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(54) **Apparatus for reducing and crushing coarse material**

Vorrichtung zum Zerkleinern und Brechen groben Materials

Appareil de fragmentation et de concassage de gros matériaux

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Description

[0001] The present invention relates to an apparatus for reducing and crushing coarse material, comprising at least two rollers in side-by-side substantially parallel relation which can be driven such that material supplied from above is discharged downwards between the rollers, on which rollers ribs are provided effecting a reduction and crushing of the material supplied.

[0002] The apparatus is in particular intended for reducing and crushing vegetable, fruit and garden waste.

[0003] Such apparatus is known from EP-A-0 081 539. In the apparatus described in this document, the ribs are formed by a screw thread provided on each of the rollers and the rollers are driven such or the screw threads are provided such that the conveying direction of one screw thread is opposite to that of the other screw thread. The screw threads comprise a crushing edge. These crushing edges are active in the - mutually opposite - conveying directions of the screw threads and engage and cut the material to be reduced and crushed in two opposite directions.

[0004] From Japanese patent application publication No. 07000847 a crushing apparatus is known that has one roller and a fixed crushing blade part. The ribs on the roller form two screw threads with opposite transporting directions. The fixed blade part contains semicircular crushing blades. The roller pushes material against the blades. Large and though fragments of material have to be either crushed or pushed over the blades.

[0005] From Japanese patent application publication No. 02048048 a crushing apparatus is known with two rollers, both with ribs in the form of circular disks. The discs have notches to pick up logs and push them towards the interface space between the rollers. The notches have no cutting function of their own.

[0006] From European patent application No. 291227 a crushing apparatus is known with two rollers with ribs in the form of a screw thread on one roller and ribs in the form of disks on the other roller. Thus a clearing and shearing movement is realized between the ribs. This allows crushing and discharging. The efficiency of the apparatus depends on a uniform distribution of material over the rollers.

[0007] However, the object of the invention is to realize an improved manner of reducing and crushing. To that end, in accordance with the invention, the apparatus as described in the preamble is characterized in that the ribs of a first one of said rollers are formed by two screw threads having opposite leads for conveying material that is fed substantially centrally above the rollers laterally outwards in either direction, and the ribs of the second one of said rollers are formed by oval disks which are obliquely provided around the roller and which, when the roller is driven, perform a reciprocating movement, viewed in axial direction, causing a shearing and clearing movement between the oval disks and the screw threads.

[0008] Through the use of these rollers it is effected that the relative speed between the ribs of the two rollers in axial direction varies substantially. When the two rollers have the same diameters and are driven at a suitably selected rotational speed, and the oblique position of the oval disks on the second roller approximately corresponds to the angle which the tangent to a screw thread on the first roller makes relative to a plane perpendicular to the longitudinal direction of the roller, the relative speed between the ribs on the two rollers in axial direction will vary from about zero to about twice the peripheral velocity of the rollers at a specific ratio of the lead of this screw thread and the radius of the rollers. Hence, the reducing and crushing action of the rollers is not constant. A kind of shearing and clearing movement or, in other words, a pulsating shearing movement is realized which improves in particular the reducing effect on large and tough fragments.

[0009] Although the direction of rotation of the second roller is not important to the reciprocating movement of the oval disks on this second roller, the two rollers are nevertheless preferably driven in opposite directions such the material supplied can readily be conveyed downwards between the rollers.

[0010] To facilitate the breaking of larger parts of the material supplied, cutting elements may be provided between the oval disks on the second roller and/or between the successive revolutions of each of the screw threads on the first roller. In view of wear or possible fracture, it is favorable when the cutting elements are arranged so as to be replaceable. To prevent the cutting elements from all being loaded at the same time, which may result in an undue load on the relevant rollers, the cutting elements may be staggered tangentially in the longitudinal direction of the roller or rollers.

[0011] The cutting action of the second roller can further be improved when the oval disks over a part of their circumference have a curvature which deviates such that a cutting face directed to the center of the disks is formed. To prevent these cutting faces from being loaded simultaneously, these cutting faces may be staggered for the successive oval disks. In particular, these cutting faces are provided where the relative speed relative to the first roller is zero.

