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(54) **Shredder with two shredding shafts with radial blades and method of operation**

(57) A shredder with two parallel and substantially horizontal shredding shafts (11, 12) with radial blades (13), comprising
- independent and reversible motors (16, 17) for the actuation of the two shredding shafts (11, 12),
- at least one electronic device (18, 19) for modulating the rotation rate of the motors (16, 17) and for controlling the direction of rotation of the shredding shafts (11, 12),
- a programmable control device (20), which is connected

to the electronic devices (18, 19) so as to drive the actuation of the shredding shafts (11, 12) according to a cyclic sequence of a shredding step and a cleaning step, the shredding step consisting in rotationally actuating the two shredding shafts (11, 12) in mutually opposite operating directions (A, B), at a preset operating speed, to entrain between them material to be shredded to be unloaded below them once shredded, and the cleaning step consisting in temporarily reversing the direction of rotation of a selected one of the shredding shafts (11, 12).

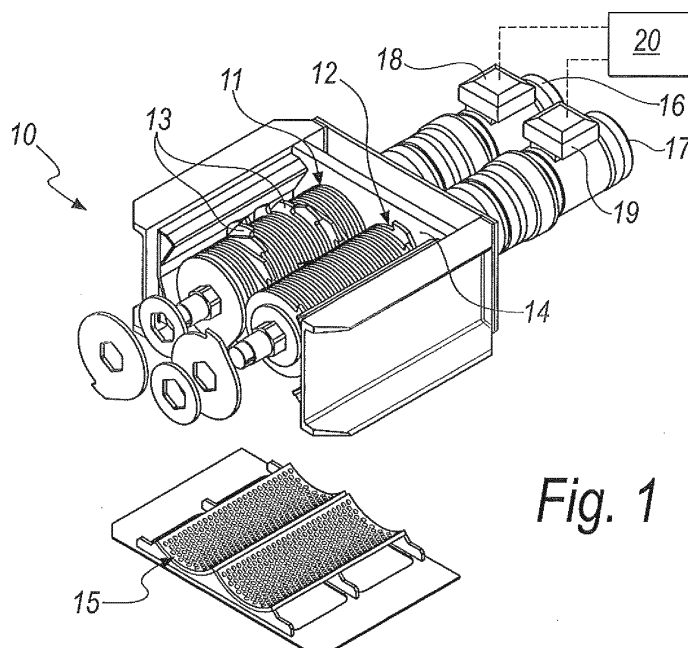


Fig. 1

Description

[0001] The present invention relates to a shredder with two shredding shafts with radial blades and to its method of operation.

[0002] Shredders with contrarotating shafts with blades interleaved in a comb-like arrangement are currently known in the field of waste shredding.

[0003] These shredders comprise a container which is open at the top and at the bottom and is obstructed by two horizontal parallel shredding shafts, both of which integrally support plates provided with perimetric blades and spacers which are interleaved between the plates and have a smaller space occupation, radially with respect to the shaft, than the blades.

[0004] In the region between the two shredding shafts the blades supported by a first shaft are inserted between the blades supported by the second shaft so as to skim their respective spacers.

[0005] The shredding shafts are actuated in a contrarotating manner so as to entrain between them the waste unloaded into the hopper and thus shred it between the blades that slide between each other.

[0006] The waste is then entrained between the shredding shafts, shredded between the blades, and unloaded from them into the region below the two shredding shafts.

[0007] For extracting from the shredder shredded material with a size below a preset limit, the shredding container is closed in a lower region by a grille through which only the fragments that can pass through its openings are discharged.

[0008] Today it is known that during the operation of these shredders the fragments entrained below the shredding shafts and having such a size that they cannot pass through the openings of the grille tend to clog it or become caught on the shredding shafts, thus being entrained in their rotation, hindering the entrainment between the shafts of additional material to be shredded, fully to the disadvantage of the efficiency of the shredder.

[0009] In this case, in order to restore the correct operation of the shredder, said shredder must be stopped and its grilles and shredding shafts must be cleaned.

[0010] In order to counteract the tendency to become clogged and/or obviate its negative effects on shredders, today it is known to provide one or two shafts for cleaning the shredding shafts, which are intended to return to the region above the shredding shafts the fragments that are too large to pass through the apertures of the grille and to free the blades of the shredding shafts from fragments that become caught in them.

