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(54) MATERIAL REDUCING DEVICE

MATERIALREDUZIERUNGSVORRICHTUNG

DISPOSITIF DE RÉDUCTION DE MATIÈRE

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Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to machines for use in reducing various materials, especially those obtained in a structural demolition process so that such materials can be more conveniently transported from a demolition site. More particularly, this invention is particularly useful in reducing railroad ties containing or contaminated with metal tie plates and spikes.

BACKGROUND OF THE INVENTION

[0002] Material reducing machines are well-known for use in connection with the demolition of a house or other structure. Such machines typically include a conveyor for moving debris such as wood, siding, roofing materials and even appliances such as water heaters toward a rotating drum having tools thereon which is contained within a housing having an anvil bar located in close proximity to the free ends of the rotating drum tools. The tools of the rotating drum carry material into contact with the anvil bar where it is broken into smaller pieces. Most commonly, a plurality of screen sections are located adjacent to and downstream of the anvil bar so that further rotation of the drum causes partially reduced material to be further reduced by successive impacts of the tools of the rotating drum until it will pass through the apertures in one or another of the screens.

[0003] US 5052630A describes a rotary chipper/shredder having a horizontally disposed rotary shaft 40 that is mounted in frame 22. The machine has a top opening 32 for receiving material to be shredded, and a bottom opening 34 through which shredded material is discharged. Top opening 32 is at the twelve o'clock position (as shown in Figure 2) and bottom opening 34 is at the six o'clock position. A plurality of small-diameter circular blades 50 and a plurality of larger diameter circular blades 52 are mounted on shaft 40 in an alternating small-large-small arrangement. Each blade is formed of flat steel plate, and each has four teeth that are equally spaced around the periphery of the blade. Short, rectangular shear bars 58 and long, rectangular shear bars 60 are located on side 36 of the frame and are arranged in a side-by-side alternating relationship at the three o'clock position (as shown in Figure 2) so that each small diameter blade 50 is aligned with a long shear bar 60 and each larger diameter blade 52 is aligned with a short shear bar 58. A second set of short, rectangular shear bars 58' and long, rectangular shear bars 60' are located on side 38 of the frame at the nine o'clock position (as shown in Figure 2) so that each small-diameter blade 50 is aligned with a long shear bar 60' and each larger diameter blade 52 is aligned with a short shear bar 58'. Because the shear bars are rectangular and symmetrical, as shown in Figures 8 and 9, each of them can be rotated about its X-X', Y-Y' and Z-Z' axes as the shearing edges wear to prolong its useful life.

[0004] Known material-reducing machines may not be suitable for use in reducing all types of materials, particularly if there is the possibility that an object which cannot be reduced, such as a large dense metal component or fragment, or a railroad tie that contains metal tie plates and spikes, can be introduced into the machine. Some machines include shear pins that will break when an object that cannot be reduced is introduced, thereby allowing a portion of the machine housing to pivot or otherwise move so as to enlarge the opening through which the object can pass. In machines which include a shear pin, operator intervention is required when a pin shears to get the machine back into operating order.

[0005] In addition, known material-reducing machines may not efficiently reduce fibrous materials like roofing shingles, because it may require multiple impacts of such materials against the anvil to provide acceptable reduction. Furthermore, some of the prior art machines may fail to produce uniformly shaped smaller pieces. Some types of materials tend to break in elongated shapes in the prior art machines, and these elongated shapes may be difficult to handle or transport, and may therefore be generally undesirable. When these elongated shapes are able to pass through the screen sections of the prior art machines along with more uniformly sized particles, they may contaminate the resulting product with pieces of an undesirable size. Finally, prior art machines are not readily adaptable to processing different types of materials.

NOTES ON CONSTRUCTION

[0006] The use of the terms "a", "an", "the" and similar terms in the context of describing the invention are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The terms "comprising", "having", "including" and "containing" are to be construed as open-ended terms (i.e., meaning "including, but not limited to,") unless otherwise noted. The terms "substantially", "generally" and other words of degree are relative modifiers intended to indicate permissible variation from the characteristic so modified. The use of such terms in describing a physical or functional characteristic of the invention is not intended to limit such characteristic to the absolute value which the term modifies, but rather to provide an approximation of the value of such physical or functional characteristic. All methods described herein can be performed in any suitable order unless otherwise specified herein or clearly indicated by context.

[0007] The use of any and all examples or exemplary language (e.g., "such as" and "preferably") herein is intended merely to better illuminate the invention and the preferred embodiments thereof, and not to place a limitation on the scope of the invention. Nothing in the specification should be construed as indicating any element as essential to the practice of the invention unless so stated with specificity.

[0008] Various terms are specifically defined herein. These terms are to be given their broadest possible construction consistent with such definitions, as follows:

The term "material reducing machine" refers to a machine that is adapted to cut, chop, shred, break or otherwise reduce material into smaller pieces.

[0009] The terms "upper", "top" and similar terms, when used in reference to a relative position or direction on or with respect to a material reducing machine, or a component or portion of such a machine, refer to a relative position or direction that is farther away from the surface on which the material reducing machine is placed for operation.

[0010] The terms "lower", "bottom" and similar terms, when used in reference to a relative position or direction on or with respect to a material reducing machine, or a component or portion of such a machine, refer to a relative position or direction that is nearer the surface on which the material reducing machine is placed for operation.

[0011] The term "horizontal", when used in reference to a plane that includes the axis of rotation of the rotor assembly of a material reducing machine, refers to a plane that is generally parallel to the surface on which the material reducing machine is placed for operation.

[0012] The term "front end" and similar terms refer to the end of a material reducing machine, or a component or portion of such a machine, which is nearest the point at which material to be reduced is introduced into the machine.

[0013] The terms "forward", "in front of', and similar terms, as used herein to describe a relative position or direction on or in connection with a material reducing machine or a component of such a machine, refer to a relative position or direction towards the front end of the machine.

[0014] The terms "back end", "rear end" and similar terms refer to the end of a material reducing machine, or a component or portion of such a machine, which is farther from the front end of the machine, component or portion thereof.

[0015] The terms "rearward", "behind", and similar terms, as used herein to describe a relative position or direction on or in connection with a material reducing machine or a component of such a machine, refer to a relative position or direction towards the rear end of the machine.

[0016] The term "leading", as used herein in connection with a cutting tool that is mounted on the rotor assembly of a material reducing machine, or in connection with a shear block or breaker block that is a part of the breaker assembly of a material reducing machine, refers to the outer edge of the cutting bit of the cutting tool that approaches the shear block or breaker block of the adjacent breaker assembly as the rotor assembly rotates, or to the outer edge or surface of the shear block or breaker block of the breaker assembly that is first encountered by material carried by the cutting tools that are mounted on the adjacent rotor as the rotor assembly rotates.

[0017] The term "long", as used herein to describe cutting tools that are mounted along the length of the rotor assembly, refers to the cutting tools having a longer outward radial projection from the axis of rotation than the "short" cutting tools.

[0018] The term "short", as used herein to describe cutting tools that are mounted along the length of the rotor assembly, refers to the cutting tools having a shorter outward radial projection from the axis of rotation than the "long" cutting tools.

[0019] The term "downstream", as used herein to describe a relative position on or in connection with a material reducing machine, refers to a relative position in the direction of the movement of material to be reduced through the machine.

[0020] The term "upstream", as used herein to describe a relative position on or in connection with a material reducing machine, refers to a relative position in a direction that is opposite to the direction of the movement of material to be reduced through the machine.

SUMMARY OF THE INVENTION

[0021] The invention comprises a material reducing machine comprising: (a) a frame; (b) a rotor assembly which is mounted for rotation about an axis of rotation with respect to the frame, said rotor assembly comprising: (i) a periphery; (ii) a length; (iii) a plurality of short cutting tools that are arranged in rows which extend across the length of the rotor assembly, with a plurality of rows being spaced around the periphery of the rotor assembly, wherein each of the short cutting tools comprises a cutting bit with a leading edge that is spaced outwardly from the periphery of the rotor assembly by a short cutter distance; (iv) a plurality of long cutting tools that are arranged in rows which extend across the length of the rotor assembly, with a plurality of rows being spaced around the periphery of the rotor assembly, wherein each of the long cutting tools comprises a cutting bit with a leading edge that is spaced outwardly from the periphery of the rotor assembly by a long cutter distance that is greater than the short cutter distance of each of the short cutting tools; (c) means for rotating the rotor assembly with respect to the frame in a rotational direction; (d) a material input device for conveying material to be reduced towards the rotor assembly, said material input device being arranged so that the short cutting tools and the long cutting tools on the rotor assembly make initial contact with material to be reduced in an upward direction; (e) a breaker assembly that is located adjacent to the rotor assembly, said breaker assembly comprising: (i) a back plate (ii) a plurality of shear blocks, which are mounted on the backplate and each of which is spaced so as to be aligned with a short cutting tool; characterized in that the leading surface of each of the shear blocks comprises any one of: a slide angle of greater than 100°, a slip angle that is within the range of 80°-100°, an anvil angle that is within the range of 50° - 80°, or a catch angle that is within the range of 40° - 50°, when measured from a horizontal plane that includes the axis of rotation of the rotor assembly ; and there is provided a plurality of said back plates that can be interchanged depending on the types of materials being processed .

[0022] In a preferred embodiment of the invention, the breaker assembly includes a plurality of breaker blocks. The shear blocks extend towards the rotor assembly a greater distance than the optional breaker blocks, and the cutting tools on the rotor assembly and the shear blocks and breaker blocks are arranged so that the long cutting tools are aligned with the breaker blocks and the short cutting tools are aligned with the shear blocks.

[0023] The shear blocks may therefore be configured differently in order to accommodate different materials being processed or different operating conditions. In one embodiment, the shear blocks may have a beveled leading edge, an angled leading edge or a flat leading edge. The shear blocks may have an outer surface that is interrupted by notches or grooves, or the outer surface may be smooth. In other embodiments of the invention, each of the shear blocks has an outer surface that is curved to describe an arc that is generally parallel to the arc described by the leading edge of the short cutting tool with which it is aligned. The shear blocks are mounted on the back plate of the breaker assembly, which allows an operator to maintain a plurality of back plates that can be easily and quickly interchanged, depending on the types of materials being processed.

[0024] In addition, the breaker blocks of the preferred embodiment may be configured differently in order to accommodate different materials being processed or different operating conditions. In some embodiments of the invention, the breaker assembly includes breaker blocks having an outer surface and a leading edge that forms a right angle or an approximate right angle with the outer surface. In other embodiments of the invention, the breaker blocks have a leading surface that gradually increases to a point of maximum outward projection from the back plate and a trailing surface that gradually decreases from the point of maximum outward projection.

[0025] In some embodiments of the invention, an anvil is mounted upstream of the breaker assembly, and in other embodiments, there is no anvil. In some embodiments of the invention, the anvil is a part of the breaker assembly, and the breaker blocks are attached to the anvil.

[0026] In a preferred embodiment of the invention, a resistance and biasing mechanism is provided between the frame and the pivot shaft on which the pivot arm and the bypass arm carrying the breaker assembly are mounted. In this embodiment of the invention, a resistance and biasing mechanism is also provided between the frame and the bypass arm.

[0027] In order to facilitate an understanding of the invention, the preferred embodiments of the invention are illustrated in the drawings, and a detailed description thereof follows. It is not intended, however, that the invention be limited to the particular embodiments described or to use in connection with the apparatus illustrated herein. Various modifications and alternative embodiments such as would ordinarily occur to one skilled in the art to which the invention relates are also contemplated and included within the scope of the invention described and claimed herein.

ADVANTAGES OF PREFERRED EMBODIMENTS OF THE INVENTION

[0028] Among the advantages of a preferred embodiment of the invention is that it provides a material reducing machine that breaks and reduces materials into uniformly sized pieces. Still another advantage of a preferred embodiment of the invention is that it provides such a machine which operates with greater efficiency than prior art devices. Still another advantage of a preferred embodiment of the invention is that it provides such a machine that can process materials that are incapable of reduction without damaging the machine or stopping its operation. Yet another advantage of a preferred embodiment of the invention is that it provides a material reducing machine that may be readily modified, by changing the breaker assembly, to allow for processing of different types of materials and for operation within a wide range of speeds. Another advantage of a preferred embodiment of the invention is that it allows the material reducing machine to operate effectively at slower speeds, reducing fuel consumption, wear and noise levels. Other advantages and features of this invention will become apparent from an examination of the drawings and the ensuing description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The presently preferred embodiments of the invention are illustrated in the accompanying drawing drawings, in which:

Figure 1 is a schematic illustration of a material reducing machine having a breaker assembly including shear blocks comprising an anvil angle and breaker blocks having an outer surface and a leading edge that forms a right angle with the outer surface.

Figure 2 is a perspective view of the breaker assembly shown in Figure 1.

Figure 3 is a perspective view of a first alternative embodiment of the breaker assembly of the material reducing machine illustrated in Figure 1.

Figure 4 is a top view of the embodiment of the breaker assembly of the material reducing machine illustrated in Figure 3.

Figure 5 is a perspective view of a second alternative embodiment of the breaker assembly of the material reducing machine illustrated in Figure 1.

Figure 6 is a schematic view of a material reducing machine having a breaker assembly with a plurality of shear blocks that are configured to form a preferred slide angle, illustrating the breaker assembly in the closed position.

Figure 7 is a schematic view of a material reducing machine having a breaker assembly with a plurality of shear blocks that are configured to form a preferred slide angle, illustrating the breaker assembly in the open position.

Figure 8 is a schematic view of a material reducing machine having a breaker assembly with a plurality of shear blocks that are configured to form a preferred slip angle, illustrating the breaker assembly in the closed position.

Figure 9 is a schematic view of a material reducing machine having a breaker assembly with a plurality of shear blocks that that are configured to form a preferred slip angle, illustrating the breaker assembly in the open position.

Figure 10 is a schematic view of a material reducing machine having a breaker assembly with a plurality of shear blocks that that are configured to form a preferred slip angle, showing the inner radius of the shear blocks and the radii of the arcs of rotation of the leading edges of the short and long cutting tools mounted on the rotor assembly.

Figure 11 is a schematic view of a material reducing machine having a breaker assembly with a plurality of shear blocks that that are configured to form a preferred anvil angle, illustrating the breaker assembly in the closed position.