[0012] To obtain a further reduction and crushing of the material conveyed between the first and second rollers, a third roller is present, centrally below and parallel to the first and second rollers, which third roller cooperates with these rollers. This third roller preferably comprises round disks provided straight around it and partitions arranged between these disks in a slightly spiral configuration. These disks and partitions form sections on the surface of the third roller, in which sections the material is confined, while material projecting from these sections is further reduced and crushed in cooperation with blades arranged beside this third roller. In this third roller, no horizontal transport of material takes place.

Like the staggered arrangement of the cutting elements on the first and second rollers and the staggered cutting faces on the second roller, the slightly spiral configuration is provided to prevent the partitions from being simultaneously loaded over the entire length of the roller.

[0013] In accordance with another facet of the invention, the speed of the rollers can be adjusted back when the load on the drive mechanism increases, so that overload can be prevented. Further, the direction of rotation of at least the first and second rollers can be reversed when the load on the drive mechanism of the rollers exceeds a predetermined value. In this manner, stoppages between the first and the second roller can be prevented.

[0014] The invention will now be specified with reference to the accompanying drawings. In these drawings:

Fig. 1 shows a longitudinal section of the apparatus according to the invention;
Fig. 2 shows a cross section of the apparatus shown in Fig. 1;
Fig. 3 is a top plan view of this apparatus;
Fig. 4 is a bottom view of the apparatus; while
Fig. 5 shows a detail of the second roller in this apparatus.

[0015] The apparatus shown in the Figures comprises a rectangular housing 1 in which three mutually parallel rollers 3, 4 and 5 are arranged between funnel-shaped inner walls 2. Provided at the top side of the housing 1 is a feed-in funnel 6. Located at the bottom side of the apparatus is a feed-out funnel formed by the lower portion of the inner walls 2, whereby the reduced and crushed material can be dumped onto a discharge conveying belt (not shown).

[0016] In this example, the rollers 3, 4 and 5 are driven by means of hydromotors 7 controlled from a hydraulic unit (not shown) disposed elsewhere. This unit is built up from an electromotor mounting a pump distribution box having four hydraulic pumps, each pump incorporated into a closed system; one pump for each of the upper rollers 3 and 4 and two pumps which jointly provide the drive of the lower roller 5.

[0017] In the direct environment of the apparatus, a control box (not shown) having a computer, monitor and keyboard (PLC - "programmable logic control" with display) is installed. On the monitor, the main process data can be displayed. The apparatus can be controlled via the keyboard and operates fully automatically. However, the possibility for a manual operation remains present. If necessary, the process parameters can be modified via the keyboard.

[0018] The (first) roller 3 is provided with ribs formed by two screw threads 8 and 9 having opposite leads for conveying material that is fed substantially centrally above the rollers laterally outwards in both directions. The (second) roller 4 is provided with ribs formed by oval disks 10 which are obliquely provided around the roller 4 and which, when the roller 4 is driven, perform a reciprocating movement, viewed in axial direction. The oval disks 10 are arranged at such an angle and are of such eccentricity that the enveloping line is formed by a cylinder having a circular, straight section. In the present exemplary embodiment, the angle $\varnothing$ at which the oval disks 10 are arranged is approximately equal to the angle which the tangent to the screw threads on the roller 3 makes relative to a straight section. Moreover, the radius R of the two rollers 3 and 4 is here chosen to be equal; R=25 cm. Further, when the rollers 3 and 4 are driven at an angular velocity of 10 and 15 revolutions per minute respectively, and the ribs on the two rollers have the same heights, while the pitch h of the screw thread is 48 cm, the relative speed V(rel) in axial direction between the rollers 3 and 4 relative to the speed of revolution of these rollers will vary from 0 to about 2.

[0019] In other words, material is laterally displaced by the two rollers at a changing speed, while the reducing and crushing action of the rollers 3 and 4 is not constant, either.

[0020] In the present exemplary embodiment, to facilitate the breaking of larger parts in the material supplied, cutting elements 11 are provided between the oval disks, which cutting elements are tangentially staggered in the longitudinal direction of the roller. To further improve the cutting action of the second roller 4, the oval disks 10, as indicated in Fig. 5, over apart of their circumference have a curvature 12 which deviates such that a cutting face 13 directed to the center of the disks is formed. These cutting faces 13 are staggered for the successive oval disks 10.