[0011] The cleaning shafts are arranged laterally with respect to the corresponding shredding shafts that they are adapted to clean and have the same structure as they have, providing plates with blades inserted between the blades of the shredding shafts.

[0012] The cleaning shaft is actuated in the same direction of rotation as the shredding shaft that it is adapted to clean, so as to extract from between its blades the

waste that tends to become wedged therein.

[0013] Shredders with three or four shafts are currently known, the former having a single cleaning shaft coupled to one of the two shredding shafts in order to clean it.

5 **[0014]** Shredders with four shafts instead have two shredding shafts, to each of which one of the two cleaning shafts is coupled.

[0015] This second structure, despite being appreciated due to its effectiveness, is bulky and has a high consumption, since the rotational actuation of four shafts is required.

10 **[0016]** The aim of the present invention is to provide a shredder with a reduced space occupation with respect to currently known shredders with three or four shafts despite having an operating efficiency which is at least equal to theirs.

15 **[0017]** Within this aim, an object of the invention is to propose a shredder that makes it possible to obtain a lower operating consumption, particularly with respect to currently known three- or four-shaft shredders, with equal quantity of shredded material and equal shredding efficiency.

20 **[0018]** Another object of the invention is to propose a shredder that is structurally simple and easy to use and can be manufactured with relatively low costs.

25 **[0019]** Another object of the invention is to provide a method of operation of a shredder that makes it possible to provide it with a smaller space occupation and with a lower consumption than currently known three- or four-shaft shredders despite having an operating efficiency which is at least equal to theirs.

30 **[0020]** Another object of the invention is to propose a method of operation of a shredder that makes it possible to prevent its clogging so as to achieve a stable and continuous operation thereof.

35 **[0021]** Another object of the invention is to provide a method of operation of a shredder that allows ensuring a long life thereof in efficient operation.

40 **[0022]** A further object of the invention is also to propose a method of operation of a shredder that is simple and easy to implement and can be performed at low cost.

45 **[0023]** This aim, as well as these and other objects that will become more apparent hereinafter, are achieved by a shredder with two parallel and substantially horizontal shredding shafts with radial blades, characterized in that it comprises

- independent and reversible motors for the actuation of said two shredding shafts,
- 50 - at least one electronic device for modulating the rotation rate of said motors and for controlling the direction of rotation of said shredding shafts,
- a programmable control device, which is connected to said at least one electronic device in order to drive the actuation of said shredding shafts according to a cyclic sequence of a shredding step and a cleaning step, said shredding step consisting in rotationally actuating said two shredding shafts in mutually op-

posite operating directions, at a preset operating speed, in order to entrain between them material to be shredded to be unloaded below them once shredded, and said cleaning step consisting in temporarily reversing the direction of rotation of a selected one of said shredding shafts.

[0024] This aim, as well as these and other objects that will become more apparent hereinafter, are further achieved by a method of operation of a shredder with two shredding shafts with parallel and substantially horizontal radial blades, characterized in that it consists of a cyclic sequence of a shredding step and a cleaning step, said shredding step consisting in rotationally actuating said two shredding shafts in mutually opposite operating directions at a preset operating speed in order to entrain between them material to be shredded and to be unloaded below them once shredded, said cleaning step consisting in temporarily reversing the direction of rotation of a selected one of said shredding shafts.

[0025] Further characteristics and advantages of the invention will become more apparent from the description of a preferred but not exclusive embodiment of the method of operation of a shredder according to the invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a partially exploded perspective view of a shredder according to the invention;

Figure 2 is a transverse sectional view of a shredder according to the invention.

[0026] With reference to the figures, the reference numeral 10 generally designates a shredder with two shredding shafts 11 and 12 with radial blades 13, the shredding shafts 11 and 12 being supported so that they are parallel and substantially horizontal in a shredding container 14.

[0027] A grille 15 is conveniently arranged below the shredding shafts 11 and 12 and has meshes with a preset aperture so as to allow the unloading only of material that has a preset maximum size from the shredder.

