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(54) Crusher and use thereof

(57) A crusher (1) is disclosed for comminuting material, in particular organic material, comprising a comminuting vessel (2) with an inner vertical side wall (3), a drive shaft (5) extending substantially vertically and centrally within said comminuting vessel, a crushing tool (7) arranged on said drive shaft within the comminuting vessel to rotate with the drive shaft, the crushing tool comprising at least one flexible, elongated crushing element (9) having a free end (11), the crusher furthermore comprising crusher drive means (13, 14) arranged to drive the rotation of said drive shaft, the comminuting vessel having an inlet opening (4) and an outlet opening (15), wherein the outlet opening of the comminuting vessel is situated in the cylindrical wall of the comminuting vessel at the horizontal level of said at least one crushing element, wherein the free end of the at least one crushing element extends out through the outlet opening during operation of the crusher when the drive means drives the rotation of the drive shaft and the crushing tool. The use of the crusher is furthermore disclosed, in particular for organic material to be used in the production ofbiogas.

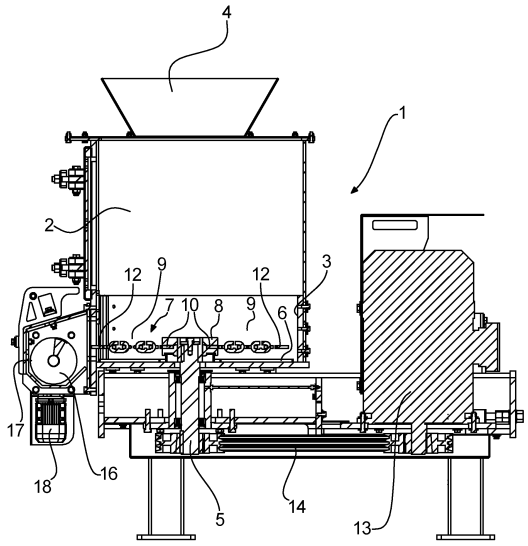

Fig. 3

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Description

[0001] The present invention relates to a crusher in particular for comminution of organic material.

BACKGROUND

[0002] Crushers that may be used for comminution of organic material as well as for other types of material are known in the prior art from European patent application EP 1 479 441 A2, where a horizontally rotating crushing tool comprising a number of chains extending out from a central hub is applied to comminution of material in a batch process, where the material is loaded into the vessel containing the crushing tool and then processed for a time period, where after a door is opened in the side wall of the vessel and the processed material is removed from the vessel by the action of the chains.

[0003] A different crusher is disclosed in US patent No. 5,697,563 where a number of scrapers are arranged at the horizontal bottom wall of the comminution vessel to rotate and cause the crushed material to be pushed outside of the vessel through an opening in the side wall of the vessel, thus allowing a continuous operation of the crusher.

[0004] It is an object of the present invention to provide a simpler crusher that allow for continuous operation in particular of organic material and it is a further object to provide a crusher where the quality of the comminution of the material can be controlled in an improved manner.

BRIEF DESCRIPTION OF THE PRESENT INVENTION

[0005] The objects of the present invention are obtained by providing a crusher for comminuting material, in particular organic material, comprising a comminuting vessel with an inner vertical side wall, a drive shaft extending substantially vertically and centrally within said comminuting vessel, a crushing tool arranged on said drive shaft within the comminuting vessel to rotate with the drive shaft, the crushing tool comprising at least one flexible, elongated crushing element having a free end, the crusher furthermore comprising crusher drive means arranged to drive the rotation of said drive shaft, the comminuting vessel having an inlet opening and an outlet opening, wherein the outlet opening of the comminuting vessel is situated in the cylindrical wall of the comminuting vessel at the horizontal level of said at least one crushing element, wherein the free end of the at least one crushing element extends out through the outlet opening during operation of the crusher when the drive means drives the rotation of the drive shaft and the crushing tool.

[0006] By forming the outlet opening, i.e. the area defined by the edges of the opening in the inner walls of the vessel, and the elongated crushing element so that the end of the at least one element during rotation of the crushing tool will extend out through the opening, i.e. will pass the opening when the tool rotates, it is ensured that the processed material is removed from the vessel by the crushing elements themselves without the need for a particular arrangement for that purpose, and the material is prevented from accidentally blocking the outlet and halting the operation of crusher, which in particular organic material that has been comminuted to a small particle size has a tendency to do. Thus, a simple crusher is obtained that is suited for continuous operation and processing of organic material.

[0007] It is preferred that the crusher further comprising a conveyor device arranged for conveying processed material away from the outlet opening, wherein the conveyor device comprising a conveying means and a conveyor drive means for driving the conveying means. The conveyor drive means is preferably arranged with an adjustable speed so as to control the flow rate of processed material out through the outlet opening. By controlling the flow rate of processed material away from the outlet opening of the vessel the processing time of the material and thus comminution degree of the processed material leaving the vessel through the outlet opening may be controlled.