[0021] The third roller 5 has round disks 14 provided straight around it and partitions 15 arranged between these disks in a slightly spiral configuration. Provided next to this roller 5, on either side thereof, is a blade 16 for further reducing and crushing material projecting from the sections 17 formed by the round disks 14 and the partitions 15.

[0022] The operation of the apparatus is as follows. The material to be reduced and crushed is supplied via the feed-in funnel 6 and passed down between the rollers 3 and 4, which normally rotate towards each other in the feeding direction, the material being cut along the top edge of the ribs due to the difference in axial speed of the ribs 8, 9 and 10 on the rollers 3 and 4, which cutting action is reinforced by the cutting elements 11 on the roller 4 and the cutting faces 13 on the oval disks 10. When the relative speed in axial direction between the screw thread and the oval disks increases, a shearing action is created between the screw thread and the oval disks. When this relative speed decreases, a clearing movement is created. During this clearing movement, the cutting faces 13 and the cutting elements 11 pass the screw thread, so that an additional reduction takes place. The torque taken up by the roller 4 is thus distributed over the entire circumference. Next, a further reduction and crushing takes place through the cutting ac-

tion of the movement between the rollers 3 and 4 on the one hand and the roller 5, provided thereunder, on the other. This involves the material being pressed into the sections 17, after which, through rotation of the roller 5 along the blades 16, another reduction and crushing takes place. Finally, the material leaves the apparatus via the feed-out funnel on the bottom side thereof.

[0023] In the event of an overload of the rollers caused by an unduly great supply of material or unduly large fragments, the speed of the rollers 3 and 4 can be adjusted back. By measuring the load permanently, this back-adjustment can be realized automatically. If the load exceeds a predetermined value, the direction of rotation of the rollers 3 and 4 is reversed. This may of course also be effected automatically.

[0024] The invention is by no means limited to the embodiment described herein with reference to the Figures, but comprises all kinds of modifications hereto in so far as they fall within the scope of the following claims. For instance, in particular when the material is already sufficiently small, the third roller need not necessarily be present. Further, for instance for increasing the reducing and crushing action, cutting elements, if necessary tangentially staggered, may also be provided on the first roller. The cutting elements mounted on the top roller or rollers may be detachable, enabling them to be readily replaced when they break down.

Claims

1. An apparatus for reducing and crushing coarse material, comprising at least two rollers (3,4) in side-by-side substantially parallel relation which can be driven such that material supplied from above is discharged downwards between the rollers (3,4), on which rollers (3,4) ribs (8,9,10) are provided effecting a reduction and crushing of the material supplied, **characterized in that** the ribs (8,9) of a first one of said rollers (3) are formed by two screw threads having opposite leads for conveying material that is fed substantially centrally above the rollers (3,4) laterally outwards in either direction, and the ribs (10) of the second one of said rollers (4) are formed by oval disks which are obliquely provided around the roller (4) and which, when the roller (4) is driven, perform a reciprocating movement, viewed in axial direction, causing a shearing and clearing movement between the oval disks (10) and the screw threads (8,9).

2. An apparatus according to claim 1, **characterized in that** cutting elements (11) are provided between the oval disks (10) on the second roller (4).

3. An apparatus according to claim 1 or 2, **characterized in that** cutting elements (11) are provided between the successive revolutions of each of the screw threads (8, 9) on the first roller (3).

4. An apparatus according to claim 2 or 3, **characterized in that** the cutting elements (11) are provided so as to be replaceable.

5. An apparatus according to claim 2, 3 or 4, **characterized in that** the cutting elements (11) are tangentially staggered in the longitudinal direction of the roller or rollers (3,4).

6. An apparatus according to any one of the preceding claims, **characterized in that** the oval disks (10) over a part of their circumference have a curvature which deviates such that a cutting face (13) directed to the center of the disks (10) is formed.

7. An apparatus according to claim 6, **characterized in that** the cutting face (13) is staggered for the successive oval disks (10).

8. An apparatus according to any one of the preceding claims, **characterized in that** centrally below and parallel to the first and second rollers (3, 4), a third roller (5) is present which, in cooperation with the rollers (3,4) arranged thereabove, can effect a further reduction and crushing.