[0028] According to the invention, the shredder 10 has a particularity in that it comprises

- independent and reversible motors 16 and 17 for the actuation of the two shredding shafts 11 and 12,
- electronic devices 18 and 19 for modulating the rotation rate of the motors 16 and 17 and for controlling the direction of rotation of the shredding shafts 11 and 12,
- a programmable control device 20, which is connected to the electronic devices 18 and 19 so as to drive the actuation of the shredding shafts 11 and 12 according to a cyclic sequence of a shredding step and a cleaning step.

[0029] The shredding step consists in rotationally actuating the two shredding shafts 11 and 12 in mutually

opposite operating directions A and B, at a preset operating speed, so as to entrain between them material to be shredded and to be unloaded below them once shredded.

[0030] The operating directions A and B of the shredding shafts 11 and 12 are conveniently such as to induce the entrainment between them of the material to be shredded that has been unloaded onto them, so that once shredded it is unloaded below them.

[0031] According to the invention, such cleaning step consists in temporarily reversing the direction of rotation of a selected one of the shredding shafts 11 and 12, making it rotate at a cleaning speed in a cleaning direction C or D that is opposite to the corresponding operating direction A or B.

[0032] The motors 16 and 17 are conveniently electric motors.

[0033] Advantageously, the electronic devices 18 and 19 comprise respectively

- a first inverter for the modulated electric power supply of a first one 16 of the motors 16 and 17 for the actuation of a first one 11 of the shredding shafts 11 and 12, and
- a second inverter for the modulated electric power supply of the second one 17 of the motors 16 and 17, for the actuation of the second one 12 of the shredding shafts 11 and 12.

[0034] In general, depending on the embodiment requirements of the invention, at least one of said electronic devices is provided.

[0035] In an alternative embodiment of the invention, advantageously such motors are hydraulic and connected to a hydrodynamic actuation circuit.

[0036] In this case, conveniently such electronic device is connected to the pump or to the pumps provided depending on the embodiment requirements of the invention, which are adapted to pressurize such hydrodynamic circuit, to modulate its flow-rate, in a manner known per se, so as to actuate gradual stops and restarts of such motors.

[0037] The control device 20 preferably comprises means for programming by an operator

- values of the durations of such steps and
- values of the operating speed and of the cleaning speed.

[0038] Preferably, such programming means, not shown in the accompanying figures, are an interface of a type known per se, such as for example a keyboard and a screen for the display of such values, which thus makes it possible to set such values by means of the keyboard and to verify the setting performed by display on such screen.

[0039] Conveniently, the control device 20 comprises means for starting, on command of an operator, such

cleaning step, which advantageously consist of such keyboard, by means of which the operator can give a preset command to the control device 20, which, by performing a preset program, starts said cleaning step, so that if the operator detects an imminent clogging of the shredder 10 he can promptly start said cleaning step in order to prevent such clogging.

[0040] Advantageously, the shredder 10 is actuated according to a method of operation which, according to the invention, has a particularity in that it consists of the cyclic sequence of a shredding step and a cleaning step, wherein said shredding step consists in rotationally actuating the two shredding shafts 11, 12 in opposite operating directions A and B at a preset operating speed so that they entrain between them material to be shredded and to be unloaded below them once shredded, and said cleaning step consists in temporarily reversing the direction of rotation of a selected one of the shredding shafts (11, 12).

[0041] Preferably, the durations of such steps are predefined and are advantageously preset in the programming of the control device conveniently in a manner that can be modified by the operator.

[0042] Such operation of temporarily reversing the direction of rotation of the selected shaft of the shredding shafts 11 and 12 conveniently provides for the rotary actuation of said selected shaft at a cleaning speed that is higher than such operating speed, such cleaning speed being preferably substantially twice such operating speed.

[0043] In successive cycles of such steps, the two shredding shafts 11 and 12 are alternately such selected shaft.

[0044] Thus, for example, during a first cycle in which a first one of such operating steps is followed by a first one of said cleaning steps, in such cleaning step the direction of rotation of the first shredding shaft 11 is reversed.

[0045] In this case, during a second cycle which follows such first cycle and consists of a second one of such operating steps followed by a second one of such cleaning steps, in such second cleaning step the direction of rotation of the second shredding shaft 12 is conveniently reversed, and so forth, alternating the reversal of the rotation of the first shredding shaft 11 and of the second shredding shaft 12 in successive cycles of such steps.