[0008] The conveying means comprises preferably a conveyor screw, in particular a centerless conveyor screw. However, other conveying means such as a flighted belt conveyor could be applied alternatively.

[0009] It is preferred that the inner wall of the comminuting vessel is of a substantially cylindrical cross-section at least at the vertical level of the rotating crushing tool.

[0010] The crushing tool comprises preferably at least two flexible, elongated crushing elements each having a free end which extends out through the outlet opening during operation of the crusher when the drive means drives the rotation of the drive shaft and the crushing tool, and the crushing elements of the crushing tool are preferably arranged in balance around the drive shaft. The crushing tool may comprise more crushing elements and the crushing elements may be arranged in a plurality of vertical levels.

[0011] The crushing element or elements are flexible and may be formed e.g. of steel wire ropes with a hammer element at the free end thereof. However, it is preferred that the crushing element or elements are formed of chains which are very wear resistant.

[0012] The comminuting vessel may in a preferred embodiment further comprise a bottom wall immediately below the horizontal plane of the crushing tool, in particular a substantially horizontal bottom wall that is parallel with the rotational plane of the crushing tool.

[0013] The outlet opening is preferably formed in said bottom wall as well as in said side wall so that the outlet opening extends from the side wall into the bottom wall and the free end or ends of the crushing elements during rotation of the crushing tool will pass vertically above the part of the outlet opening defined in the bottom wall, whereby the gravitational pull will assist in removing the processed material from the comminuting vessel.

[0014] The crusher preferably also comprises a driven

feeding device for feeding material into the inlet opening so that the feeding of material may be controlled.

[0015] The crusher may preferably further comprise control means arranged to receive an input relating to the power consumption of the crusher drive means during operation of the crusher and to control the operation of said feeding device in response to the input. The crusher is suited for being operated in a continuous mode, where the control means of the crusher monitors the power consumption of the motor driving the crushing tool and controls the operation of the material feeding device. The power consumption of the motor decreases when the material contained within the vessel is processed to a finer size and the feeding device may is in response to a lowering of the power consumption be activated by the control means to increase the feeding of material into the vessel in order to maintain the power consumption of the motor and thus the processing rate of the crusher substantially constant.

[0016] During comminution of certain types of organic material, such as livestock bedding which is a mixture of urine, faeces and an absorbing material such as straw or woodchips, the partly comminuted mass tend to become sticky and may form an annulus sticking to the wall on the inside of the comminuting vessel right above the rotating crushing tool. At intervals, parts of this annulus breaks free and interacts with the crushing tool, causing an excessive load on the crusher drive means and a non-continuous flow of comminuted material out through the outlet opening, both consequences of the formation of the annulus being disadvantageous. To solve this problem, it has been found that the supplying of a liquid into the comminuting vessel during operation of the crusher may prevent the formation of the annulus and thereby increase the comminuting capacity of the crusher with up to as much as about 100% while ensuring a more steady load on the crusher drive means. Thus, it is preferred that the crusher further comprises a liquid supplying device for supplying liquid into the comminuting vessel during operation of the crusher.

[0017] The liquid supplying device may comprise one or more nozzles as well as piping to connect the nozzle(s) to an arrangement for providing the liquid under pressure, e.g. comprising a pump and a reservoir. The liquid may be water, such as waste water used for cleaning of the crusher and other equipment, or it may in a preferred embodiment be liquid farm slurry.

[0018] The amount of liquid supplied into the comminuting vessel during operation of the crusher may in a preferred embodiment be controlled by control means in response to the feeding of material into the inlet opening. The crusher may for that purpose comprise feeding measuring means for determining the amount of material fed into the inlet opening and providing an output accordingly to the control means for controlling the supply of liquid, the feeding measuring means being such as weighing means for determining the weight of the material fed into the inlet opening e.g. by means of the driven feeding device.

[0019] As the formation of such annulus of sticky, partly comminuted organic material may occur in other types of crushers, the present invention relates in a second aspect of the invention to a crusher for comminuting material, in particular organic material, comprising a comminuting vessel with an inner vertical side wall, a drive shaft extending substantially vertically and centrally within said comminuting vessel, a crushing tool arranged on said drive shaft within the comminuting vessel to rotate with the drive shaft, the crushing tool comprising at least one flexible, elongated crushing element having a free end, the crusher furthermore comprising crusher drive means arranged to drive the rotation of said drive shaft, the comminuting vessel having an inlet opening and an outlet opening, the outlet opening being situated in the cylindrical wall of the comminuting vessel at the horizontal level of said at least one crushing element, wherein the crusher further comprises a liquid supplying device for supplying liquid into the comminuting vessel during operation of the crusher.

[0020] The crusher according to this second aspect of the present invention may comprise one or more of the optional features of the crusher according to the first mentioned aspect of the invention as discussed herein.