9. An apparatus according to claim 8, **characterized in that** the third roller (5) comprises round disks (14) provided straight around it and partitions (15) arranged between said disks (14) in a slightly spiral configuration.

10. An apparatus according to claim 9, **characterized in that** next to the third roller (5), blades (16) are arranged for further reducing and crushing material projecting from the sections formed by the round disks (14) and partitions (15).

11. An apparatus according to any one of the preceding claims, **characterized in that** the speed of the rollers (3,4) is adjusted back when the load on the drive mechanism of the rollers (3,4) increases.

12. An apparatus according to any one of the preceding claims, **characterized in that** the direction of rotation of at least the first and the second roller (3,4) is reversed when the load on the drive mechanism of the rollers (3,4) exceeds a predetermined value.

Patentansprüche

1. Vorrichtung zur Zerkleinern und Brechen von grobem Material, die nebeneinander und im wesentlichen parallel zumindest zwei Walzen (3,4) aufweist, die in einer solchen Weise angetrieben werden kön-

nen, daß das Material, das von oben zugeführt wird, nach unten zwischen den Walzen (3,4) ausgegeben wird, wobei auf den Walzen (3,4) Rippen (8,9,10) vorgesehen sind, die ein Zerkleinern und ein Brechen des zugeführten Material bewirken, **dadurch gekennzeichnet, daß** die Rippen (8,9) einer ersten der Walzen (3) durch zwei Schraubengewinde mit entgegengesetzten Steigungen zum Transportieren des Material, das im wesentlichen zentral oberhalb der Walzen (3,4) zugeführt wird, seitlich nach außen in beide Richtungen gebildet wird, und daß die Rippen (10) der zweiten der Walzen (4) durch ovale Scheiben gebildet sind, die um die Walze (4) herum schräg vorgesehen sind und die bei Antrieb der Walze (4) eine hin- und hergehende Bewegung bei Betrachtung in Axialrichtung ausführen, wodurch eine Scher- und Freigabebewegung zwischen den ovalen Scheiben (10) und den Schraubengewinden (8,9) bewirkt wird.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß** die Schneidelemente (11) zwischen den ovalen Scheiben (10) auf der zweiten Walze (4) vorgesehen sind.

3. Vorrichtung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** die Schneidelemente (11) zwischen den aufeinanderfolgenden Umläufen von jedem der Schraubengewinde (8,9) auf der ersten Walze (3) vorgesehen sind.

4. Vorrichtung nach Anspruch 2 oder 3, **dadurch gekennzeichnet, daß** die Schneidelemente (11) in einer solchen Weise vorgesehen sind, daß diese auswechselbar sind.

5. Vorrichtung nach Anspruch 2, 3 oder 4, **dadurch gekennzeichnet, daß** die Schneidelemente (11) tangential versetzt in Längsrichtung der Walze oder der Walzen (3,4) angeordnet sind.

6. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** die ovalen Scheiben (10) über einen Teil ihres Umfangs eine Krümmung haben, die in einer solchen Weise abweicht, daß eine Schneidfläche (13), die zur Mitte der Scheiben (10) gerichtet ist, ausgebildet wird.

7. Vorrichtung nach Anspruch 6, **dadurch gekennzeichnet, daß** die Schneidfläche (13) für die aufeinanderfolgenden ovalen Scheiben (10) versetzt angeordnet ist.

8. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** zentral unterhalb der ersten und zweiten Walze (3,4) und parallel zu diesen eine dritte Walze (5) vorhanden ist, die im Zusammenwirken mit den Walzen (3,4), die oberhalb von dieser angeordnet sind, eine weitere Zerkleinerung und ein weiteres Brechen bewirken kann.

9. Vorrichtung nach Anspruch 8, **dadurch gekennzeichnet, daß** die dritte Walze (5) runde Scheiben (14), die gerade um diese herum angeordnet sind, und Trennwände (15) aufweist, die zwischen den Scheiben (14) in einer geringfügig spiralförmigen Anordnung vorgesehen sind.