Figure 12 is a schematic view of a material reducing machine having a breaker assembly with a plurality of shear blocks that that are configured to form a preferred anvil angle, illustrating the breaker assembly in the open position.

Figure 13 is a schematic view of a material reducing machine having a breaker assembly with a plurality of shear blocks that that are configured to form a preferred catch angle, illustrating the breaker assembly in the closed position.

Figure 14 is a schematic view of a material reducing machine having a breaker assembly with a plurality of shear blocks that that are configured to form a preferred catch angle, illustrating the breaker assembly in the open position.

Figure 15 is a schematic view of a material reducing machine having a breaker assembly with a plurality of breaker blocks that have a leading surface which gradually increases to a point of maximum outward projection from the back plate and a trailing surface that gradually decreases from the point of maximum outward projection, showing the inner radius of the breaker blocks and the radii of the arcs of rotation of the leading edges of the short and long cutting tools mounted on the rotor assembly.

Figure 16 is a schematic illustration of a material reducing machine, including a breaker assembly comprising a plurality of shear blocks, each of which is attached to the back plate, and each of which comprises an inner surface that is curved to describe an arc that is generally parallel to the arc described by the cutting bit of the short cutting tool with which it is aligned, and an anvil to which a plurality of breaker blocks are attached.

Figure 17 is a perspective view of a portion of the material reducing machine shown in Figure 16.

Figure 18A is a front view of the anvil assembly that comprises a portion of the material reducing machine shown in Figures 16 and 17.

Figure 18B is a side view of the anvil assembly shown in Figure 18A.

Figure 18C is a perspective view of the anvil assembly shown in Figures 18A and 18B.

Figure 19A is a front view of the back plate and shear blocks that comprise a portion of the material reducing machine shown in Figures 16 and 17.

Figure 19B is a perspective view of the back plate and shear blocks shown in Figure 19A.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

[0030] A first embodiment of the invention is illustrated in Figure 1. As shown therein, material reducing machine 20 includes a generally horizontal material input device such as input conveyor 21. Conveyor 21 is adapted to move material to be reduced in the direction indicated by arrow 22 toward rotor assembly 23. In other embodiments of the invention (not shown in the drawings), the material input device may comprise a chute, and it may be placed with respect to the rotor assembly other than a generally horizontal orientation.

[0031] Rotor assembly 23 comprises a plurality of generally circular rotor plates, one of which, plate 24, is shown in Figure 1. Because of its generally circular rotor plates, rotor assembly has a generally cylindrical periphery 26. Rotor assembly 23 is adapted to rotate in a clockwise rotational direction, as shown in Figure 1, about its axis of rotation 28. Rotor assembly 23 comprises a plurality of short cutting tools comprising short tool holders 30 with cutting bits 32 mounted thereon and a plurality of long cutting tools comprising long tool holders 34 with cutting bits 36 mounted thereon. The cutting tools are arranged in rows that extend across the length of the rotor assembly (i.e., across the width of the frame of the machine), and rows of cutting tools are spaced around the periphery of the rotor assembly. Because of the location of input conveyor 21 with respect to rotor assembly 23 and the direction of rotation of rotor assembly 23, the cutting tools on rotor assembly 23 will make initial contact with material being introduced by the input conveyor in an upward (or up-cutting) direction. Consequently, as the rotor assembly is rotated, the tools will carry material from conveyor 21 upwardly and into engagement with a breaker assembly that is located adjacent to the rotor assembly. The leading edges of cutting bits 32 of the short cutting tools mounted on rotor assembly 23 define an arc that is spaced outwardly from periphery 26 by a short cutter distance. A portion 38 of this arc is shown in Figure 1. Similarly, the leading edges of cutting bits 36 of the long cutting tools mounted on rotor assembly 23 define an arc that is spaced outwardly from periphery 26 by a long cutter distance which is greater than the short cutter distance. A portion 40 of this arc is also shown in Figure 1. As shown in Figure 1, it is preferred that the short cutting tools be arranged in rows that are parallel to axis of rotation 28, which rows extend all the way across the length of the rotor assembly. Similarly, it is preferred that the long cutting tools be arranged in rows that are parallel to the axis of rotation, which rows extend all the way across the length of the rotor assembly. It is also preferred that alternating rows of short cutting tools and long cutting tools be spaced equally around the periphery of the rotor assembly, so that each row of long cutting tools is adjacent a row of short cutting tools.

[0032] Material reducing machine 20 also includes a breaker assembly that is located adjacent to the rotor assembly. The breaker assembly includes a curved back plate 42 with a plurality of shear blocks 44 and breaker blocks 46 arranged across the width of the machine on the side of back plate 42 adjacent to rotor assembly 23. In some embodiments of the invention, such as, for example, the embodiment shown in Figures 19A and 19B, the back plate includes a plurality of apertures through which reduced material may pass. The shear blocks extend from the back plate towards the rotor assembly a greater distance than the breaker blocks, and the cutting tools on the rotor assembly and the shear blocks and breaker blocks on the back plate are arranged so that the long cutting tools are aligned with breaker blocks 46 and the short cutting tools are aligned with shear blocks 44. Furthermore, it is also preferred that the cutting tools of the rotor assembly and the shear blocks and breaker blocks of the breaker assembly are arranged so that at least one short cutting tool 30 passes over a shear block 44 with which it is aligned, and at least one long cutting tool 34 passes between a pair of adjacent shear blocks 44 and over the breaker block 46 with which it is aligned. More particularly, as shown in Figures 1 and 2, it is preferred that the short cutting tools and the long cutting tools are spaced along the length of the rotor assembly, and the shear blocks and the breaker blocks are spaced along the back plate in such a manner that all of the short cutting tools pass over the curved outer surfaces 48 of shear blocks 44, and the long cutting tools pass between adjacent shear blocks 44 and over the breaker blocks 46. The leading edges 50 of shear blocks 44 are beveled, as best shown in Figure 2. Back plate 42 is a part of bypass arm 52, which is adapted to pivot about pivot axis 54 when non-crushable material encounters the breaker assembly.

[0033] Figures 3 and 4 illustrate a second embodiment of the breaker assembly. As shown therein, the breaker assembly includes curved back plate 42 with a plurality of shear blocks 144 and breaker blocks 46 arranged across the width of the machine on the side of back plate 42 that would be adjacent to rotor assembly 23 if this breaker assembly were substituted for the one shown in Figures 1 and 2. In that event, shear blocks 144 would extend from back plate 42 towards the rotor assembly a greater distance than breaker blocks 46, and the cutting tools on the rotor assembly and the shear blocks and breaker blocks on the back plate would be arranged so that the long cutting tools would be aligned with breaker blocks 46 and the short cutting tools would be aligned with shear blocks 144. In this embodiment of the invention, the short cutting tools would pass over the curved outer surfaces 148 of shear blocks 144, and the long cutting tools would pass between adjacent shear blocks 144. The leading edges 150 of shear blocks 144 are angled.

[0034] A third embodiment of the breaker assembly is illustrated in Figure 5. As shown therein, the breaker assembly includes curved back plate 42 with a plurality of shear blocks 244 and breaker blocks 46 arranged across the width of the machine on the side of back plate 42 that would be adjacent to rotor assembly 23 if this breaker assembly were substituted for the one shown in Figures 1 and 2. In that event, shear blocks 244 would extend from back plate 42 towards the rotor a greater distance than breaker blocks 46, and the cutting tools on the rotor and the shear blocks and breaker blocks on the back plate would be arranged so that the long cutting tools would be aligned with breaker blocks 46 and the short cutting tools would be aligned with shear blocks 244. In this embodiment of the invention, the short cutting tools would pass over the curved outer surfaces 248 of shear blocks 244, which surfaces include a plurality of notches 249. The long cutting tools would pass between adjacent shear blocks 244. As shown in Figure 5, the leading edges 250 of shear blocks 244 are flat.

[0035] Material reducing machine 20 includes compression roller 56 having ribs 58. Compression roller 56 is mounted on pivot arm 60, which is mounted for rotation on pivot shaft 54. Bypass arm 52 is also mounted for rotation on pivot shaft 54 in front of pivot arm 60 (as viewed in Figure 1), so that the bypass arm may pivot on pivot shaft 54 independently of pivot arm 60. Collar 62 is provided on pivot shaft 54 so that a first resistance and biasing mechanism, such as spring 66, may be mounted between the frame 67 of machine 20 and collar 62 to provide for limited upward elastic movement of the pivot shaft to minimize the risk of damage or breakage of pivot shaft 54 caused by forces generated during operation of the reducing machine. The weight and placement of pivot arm 60 and compression roller 56 cause the compression roller to urge material on conveyor 22 downwardly and towards rotor 24.

[0036] A second resistance and biasing mechanism, such as spring 68, is mounted between the frame of the machine and rear end 70 of bypass arm 52 and adapted to urge the breaker assembly towards rotor assembly 23. Material that is conveyed by input conveyor 22 to rotor assembly 23 will be carried by the rotor into contact with the breaker assembly, where it may be broken into smaller pieces by contact between the short cutting tools on rotor assembly 23 and the leading edges 50 and the upper surfaces 48 of shear blocks 44 and/or by the long cutting tools on the rotor assembly and the leading edges 72 and the outer surfaces 74 of breaker blocks 46. In the embodiments of the invention illustrated in Figures 1-5, breaker blocks 46 of the breaker assembly have an outer surface 74 and a leading edge 72 that forms a right angle or an approximate right angle with the outer surface.

[0037] As the material is carried past the breaker assembly by the cutting tools on rotor assembly 23, continued rotation of the rotor assembly causes partially reduced material to be further reduced by successive impacts of the cutting tools of the rotor assembly until it will pass through the apertures in one or another of screen sections 76, 78 or 80 and fall onto output conveyor 81 for removal from the machine in the direction indicated by arrow 82. Material that does not pass through any of the screen sections on a first pass may be carried by the cutting tools on the rotor assembly into contact with the breaker assembly again.

[0038] The invention allows for operation of the material reducing machine at a wide range of rotational speeds. More particularly, the rotor assembly of the invention may be rotated about its axis of rotation at a rate within the range of 50-1000 RPM. The lower end of this range is outside the range at which conventional machines can be effectively operated. When the back plate of the invention is provided with apertures through which reduced material may pass (such as is shown in Figures 19A and 19B), the invention allows for removal of one or more of screen sections 76, 78 and 80, so that some or all of the reduced material will pass through the apertures in the back plate and fall onto output conveyor 81. However, when some or all of the screen sections are removed, it is desirable that a deflector plate 79 be installed along the length of rotor assembly 23 to deflect reduced material passing through the apertures in the back plate, thereby protecting output conveyor 81, especially when the output conveyor comprises a belt that can be torn or cut by reduced material.

[0039] Included within the scope of the invention are shear blocks that can be formed in various configurations depending on the nature of the materials being processed by the material reducing machine, as well as on the operating conditions and parameters of the machine. Figures 6 and 7 illustrate a portion of material reducing machine 100 having rotor assembly 123 on which are mounted short cutting tools 130 and long cutting tools 134. Machine 100 also includes a breaker assembly that is located adjacent to the rotor. The breaker assembly includes a curved back plate 142 with a plurality of shear blocks 344 and breaker blocks (not shown) arranged across the width of the machine on the side of back plate 142 adjacent to rotor assembly 123. Shear blocks 344 include a leading surface 372. Each of the shear blocks extends from the back plate towards the rotor assembly a greater distance than the breaker blocks, and the cutting tools on the rotor assembly and the shear blocks and breaker blocks on the back plate are arranged so that the long cutting tools 134 are aligned with the breaker blocks and the short cutting tools 130 are aligned with shear blocks 344. Back plate 142 is a part of bypass arm 152, as is anvil 153, and the bypass arm is adapted to rotate about pivot shaft 154. In the embodiment of the invention illustrated in Figures 6 and 7, the leading surfaces of the shear blocks comprise a slide angle of greater than 100°, preferably about 115°, when measured from a horizontal plane that includes the axis 128 of rotation of rotor assembly 123. Shear blocks of this configuration present minimal resistance to the flow of materials within the machine, and they may be employed when it is anticipated that oversized materials are included among easily reducible materials on the input conveyor. When shear blocks including leading surfaces comprising a slide angle are employed and an object that cannot be reduced encounters the breaker assembly, the force of the impact of the object on the breaker assembly, either alone or in combination with the added impact forces imparted to the object by the tools on rotating rotor assembly 123, will cause bypass arm 152 to pivot on pivot shaft 154 from the closed position shown in Figure 6 to the open position shown in Figure 7. This will allow the oversized object to fall out of the machine onto the output conveyor. Then, when the oversized object has cleared the breaker bar assembly, the opening force is removed, and a spring (similar to spring 68 of machine 20) may apply a biasing force to move bypass arm 152 from the open position shown in Figure 7 to the closed position shown in Figure 6.

[0040] Figures 8 and 9 illustrate a portion of material reducing machine 200 having rotor assembly 223 on which are mounted short cutting tools 230 and long cutting tools 234. Machine 200 also includes a breaker assembly that is located adjacent to the rotor assembly. The breaker assembly includes a curved back plate 242 with a plurality of shear blocks 444 and breaker blocks (not shown) arranged across the width of the machine on the side of back plate 242 adjacent to rotor assembly 223. Each of shear blocks 444 has a leading surface 472 and a trailing surface 476. Shear blocks 444 extend from the back plate towards the rotor a greater distance than the breaker blocks, and the cutting tools on the rotor and the shear blocks and breaker blocks on the back plate are arranged so that the long cutting tools 234 are aligned with the breaker blocks and the short cutting tools 230 are aligned with shear blocks 444. Back plate 242 is a part of bypass arm 252, which is adapted to rotate about pivot shaft 254. In the embodiment of the invention illustrated in Figures 8 and 9, the leading surfaces 472 of the shear blocks comprise a slip angle that is within the range of 80° - 100°, preferably about 90°, when measured from a horizontal plane that includes the axis 228 of rotation of rotor assembly 223. Shear blocks of this configuration present greater resistance to the flow of materials within the machine than do shear blocks that include leading surfaces that comprise a slide angle, and they may be employed when it is anticipated that a mixture of non-reducible objects and reducible materials will be conveyed towards the rotor on the input conveyor. When shear blocks including leading surfaces that comprise a slip angle are employed and an object that cannot be reduced encounters the breaker assembly, the force of the impact of the object on the breaker assembly, either alone or in combination with the added impact forces imparted to the object by the tools on rotating rotor assembly 223, will cause bypass arm 252 to pivot on pivot shaft 254 from the closed position shown in Figure 8 to the open position shown in Figure 9. This will allow the non-reducible object to fall out of the machine onto the output conveyor. Then, when the non-reducible object has cleared the breaker bar assembly, the opening force is removed, and a spring (similar to spring 68 of machine 20) may apply a biasing force to move bypass arm 252 from the open position shown in Figure 9 to the closed position shown in Figure 8.