[0021] The present invention further relates to the use of a crusher as described herein for the comminuting of material in a continuous process, in particular where the material is organic material. The comminution of organic material is in particular in use for organic material that is further processed in a plant for biological decomposition of the organic material for the production of biogas as the finer size of the material allows for a faster and more uniform biological decomposition and the present crusher is preferably used for such purpose.

BRIEF DESCRIPTION OF THE FIGURES

[0022] A preferred embodiment of the present invention is shown in the accompanying drawing which comprises the following figures

Fig. 1 is an end view of a crusher according to the invention,

Fig. 2 is a perspective view of the crusher of Fig. 1,

Fig. 3 is a vertical cross-section of the crusher of Figs. 1 and 2,

Fig. 4 is a detail of the cross-section of Fig. 3, and

Fig. 5 is a horizontal cross-section of the lower part of the comminution vessel of the crusher.

[0023] The embodiment of the present invention shown in the drawing is an example of the invention provided to illustrate it and is not in any way to be construed

as a limitation of the present invention.

DETAILED DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

[0024] The embodiment of the crusher 1 shown in the accompanying drawing is primarily intended for comminution of organic material such as animal excrements mixed with straw, organic industrial waste or food waste so that it is better suited for being fed to a biogas plant, also known as a biogas digester. The crusher 1 comprises a comminution vessel 2 having an inner vertical wall 3 of a cylindrical cross-section with a funnel 4 at the top of the vessel 2 which constitutes an inlet of the comminution vessel 2. A feeding device (not shown) may be provided as part of the crusher 1 for controlled feeding of material into the vessel 2 through the funnel 4.

[0025] A vertical drive shaft 5 extends through the horizontal bottom wall 6 of the vessel 2 and carries a crushing tool 7 comprising a hub 8 rigidly connected to the drive shaft 5 and two chains 9 extending on opposing sides of the hub 8. Each chain 9 is at one end 10 fastened to the hub 8 and has an opposing free end 11 carrying an end link 12 of the chain 9 acting as a hammer. An electric motor 13 is a drive means for the crushing tool 7 and is connected to the drive shaft 5 by means of a belt drive 14. The crushing tool 7 is arranged right above the bottom wall 6 so that the chains 9 during operation of the crusher 1 will rotates parallel to and immediately above the bottom wall 6.

[0026] The comminution vessel 2 has an outlet opening 15 formed in the bottom part of the side wall 3 of the vessel 2 as well as in the bottom wall 6 and the outlet opening 15 is formed so that the free ends 11 of the chains 9 under operation of the crusher 1 will extend out through the outlet opening 15, i.e. the outer part of the end links 12 of the chains 9 will pass out through the opening area defined by the of the edges of the outlet opening 15 in the inner walls 3, 6 of the comminution vessel 2 when the electric motor 13 drives the crushing tool 7 to rotate during operation of the crusher 1. The outlet opening 15 extends horizontally along an angle range of the inner wall 3 of the vessel 2 and in the vertical direction in a height sufficient to accommodate the passing of the free ends 11 of the chains 9.

[0027] A centerless conveyor screw 16 arranged in a cylindrical housing 17 is arranged outside the outlet opening 15 of the comminution vessel 2 of the crusher 1 to convey the processed material away from the outlet opening 15. The conveyor screw 16 is driven by means of an electrical motor 18 with a variable speed which may be adjusted to control the flow rate of processed material out from the comminution vessel 2 and thus the degree of processing of the material.

[0028] The crusher 1 is suited for being operated in a continuous mode, where a control unit (not shown) of the crusher 1 monitors the power consumption of the electrical motor 13 driving the crushing tool 7 and controls the operation of the material feeding device (not shown). The power consumption of the motor 13 is decreasing when the material contained within the vessel 2 is processed to a finer size and the feeding device is in response to a lowering of the power consumption activated to increase the feeding of material into the vessel 2 through the inlet opening 4 thereof in order to maintain the power consumption of the motor 13 and thus the processing rate of the crusher 2 substantially constant.

[0029] The operation of the crusher 1 to produce an output of material that has been comminuted to a suitable degree may be continuous by the fact that has been realised by the inventor of the present invention, that the material of the finest size has a tendency to move to the lowest part of the comminution vessel 2 where the free ends 11 of the chains 9 during rotation will force the material out through the outlet opening 15, and the fact that these free ends 11 extend out through the inner opening area of the outlet opening 15 ensures that the flow of material out through the outlet opening 15 is continuous and that the opening 15 will not be blocked by the material.

[0030] The crusher furthermore comprises nozzles (not shown) for adding a liquid, preferably farm slurry to the interior of the comminuting vessel 2 in order to prevent the formation of an annulus of sticky, partly comminuted organic material, which may happen during comminution of some types of material, in particular when such material as livestock bedding is fed into the crusher. The amount of liquid added to the vessel 2 may preferably be controlled parallel to the feeding device for feeding the organic material into the inlet opening of the comminution vessel 2 so that the amount of liquid matches the amount of material fed by the feeding device. Alternatively, the feeding device may comprise weighting means for determining the weight of the material fed into the vessel and the control means may then control the supply of liquid in response to said weight of material fed to the vessel 2.

