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(54) **CRUSHER FOR GRINDING AND CRUSHING MATERIALS**

(57) The crusher (1) for grinding and crushing materials, especially residual and waste material resulting from metal working, consists of a frame (2) with a hopper (3), at least one drive unit and a crushing and grinding assembly (4). The crushing and grinding assembly (4) comprises at least two counter-driven screw rotors (5, 5'), wherein each of the screw rotors (5, 5') is provided with at least two screw blades (6, 6'). There is at least one pair of screw blades (6, 6') on both the first screw rotor (5) and the second screw rotor (5'), which are arranged symmetrically to each other to the centre of the screw rotor (5, 5'), with one of the screw blades (6, 6') forming a right-hand thread and the other of the screw blades (6, 6') forming a left-hand thread. The left-hand screw blade (6') on the second screw rotor (5') is assigned to the right-hand screw blade (6) on the first screw rotor (5) and the right-hand screw blade (6) on the second screw rotor (5') is assigned to the left-hand screw blade (6') on the first screw rotor (5). The outer edges of the screw blades (6, 6') on the first screw rotor (5) and the second screw rotor (5') skew to each other when the screw rotors (5, 5') are rotated, with an overlap on the projection in the horizontal plane. Recesses (7) corresponding to the shape of the separation bars (8) mounted on the surface of the screw rotors (5, 5') parallel to the axis of their rotation are formed on the screw blades (6, 6'). Separation bars (8) are positioned such that when rotating the screw rotors (5, 5'), the separation bars (8) on the first screw rotor (5) are associated with the recesses (7) of the screw blades (6, 6') on the second screw rotor (5') and the separation bars (8) on the second screw rotor (5') are associated with the recesses (7) of the screw blades (6, 6') on the first screw rotor (5).

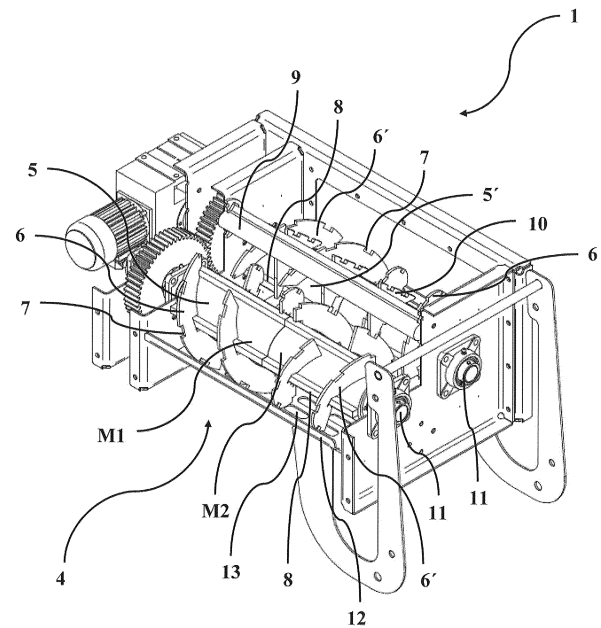


FIG. 2

Description

Field of the Invention

[0001] The present invention relates to a crusher for grinding and crushing the inserted material into smaller segments for further industrial processing or disposal, in particular for crushing waste and residual material resulting from metal working.

Background of the Invention

[0002] Patent documents such as US 9943855 (B2) are known in the field of processing of metallic material and material with metallic admixtures, which discloses a cutting and crushing machine with replaceable crushing segments allowing a choice between methods of separating material by cutting or breaking. The principle of operation consists in counter-rotating movement of a pair of breaking or cutting assemblies with blades placed on rotating shafts. These blocks of cutting or breaking blades are positioned with gaps on the shaft so that the blades engage sequentially, i.e. they are placed in a helix. The shafts are fitted so that the cutting blocks engage with each other with overlap when the blades of one block are aligned against the gaps of the other block. The material is fed to the blades by its own weight and held by the self-locking mechanism of blades when cutting into the separated material. On the side adjacent to the side walls there are blocks of scrapers and crushers for cleaning the gaps between the individual blades in the assembly, while also assisting in the crushing and cutting of material.

[0003] The patent document US 2011/0062263, on the other hand, discloses a cutting and crushing machine where the principle is based on the fact that a pair of shafts with counter-movement is installed in the machine casing without overlap, i.e. the crushing assemblies do not engage with each other. In this case, the crushing assembly is sandwich-formed where the rotating crushing segments alternate with stationary crushing segments, while the blades are on both rotating segments and stationary segments, where the stationary segment forms a counterpart for holding the crushed material and at the same time facilitates the crushing by the rotary blade due to its cutting capabilities.