[0041] Figure 10 illustrates the relationships between the radius R_T of the trailing surface 476 of shear blocks 444, the radius of the arc of rotation of the leading edges of the short cutting tools R_S and the radius of the arc of rotation of the leading edges of the long cutting tools R_L on the rotor assembly. In this embodiment of the invention, R_S is within the range of $0.90R_T$ - $0.995R_T$, and R_L is greater than $1.05R_T$. Furthermore, R_S is within the range of $0.5R_L$ - $0.9R_L$.

[0042] Figures 11 and 12 illustrate a portion of material reducing machine 300 having rotor assembly 323 on which are mounted short cutting tools 330 and long cutting tools 334. Machine 300 also includes a breaker assembly that is located adjacent to the rotor assembly. The breaker assembly includes a curved back plate 342 with a plurality of shear blocks 544 and breaker blocks (not shown) arranged across the width of the machine on the side of back plate 342 adjacent to rotor assembly 323. Each of shear blocks 544 has a leading surface 572 and a trailing surface 576. Shear blocks 544 extend from the back plate towards the rotor assembly a greater distance than the breaker blocks, and the cutting tools on the rotor assembly and the shear blocks and breaker blocks on the back plate are arranged so that the long cutting tools 334 are aligned with the breaker blocks and the short cutting tools 330 are aligned with shear blocks 544. Back plate 342 is a part of bypass arm 352, which is adapted to rotate about pivot shaft 354. In the embodiment of the invention illustrated in Figures 11 and 12, the leading surface of each of the shear blocks comprises an anvil angle that is within the range of 50° - 80°, preferably about 65°, when measured from a horizontal plane that includes the axis 328 of rotation of rotor 324. Shear blocks of this configuration present greater resistance to the flow of materials within the machine than do shear blocks having leading surfaces that comprise a slip angle, and they may be employed when it is anticipated that few non-reducible objects will be conveyed towards the rotor on the input conveyor. Shear blocks having leading surfaces that comprise an anvil angle create resistance that is similar to that of conventional anvils in material reducing machines. When shear blocks having leading surfaces comprising an anvil angle are employed and an object that cannot be reduced encounters the breaker assembly, the force of the impact of the object on the breaker assembly, either alone or in combination with the added impact forces imparted to the object by the tools on rotating rotor assembly 323, will cause bypass arm 352 to pivot on pivot shaft 354 from the closed position shown in Figure 11 to the open position shown in Figure 12. This will allow the non-reducible object to fall out of the machine onto the output conveyor. Then, when the non-reducible object has cleared the breaker bar assembly, the opening force is removed, and a spring (similar to spring 68 of machine 20) may apply a biasing force to move bypass arm 352 from the open position shown in Figure 12 to the closed position shown in Figure 11.

[0043] Figures 13 and 14 illustrate a portion of material reducing machine 400 having rotor assembly 423 on which are mounted short cutting tools 430 and long cutting tools 434. Machine 400 also includes a breaker assembly that is located adjacent to the rotor assembly. The breaker assembly includes a curved back plate 442 with a plurality of shear blocks 644 and breaker blocks (not shown) arranged across the width of the machine on the side of back plate 442 adjacent to rotor assembly 423. Each of shear blocks 644 has a leading surface 672 and a trailing surface 676. Shear blocks 644 extend from the back plate towards the rotor assembly a greater distance than the breaker blocks, and the cutting tools on the rotor assembly and the shear blocks and breaker blocks on the back plate are arranged so that the long cutting tools 434 are aligned with the breaker blocks and the short cutting tools 430 are aligned with shear blocks 644. Back plate 442 is a part of bypass arm 452, which is adapted to rotate about pivot shaft 454. In the embodiment of the invention illustrated in Figures 13 and 14, shear blocks 644 have a leading surface 672 that comprises a catch angle that is within the range of 40° - 50°, preferably about 45°, when measured from a horizontal plane that includes the axis 428 of rotation of rotor assembly 423. Shear blocks of this configuration present greater resistance to the flow of materials within the machine than do shear blocks having leading surfaces that comprise an anvil angle, and they may be employed when it is anticipated that only small non-reducible objects will be conveyed towards the rotor on the input conveyor. When shear blocks having leading surfaces comprising a catch angle are employed and an object that cannot be reduced encounters the breaker assembly, the force of the impact of the object on the breaker assembly, either alone or in combination with the added impact forces imparted to the object by the tools on rotating rotor assembly 423, will cause bypass arm 452 to pivot on pivot shaft 454 from the closed position shown in Figure 13 to the open position shown in Figure 14. This will allow the non-reducible object to fall out of the machine onto the output conveyor. Then, when the non-reducible object has cleared the breaker bar assembly, the opening force is removed, and a spring (similar to spring 68 of machine 20) may apply a biasing force to move bypass arm 452 from the open position shown in Figure 14 to the closed position shown in Figure 13.

[0044] Figure 15 illustrates a portion of material reducing machine 500 having rotor assembly 523 on which are mounted short cutting tools and long cutting tools. Machine 500 also includes a breaker assembly that is located adjacent to the rotor assembly. The breaker assembly includes a curved back plate 542 with a plurality of shear blocks (not shown) and breaker blocks 546 arranged across the width of the machine on the side of back plate 542 adjacent to rotor assembly 523. The shear blocks extend from the back plate towards the rotor assembly a greater distance than breaker blocks 546, and the cutting tools on the rotor assembly and the shear blocks and breaker blocks on the back plate are arranged so that the long cutting tools are aligned with breaker blocks 546 and the short cutting tools are aligned with the shear blocks. Back plate 542 is a part of bypass arm 552, which is adapted to rotate about pivot shaft 554. Each of breaker blocks 546 has a leading surface 572 that gradually increases to a point 574 of maximum outward projection from the back plate and a trailing surface 576 that gradually decreases from the point of maximum outward projection to the back plate. Figure 15 also illustrates the relationships between the radius R_B of the trailing surface 576 of the breaker blocks, the radius of the arc of rotation of the leading edges of the short cutting tools R_S and the radius of the arc of rotation of the leading edges of the long cutting tools R_L on the rotor. In this embodiment of the invention, R_S is less than $0.90R_B$, and R_L is within the range of $0.9R_B$ - $0.995R_B$.

[0045] Figures 16-19B illustrate a portion of material reducing machine 600 having rotor assembly 623 on which are mounted short cutting tools 630 and long cutting tools 634. Rotor assembly 623 comprises a plurality of generally circular rotor plates (shown in Figure 17), one of which, plate 624, is also shown in Figure 16. Rotor assembly 623 is adapted to rotate in a clockwise direction, as shown in Figure 16, about its axis of rotation 628. Short cutting tools 630 and long cutting tools 634 are arranged in rows that extend across the length of the rotor assembly (i.e., across the width of the frame of the machine), and rows of cutting tools are spaced around the periphery of the rotor assembly so that as the rotor assembly is rotated, the tools carry material from conveyor into engagement with a breaker assembly that is located adjacent to the rotor assembly. The leading edges of cutting bits 632 of the short cutting tools 630 mounted on rotor assembly 623 define an arc that is spaced outwardly from the periphery of rotor assembly 623 by a short cutter distance. Similarly, the leading edges of cutting bits 636 of the long cutting tools 634 mounted on rotor assembly 623 define an arc that is spaced outwardly from the periphery of the rotor assembly by a long cutter distance which is greater than the short cutter distance. As shown in Figures 16 and 17, it is preferred that the short cutting tools be arranged in rows that are parallel to axis of rotation 628, which rows extend all the way across the length of the rotor assembly. Similarly, it is preferred that the long cutting tools be arranged in rows that are parallel to the axis of rotation, which rows extend all the way across the length of the rotor assembly. It is also preferred that alternating rows of short cutting tools and long cutting tools be spaced around the periphery of the rotor assembly.

[0046] Material reducing machine 600 also includes a breaker assembly that is located adjacent to the rotor assembly. The breaker assembly includes anvil 645 (also shown in Figures 18A-18C) and a plurality of breaker blocks 646 arranged across the width of the machine on the side of anvil 645 adjacent to rotor assembly 623. Each of these breaker blocks has a leading surface 647 that forms an angle θ that is within the range of 30° - 75°, preferably about 60°, when measured from a horizontal plane that includes the axis of rotation 628 of the rotor assembly. The breaker assembly of this embodiment of the invention also includes curved back plate 642 (also shown in Figures 19A and 19B), which is provided with a plurality of apertures 643 (best shown in Figures 19A and 19B) through which reduced material may pass. A plurality of shear blocks 644 are arranged across the width of the machine on the side of back plate 642 adjacent to rotor assembly 623. The shear blocks extend from the back plate towards the rotor assembly a greater distance than the breaker blocks, and the cutting tools on the rotor assembly and the shear blocks and breaker blocks on the back plate are arranged so that the long cutting tools 634 are aligned with breaker blocks 646 and the short cutting tools 630 are aligned with shear blocks 644. Each of shear blocks 644 has a curved outer surface 648 that is parallel to the arc described by the leading edge of the cutting bit 632 of the short cutting tool 630 with which it is aligned. It is preferred that the cutting tools of rotor assembly 623 and the shear blocks 644 and breaker blocks 646 of the breaker assembly are arranged so that at least one short cutting tool 630 passes over a shear block 644 with which it is aligned, and at least one long cutting tool 634 passes between a pair of adjacent shear blocks 644 and over the breaker block 646 with which it is aligned. More particularly, as shown in Figure 16, the short cutting tools 630 and the long cutting tools 634 are spaced along the length of the rotor assembly 623, and the shear blocks 644 and the breaker blocks 646 are spaced along the back plate 642 in such a manner that all of the short cutting tools pass over the curved outer surfaces 648 of shear blocks 644, and the long cutting tools pass between adjacent shear blocks 664 and over the breaker blocks 646. The components of the breaker assembly of this configuration allow the machine to be operated with more "release" action but with less stress. This permits the rotor assembly to be rotated at a rate within the range of 50-1000 RPM, which includes rates that are too slow for efficient operation of conventional machines. Operating the machine at the low end of this range reduces fuel consumption, wear and noise levels.

[0047] Although this description contains many specifics, these should not be construed as limiting the scope of the invention as defined in the appended claims but as merely providing illustrations of the presently preferred embodiments thereof, as well as the best mode contemplated by the inventors of carrying out the invention.

[0048] The material reducing machine may include:

(a) a pivot arm carrying a compression roller;

(b) a bypass arm on which the breaker assembly is mounted, which bypass arm carries a resistance and biasing mechanism that is provided between the frame and a pivot shaft on which the pivot arm carrying the compression roller and the bypass arm carrying the breaker assembly are mounted;

(c) a resistance and biasing mechanism between the frame and the bypass arm.

[0049] The material reducing machine may be adapted to be operated at a rate of rotation of the rotor assembly within the range of 50-1000 RPM.

Claims

1. A material reducing machine (20) comprising:

(a) a frame;
(b) a rotor assembly (23) which is mounted for rotation about an axis of rotation (28) with respect to the frame, said rotor assembly (23) comprising:

(i) a periphery (26);
(ii) a length;
(iii) a plurality of short cutting tools (30,32) that are arranged in rows which extend across the length of the rotor assembly (23), with a plurality of rows being spaced around the periphery of the rotor assembly, wherein each of the short cutting tools (30,32) comprises a cutting bit (32) with a leading edge that is spaced outwardly from the periphery (26) of the rotor assembly by a short cutter distance;
(iv) a plurality of long cutting tools (34,36) that are arranged in rows which extend across the length of the rotor assembly (23),with a plurality of rows being spaced around the periphery (26) of the rotor assembly, wherein each of the long cutting tools (34,36) comprises a cutting bit (36) with a leading edge that is spaced outwardly from the periphery (26) of the rotor assembly by a long cutter distance that is greater than the short cutter distance of each of the short cutting tools (30,32);

(c) means for rotating the rotor assembly (23) with respect to the frame in a rotational direction;
(d) a material input device (21) for conveying material to be reduced towards the rotor assembly (23), said material input device (21) being arranged so that the short cutting tools (30,32) and the long cutting tools (34,36) on the rotor assembly (23) make initial contact with material to be reduced in an upward direction;
(e) a breaker assembly that is located adjacent to the rotor assembly (23), said breaker assembly comprising:

(i) a back plate (42;142;242;342;442; 542;642)
(ii) a plurality of shear blocks (44;144;244; 344;444;544;644), which are mounted on the backplate (42;142;242;342; 442; 542; 642) and each of which is spaced so as to be aligned with a short cutting tool (30,32);

characterized in that:-
the leading surface (372; 472;572;672) of each of the shear blocks comprises any one of:

a slide angle of greater than 100°,
a slip angle that is within the range of 80° - 100°,

an anvil angle that is within the range of 50° - 80°, or
a catch angle that is within the range of 40° - 50°, when measured from a horizontal plane that includes the axis of rotation (28) of the rotor assembly (23); and
there is provided a plurality of said back plates (42;142;242;342;442;542;642) that can be interchanged depending on the types of materials being processed.

2. The material reducing machine of claim 1, wherein a plurality of rows of long cutting tools (34,36) are spaced around the periphery (26) of the rotor assembly (23) so as to be separated from the plurality of rows of short cutting tools (30,32).

3. The material reducing machine of claim 1 or 2 wherein:

(a) the leading edge of the cutting bit (32) of each short cutting tool (30,32) describes an arc as the rotor assembly (23) is rotated with respect to the frame;
(b) each of the shear blocks has an outer surface that is curved to describe an arc that is generally parallel to the arc described by the leading edge of the cutting bit (32) of the short cutting tool (30,32) with which it is aligned.