10. Vorrichtung nach Anspruch 9, **dadurch gekennzeichnet, daß** benachbart zur dritten Walze (5) Flügel (16) zur weiteren Zerkleinerung und zum weiteren Brechen von Material angeordnet sind, das von den durch die runden Scheiben (14) und die Trennwände (15) gebildeten Abschnitten vorsteht.

11. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** die Drehzahl der Walzen (3,4) zurückgeregelt wird, wenn sich die Last auf den Antriebsmechanismus der Walzen (3,4) erhöht.

12. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** die Rotationsrichtung von zumindest der ersten und der zweiten Walze (3,4) umgekehrt wird, wenn die Last auf den Antriebsmechanismus der Walzen (3,4) einen vorbestimmten Wert übersteigt.

Revendications

1. Appareil destiné à réduire et broyer une matière grossière, comportant au moins deux rouleaux (3, 4) en relation côte à côte sensiblement parallèle qui peuvent être entraînés de telle sorte qu'une matière délivrée par en dessus est déchargés vers le bas entre les rouleaux (3, 4), des nervures (8, 9, 10) étant prévues sur ces rouleaux (3, 4) afin d'effectuer une réduction et un broyage de la matière délivrée, **caractérisé en ce que** les nervures (8, 9) d'un premier desdits rouleaux (3) sont formées par deux filets de vis ayant des pas opposés afin de transporter la matière qui est délivrée sensiblement de manière centrale au-dessus des rouleaux (3, 4) latéralement vers l'extérieur dans chaque direction, et les nervures (10) du deuxième desdits rouleaux (4) sont formées par des disques ovales qui sont prévus de manière oblique autour du rouleau (4) et qui, lorsque le rouleau (4) est entraîné, réalisent un mouvement alternatif, vu dans une direction axiale, ce qui provoque un mouvement de cisaillement et de dégagement entre les disques ovales (10) et les filets de vis (8, 9).

2. Appareil selon la revendication 1, **caractérisé en**

ce que des éléments de coupe (11) sont prévus entre les disques ovales (10) sur le rouleau (4).

3. Appareil selon la revendication 1 ou 2, **caractérisé en ce que** les éléments de coupe (11) sont prévus entre les tours successifs de chacun des filets de vis (8, 9) sur le premier rouleau (3).

4. Appareil selon la revendication 2 ou 3, **caractérisé en ce que** les éléments de coupe (11) sont prévus de façon à être remplaçables.

5. Appareil selon la revendication 2, 3 ou 4, **caractérisé en ce que** les éléments de coupe (11) sont décalés de manière tangentielle dans la direction longitudinale du rouleau ou des rouleaux (3, 4).

6. Appareil selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les disques ovales (10) sur une partie de leur circonférence ont une courbure qui s'écarte de telle sorte qu'une face de coupe (13) orientée vers le centre des disques (10) est formée.

7. Appareil selon la revendication 6, **caractérisé en ce que** la face de coupe (13) est décalée pour les disques ovales (10) successifs.

8. Appareil selon l'une quelconque des revendications précédentes, **caractérisé en ce que**, d'une manière centrale en dessous et parallèlement aux premier et deuxième rouleaux (3, 4) est présent un troisième rouleau (5) qui, en coopération avec les rouleaux (3, 4) disposés au-dessus, peut effectuer une réduction et un broyage supplémentaires.

9. Appareil selon la revendication 8, **caractérisé en ce que** le troisième rouleau (5) comporte des disques ronds (14) prévus tout autour de celui-ci et des séparations (15) disposées entre lesdits disques (14) dans une configuration légèrement en spirale.

10. Appareil selon la revendication 9, **caractérisé en ce que**, à la suite du troisième rouleau (5), des lames (16) sont disposées pour une réduction et un broyage de matière supplémentaires en dépassant des sections formées par les disques ronds (14) et les séparations (15).

11. Appareil selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la vitesse des rouleaux (3, 4) est réduite lorsque la charge sur le mécanisme d'entraînement des rouleaux (3, 4) augmente.

12. Appareil selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le sens de rotation d'au moins le premier et le deuxième rouleau est inversé lorsque la charge sur le mécanisme d'entraînement des rouleaux (3, 4) dépasse une valeur prédéterminée.