[0004] Similar to the patent document US 9943855 (B2) is the patent document US 6241170 (B1). Even here, the two overlapping blocks of the cutting discs rotating in counter-movement ensure the crushing process. In this solution, however, the scraper blocks at the device walls do not have an additional crushing function and do not have their own cut surfaces, so that they only clean the joints of the cutting blocks from the adhered pieces of crushed material.

[0005] The patent document US 5562255 (A1) discloses a device for crushing tires into a rubber-ferrous granulate, since the tire is always a combination of rubber

and a metal wire cord. This device, however, is designed as a two-stage, when at the first stage the tire is cut into long strips by a system of feeding rollers pushing the tire through two blocks of cutting blades with edge cut with mutual overlap. The second stage then, by means of the cutting rollers with cutting bars with a partially helical profile of the bending, breaks apart these strips against a fixed cutting bar which causes the resulting scissor effect.

[0006] All known devices use sharp cutting and crushing blades, mostly without an additional feeder to cut and crush large pieces of material into small granules. The basis is the support of the material on the counter-piece and its cutting or breaking against this support, i.e. more or less a scissor effect using double cutting edge or cutting edge and support. What is important, however, is that the separation process is dependent on the direction of rotation, where the reverse run may cause the jammed material to be released, but the material is not separated during this run. The use of blades or discs on a rotating shaft by a helical system has the reason for the gradual engagement of individual blades, utilizing the need for a lower specific pressure per cm² than as if all blades engage simultaneously. The operation is then smoother and less energy and performance intensive. A disadvantage of the present solutions is that the material is usually not intentionally directed when it is moved to the crushing machine. There is no known crusher that would be equipped with a device that would intentionally move the material to be crushed from the hopper edges to the centre, i.e. into the optimum crushing area.

[0007] The purpose of the present invention is to eliminate the disadvantages of the solutions described above from the background of the invention by providing a device enabling separation operation in both machine directions with increased separation crushing effect and centred movement effect of material for crushing and grinding.

Summary of the Invention

[0008] The deficiencies of the known crusher solutions are eliminated by the crusher for grinding and crushing materials, especially residual and waste materials resulting from metal working, according to the present invention.

[0009] The crusher consists of a hopper frame, a drive unit and a crushing and grinding assembly. The crushing and grinding assembly consists of at least two counter-driven screw rotors. Each of the screw rotors is provided with at least two screw blades, with both the first screw rotor and the second screw rotor having at least one pair of screw blades, which are arranged symmetrically to each other to the centre of the screw rotor. One of the screw blades of one screw rotor then forms a right-hand thread and the other of the screw blades forms a left-hand thread. The left-hand screw blade on the second screw rotor is mirrored to the right-hand screw blade on the first screw rotor, and the right-hand screw blade on

the second screw rotor is subsequently mirrored to the left-hand screw blade on the first screw rotor. The outer edges of the screw blades on the first screw rotor and the second screw rotor skew to each other when the screw rotors are rotated, with an overlap on the projection in the horizontal plane. Recesses corresponding to the shape of the separation bars mounted on the surface of the screw rotors parallel to the axis of their rotation are formed on the screw blades. These separation bars are positioned such that when rotating the screw rotors, the separation bars on the first screw rotor are associated with the recesses of the screw blades on the second screw rotor and the separation bars on the second screw rotor are associated with the recesses of the screw blades on the first screw rotor.

[0010] In a preferred embodiment, there are at least two pairs of screw blades on the first screw rotor and the second screw rotor. One transverse bracket is attached to the crusher hopper walls to which the separating blades are fixed. One end of each separating blade extends transversely between the pair of screw blades of the first screw rotor when the screw rotors are rotated. At the same time, the other end of the same separating blade passes also between the pair of screw blades assigned to the pair of screw blades on the second screw rotor.

[0011] In another preferred embodiment, the recesses of the screw blades on the screw rotors are U-shaped and the separation bars have a quadrangular cross-section, with the geometric shapes and dimensions of the inner part of the recess and the cross-section of the bar being identical.

[0012] In another preferred embodiment, the crusher drive unit comprises at least one electric motor with a gearbox for transmitting torque to the driven shafts of screw rotors. The transmission of forces and torques is effected by a set of gears and/or chains.

[0013] In another preferred embodiment, the crusher drive unit comprises at least one hydraulic motor with a gearbox for transmitting torque to the driven shafts of screw rotors. The transmission of forces and torques is effected by a set of gears and/or chains.