4. The material reducing machine of claim 1, 2 or 3, wherein each of the shear blocks (44;144;244) has a leading edge (50;150;250) selected from the group consisting of bevelled leading edges, angled leading edges and flat leading edges, and each of the shear blocks has an outer surface (48;148;248) that is interrupted by notches (249) or grooves, or the outer surface is smooth.

5. The material reducing machine of any preceding claim, wherein the radius of the arc of rotation described by the leading edge of a cutting bit (32) of a short cutting tool (30,32) is within the range of 0.5 - 0.9 of the radius of the arc of rotation described by the leading edge of the cutting bit (36) of an adjacent long cutting tool (34, 36).

6. The material reducing machine of any preceding claim, wherein the breaker assembly includes a plurality of breaker blocks (46;546;646), each of which is spaced so as to be aligned with a long cutting tool (34,36).

7. The material reducing machine of claim 6, wherein the cutting tools (30,32,34,36) of the rotor assembly (23) and the shear blocks (44;144;244;344; 444;544;644) and breaker blocks (46;546;646) of the breaker assembly are arranged so that at least one short cutting tool (30,32) passes over the shear block with which it is aligned, and at least one long cutting tool (34,36) passes between a pair of adjacent shear blocks and over the breaker block with which it is aligned.

8. The material reducing machine of claim 6 or 7, wherein each of the breaker blocks (46) has an outer surface (74) and a leading edge (72) that forms a right angle with the outer surface.

Patentansprüche

1. Materialzerkleinerungsmaschine (20), umfassend:

a) einen Rahmen;
b) eine Rotoranordnung (23), die zur Drehung um eine Drehachse (28) bezüglich des Rahmens montiert ist, wobei die Rotoranordnung (23) umfasst:

i) einen Umfang (26);
ii) eine Länge;
iii) eine Vielzahl kurzer Schneidwerkzeuge (30, 32), die in Reihen angeordnet sind, die sich quer zur Länge der Rotoranordnung (23) erstrecken, wobei eine Vielzahl von Reihen um den Umfang der Rotoranordnung beabstandet angeordnet ist, wobei jedes der kurzen Schneidwerkzeuge (30, 32) eine Schneidklinge (32) mit einer Vorderkante umfasst, die von dem Umfang (26) der Rotoranordnung um einen kurzen Schneiderabstand nach außen beabstandet ist;
iv) eine Vielzahl langer Schneidwerkzeuge (34, 36), die in Reihen angeordnet sind, die sich quer zur Länge der Rotoranordnung (23) erstrecken, wobei eine Vielzahl von Reihen um den Umfang (26) der Rotoranordnung beabstandet angeordnet ist, wobei jedes der langen Schneidwerkzeuge (34, 36) eine Schneidklinge (36) mit einer Vorderkante umfasst, die von dem Umfang (26) der Rotoranordnung um einen langen Schneiderabstand nach außen beabstandet ist, der größer als der kurze Schneiderabstand eines jeden der kurzen Schneidwerkzeuge (30, 32) ist;

c) Mittel zum Drehen der Rotoranordnung (23) bezüglich des Rahmens in einer Drehrichtung;
d) eine Materialeintragsvorrichtung (21) zum Fördern von Material, das zu zerkleinern ist, zur Rotoranordnung (23), wobei die Materialeintragsvorrichtung (21) so angeordnet ist, dass die kurzen Schneidwerkzeuge (30, 32) und die lan-

gen Schneidwerkzeuge (34, 36) auf der Rotoranordnung (23) einen anfänglichen Kontakt mit dem zu zerkleinernden Material in einer Aufwärtsrichtung herstellen;
e) eine Brecheranordnung, die benachbart zu der Rotoranordnung (23) angeordnet ist, wobei die Brecheranordnung umfasst:

i) eine Rückplatte (42; 142; 242; 342; 442; 542; 642);
ii) eine Vielzahl von Scherblöcken (44; 144; 244; 344; 444; 544; 644), die auf der Rückplatte (42; 142; 242; 342; 442; 542; 642) montiert sind und die jeweils so beabstandet sind, dass sie mit einem kurzen Schneidwerkzeug (30, 32) ausgerichtet sind;

dadurch gekennzeichnet, dass:
die Vorderfläche (372; 472; 572; 672) eines jeden der Scherblöcke eines aus dem Folgenden umfasst:

einen Gleitwinkel, der größer als 100° ist,
einen Schlupfwinkel, der in dem Bereich von 80° bis 100° ist,
einen Ambosswinkel, der in dem Bereich von 50° bis 80° ist, oder
einen Fangwinkel, der in dem Bereich von 40° bis 50° ist,
wobei diese von einer waagrechten Ebene aus gemessen werden, die die Drehachse (28) der Rotoranordnung (23) beinhaltet; und
eine Vielzahl der Rückplatten (42; 142; 242; 342; 442; 542; 642) vorgesehen ist, die je nach den Arten der zu verarbeitenden Materialien ausgetauscht werden können.

2. Materialzerkleinerungsmaschine gemäß Anspruch 1, wobei eine Vielzahl von Reihen langer Schneidwerkzeuge (34, 36) so um den Umfang (26) der Rotoranordnung (23) beabstandet angeordnet ist, dass sie von der Vielzahl von Reihen kurzer Schneidwerkzeuge (30, 32) getrennt sind.

3. Materialzerkleinerungsmaschine gemäß Anspruch 1 oder 2, wobei:

a) die Vorderkante der Schneidklinge (32) eines jeden kurzen Schneidwerkzeugs (30, 32) einen Bogen beschreibt, wenn die Rotoranordnung (23) bezüglich des Rahmens gedreht wird;
b) jeder der Scherblöcke eine Außenoberfläche hat, die gebogen ist, um einen Bogen zu beschreiben, der allgemein parallel zu dem Bogen ist, der von der Vorderkante der Schneidklinge (32) des kurzen Schneidwerkzeugs (30, 32) beschrieben wird, mit dem er ausgerichtet ist.

4. Materialzerkleinerungsmaschine gemäß Anspruch 1, 2 oder 3, wobei jeder der Scherblöcke (44; 144; 244) eine Vorderkante (50; 150; 250) hat, die aus der Gruppe ausgewählt ist, die aus angeschrägten Vorderkanten, angewinkelten Vorderkanten und flachen Vorderkanten besteht, und jeder der Scherblöcke eine Außenoberfläche (48; 148; 248) hat, die von Kerben (249) oder Nuten unterbrochen ist, oder die Außenoberfläche glatt ist.

5. Materialzerkleinerungsmaschine gemäß einem der vorhergehenden Ansprüche, wobei der Radius des Rotationsbogens, der von der Vorderkante einer Schneidklinge (32) eines kurzen Schneidwerkzeugs (30, 32) beschrieben wird, in dem Bereich von 0,5 bis 0,9 mal dem Radius des Rotationsbogens liegt, der von der Vorderkante der Schneidklinge (36) eines benachbarten langen Schneidwerkzeugs (34, 36) beschrieben wird.

6. Materialzerkleinerungsmaschine gemäß einem der vorhergehenden Ansprüche, wobei die Brecheranordnung eine Vielzahl von Brecherblöcken (46; 546; 646) umfasst, die jeweils so beabstandet sind, dass sie mit einem langen Schneidwerkzeug (34, 36) ausgerichtet sind.

7. Materialzerkleinerungsmaschine gemäß Anspruch 6, wobei die Schneidwerkzeuge (30, 32, 34, 36) der Rotoranordnung (23) und die Scherblöcke (44; 144; 244; 344; 444; 544; 644) und Brecherblöcke (46; 546; 646) der Brecheranordnung so angeordnet sind, dass mindestens ein kurzes Schneidwerkzeug (30, 32) über den Scherblock bewegt wird, mit dem es ausgerichtet ist, und mindestens ein langes Schneidwerkzeug (34, 36) zwischen einem Paar benachbarter Scherblöcke hindurch und über den Brecherblock bewegt wird, mit dem es ausgerichtet ist.

8. Materialzerkleinerungsmaschine gemäß Anspruch 6 oder 7, wobei jeder der Brecherblöcke (46) eine Außenoberfläche (74) und eine Vorderkante (72) hat, die mit der Außenoberfläche einen rechten Winkel bildet.

Revendications

1. Machine de réduction de matière (20) comprenant :

(a) un bâti ;
(b) un ensemble de rotor (23) qui est monté pour tourner autour d’un axe de rotation (28) par rapport au bâti, ledit ensemble de rotor (23) comprenant :

(i) une périphérie (26) ;
(ii) une longueur ;

(iii) une pluralité d'outils de coupe courts (30, 32) qui sont agencés en rangées qui s'étendent sur la longueur de l'ensemble de rotor (23), avec une pluralité de rangées qui sont espacées autour de la périphérie de l'ensemble de rotor, dans laquelle chacun des outils de coupe courts (30, 32) comprend un foret de coupe (32) avec un bord d'attaque qui est espacé vers l'extérieur par rapport à la périphérie (26) de l'ensemble de rotor par une distance de dispositif de coupe court ;

(iv) une pluralité d'outils de coupe longs (34, 36) qui sont agencés en rangées qui s'étendent sur la longueur de l'ensemble de rotor (23), avec une pluralité de rangées qui sont espacées autour de la périphérie (26) de l'ensemble de rotor, dans laquelle chacun des outils de coupe longs (34, 36) comprend un foret de coupe (36) avec un bord d'attaque qui est espacé vers l'extérieur par rapport à la périphérie (26) de l'ensemble de rotor par une distance de dispositif de coupe long qui est supérieure à la distance de dispositif de coupe court de chacun des outils de coupe courts (30, 32) ;

(c) un moyen pour faire tourner l'ensemble de rotor (23) par rapport au bâti, dans une direction de rotation ;

(d) un dispositif d'entrée de matière (21) pour transporter la matière à réduire vers l'ensemble de rotor (23), ledit dispositif d'entrée de matière (21) étant agencé de sorte que les outils de coupe courts (30, 32) et les outils de coupe longs (34, 36) sur l'ensemble de rotor (23) établissent un contact initial avec la matière à réduire dans une direction ascendante ;

(e) un ensemble de broyeur qui est positionné de manière adjacente à l'ensemble de rotor (23), ledit ensemble de broyeur comprenant :

(i) une plaque arrière (42 ; 142 ; 242 ; 342 ; 442 ; 542 ; 642)

(ii) une pluralité de blocs de cisaillement (44 ; 144 ; 244 ; 344 ; 444 ; 544 ; 644) qui sont montés sur la plaque arrière (42 ; 142 ; 242 ; 342 ; 442 ; 542 ; 642) et dont chacun est espacé afin d'être aligné avec un outil de coupe court (30, 32) ;

caractérisée en ce que :
la surface d'attaque (372 ; 472 ; 572 ; 672) de chacun des blocs de cisaillement comprend l'un quelconque parmi :

un angle de coulissement supérieur à 100°,
un angle de dérive qui est dans la plage de 80° à 100°,
un angle d'enclume qui est dans la plage de 50° à 80°, ou bien
un angle de prise qui est dans la plage de 40° à 50°,
lorsqu'il est mesuré à partir d'un plan horizontal qui comprend l'axe de rotation (28) de l'ensemble de rotor (23) ; et
on prévoit une pluralité desdites plaques arrière (42 ; 142 ; 242 ; 342 ; 442 ; 542 ; 642) qui peuvent être interchangées en fonction des types de matières qui sont traitées.

2. Machine de réduction de matière selon la revendication 1, dans laquelle une pluralité de rangées d'outils de coupe longs (34, 36) sont espacées autour de la périphérie (26) de l'ensemble de rotor (23) afin d'être séparées de la pluralité de rangées d'outils de coupe courts (30, 32).

3. Machine de réduction de matière selon la revendication 1 ou 2, dans laquelle :

(a) le bord d'attaque du foret de coupe (32) de chaque outil de coupe court (30, 32) décrit un arc lorsque l'ensemble de rotor (23) tourne par rapport au bâti ;

(b) chacun des blocs de cisaillement a une surface externe qui est incurvée afin de décrire un arc qui est généralement parallèle à l'arc décrit par le bord d'attaque du foret de coupe (32) de l'outil de coupe court (30, 32) avec lequel il est aligné.

4. Machine de réduction de matière selon la revendication 1, 2 ou 3, dans laquelle chacun des blocs de cisaillement (44 ; 144 ; 244) a un bord d'attaque (50 ; 150 ; 250) sélectionné dans le groupe comprenant les bords d'attaque biseautés, les bords d'attaque coudés et les bords d'attaque plats, et chacun des blocs de cisaillement a une surface externe (48 ; 148 ; 248) qui est interrompue par des encoches (249) ou des rainures, ou la surface externe est lisse.

5. Machine de réduction de matière selon l'une quelconque des revendications précédentes, dans laquelle le rayon de l'arc de rotation décrit par le bord d'attaque d'un foret de coupe (32) d'un outil de coupe court (30, 32) est dans la plage de 0,5 à 0,9 du rayon de l'arc de rotation décrit par le bord d'attaque du foret de coupe (36) d'un outil de coupe long (34, 36) adjacent.

6. Machine de réduction de matière selon l'une quelconque des revendications précédentes, dans laquelle l'ensemble de broyeur comprend une pluralité de blocs de broyeur (46 ; 546 ; 646), dont chacun est espacé pour être aligné avec un outil de coupe long (34, 36).

7. Machine de réduction de matière selon la revendication 6, dans laquelle les outils de coupe (30, 32, 34, 36) de l'ensemble de rotor (23) et les blocs de cisaillement (44 ; 144 ; 244 ; 344 ; 444 ; 544 ; 644) et les blocs de broyeur (46 ; 546 ; 646) de l'ensemble de broyeur sont agencés de sorte qu'au moins un outil de coupe court (30, 32) passe sur le bloc de cisaillement avec lequel il est aligné, et au moins un outil de coupe long (34, 36) passe entre une paire de blocs de cisaillement adjacents et sur le bloc de broyeur avec lequel il est aligné.

8. Machine de réduction de matière selon la revendication 6 ou 7, dans laquelle chacun des blocs de broyeur (46) a une surface externe (74) et un bord d'attaque (72) qui forme un angle droit avec la surface externe.