[0046] Thus, alternately the first shredding shaft 11 and the second shredding shaft 12 perform a function of cleaning the other shredding shaft, achieving high cleaning efficiency and therefore high efficiency in the operation of the shredder 10.

[0047] The operation of a shredder 10 according to the method of operation according to the invention is as follows.

[0048] Depending on the type of material to be shredded, the operator sets such values of the durations of such steps and of the operating speed and of the cleaning speed, or chooses among predefined sets of such val-

ues, which are preset as a function of different types of materials or mixtures of materials to be shredded.

[0049] Then, once the shredder 10 has been started, it performs one of such shredding steps, during which the first shredding shaft 11 rotates in a first operating direction A, which is opposite to the second operating direction B, in which the second shredding shaft 12 rotates.

[0050] Thus, the material to be shredded, fed into the shredding container 14 onto the shredding shafts 11 and 12, is entrained between them and is shredded by the blades 13.

[0051] The material thus shredded is unloaded below the shredding shafts 11 and 12 onto the grille 15 through the apertures of which the fragments of material having a smaller size are output.

[0052] In a first cycle of operation, when the duration predefined for such first operating step has elapsed, the control device 20 controls the transition to a first one of such cleaning steps, driving the first electronic device 18 so as to modulate, by means of such first inverter, the electric power supplied to the first motor 16, so as to cause a gradual stop of the first shredding shaft 11 and a subsequent gradual restart in a first cleaning direction C which is opposite to the first operating direction A, gradually accelerating it until it reaches a rotation rate that corresponds to such cleaning speed.

[0053] In this manner, the first shredding shaft 11 cleans the second shredding shaft 12, propelling fragments of material to be shredded that have jammed therein toward the region above the shredding shafts 11 and 12.

[0054] Once the duration predefined for such first cleaning step has elapsed, the control device 20 drives the transition to a second one of such cleaning steps, gradually stopping the first shredding shaft and subsequently restarting it in the first operating direction A, gradually bringing it to such operating speed.

[0055] Then, in a second cycle of operation, once the duration predefined for such second working step has elapsed, the control device 20 controls the transition to a second one of such cleaning steps, actuating the second electronic device 19 so as to modulate, by means of such second inverter, the electric power supplied to the second motor 17, so as to cause a gradual stop of the second shredding shaft 12 and a subsequent gradual restart in a second cleaning direction D which is opposite to the first operating direction B, gradually accelerating the second shredding shaft 12 until it reaches such cleaning speed.

[0056] Thus, the second shredding shaft 12 now cleans the first shredding shaft 11.

[0057] Thus, a third cycle of operation follows which is advantageously identical to such first cycle, and then a fourth cycle of operation which is identical to such second cycle.

[0058] The operation of a shredder in which such motors are hydraulic, driven by such electronic device which

operates the pump or pumps that drive the hydraulic fluid for the actuation of such motors, is substantially analogous.

[0059] In practice it has been found that the invention achieves the intended aim and objects, providing a shredder that is more compact with equal efficiency in operation than currently known three- or four-shaft shredders, making it possible to provide it with just two shafts, for shredding, avoiding the provision of cleaning shafts.

[0060] A shredder according to the invention further allows lower operating consumption, particularly with respect to currently known three- or four-shaft shredders, with equal quantity of shredded material and with equal shredding efficiency, requiring the actuation of just two shafts which operate alternately to shred or to clean the other shaft.

[0061] A shredder according to the invention is further structurally simple and easy to use and can be manufactured at relatively low costs.

[0062] Furthermore, an operating method according to the invention allows the provision of a shredder with a smaller space occupation than currently known shredders with three or four shafts, despite having an at least equal efficiency in operation and a lower consumption than said shredders.

[0063] Moreover, a method of operation according to the invention makes it possible to prevent the clogging of the shredder, allowing a stable and continuous operation thereof.

[0064] Moreover, a method of operation according to the invention, through the actuation of the shredding shafts by means of electronic devices provided with an inverter, allows an actuation thereof that prevents peaks of braking or accelerating torque of the shredding shafts, ensuring that the shredder has a long life in efficient operation.

[0065] The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims; all the details may further be replaced with other technically equivalent elements.

[0066] In practice, the materials used, as long as they are compatible with the specific use, as well as the contingent shapes and dimensions, may be any according to requirements and to the state of the art.