[0014] In the subsequent preferred embodiment, the crusher drive unit is provided with a switch and/or a remote control which allow the direction of rotation of the drive unit and hence the screw rotors to be controlled and switched over.

[0015] In another preferred embodiment, the screw rotor consists of at least two demountable connected cylindrical modules. The number of modules can be further increased, but for optimal operation the number must always be even.

[0016] In another preferred embodiment, the crusher comprises a replaceable separation sieve provided with separation meshes, whereby the crusher also becomes a separator. This sieve is placed horizontally in the frame under the crushing and grinding assembly. The separation sieve is hinged, which allows the additional removal

of the trapped large under-crushed pieces of material.

[0017] In another preferred embodiment, the crusher comprises a replaceable mobile container of the separator, which is placed under the crushing and grinding assembly and/or the separation sieve between the legs of the frame. The container serves for collecting the separate and/or chippings and then transporting this material for further processing or storage.

[0018] The main advantage of the present invention is the use of counter-movement of screw rotors equipped with counter-rotating screw blades. This combination of counter-movements causes the material to move continuously from the hopper edges to the centre of the machine for crushing. The use of screw blades with recesses in combination with separation bars then results in the material being crushed in all directions of rotation of the drive unit, thus avoiding the state of overload of the invention with a larger amount of material to be crushed. Modularity in the possibility of combining the number of cylindrical screw rotor modules results in a modular resulting size of the invention. This gives the possibility of regulating the crushing capacity of the invention and increases its utility properties.

25 Explanation of drawings

[0019] The invention will be explained in detail by drawings which illustrate:

- 30 Fig. 1 perspective top view of a crusher with a mobile container,
 Fig. 2 perspective top view of a part of the crusher in sectional view with a more detailed illustration of the crushing and grinding assembly,
 35 Fig. 3 side view of a pair of screw rotors with screw blades and a separating blade,
 Fig. 4 perspective top sectional view of a pair of screw rotors with screw blades and separating blades,
 Fig. 5 plan view of a pair of screw rotors with screw blades, without separating blade.

Examples of the invention embodiments

[0020] As shown in Fig. 1 and 2, the crusher 1 for grinding and crushing materials, especially residual and waste materials resulting from metal working, consists of four main components, a frame 2 with a hopper 3, a drive unit and a crushing and grinding assembly 4.

[0021] As shown in Fig. 2, 3 and 4, the crushing and grinding assembly 4, which is to carry out the actual grinding and crushing of the inserted material, is composed of at least two counter-driven screw rotors 5, 5'. Each of the screw rotors 5, 5' is provided with at least two screw blades 6, 6', with both the first screw rotor 5 and the second screw rotor 5' having at least one pair of screw blades 6, 6', which are arranged symmetrically to each other to the centre of the screw rotor 5, 5'. One of the screw blades 6, 6' of one screw rotor 5, 5' then forms a

right-hand thread and the other of the screw blades 6, 6' forms a left-hand thread. The left-hand screw blade 6' on the second screw rotor 5' is mirrored to the right-hand screw blade 6 on the first screw rotor 5 and the right-hand screw blade 6 on the second screw rotor 5' is subsequently mirrored to the left-hand screw blade 6' on the first screw rotor 5. The outer edges of the screw blades 6, 6' on the first screw rotor 5 and the second screw rotor 5' skew to each other when the screw rotors 5, 5' are rotated, with an overlap on the projection in the horizontal plane.

[0022] The arrangement of the screw blades 6, 6' as shown in Fig. 3 and 5 causes the screw blades 6, 6' to grab the inserted material to be ground and crushed while simultaneously counter-rotating the two screw rotors 5, 5' and moving it automatically from the edges of the hopper 3 to the centre of the crusher 1 where it is ground and crushed without being deposited on the sides of the hopper 3. On the contrary, the opposite rotation of the screw rotors 5, 5' leads to material shifting to the sides of the hopper 3, whereby it is possible to release the crushing and grinding assembly 4 in case it is flooded with crushed and ground material.

[0023] As shown in Fig. 2 through 5, recesses 7 corresponding to the shape of the separation bars 8 mounted on the surface of the screw rotors 5, 5' parallel to the axis of their rotation are formed on the screw blades 6, 6'. These separation bars 8 are positioned such that when rotating the screw rotors 5, 5', the separation bars 8 on the first screw rotor 5 are associated with the recesses of the screw blades 6, 6' on the second screw rotor 5' and the separation bars 8 on the second screw rotor 5' are associated with the recesses of the screw blades 6, 6' on the first screw rotor 5. Due to the matching of the recesses 7 and the separation bars 8 and the alignment of the shape together with the synchronization of the relative position during rotation, the rotation of the screw rotors 5, 5' causes grabbing of the ground and crushed material by edges of the recess 7 where squeezing of the material and its tearing in combination with the shear effect of the edges of the recesses 7 and the separation bars 8 take place following assignment of the recess 7 to the separation bar 8, see Fig. 7. The recesses 7 of the screw blades 6, 6' on the screw rotors 5, 5' are U-shaped and the separation bars 8 have a quadrangular cross-section, with the geometric shapes and dimensions of the inner part of the recess 7 and the cross-section of the separation bar 8 being identical.