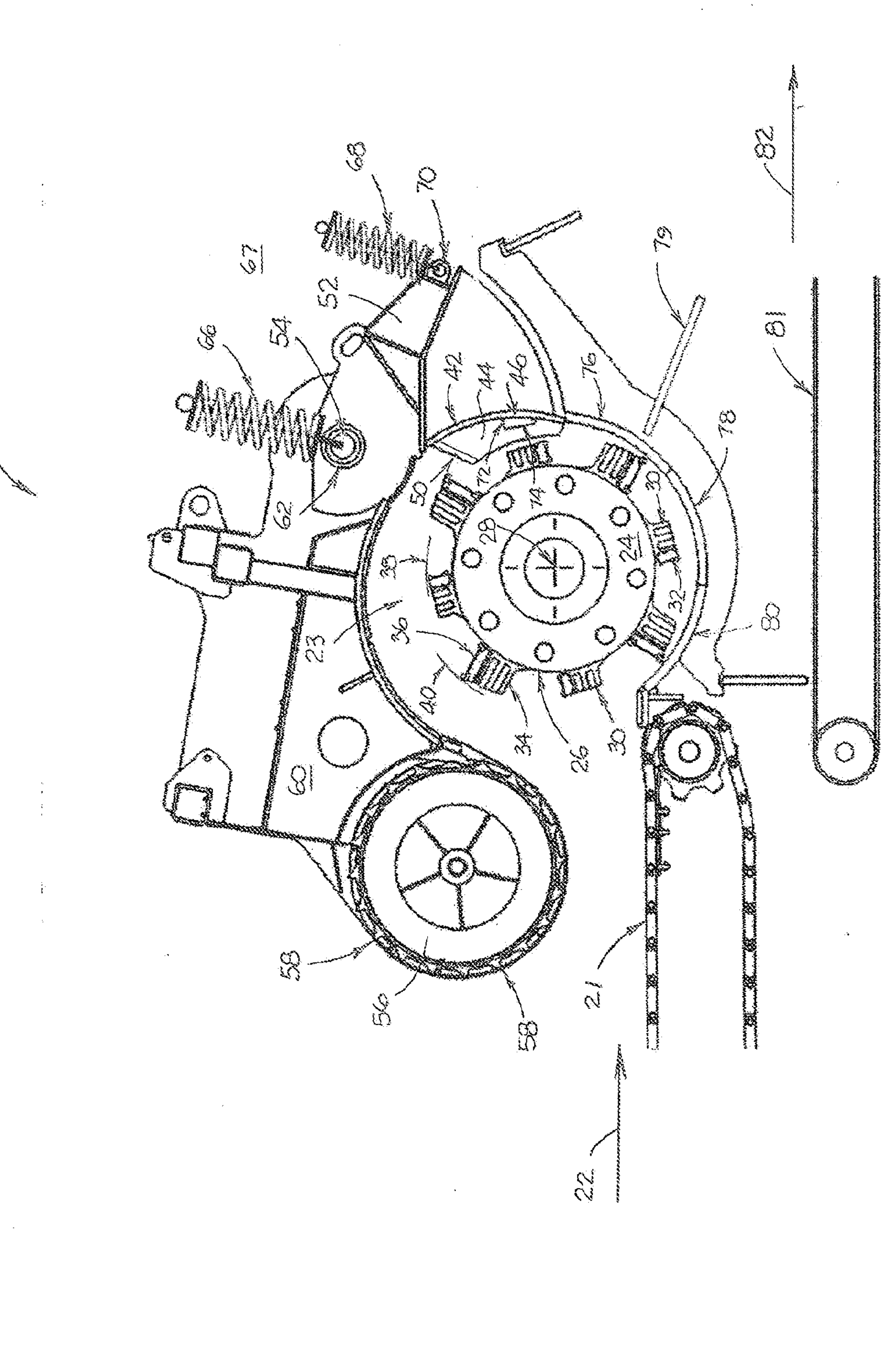
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FIGURE 1

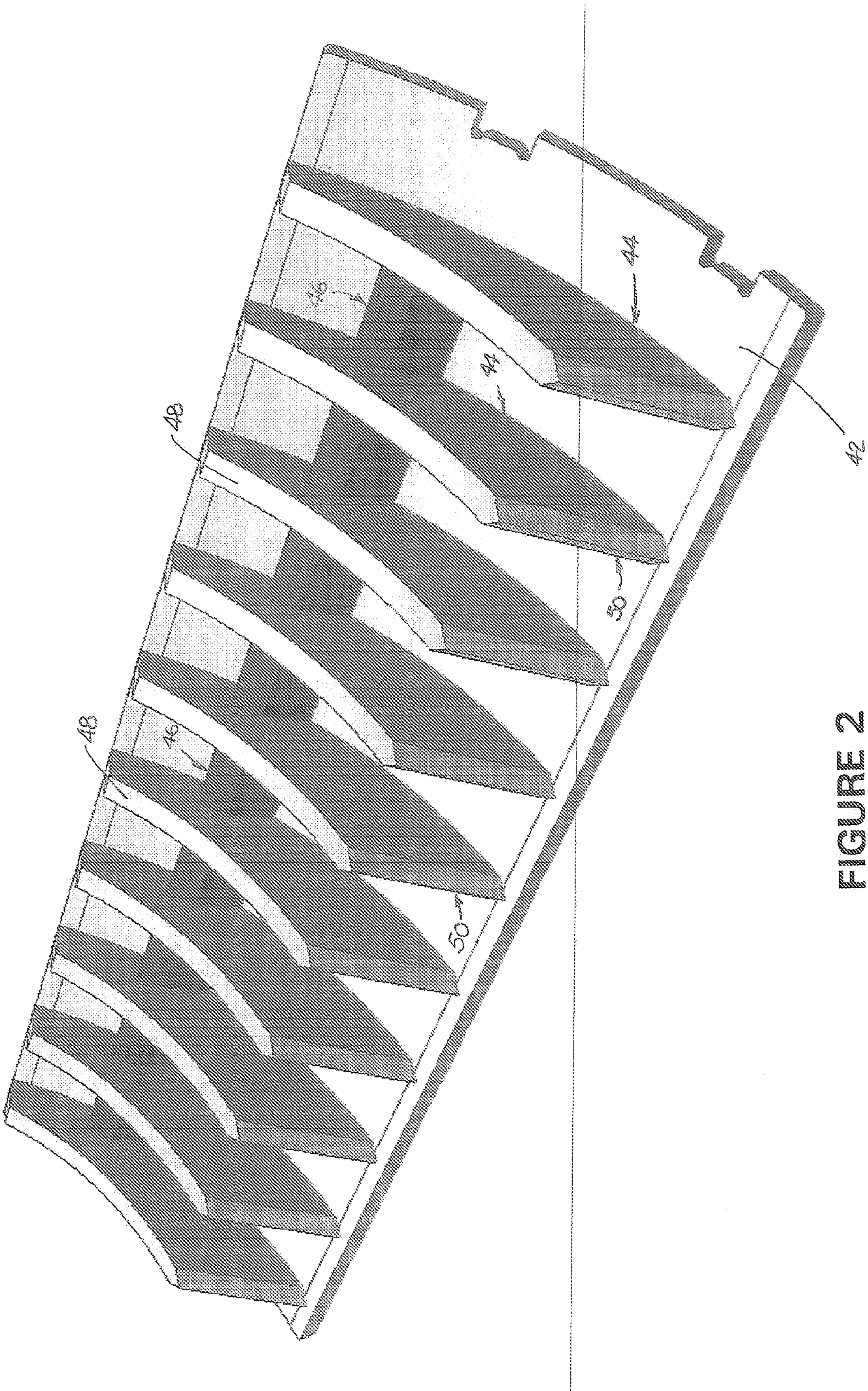


FIGURE 2

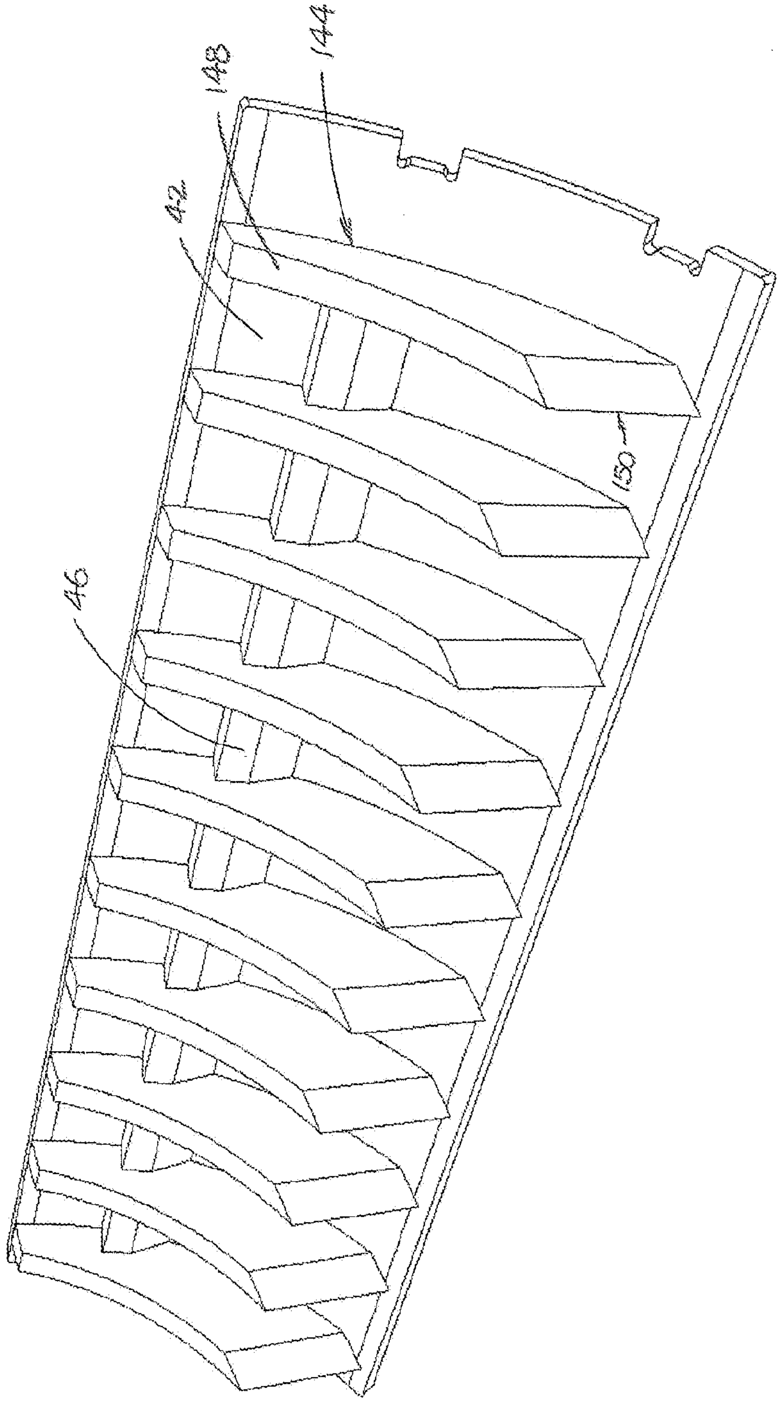
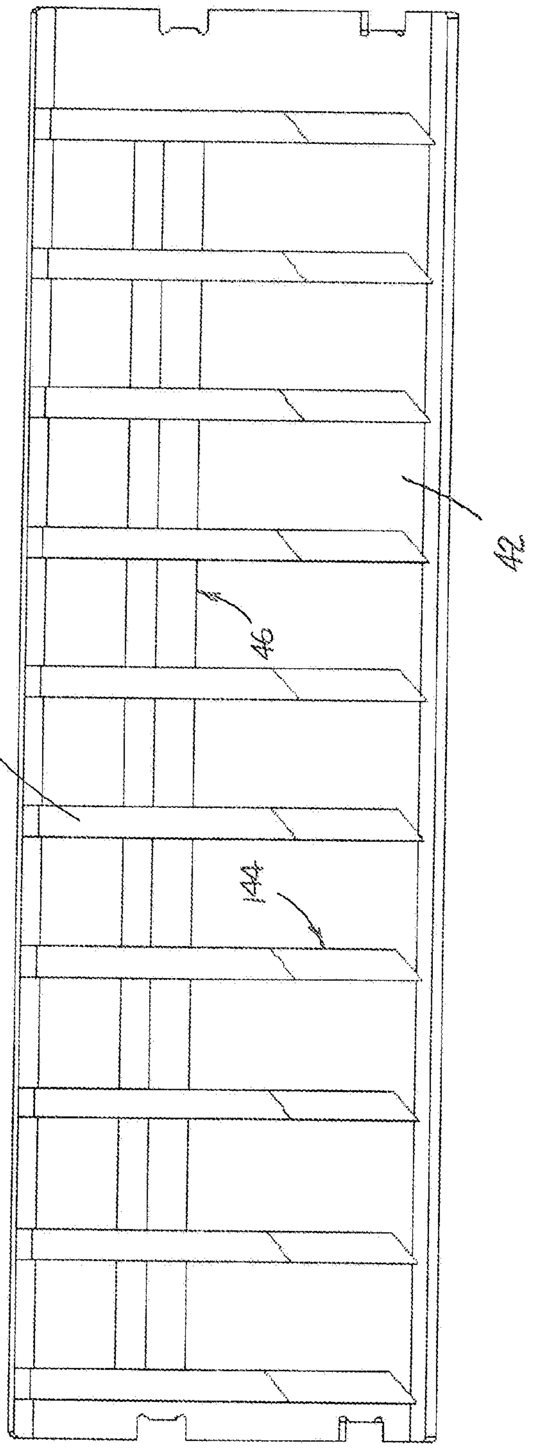