REFERENCE NUMERALS

[0031]

1	Crusher
2	Commination vessel
3	Inner vertical wall of comminution vessel
4	Funnel defining inlet opening of comminution vessel
5	Drive shaft
6	Bottom wall of comminution vessel
7	Crushing tool
8	Hub of crushing tool
9	Chains
10	Inner end of chains
11	Free end of chains
12	End link of chains
13	Electric motor driving crushing tool

14 Belt drive
15 Outlet opening
16 Conveyor screw
17 Housing of conveyor screw
18 Electrical motor for driving the conveyor screw

Claims

1. A crusher (1) for comminuting material, in particular organic material, comprising
a comminuting vessel (2) with an inner vertical side wall (3),
a drive shaft (5) extending substantially vertically and centrally within said comminuting vessel,
a crushing tool (7) arranged on said drive shaft within the comminuting vessel to rotate with the drive shaft, the crushing tool comprising at least one flexible, elongated crushing element (9) having a free end (11),
the crusher furthermore comprising crusher drive means (13, 14) arranged to drive the rotation of said drive shaft,
the comminuting vessel having an inlet opening (4) and an outlet opening (15), wherein the outlet opening of the comminuting vessel is situated in the cylindrical wall of the comminuting vessel at the horizontal level of said at least one crushing element,
wherein the free end of the at least one crushing element extends out through the outlet opening during operation of the crusher when the drive means drives the rotation of the drive shaft and the crushing tool.

2. Crusher according to claim 1 further comprising a conveyor device (16, 17, 18) arranged for conveying processed material away from the outlet opening, the conveyor device comprising a conveying means (16) and a conveyor drive means (18) for driving the conveying means.

3. Crusher according to claim 2, wherein the conveying means comprises a conveyor screw, in particular a centerless conveyor screw.

4. Crusher according to any of claims 1 to 3, wherein said inner wall of the comminuting vessel is of a substantially cylindrical cross-section.

5. Crusher according to any of the preceding claims, wherein the crushing tool comprises at least two flexible, elongated crushing elements each having a free end which extends out through the outlet opening during operation of the crusher when the drive means drives the rotation of the drive shaft and the crushing tool.

6. Crusher according to claim 5, wherein the crushing elements of the crushing tool are arranged in balance around the drive shaft.

7. Crusher according to any of the preceding claims, wherein the crushing element or elements are formed of chains.

8. Crusher according to any of the preceding claims, wherein the comminuting vessel further comprises a bottom wall (6) immediately below the horizontal plane of the crushing tool.

9. Crusher according to claim 8, wherein said bottom wall is substantially horizontal.

10. Crusher according to claim 8 or 9, wherein the outlet opening is formed in said bottom wall as well as in said side wall.

11. Crusher according to any of the preceding claims further comprising a driven feeding device for feeding material into the inlet opening.

12. Crusher according to claim 11 further comprising control means arranged to receive an input relating to the power consumption of the crusher drive means during operation of the crusher and to control the operation of said feeding device in response to the input.

13. Crusher according to any of the preceding claims, further comprising a liquid supplying device for supplying liquid into the comminuting vessel (2) during operation of the crusher (1).

14. Crusher according to claim 13, wherein the amount of liquid supplied into the comminuting vessel (2) during operation of the crusher (1) is controlled by control means in response to the feeding of material into the inlet opening (4).

15. Crusher according to claim 14 comprising feeding measuring means for determining the amount of material fed into the inlet opening (4) and providing an output accordingly to the control means for controlling the supply of liquid.

16. A crusher (1) for comminuting material, in particular organic material, comprising
a comminuting vessel (2) with an inner vertical side wall (3),
a drive shaft (5) extending substantially vertically and centrally within said comminuting vessel,
a crushing tool (7) arranged on said drive shaft within the comminuting vessel to rotate with the drive shaft, the crushing tool comprising at least one flexible, elongated crushing element (9) having a free end (11),

the crusher furthermore comprising crusher drive means (13, 14) arranged to drive the rotation of said drive shaft,
the comminuting vessel having an inlet opening (4) and an outlet opening (15), the outlet opening being situated in the cylindrical wall of the comminuting vessel at the horizontal level of said at least one crushing element,
wherein the crusher further comprises a liquid supplying device for supplying liquid into the comminuting vessel (2) during operation of the crusher (1).

17. Crusher according to claim 16, wherein the amount of liquid supplied into the comminuting vessel (2) during operation of the crusher (1) is controlled by control means in response to the feeding of material into the inlet opening (4).

18. Crusher according to claim 17 comprising feeding measuring means for determining the amount of material fed into the inlet opening (4) and providing an output accordingly to the control means for controlling the supply of liquid.

19. Crusher according to any of claims 16 to 18 further comprising a conveyor device (16, 17, 18) arranged for conveying processed material away from the outlet opening, the conveyor device comprising a conveying means (16) and a conveyor drive means (18) for driving the conveying means.