[0024] As shown in Fig. 2 and 5, there are at least two pairs of screw blades 6, 6' on the first screw rotor 5 and the second screw rotor 5'. A transverse bracket 9 is attached to the crusher 1 hopper 3 walls to which the separating blades 10 are fixed. One end of each separating blade 10 extends transversely between the pair of screw blades 6, 6' with the same thread pitch of the first screw rotor 5 when the screw rotors 5, 5' are rotated. At the same time, the other end of the same separating blade 10 passes also between the pair of screw blades 6, 6'

assigned to the pair of screw blades 7 on the second screw rotor 5'.

[0025] As shown in Fig. 3 and 4, the separating blade 10 serves to lift the material that has adhered between the screw blades 6, 6' and, at the same time, its edges help to tear and break apart the material that enters the crusher 1 in large lumps and sheets.

[0026] The crusher 1 is driven by a drive unit which is at least one electric motor with a gearbox for transmission of torque to the driven shafts 11 of the screw rotors 5, 5'. The transmission of forces and torques is effected by a set of gears and/or chains. The crusher drive unit 1 can also be a hydraulic motor with a gearbox for transmission of torque to the driven shafts 11 of the screw rotors. The transmission of forces and torques is also effected by a set of gears and/or chains. The crusher drive unit 1 is provided with a switch and/or a remote control which allow the direction of rotation of the drive unit and hence the screw rotors 5, 5' to be controlled and switched over. This control allows the basic centred rotational movement of the screw rotors 5, 5', but also the opposite movement, which allows the crushing and grinding assembly 4 to be released from the material in case of overload. The design of the crushing and grinding assembly 4 allows the crushing and grinding of the material in the crusher 1 in all directions of rotation of the screw rotors 5, 5', but only the counter-rotating centred movement of the screw rotors 5, 5' results in more intensive feeding of the material from the edges of the hopper 3 to the centre of the crushing and grinding assembly 4.

[0027] The screw rotor 5, 5' is constructed from at least two mutually detachable cylindrical modules M1, M2. The number of modules M1, M2 can be further increased, but for optimal operation the number must always be even.

[0028] As shown in Fig. 6, the crusher 1 may further comprise a replaceable separation sieve 12 provided with separation meshes 13. This separation sieve 12 is placed horizontally in the frame 2 under the crushing and grinding assembly 4. The separation sieve 12 in the crusher 1 is hinged in order to allow the additional removal of the trapped large and under-crushed pieces of crushed and ground material. Furthermore, the crusher 1 may also comprise a mobile container 15 for separate, which is placed below the crushing and grinding assembly 4 and/or the separation sieve between the legs 14 of the frame 2. The container 15 serves for collecting the separate and/or chippings and then transporting this material for further processing or storage.

50 Industrial applicability

[0029] The invention can be used in industrial production for the crushing and grinding of industrial waste generated as large structures or aggregates of waste materials. For the treatment of such waste and its storage or transport it is necessary to crush the waste into smaller particles.

List of reference numerals used in the drawings

[0030]

1	crusher for grinding and crushing materials	5
2	frame	
3	hopper for material	
4	crushing and grinding assembly	
5	first screw rotor	
5'	second screw rotor	10
6	right-hand screw blade	
6'	left-hand screw blade	
7	recess of the screw blade	
8	separation bar	
9	transverse bracket	15
10	separating blade	
11	driven screw rotor shaft	
12	separation sieve	
13	separation mesh	
14	frame leg	20
M1, M2	cylindrical screw rotor module	
15	mobile container	

