onto the shaft in a radial direction thereof. This facilitates replacement of a circular or non-circular disk between neighbouring circular or non-circular disks which should remain in place.

[0024] The invention will hereafter be elucidated with reference to very schematic drawings showing embodiments of the invention by way of example.

Fig. 1 is a cut-away view of an embodiment of an apparatus according to the invention.

Fig. 2 is a sectional view along the line II-II in Fig. 1.

Fig. 3 is a perspective view of a part of the embodiment as shown in Fig. 1.

Fig. 4 is a similar view as Fig. 3, showing a part thereof on a larger scale.

Fig. 5 is a side view of a circular disk of an alternative embodiment of the apparatus.

Fig. 6 is a similar view as Fig. 5, showing a non-circular disk of the alternative embodiment of the apparatus.

Fig. 7 is a similar view as Fig. 5, showing a circular disk of still another alternative embodiment.

[0025] Fig. 1 shows an embodiment of an apparatus 1 according to the invention. The apparatus 1 is suitable for removing cement paste from recycled concrete aggregate which cement paste is adhered to particulate material of the recycled concrete aggregate. The recycled concrete aggregate is a result of crushing concrete that is collected from a demolition site, for example.

[0026] The apparatus 1 comprises an elongated housing 2. An inlet 3 is located at one side of the housing 2 and an outlet 4 is located at an opposite side of the housing 2 as seen in longitudinal direction of the housing 2. The housing 2 comprises a circular cylindrical inner side. Under operating conditions coarse material including concrete aggregate from existing concrete, which comprises particulate material, is introduced through the inlet 3 into the housing 2. The untreated particulate material travels through the housing 2 in a direction X and is treated. The resulting treated particulate material leaves the housing 2 through the outlet 4.

[0027] The apparatus 1 is provided with a shaft 5 which extends in longitudinal direction of the housing 2, in this case horizontally. The shaft 5 is mounted to the housing 2 and rotatable with respect to the housing 2 about an axis of rotation 6. A driving member in the form of an electric motor 7 drives the shaft 5 about its axis of rotation 6 via a transmission 8. In this case the transmission 8 comprises a pair of pulleys which are drivably coupled to each other through an endless belt, but numerous alternative driving members and transmissions are conceivable.

[0028] The apparatus 1 is provided with a plurality of circular steel disks 9, in this case 18, which are each eccentrically mounted on the shaft 5 and located against each other inside the housing 2. The centre of each successive circular disk 9 is shifted with respect to the centre of its preceding circular disk 9 in a rotational direction about the axis of rotation 6. Compared to Fig. 1, Fig. 3 shows one circular disk 9 less at the left of the shaft 5 in order to create an appropriate view on the shaft 5.

[0029] At a portion of the shaft 5 where the circular disks 9 are provided the shaft 5 has a polygonal cross-section. Each circular disk 9 has an eccentrically located through-hole 10 in which the polygonal portion of the shaft 5 fits at different discrete angular positions about the axis of rotation 6. For this reason the through-holes 10 of the respective circular disks 9 have the same polygonal shapes as the polygonal portion of the shaft 5 whereas the dimensions correspond to each other.

[0030] The circular disks 9 are mounted to the shaft 5 next to each other at mutual different angular positions such that the centre of each successive circular disk 9 is shifted with respect to the centre of its preceding circular disk 9 in one direction about the axis of rotation 6. Since the shaft 5 and the corresponding through-holes 10 of the circular disks 9 form a hexagon, the circular disks 9 are mounted to the shaft 5 at six different angular positions about the axis of rotation 6. Hence, the centre of each successive circular disk 9 is shifted with respect to the centre of its preceding circular disk 9 by an angle of 60°.

[0031] The thickness of each circular disk 9 as well as the distances between the centre of each circular disk 9 and the axis of rotation 6 may vary. For example, the minimum distance between each circular disk 9 and the inner side of the housing 2, as measured in radial direction of the axis of rotation 6, may be smaller than the diameter of each of the circular disks 9.

[0032] Figs. 1-4 show that the apparatus 1 also comprises a plurality of non-circular metal disks 11, in this case six, which are each provided with a cam 12 on its outer circumference. Fig. 4 shows one of the non-circular disks 11 as a separate part. Similar to the circular disks 9, the non-circular disks 11 are also mounted on the shaft 5 and located against each other inside the housing 2. The non-circular disks 11 are mounted on the shaft 5 such that the cam 12 of each successive non-circular disk 11 is shifted with respect to the cam 12 of its preceding non-circular disk 11 in a rotational direction about the axis of

rotation 6 such that the cams 12 form a helical shape about the axis of rotation 6. The helical shape is visible in Fig. 3.