20. Crusher according to claim 19, wherein the conveying means comprises a conveyor screw, in particular a centerless conveyor screw.

21. Crusher according to any of claims 16 to 20, wherein said inner wall of the comminuting vessel is of a substantially cylindrical cross-section.

22. Crusher according to any of claims 16 to 21, wherein the crushing tool comprises at least two flexible, elongated crushing elements each having a free end which extends out through the outlet opening during operation of the crusher when the drive means drives the rotation of the drive shaft and the crushing tool.

23. Crusher according to claim 22, wherein the crushing elements of the crushing tool are arranged in balance around the drive shaft.

24. Crusher according to any of claims 16 to 23, wherein the crushing element or elements are formed of chains.

25. Crusher according to any of claims 16 to 24, wherein the comminuting vessel further comprises a bottom wall (6) immediately below the horizontal plane of the crushing tool.

26. Crusher according to claim 25, wherein said bottom wall is substantially horizontal.

27. Crusher according to any of claims 16 to 26 further comprising a driven feeding device for feeding material into the inlet opening.

28. Crusher according to claim 27 further comprising control means arranged to receive an input relating to the power consumption of the crusher drive means during operation of the crusher and to control the operation of said feeding device in response to the input.

29. Use of a crusher according to any of the preceding claims for the comminuting of material in a continuous process.

30. Use according to claim 29, wherein the material is organic material

31. Use according to claim 30, wherein the organic material is further processed in a plant for biological decomposition of the organic material for the production of biogas.