Claims

1. The crusher (1) for grinding and crushing materials, especially residual and waste material resulting from metal working, comprising a frame (2) with a hopper (3), at least one drive unit and a crushing and grinding assembly (4) comprising at least two counter-driven screw rotors (5, 5'), where each of the screw rotors (5, 5') is provided with at least two screw blades (6, 6'), **characterized in that** on both the first screw rotor (5) and the second screw rotor (5'), is at least one pair of screw blades (6, 6'), which are arranged symmetrically to each other to the centre of the screw rotor (5, 5'), where one of the screw blades (6, 6') forms a right-hand thread and the other of the screw blades (6, 6') forms a left-hand thread, and the left-hand screw blade (6') on the second screw rotor (5') is assigned to the right-hand screw blade (6) on the first screw rotor (5) and the right-hand screw blade (6) on the second screw rotor (5') is assigned to the left-hand screw blade (6') on the first screw rotor (5), where the outer edges of the screw blades (6, 6') on the first screw rotor (5) and the second screw rotor (5') skew to each other when the screw rotors (5, 5') are rotated, with an overlap on the projection in the horizontal plane, and recesses (7) corresponding to the shape of the separation bars (8) mounted on the surface of the screw rotors (5, 5') parallel to the axis of their rotation are formed on the screw blades (6, 6') and positioned such that when rotating the screw rotors (5, 5'), the separation bars (8) on the first screw rotor (5) are associated with the recesses (7) of the screw blades (6, 6') on the second screw rotor (5') and the separation bars (8) on the second screw

rotor (5') are associated with the recesses (7) of the screw blades (6, 6') on the first screw rotor (5).

2. The crusher of claim 1, **characterized in that** there are at least two pairs of screw blades (6, 6') on the first screw rotor (5) and the second screw rotor (5') and one transverse bracket (9) with separating blades (10) is attached to the hopper (3) walls, where one separating blade (10) always passes transversely between the pair of screw blades (6, 6') of the first screw rotor (5) while rotating the screw rotors (5, 5') and, at the same time, this separating blade (10) also passes between this pair of screw blades (6, 6') associated with the pair of screw blades (6, 6') on the second screw rotor (5').

3. The crusher of claims 1 and 2, **characterized in that** the recesses (7) of the screw blades (6, 6') on the screw rotors (5, 5') are U-shaped and the separation bars (8) have a quadrangular cross-section.

4. The crusher of claims 1 through 3, **characterized in that** the drive unit is at least one electric motor with a gearbox for transmitting torque to the driven shafts (11) of the screw rotors (5, 5') by a gear and/or chain assembly.

5. The crusher of claims 1 through 3, **characterized in that** the drive unit is at least one hydraulic motor with a gearbox for transmitting torque to the driven shafts (11) of the screw rotors (5, 5') by a gear and/or chain assembly.

6. The crusher of claims 1 through 5, **characterized in that** the drive unit is provided with a switch and/or a remote control regulating the direction of rotation of the drive unit and thus of the screw rotors (5, 5').

7. The crusher of any of claims 1 through 6, **characterized in that** each screw rotor (5, 5') consists of at least two mutually detachable cylindrical modules (M1, M2).

8. The crusher of any of claims 1 through 7, **characterized in that** it comprises a replaceable separation sieve (12) provided with separation meshes (13), located in a horizontal plane in the frame (2) below the crushing and grinding assembly (4), where the separation sieve (12) is hinged.

9. The crusher of any of claims 1 through 8, **characterized in that** it comprises a replaceable mobile container (15) for separate located below the crushing and grinding assembly (4) and/or a separation sieve (12) between the legs (14) of the frame (2) for collection and subsequent removal of the generated chippings.