FIGURE 3



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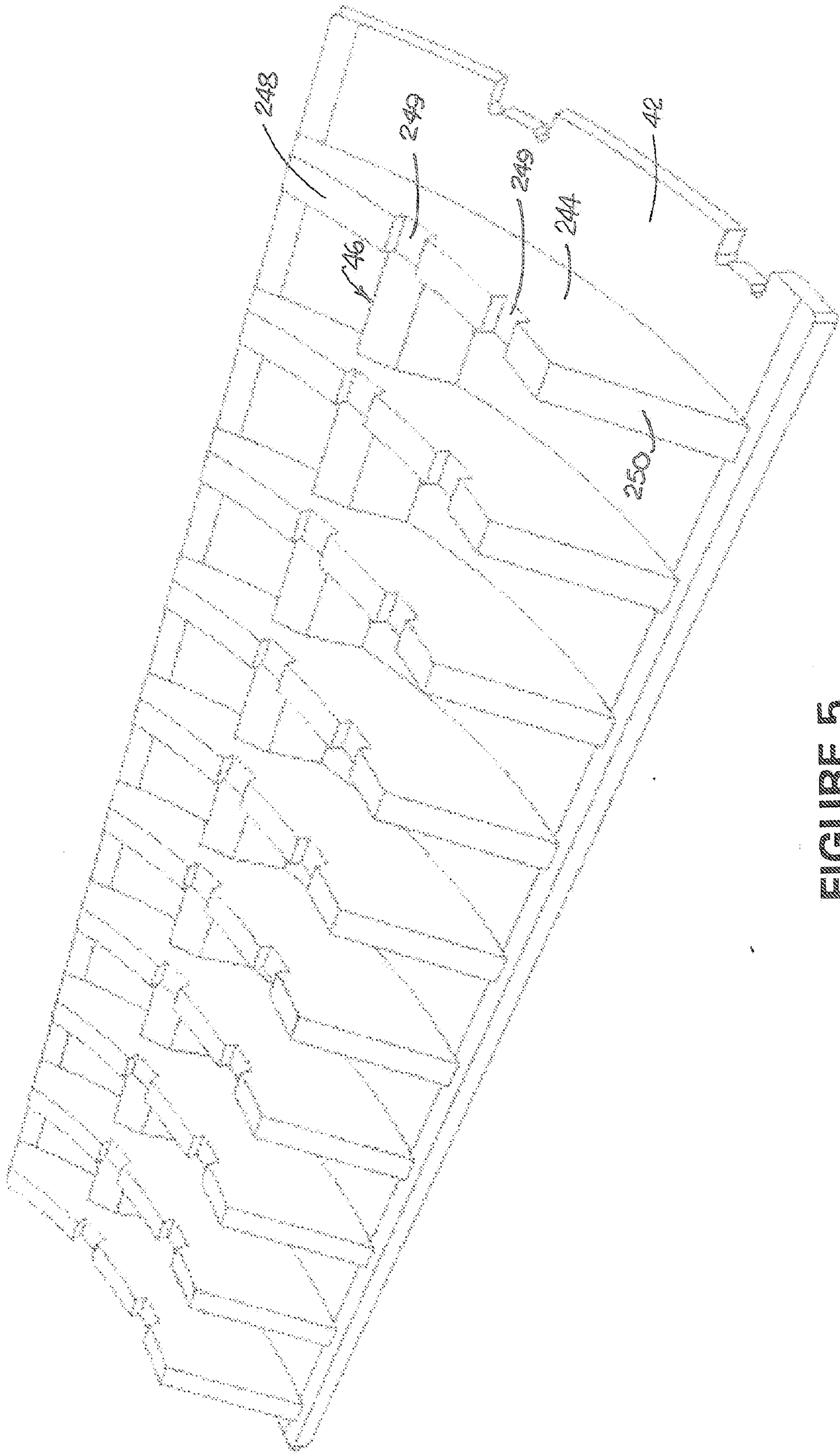

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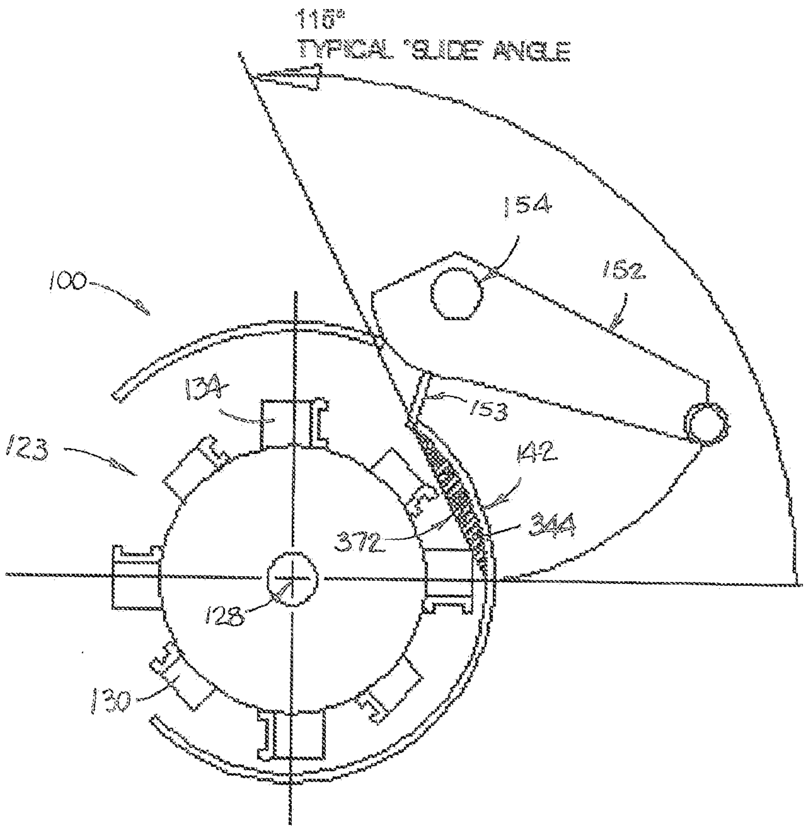

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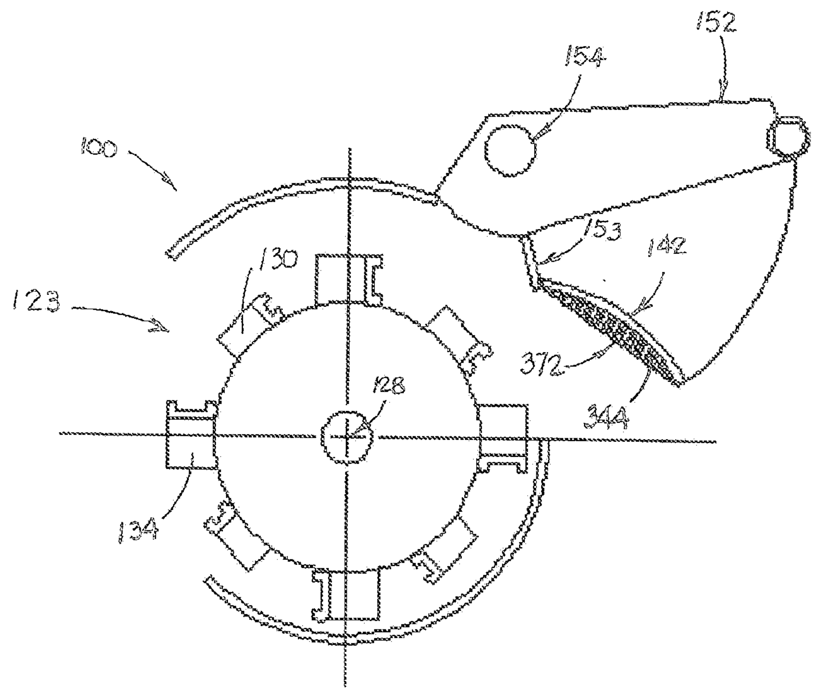


FIGURE 7

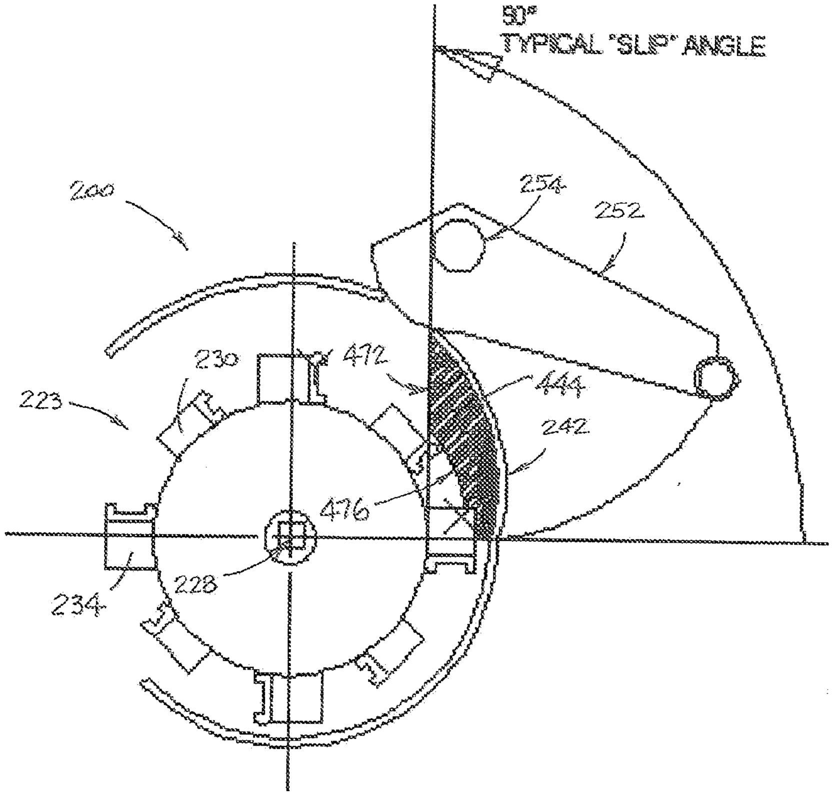
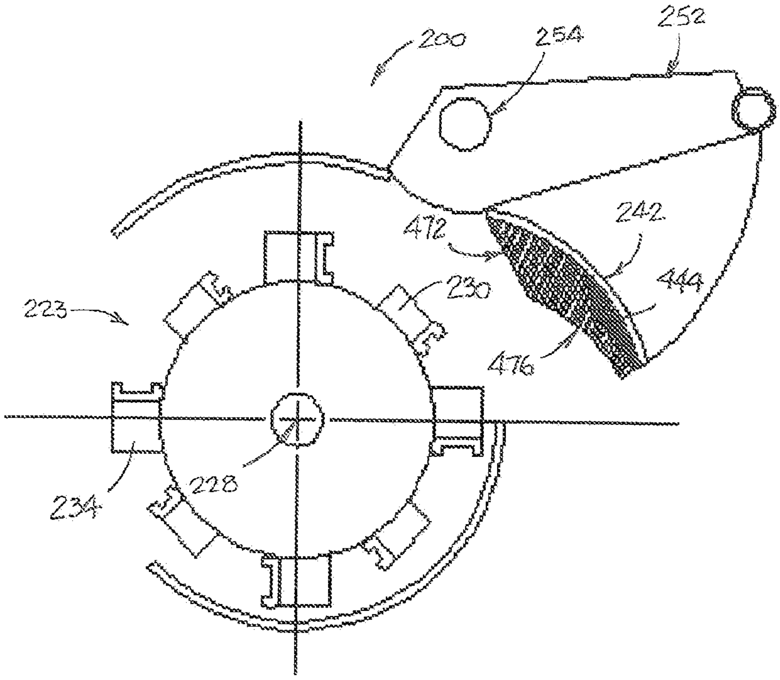


FIGURE 8



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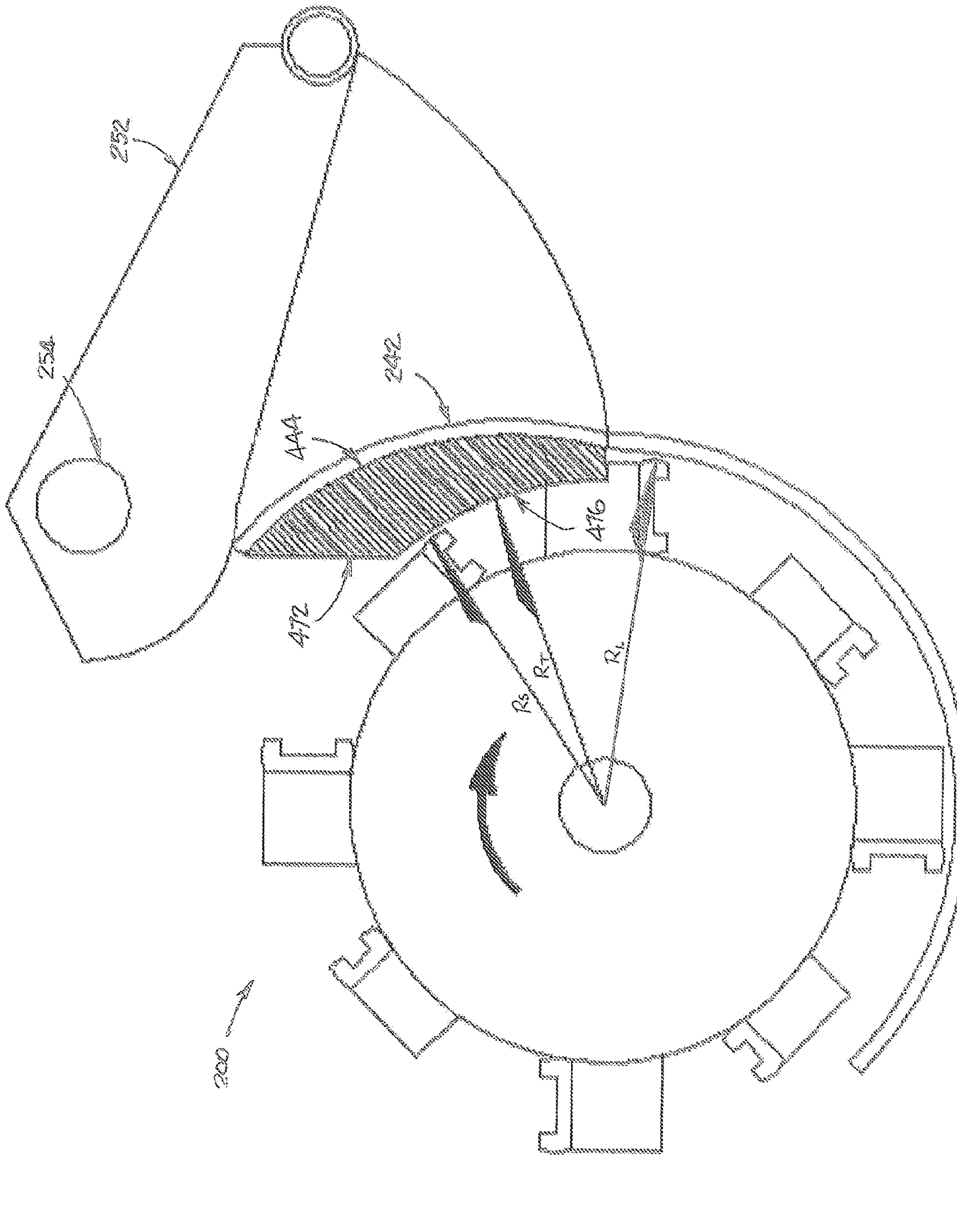