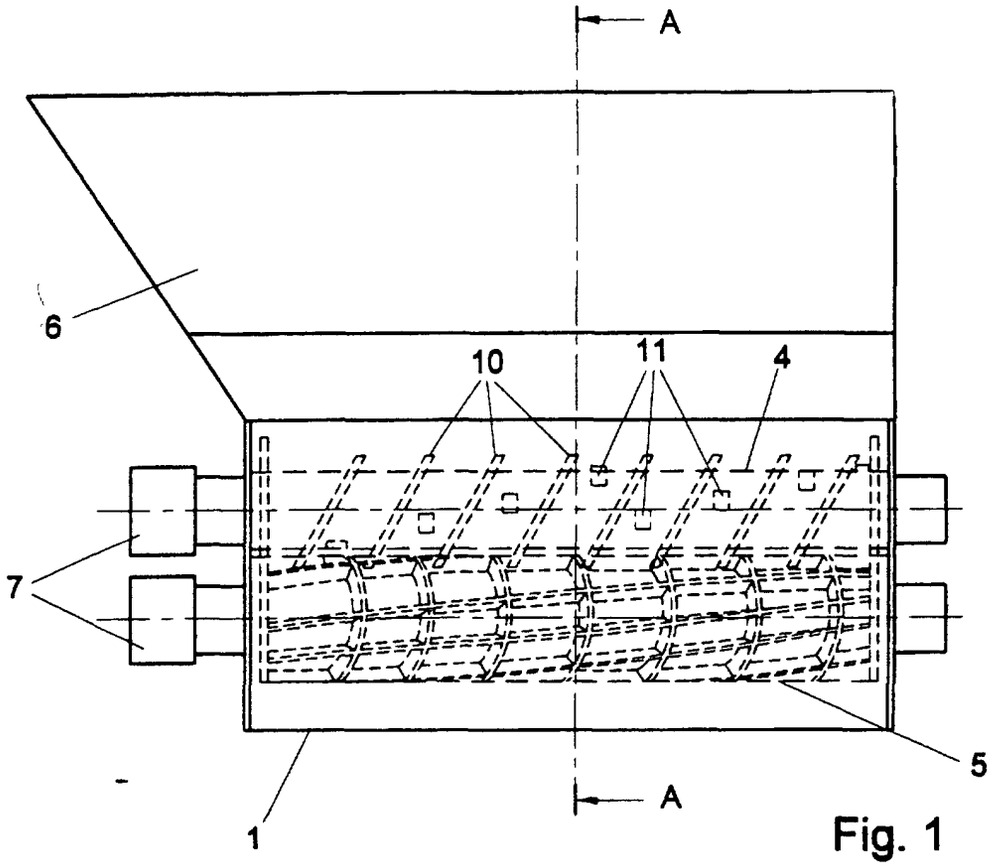

Fig. 1

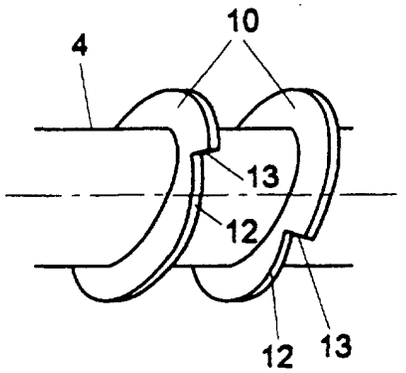

Fig. 5

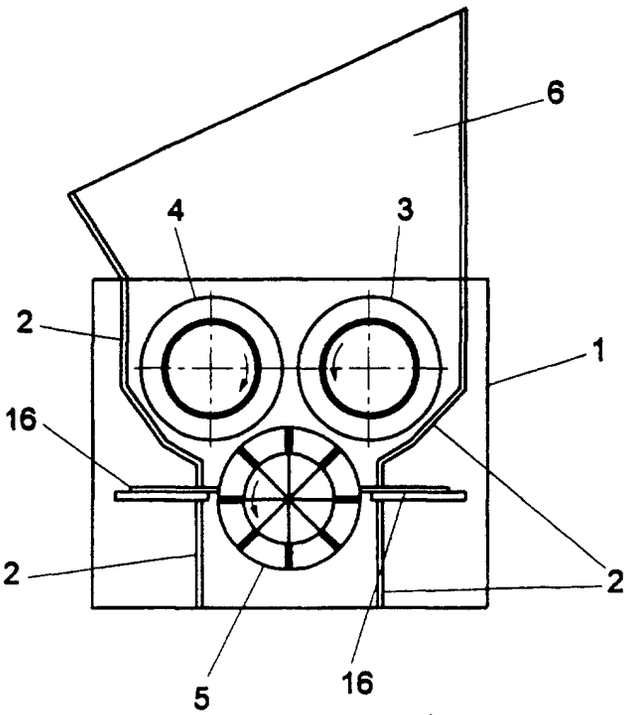