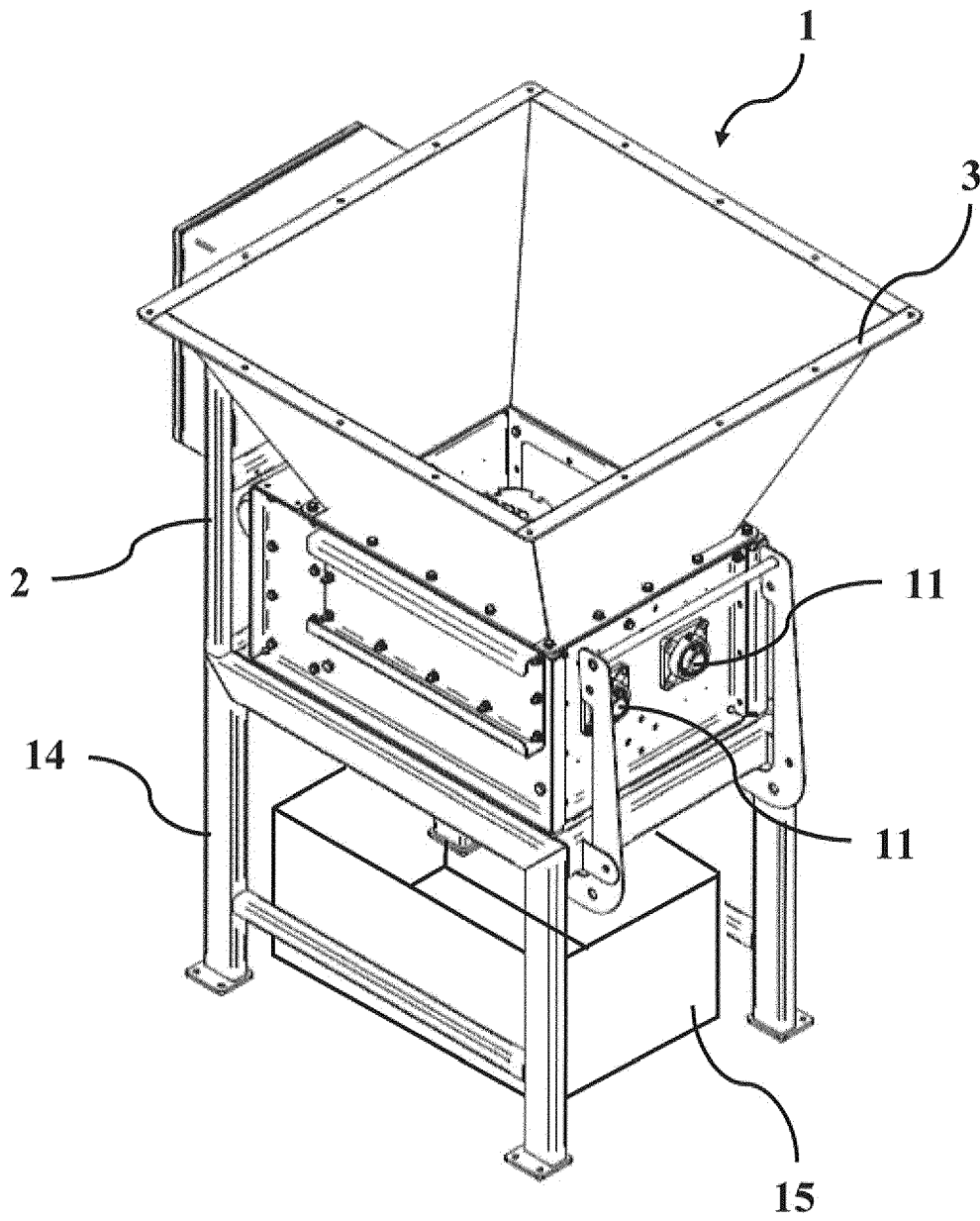


FIG. 1