FIGURE 10

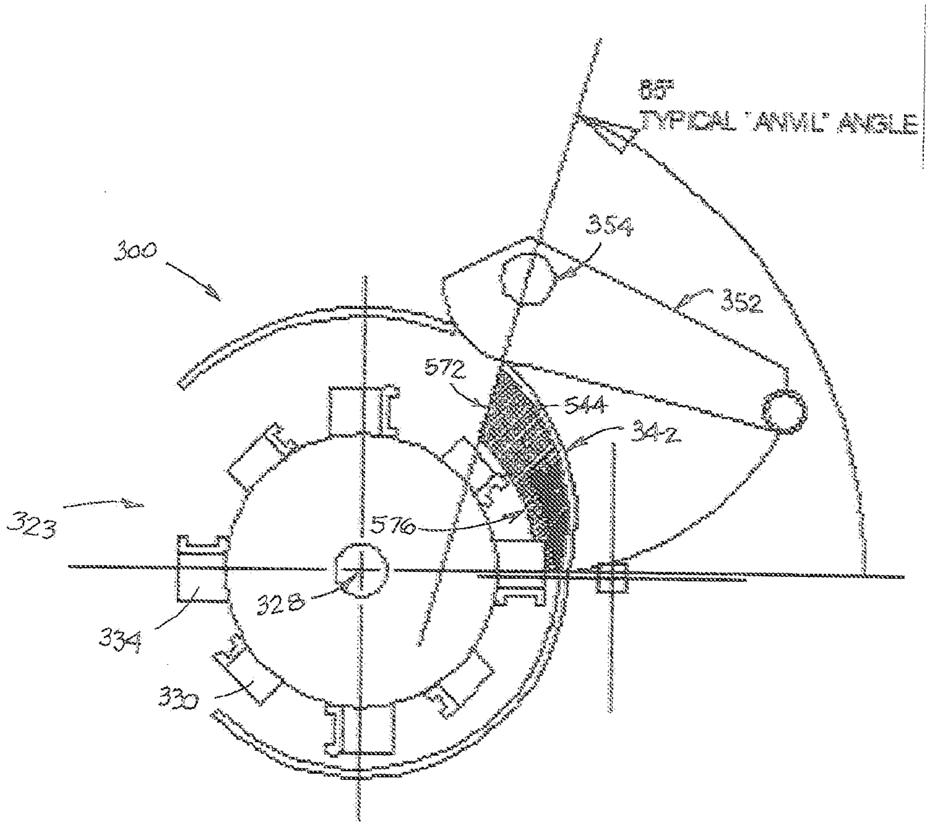
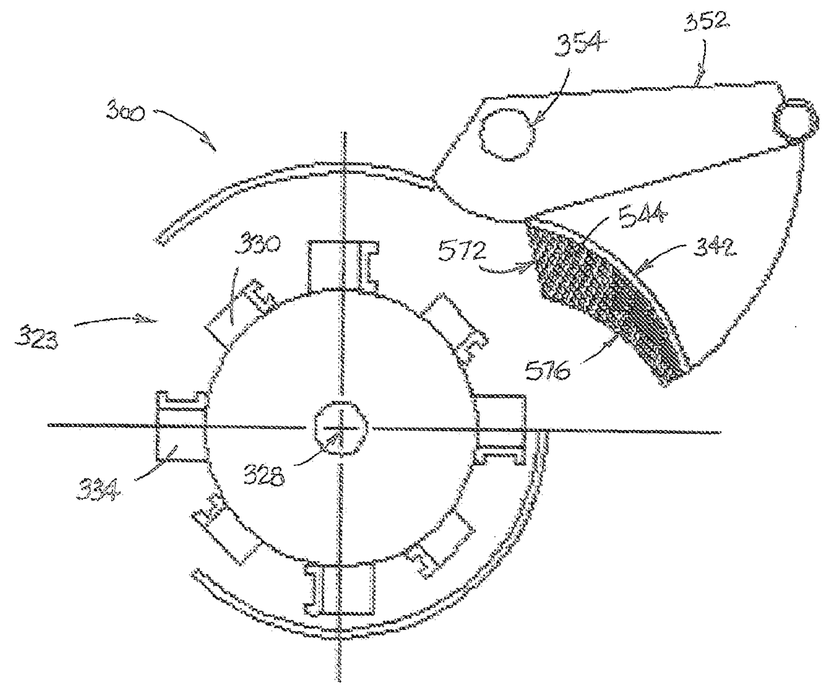


FIGURE 11



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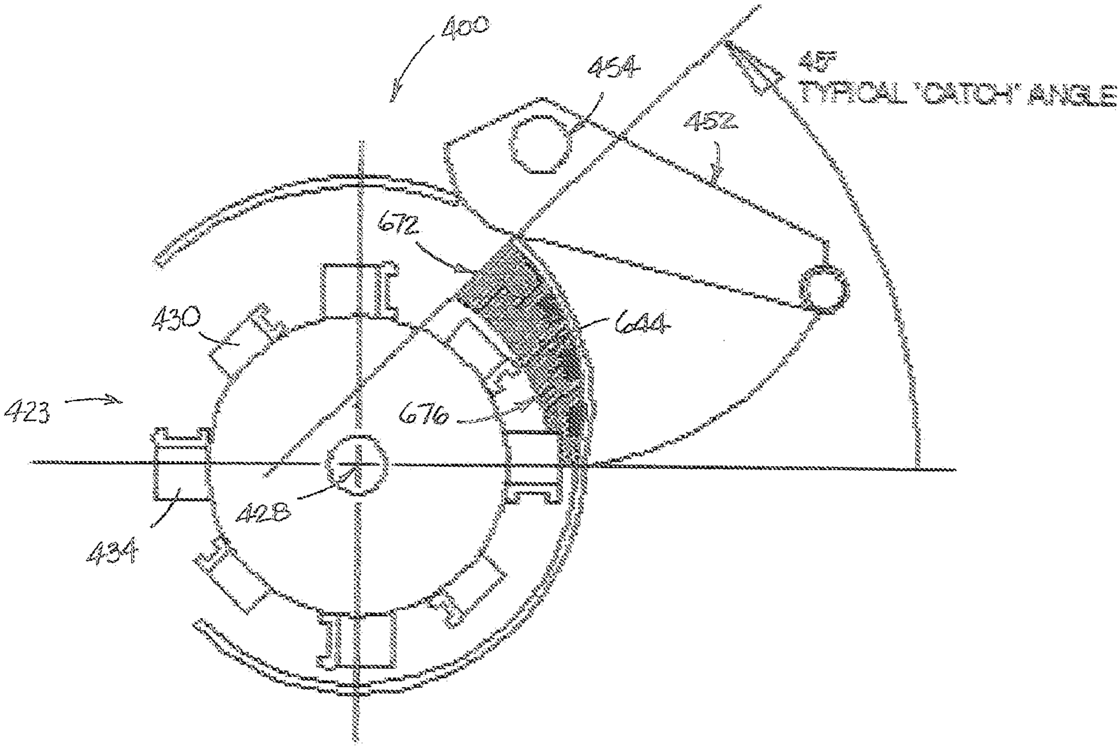