[0033] Each of the non-circular disks 11 has a circular cylindrical portion outside the cam 12, but alternative shapes are conceivable. For example, the non-circular disk 11 may be manufactured by machining a circular disk such that recesses at opposite sides of the resulting cam 12 arise.

[0034] Fig. 4 shows that portions of the circumferential surface of the non-circular disk 11 have hardened surface layers 13.

[0035] In the embodiment as shown in Figs. 1-4 the non-circular disks 11 are mounted on a portion of the shaft 5 which has the same polygonal cross-section as the portion where the circular disks 9 are mounted. Consequently, the cam 12 of each successive non-circular disk 11 is shifted with respect to the cam 12 of its preceding non-circular disk 11 by an angle of 60°, as well. In other words, a portion of the shaft 5 where the circular disks 9 are mounted and a portion of the shaft 5 where the non-circular disks 11 are mounted are similar. This means that both the circular disks 9 and the non-circular disks 11 can be mounted onto the shaft 5 by stabbing the shaft 5 into each of them and slide them to each other in axial direction along the shaft 5. In the embodiment as shown in Fig. 3 the cams 12 form a helical shape of almost one winding, but one or more than one winding is also possible.

[0036] Fig. 1 shows that the non-circular disks 11 are located at the inlet 3 and the circular disks 9 are located downstream of the non-circular disks 11. Due to the helical shape of the cams 12 of the non-circular disks 11 the untreated particulate material and already partly or fully treated material is forced to travel through the housing 2 in the direction X.

[0037] Fig. 2 shows that the contours of the non-circular disks 11 together form a substantially circular projection in axial direction of the shaft 5. The contours of the circular disks 9 together also form a substantially circular projection in axial direction of the shaft 5. Both circular projections substantially coincide in this case, but they may be different in an alternative embodiment.

[0038] Fig. 4 shows that the non-circular disks 11 are provided with the same through-holes 10 as the circular disks 9.

[0039] Figs. 5 and 6 show the circular and non-circular disks 9, 11 of an alternative embodiment. They are provided with respective rubber rings 14. The rubber rings 14 are located between an inner metal part 15 and an outer metal part 16 of each of the circular and non-circular disks 9, 11. The inner and outer metal parts 15, 16 as well as the rubber rings 14 are provided with cooperating radial protrusions and recesses for avoiding slip between the respective parts. It is noted that the flexible elements may also be applied in an apparatus which is not provided with non-circular disks. In other words, the invention is also related to an apparatus for removing adhered substance from particulate material, such as cement paste from

particulate material of recycled concrete aggregate, or for crushing material, comprising a housing including an inlet for introducing untreated particulate material into the housing and an outlet for discharging treated particulate material from the housing, wherein the inlet and the outlet are located at a distance from each other, a shaft which is mounted to the housing and rotatable with respect to the housing about an axis of rotation, a driving member for driving the shaft about its axis of rotation, a plurality of disks which are each mounted on the shaft and located behind each other inside the housing, wherein a flexible element is provided between each of the disks and the shaft.