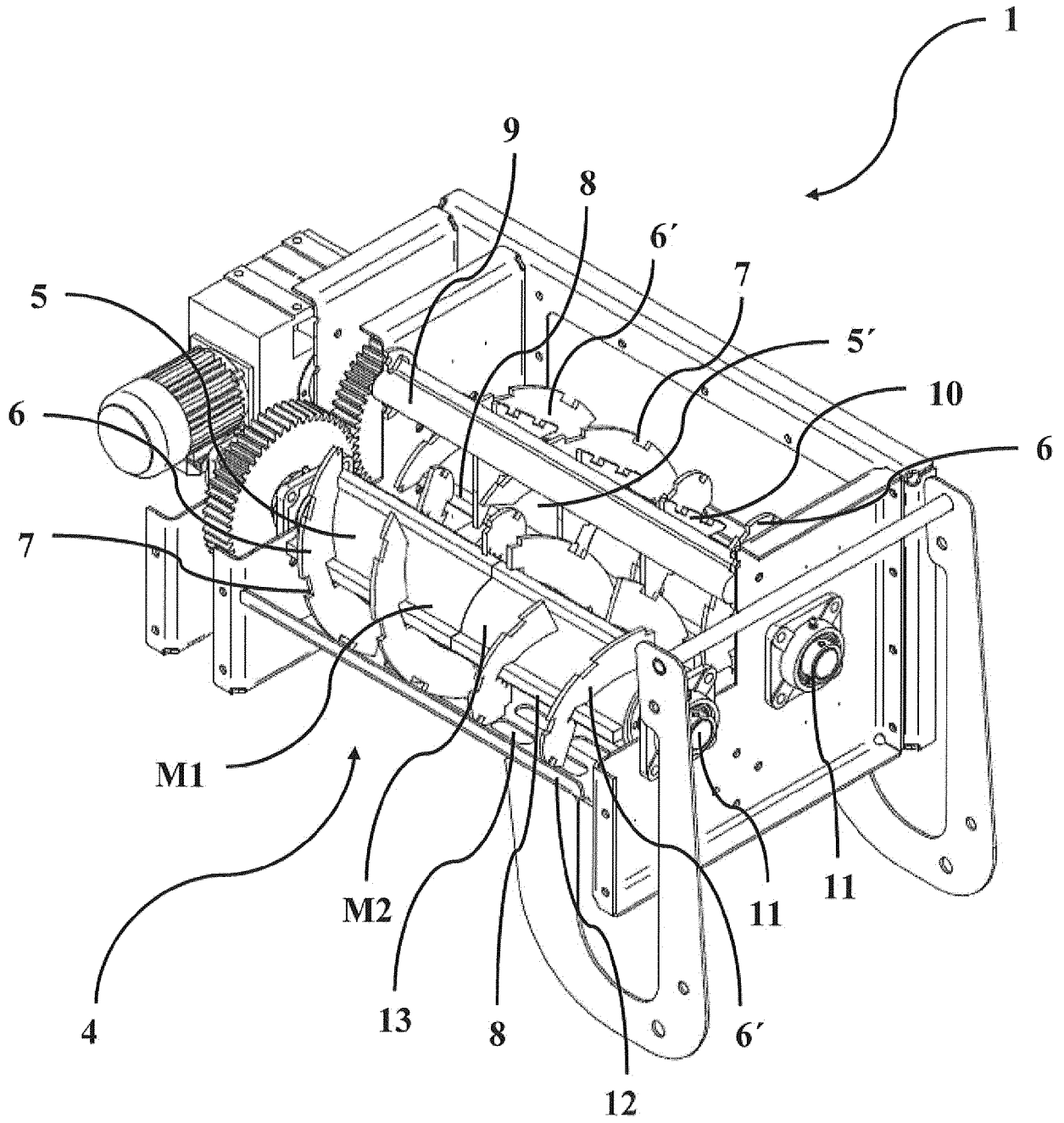
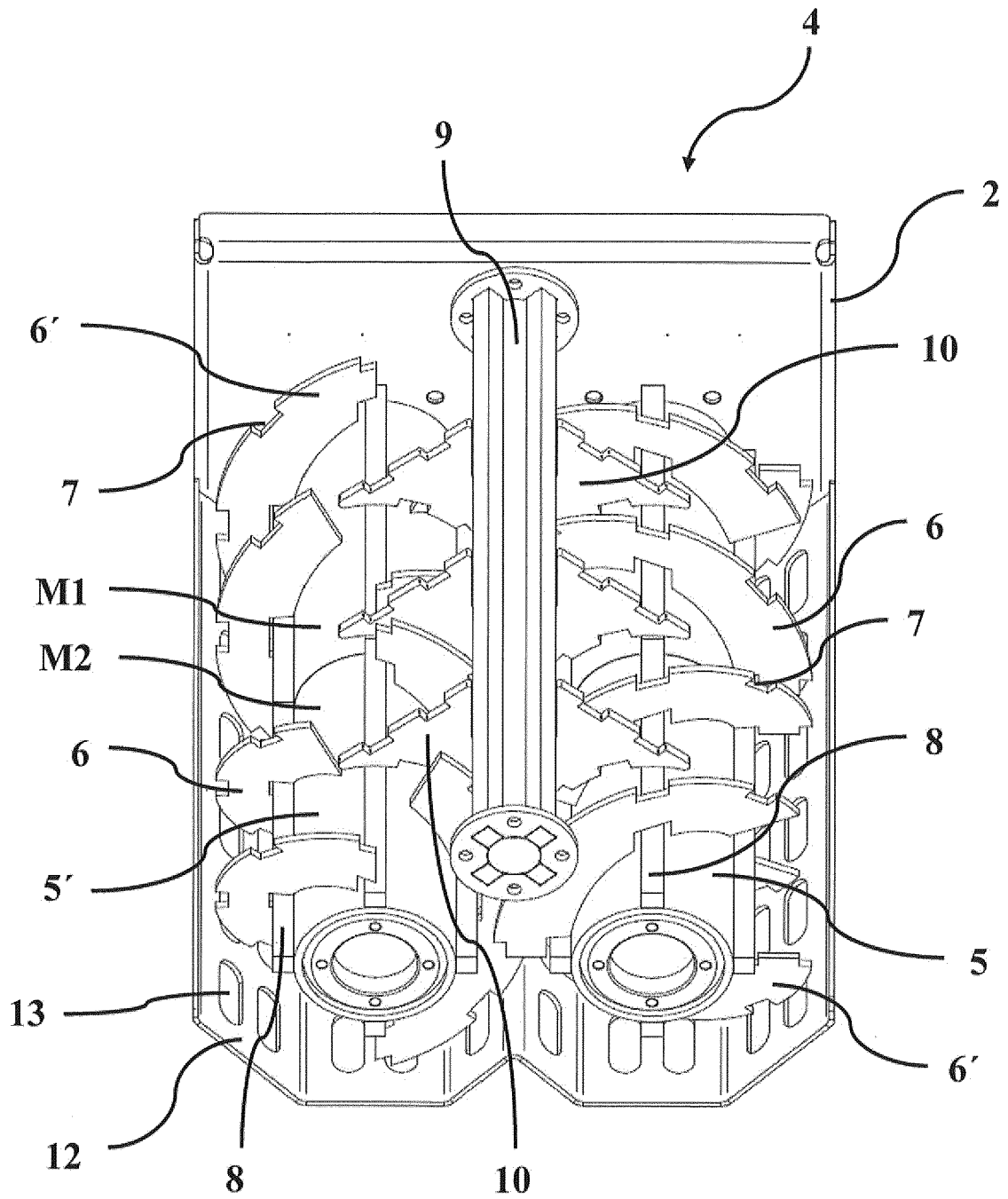