Fig. 2

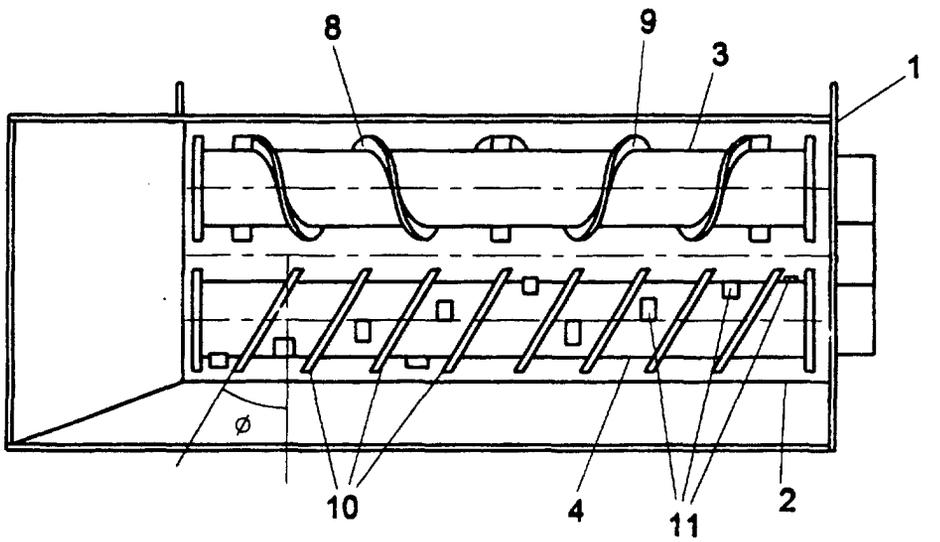

Fig. 3

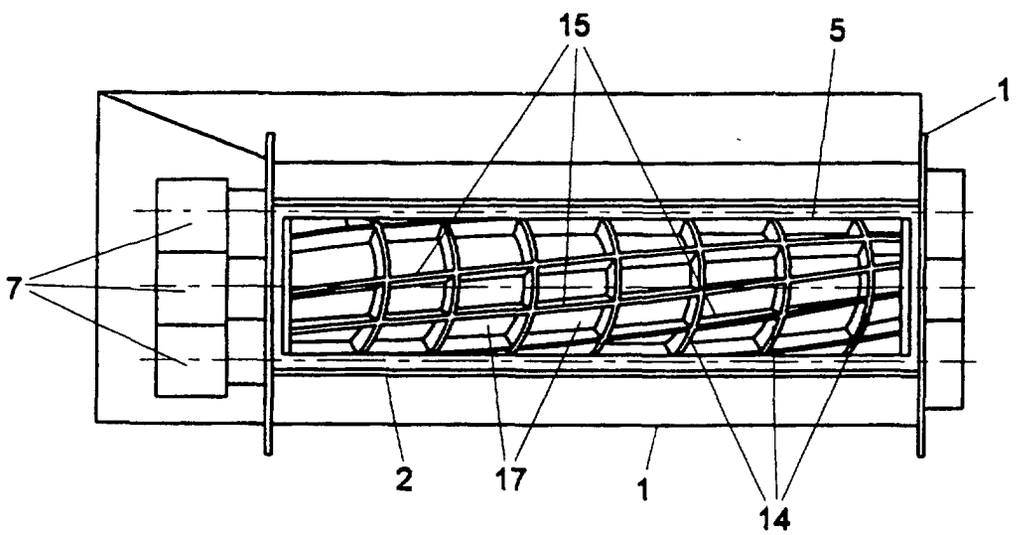

Fig. 4