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Description

This application pertains to the art of particle comminuting and more particularly to one pass comminuting of centimeter sized pellets or particles to micron sized particulates. The invention is particularly applicable to comminuting vulcanized rubber and will be described with particular reference thereto. However, it is to be appreciated that the invention has other applications such as comminuting coal, thermoplastics, thermosetting plastics, woods, ceramics, glass, resins, and other materials.

As shown, for example, in W. German Patent Application DE—A—2 936 194, which forms the preamble of claim 1, comminution apparatae commonly include a rotor and a stator which have opposing surfaces. The opposing surfaces define a central material receiving region and have surrounding abrasive surfaces that defined a grinding zone therebetween. An urging means urges the rotor and stator together as the rotor is rotated about an axis.

To facilitate reprocessing of vulcanized rubber and other elastomeric materials for reuse, the materials are commonly reduced to micron sized particles. Heretofore, various methods and apparatus have been employed to reduce the elastomeric materials to micron size. However, the prior art apparatus have had certain drawbacks, particularly when used for commercial production. One method for producing small particulates has been to subject material to a cryogenic temperature. The embrittled material is ground by conventional grinding techniques. Commonly, the ground particles are large and must be refrozen and ground another time before they can be reused efficiently. Thus, this technique is expensive and finds great difficulty in producing particles in the lower micron range. Others have used abrasion devices for reducing the particle size of rubber and other elastomers. However, abrasion devices have relatively low particle yields. Further, abrasion devices have an inherent temperature increase that causes a hazard of the rubber combusting. Moreover, the elevated temperatures involved in prior art methods tend to degrade the material being processed.

Accordingly, it has been found desirable to provide an effective method and apparatus for comminuting of a vulcanized rubber and other elastomers to micron sized particles to facilitate reuse. The present invention provides an apparatus which although relatively simple in design and operation efficiently produces micron sized particles.

In accordance with the invention there is provided a comminuting apparatus having a rotor and a stator which have opposing surfaces that define a receiving region therebetween and peripheral abrasive surfaces that define a grinding zone therebetween, an urging means for urging at least one of the stator and the rotor toward the other, and means for rotating the rotor about an axis, said apparatus having at least two recesses on said stator with an orientation in an outward flow direction from said axis, at least the same number of similarly oriented recesses, on said rotor and an outward sloping portion at an outward end of said rotor recesses oriented in a direction generally opposed to the direction of rotation about said axis;

supplying means for supplying a mixture of fluid and vulcanized rubber-like pellets to be reduced in size to said receiving region; and,

pressurizing means for increasing the pressure along said rotor recesses disposed within the receiving region.

Furthermore according to the invention, a method of comminuting particles is disclosed, in which said method includes the steps of

receiving the slurry of vulcanized rubber or rubber-like pellets with a median diameter of at least 3 mm and water in said receiving region disposed between said rotor and stator;

urging the pellets along said outward extending recesses in said rotor abrasive surface surrounding the receiving region by rotating said rotor, said rotor recess having a sloping portion along said trailing edge relative to the direction of rotation;

wedging the pellets between said rotor recess sloping portion and said stator peripheral abrasive surface surrounding the receiving region and into the grinding zone defined between the rotor and stator zone defined between the rotor and stator peripheral abrasive surfaces;

continuing rotation of said rotor comminuting the pellets in a single pass into particles between said stator and rotor peripheral abrasive surfaces until the particles have a median diameter of less than 50 microns.

The invention may take form in various parts and arrangements of parts. The FIGURES are only for purposes of illustrating a preferred embodiment of the invention and are not to be construed as limiting the invention.

FIGURE 1 is a side elevational view in partial section of a comminuting apparatus in accordance with the present invention;

FIGURE 1A is an enlarged copy of the stator/rotor region of FIGURE 1 with additional reference numerals.