FIG. 2



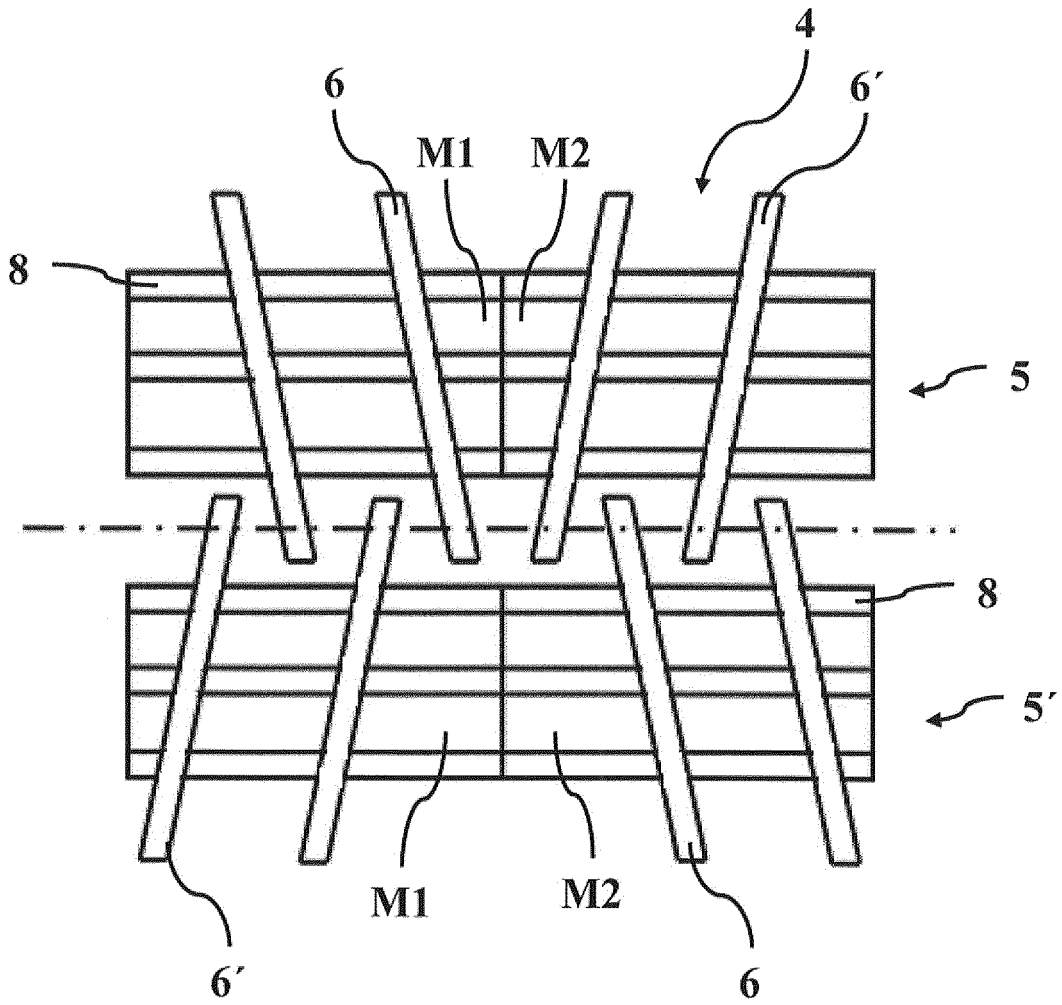


FIG. 5



EUROPEAN SEARCH REPORT

Application Number
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