FIGURE 13

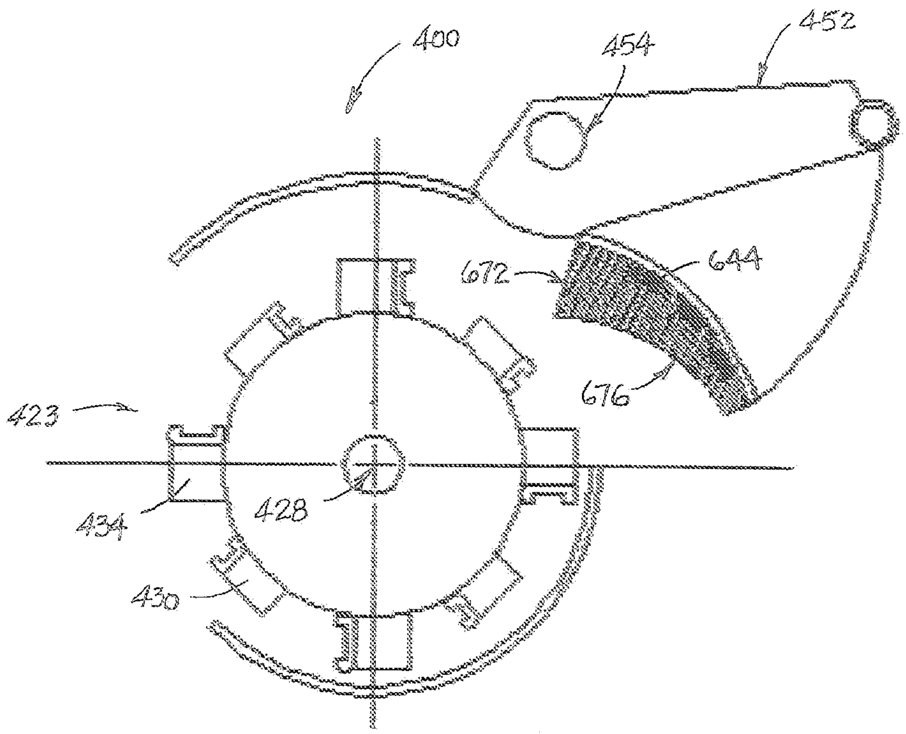

FIGURE 14

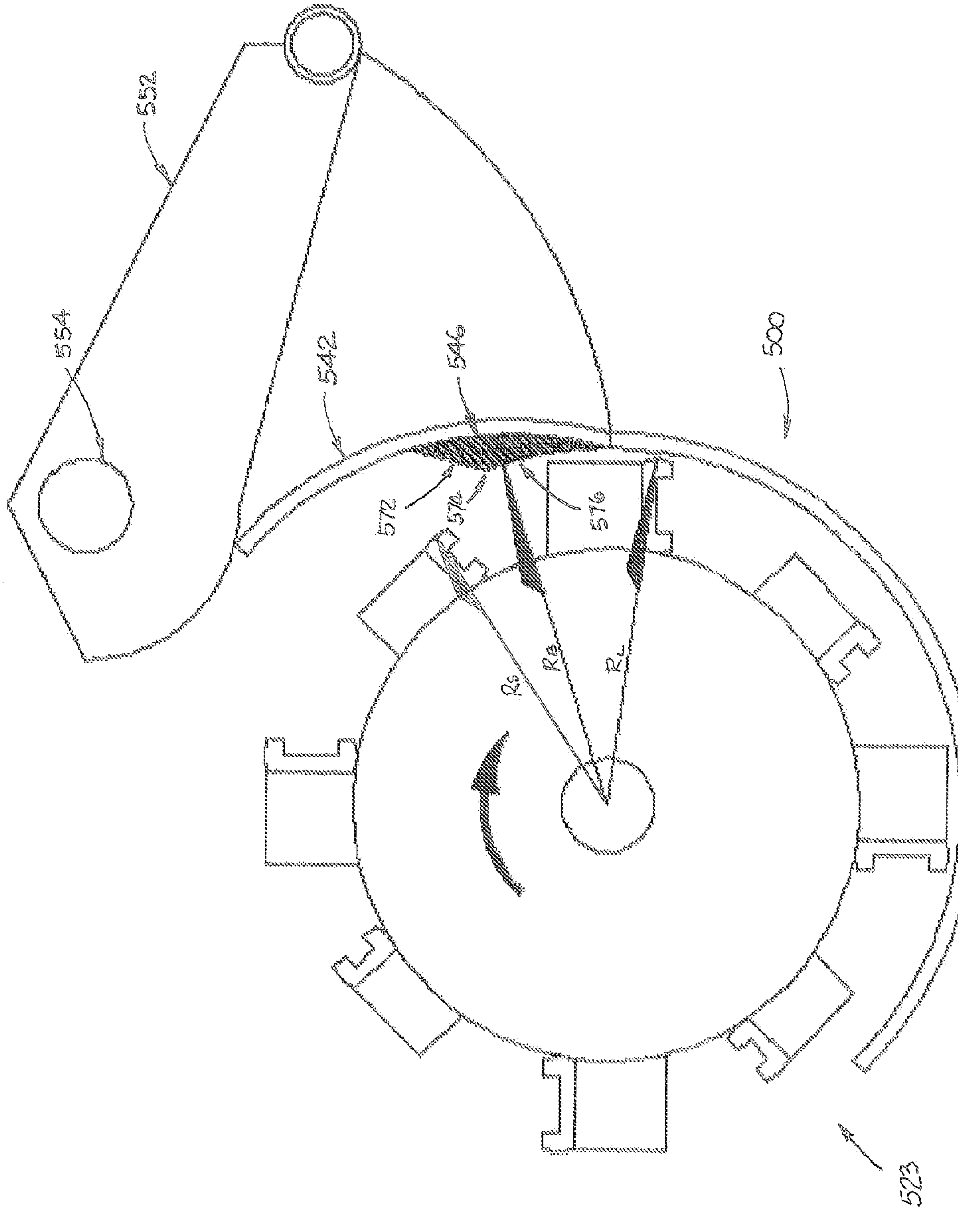

FIGURE 15

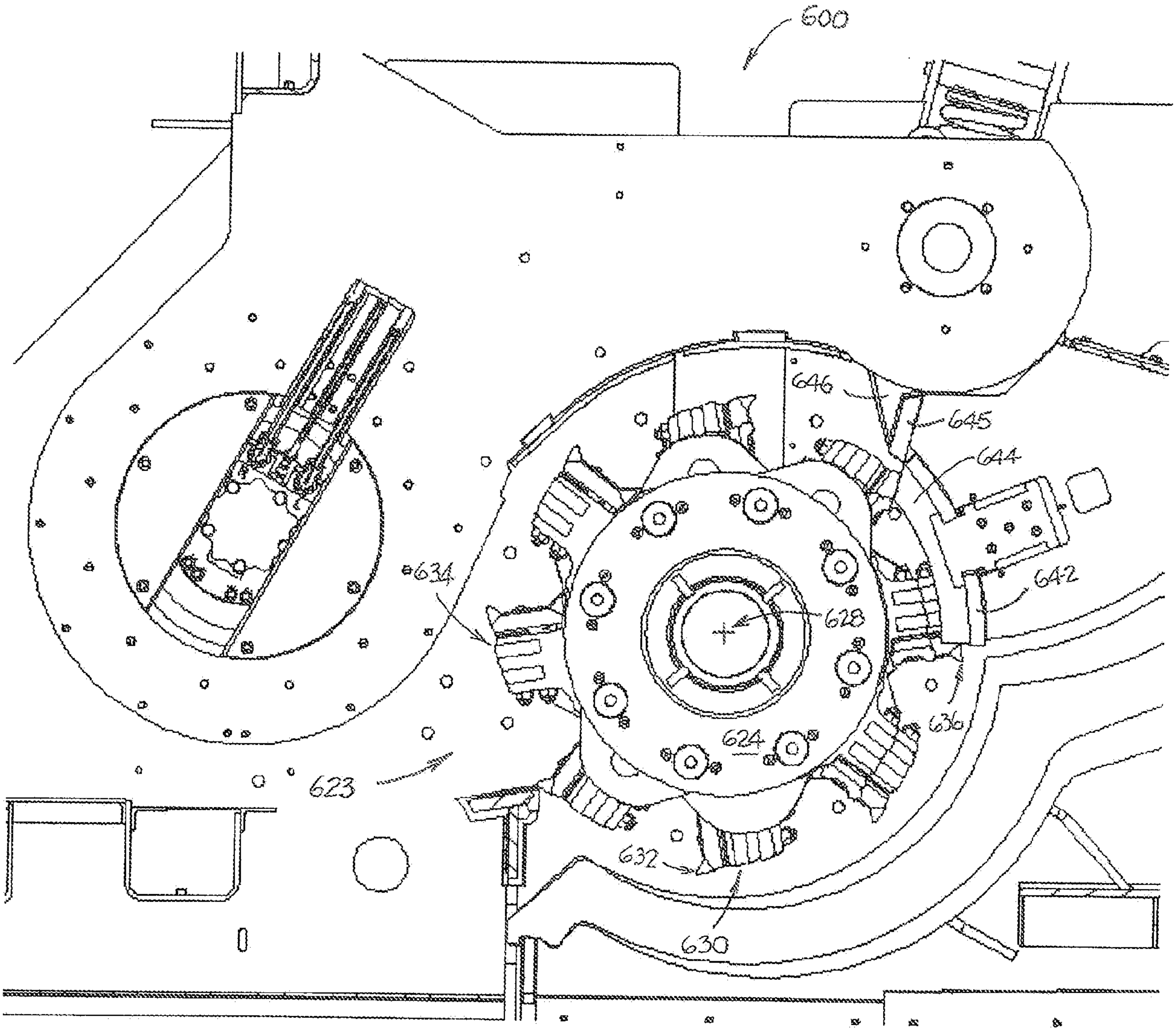

FIGURE 16

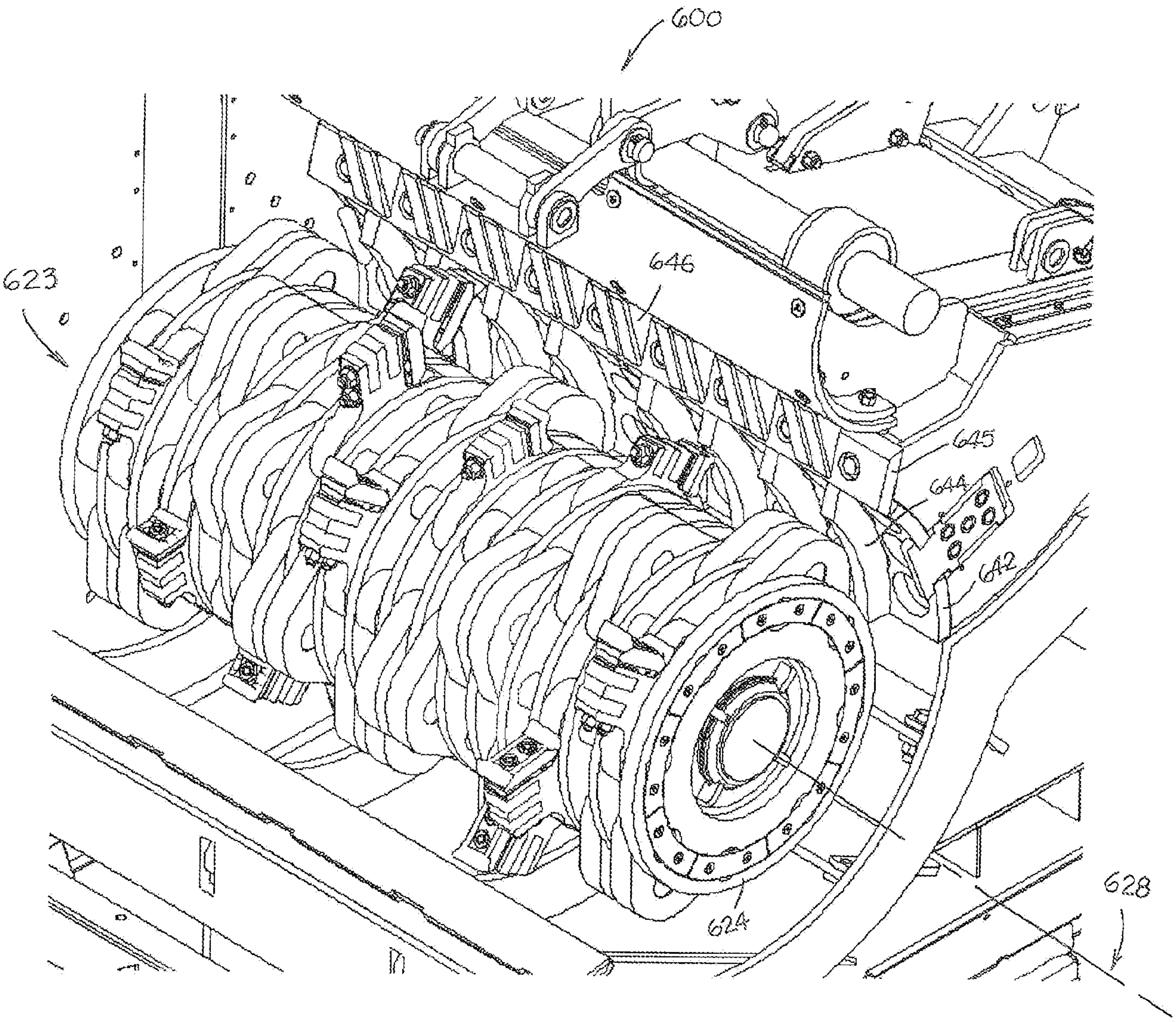

FIGURE 17

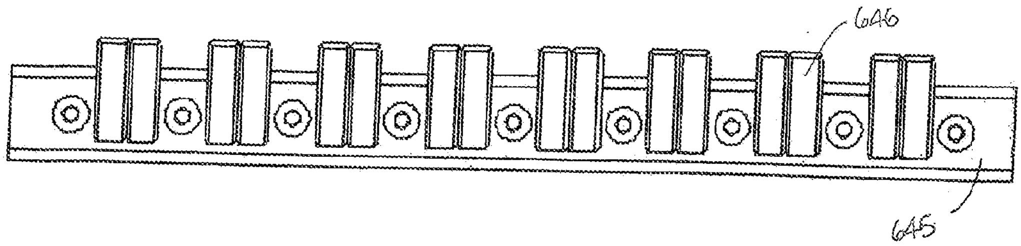

FIGURE 18A

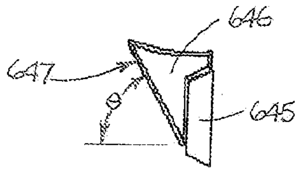

FIGURE 18B

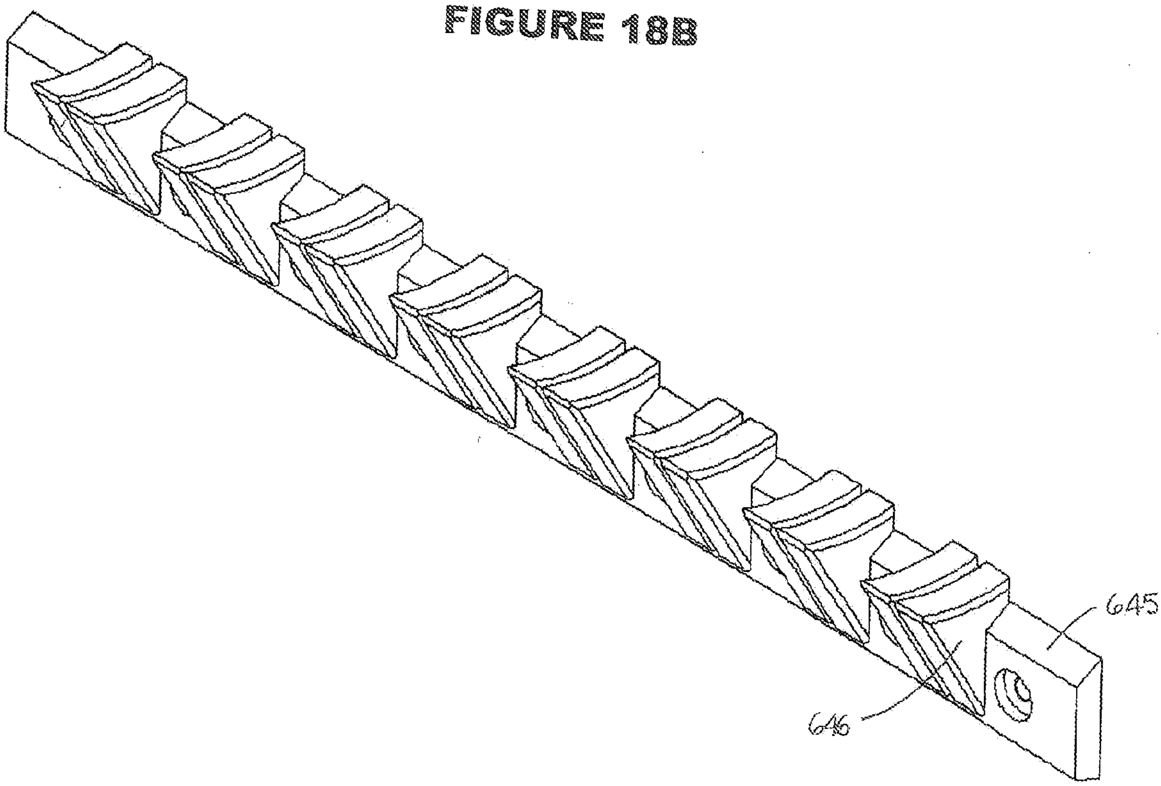

FIGURE 18C

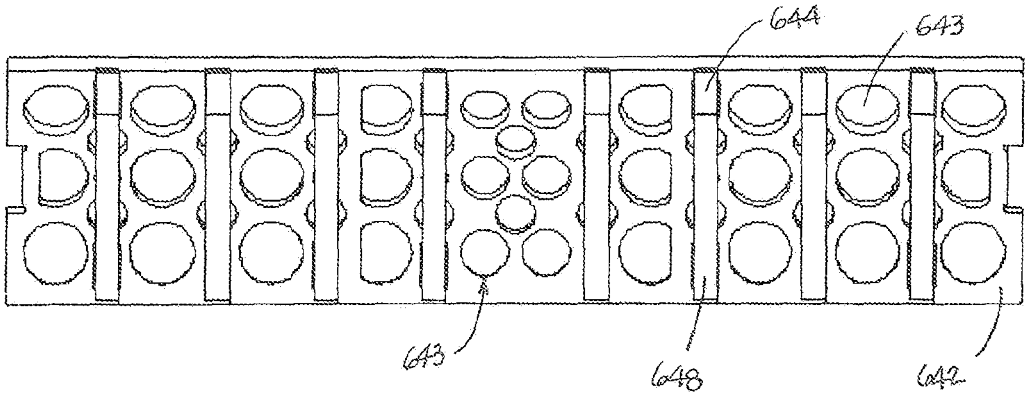

FIGURE 19A

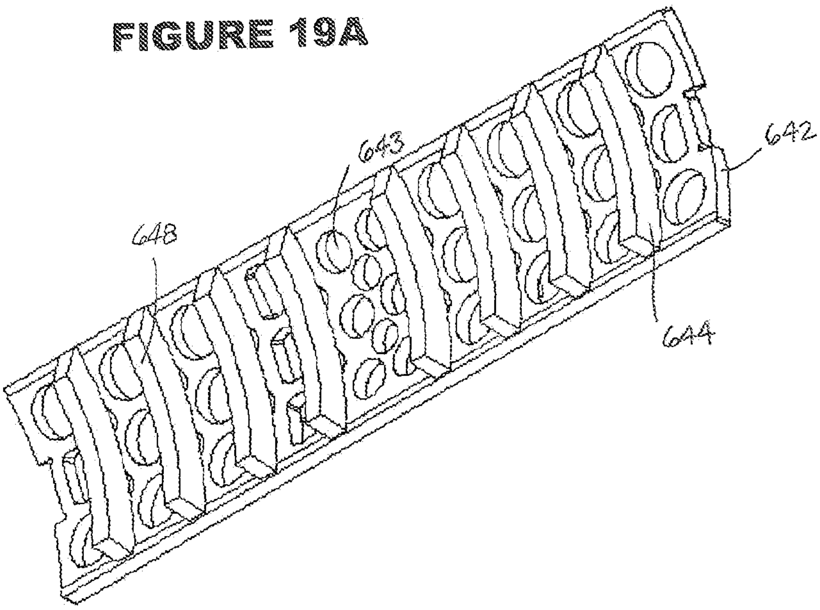

FIGURE 19B

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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