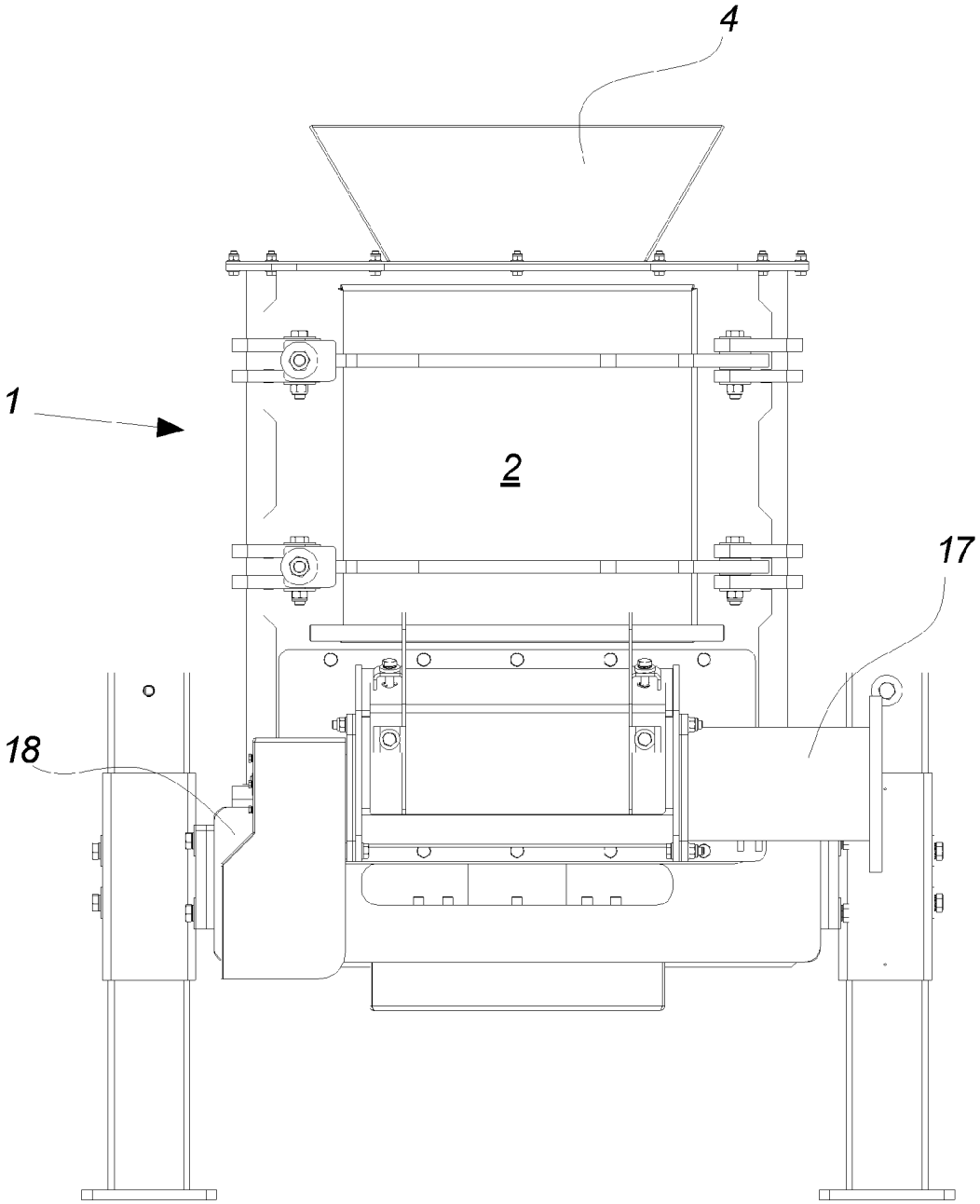

Fig. 1

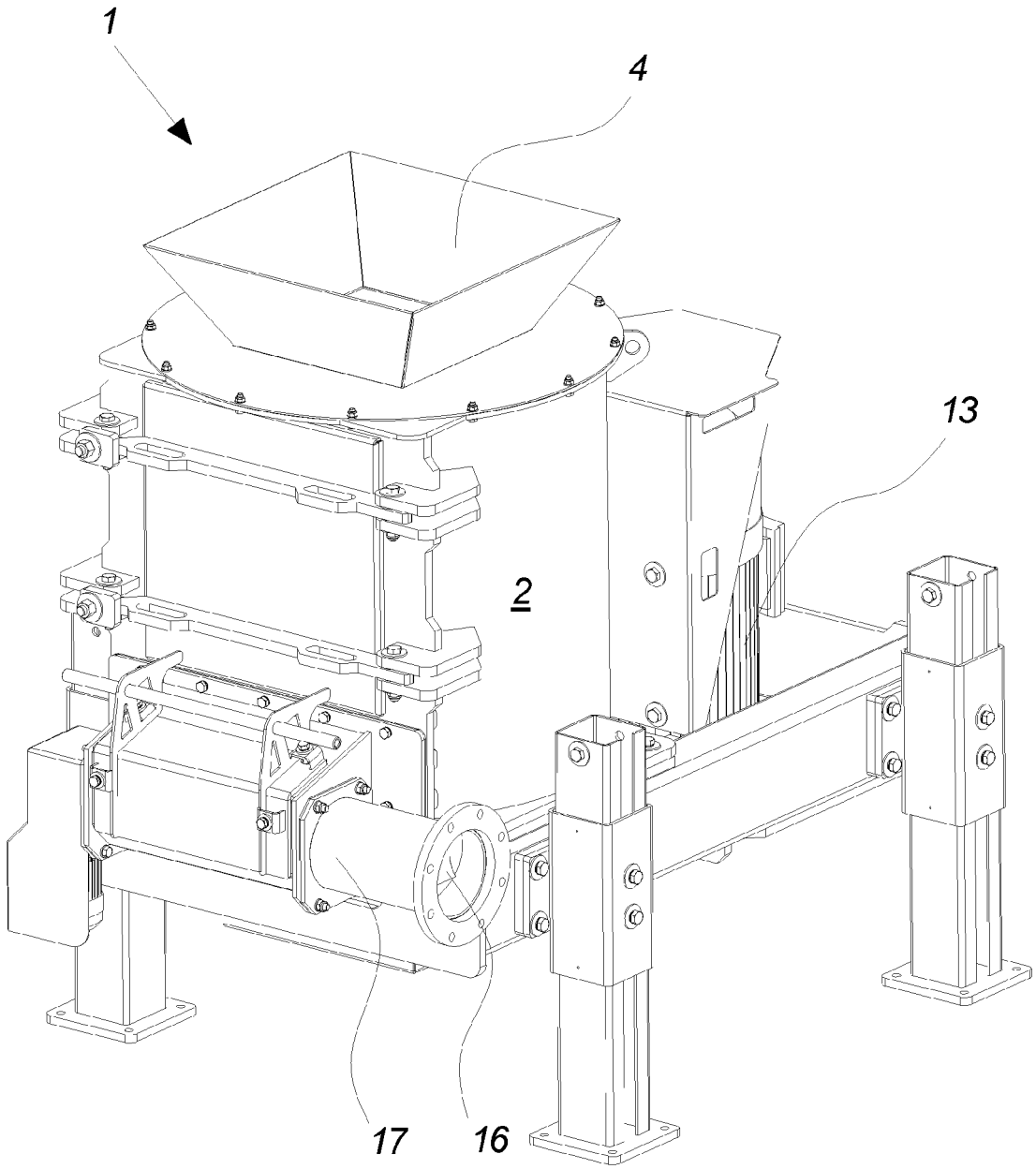

Fig. 2

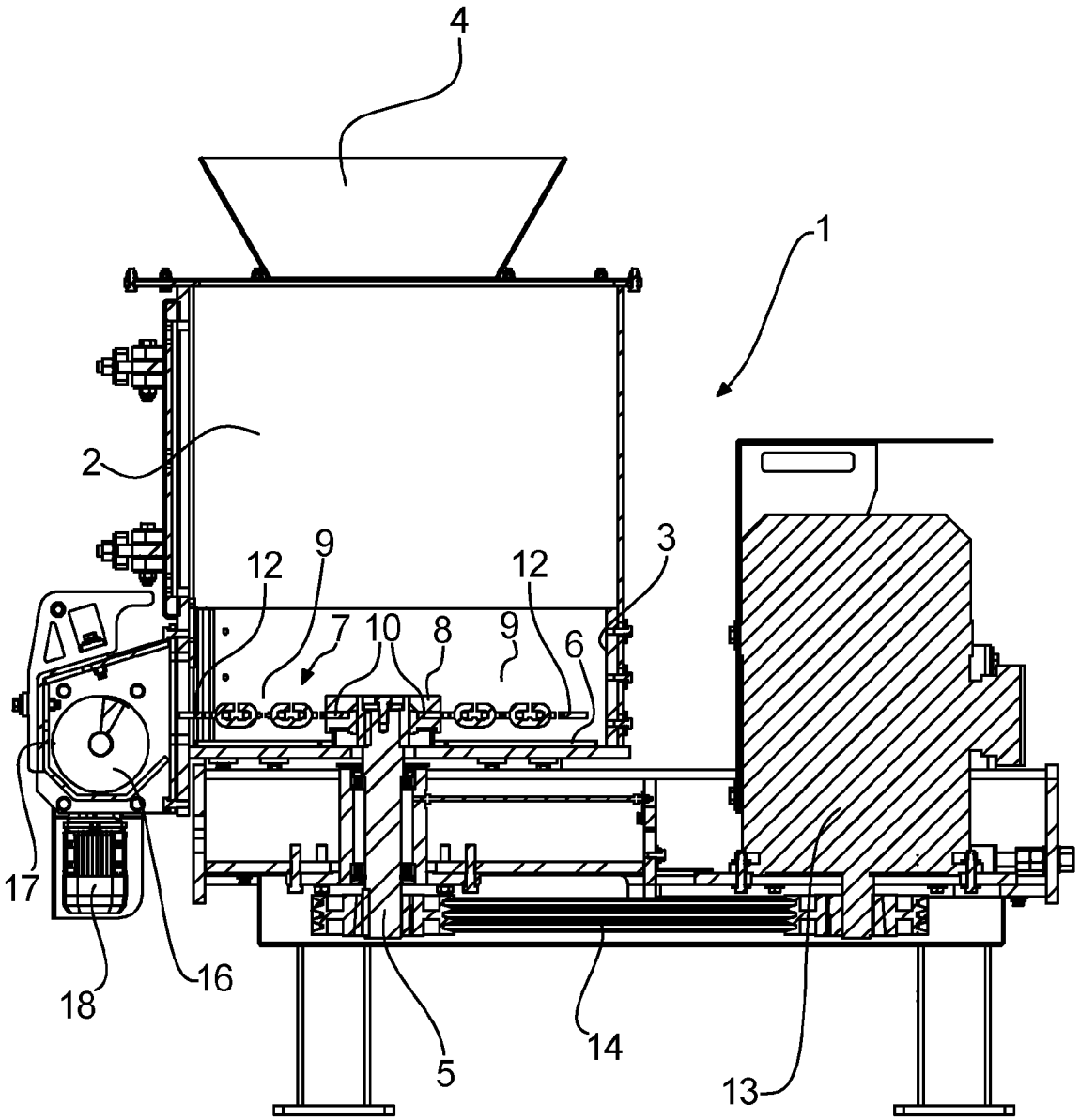