[0067] The disclosures in Italian Patent Application No. PD2010A000341 from which this application claims priority are incorporated herein by reference.

[0068] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A shredder (10) with two parallel and substantially horizontal shredding shafts (11, 12) with radial blades (13), **characterized in that** it comprises

- independent and reversible motors (16, 17) for the actuation of said two shredding shafts (11, 12),
- at least one electronic device (18, 19) for modulating the rotation rate of said motors (16, 17) and for controlling the direction of rotation of said shredding shafts (11, 12),
- a programmable control device (20), which is connected to said at least one electronic device (18, 19) to drive the actuation of said shredding shafts (11, 12) according to a cyclic sequence of a shredding step and a cleaning step, said shredding step consisting in rotationally actuating said two shredding shafts (11, 12) in mutually opposite operating directions (A, B), at a preset operating speed, to entrain between them material to be shredded to be unloaded below them once shredded, and said cleaning step consisting in temporarily reversing the direction of rotation of a selected one of said shredding shafts (11, 12).

2. The shredder according to claim 1, **characterized in that** the durations of said steps are predefined.

3. The shredder according to one or more of the preceding claims, **characterized in that** said operation of temporarily reversing the direction of rotation of a selected one of said shredding shafts (11, 12) provides for the rotational actuation of said selected shaft at a cleaning speed that is higher than said operating speed.

4. The shredder according to one or more of the preceding claims, **characterized in that** said at least one electronic device (18, 19) comprises

- a first inverter for the modulated electric power supply of a first one (16) of said motors (16, 17) for the actuation of a first one (11) of said shredding shafts (11, 12), and
- a second inverter for the modulated electric power supply of the second one (17) of said motors (16, 17), for the actuation of the second one (12) of said shredding shafts (11, 12).

5. The shredder according to one or more of the preceding claims, **characterized in that** said control device (20) comprises means for the programming, by an operator,