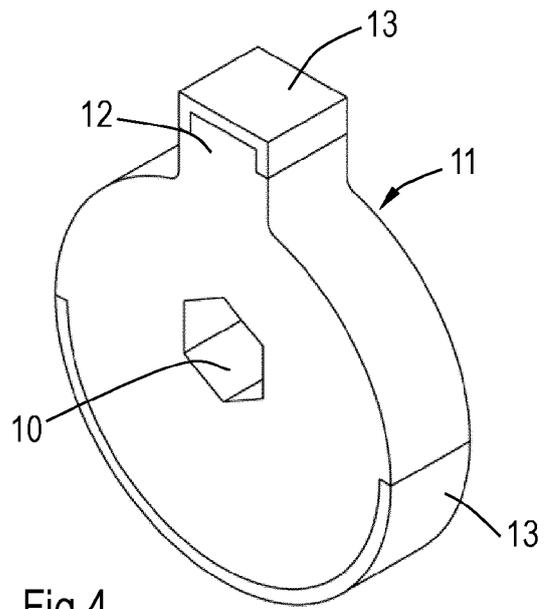
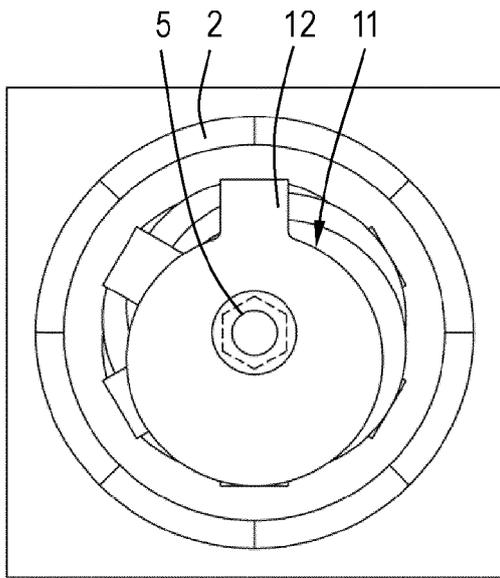
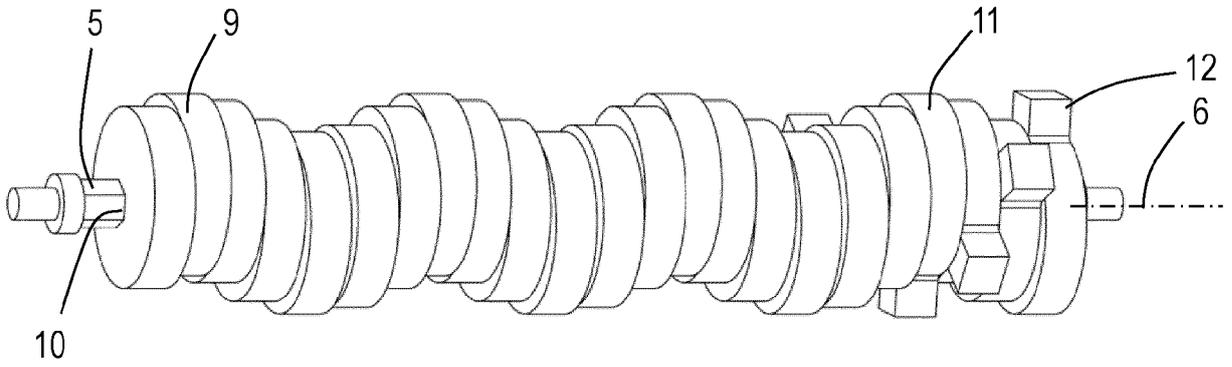
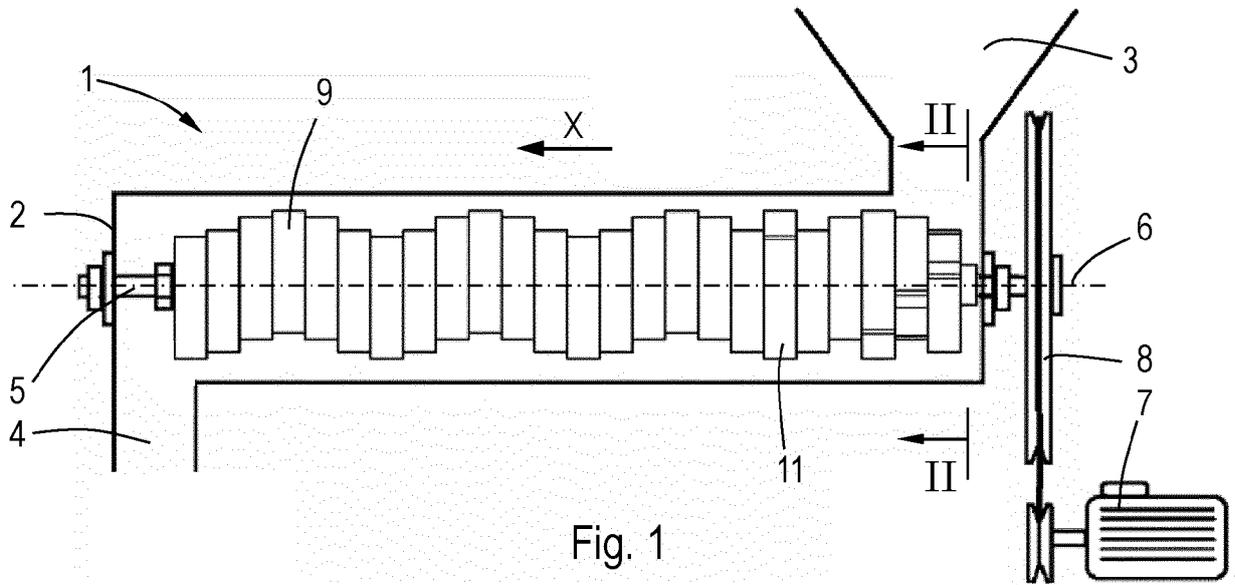
[0040] Fig. 7 shows a circular disk 9 of still another embodiment of the apparatus 1. The circular disk 9 is made of two parts 9a, 9b which are fixed to each other about the shaft 5 by means of bolts 17. Alternative fixing means are conceivable. This makes it easier to replace a single circular disk 9 if it is damaged, for example. Similarly, the non-circular disks may be made of two parts in a similar way.