Fig. 3

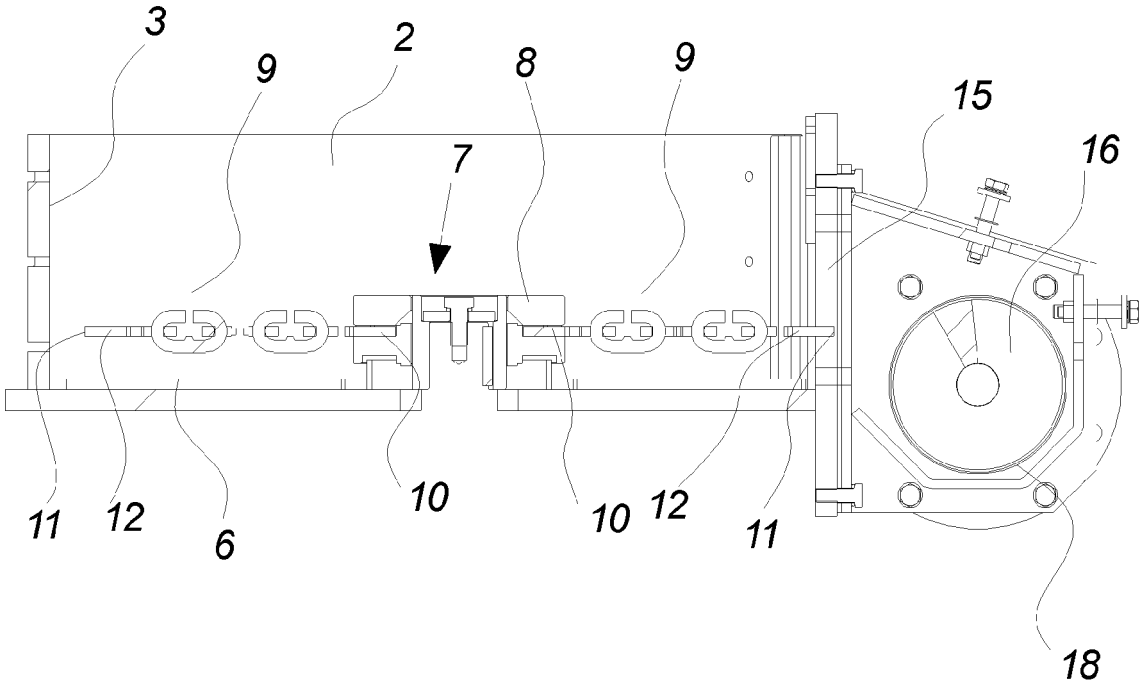

Fig. 4

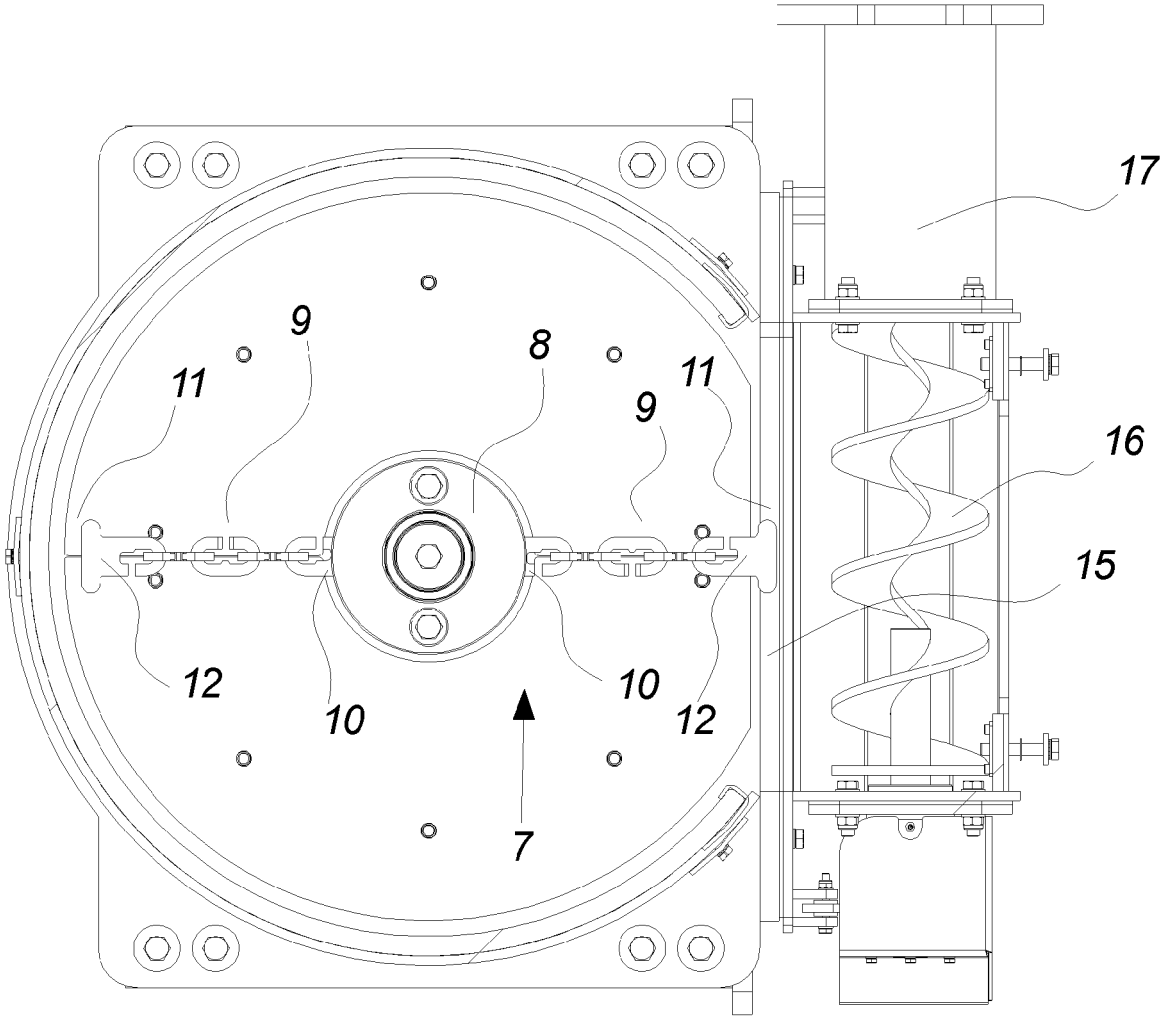

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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- US 5697563 A **[0003]**