- of values of said durations of said steps and

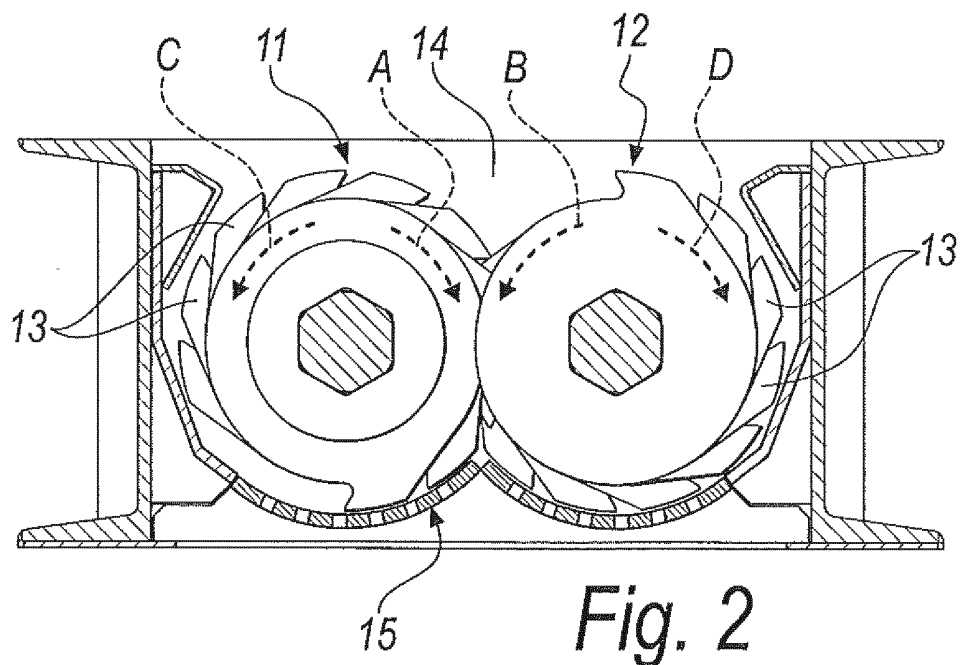
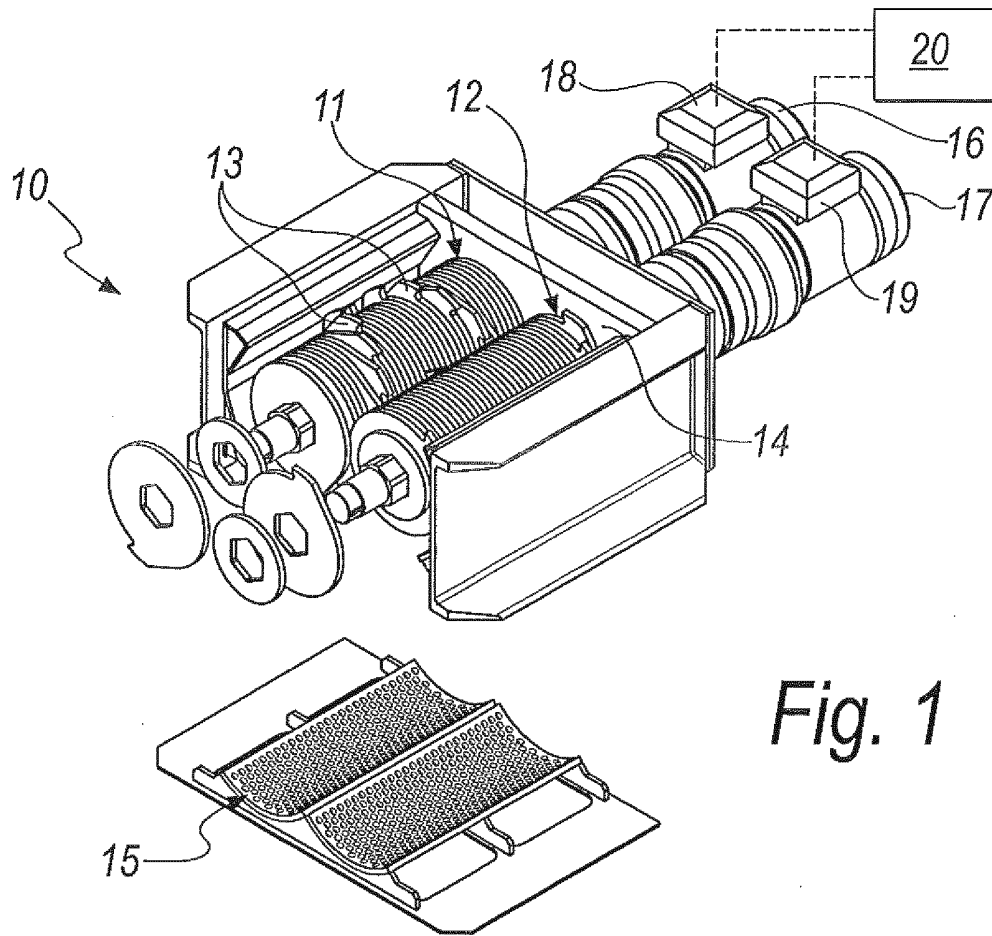
- of values of said operating speed and of said cleaning speed.

6. The shredder according to one or more of the preceding claims, **characterized in that** said control device (20) comprises means for starting said cleaning step on command by an operator. 5
7. A method of operation of a shredder with two parallel and substantially horizontal shredding shafts (11, 12) with radial blades (13), **characterized in that** it consists of the cyclic sequence of a shredding step and a cleaning step, said shredding step consisting in rotationally actuating said two shredding shafts (11, 12) in mutually opposite operating directions (A, B) at a preset operating speed to entrain between them material to be shredded and to be unloaded below them once shredded, said cleaning step consisting in temporarily reversing the direction of rotation of a selected one of said shredding shafts (11, 12). 10 15 20
8. The method according to claim 7, **characterized in that** the durations of said steps are predefined. 25
9. The method according to one or more of claims 7 and 8, **characterized in that** said operation of temporarily reversing the direction of rotation of a selected one of said shredding shafts (11, 12) provides for the rotational actuation of said selected shaft at a cleaning speed that is higher than said operating speed. 30
10. The method according to claim 9, **characterized in that** said cleaning speed is substantially twice said operating speed. 35
11. The method according to one or more of claims 7 to 10, **characterized in that** in successive cycles of said steps said two shredding shafts (11, 12) are alternately said selected shaft. 40

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EUROPEAN SEARCH REPORT

Application Number
EP 11 18 9078

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 9 March 2012	Examiner Swiderski, Piotr
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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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 18 9078

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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