[0041] The invention is not limited to the embodiments shown in the drawings and described hereinbefore, which may be varied in different manners within the scope of the claims and their technical equivalents. For example, the number of circular disks and non-circular disks may be different.

30 Claims

1. An apparatus (1) for removing adhered substance from particulate material, such as cement paste from particulate material of recycled concrete aggregate, or for crushing material, comprising a housing (2) including an inlet (3) for introducing untreated particulate material into the housing (2) and an outlet (4) for discharging treated particulate material from the housing (2), wherein the inlet (3) and the outlet (4) are located at a distance from each other, a shaft (5) which is mounted to the housing (2) and rotatable with respect to the housing (2) about an axis of rotation (6), a driving member (7, 8) for driving the shaft (5) about its axis of rotation (6), a plurality of circular disks (9) which are each eccentrically mounted on the shaft (5) and located behind each other inside the housing (2), wherein the centre of each successive circular disk (9) is shifted with respect to the centre of its preceding circular disk (9) in a rotational direction about the axis of rotation (6), **characterized in that** the apparatus (1) comprises a plurality of non-circular disks (11) which are each provided with a cam (12) on its outer circumference, wherein the non-circular disks (11) are mounted on the shaft (5) and located behind each other inside the housing (2), wherein the cam (12) of each successive non-circular disk (11) is shifted with respect to the cam (12) of its preceding non-circular disk (11) in

- a rotational direction about the axis of rotation (6) such that the cams (12) form a helical shape about the axis of rotation (6).
2. An apparatus (1) according to claim 1, wherein the plurality of circular disks (9) are located downstream of the plurality of non-circular disks (11) as seen from the inlet (3) to the outlet (4). 5
 3. An apparatus (1) according to claim 2, wherein the plurality of non-circular disks (11) are located at the inlet (3). 10
 4. An apparatus (1) according to any one of the preceding claims, wherein the shaft (5) has a horizontal orientation. 15
 5. An apparatus (1) according to any one of the preceding claims, wherein the contours of the non-circular disks (11) together form a substantially circular projection in axial direction of the shaft (5), which substantially coincides with the contours of the circular disks (9) which together form a substantially circular projection in axial direction of the shaft (5). 20
 6. An apparatus (1) according to any one of the preceding claims, wherein the housing (2) comprises a circular cylindrical inner side. 25
 7. An apparatus (1) according to any one of the preceding claims, wherein the shaft (5) has a polygonal cross-section and each circular disk (9) and non-circular disk (11) has a through-hole (10) in which the shaft (5) fits at different discrete angular positions with respect to the corresponding circular disk (9) and non-circular disk (11). 30
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 8. An apparatus (1) according to claim 7, wherein a portion of the shaft (5) where the circular disks (9) are mounted and a portion of the shaft (11) where the non-circular disks (11) are mounted are shaped and dimensioned similarly. 40
 9. An apparatus (1) according to any one of the preceding claims, wherein at least one of the shaft (5), the circular disks (9), the non-circular disks (11) and an inner side of the housing (2) is made of metal. 45
 10. An apparatus (1) according to any of the preceding claims, wherein the minimum distance between the housing and the circular and non-circular disks (9, 11), as measured in radial direction of the axis of rotation (6), is smaller than each of the diameters of the circular disks (9). 50
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 11. An apparatus (1) according to any of the preceding claims, wherein the angle by which the cam (12) of each successive non-circular disk (11) is shifted with respect to the cam (12) of its preceding non-circular disk (11) in the rotational direction about the axis of rotation (6) is smaller than 90° , preferably smaller than 70° .
 12. An apparatus (1) according to any of the preceding claims, wherein the helical shape has at least one winding.
 13. An apparatus (1) according to any of the preceding claims, wherein a flexible element (14) is provided between each of the circular disks (9) and the shaft (5) and/or between each of the non-circular disks (11) and the shaft (5).
 14. An apparatus (1) according to claim 12, wherein the flexible element (14) comprises a ring, preferably made of rubber.
 15. An apparatus (1) according to any of the preceding claims, wherein at least one of the circular and non-circular disks (9, 11) is made of two parts (9a, 9b) which are fixed to each other about the shaft (5), which parts (9a, 9b) are adapted such that they can be mounted onto the shaft (5) in a radial direction thereof.



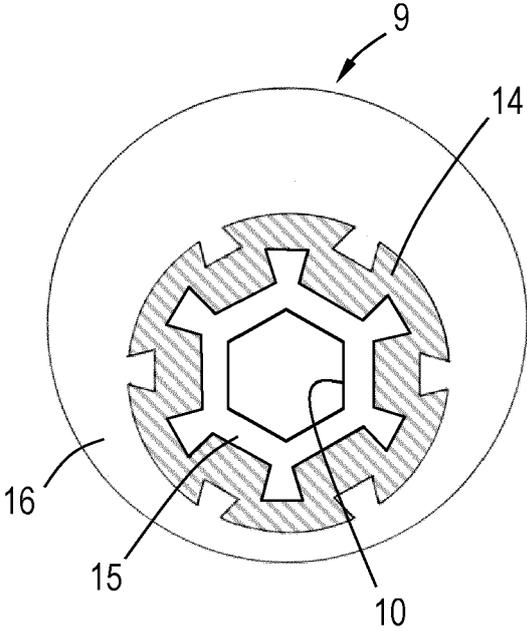


Fig.5

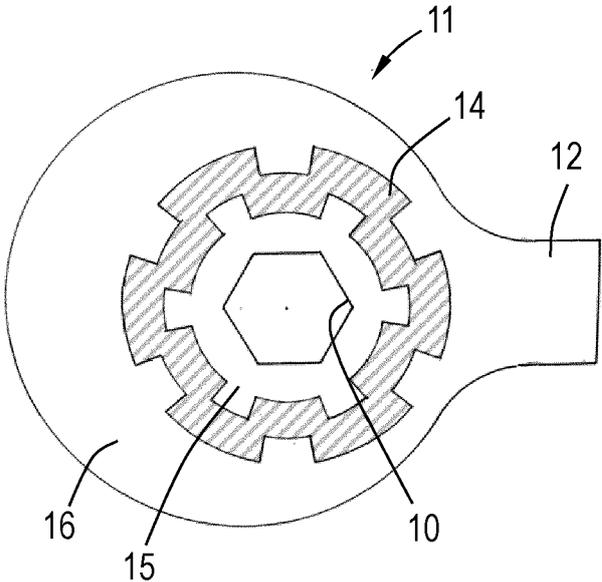


Fig.6

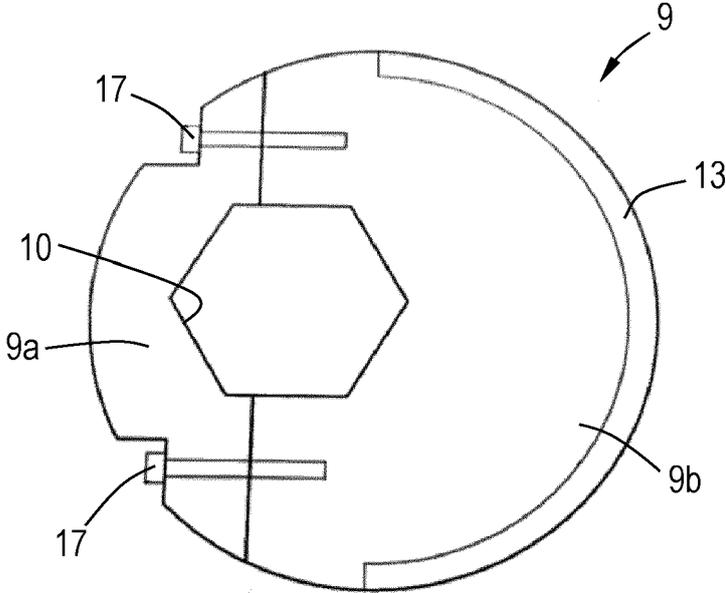


Fig.7



EUROPEAN SEARCH REPORT

Application Number
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A	----- CN 110 898 928 A (WUXI TAIXIAN POWDER TECH CO LTD) 24 March 2020 (2020-03-24) * claims 3,4,7; figures 1-3 *	1-15	
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			TECHNICAL FIELDS SEARCHED (IPC)
			B02C B01F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 February 2024	Examiner Pössinger, Tobias
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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