FIGURE 2 is a bottom view of the face of the stator of FIGURE 1;

FIGURE 3 is a sectional view through section 3—3 of the stator of FIGURE 2;

FIGURE 4 is a side elevational view of the rotor of FIGURE 1;

FIGURE 5 is a top view of the rotor of FIGURE 1 with the impeller in phantom;

FIGURES 6A through 6I are enlarged cross sectional views of a pellet being received between the stator and rotor of a comminuting apparatus with progressive rotation of the rotor, the stator and rotor spacing being exaggerated for the ease of illustration;

FIGURE 7 is a schematic diagram of an electric control circuit for the comminuting apparatus in accordance with the present invention;

FIGURE 8 is a diagramatic illustration in partial sectional view of an alternate embodiment of a comminuting system in accordance with the present invention;

FIGURE 9 is a bottom view of the stator of FIGURE 8;

FIGURE 10 is a sectional view through section 10—10 of FIGURE 9;

FIGURE 11 is a top view of the rotor of FIGURE 8;

FIGURE 12 is a sectional view through section 12—12 of the rotor of FIGURE 11; and

FIGURE 13 is a sectional view through section 13—13 of FIGURE 11.

With reference to FIGURE 1, a feeding means A feeds fluid and pellets of the vulcanized rubber or other elastomer to be comminuted at coordinated rates. Preferably, the pellets are chunks which have a maximum cross sectional dimension on the order of a centimeter or less. The apparatus may be scaled up to handle larger pellets. A mixing means B receives the pellets and fluid and mixes them into a slurry. The slurry is fed to a mill C which grinds the pellets into micron sized particles preferably with 90% of the particles by number having a diameter on the order of 20 microns or less.

The feeding means A includes a pellet feeding means for feeding pellets at a selectable rate and a fluid feeding means for feeding fluid commensurate with the rate that the slurry is fed to the mill. The pellet feeding means includes a hopper 10 which discharges the pellets into a vibratory feeder 12. The vibratory feeder includes a generally horizontal trough 14 which is mounted on springs 16 and vibrated by a motor 18. The vibratory feeder 12 moves the pellets at a rate controlled by the speed or duty cycle of the motor 18. Optionally, a plurality of vibratory feeders may be used. The fluid feeding means includes a water or other fluid inlet 20 and a level controlled valve 22.

The mixing means B includes a mixing tank 30 which receives pellets from the pellet feeding means and fluid from the fluid feeding means. An agitating means 32 mixes the pellets and fluid into a slurry. The slurry is pumped by a positive displacement pump 34 driven by a variable speed pump motor 36 from the mixing tank 30 through a feed line 38 to the mill C. The pump 34 is a progressing cavity positive displacement pump or other pump which supplies the slurry to the mill with a generally constant pressure. The fluid level in the mixing tank is maintained substantially constant by the fluid feeding means which adds fluid at the same rate that pump 34 pumps fluid from the tank. The slurry feed line 38 is of sufficiently small diameter that the slurry velocity maintains the pellets suspended in the slurry but not so small that the pump 34 or pump motor 36 are overloaded.

The mill C has a mill housing 40 upon which are mounted a plurality, four in the preferred embodiment, of upward extending posts, including posts 42 and 44. A stator mounting bracket 46 in which a stator 48 is mounted is slidably disposed on the posts for longitudinal, but not rotational, movement relative thereto. Connected between each of the posts and the stator mounting bracket 46 is a plurality of fluid cylinders, including cylinders 50 and 52 for urging the stator mounting bracket and stator relative to the mill housing with a preselected force or load. When comminuting vulcanized rubber between a stator and a 25 centimeter (10 inch) rotor, a load of 900—4500 kilograms (2000—10,000 pounds) has been found to produce satisfactory results, 1750 kilograms (3850 pounds) of load being preferred.

A rotor motor 60, such as 75 kilowatt (100 horsepower) motor, is mounted in a mill frame which is rigidly secured to the mill housing 40. The rotor motor 60 is coupled to a shaft 62 which is supported on the mill housing 40 by a thrust bearing 64. Mounted on the end of the mill shaft 62 is a rotor plate 66 for supporting a rotor 68.

A central portion of the rotor 68 and the stator 48 define a receiving region 70 for receiving the pellet and fluid slurry from the mixing means B. A peripheral region of the stator 48 and rotor 68 define a grinding zone 72 for comminuting the pellets into micron sized particles.

An impeller 74 is disposed in the said receiving region 70 to facilitate movement of the pellets into the grinding zone 72. The particles and the fluid passing from the grinding zone 72 are collected in a trough 76 and pass through an outlet pipe 78. Downstream, not shown, the comminuted rubber particles and the fluid are separated.

With continuing reference to FIGURES 1 and 1A and further reference to FIGURES 2 and 3, the stator 48 is a unitary abrasive structure.

The stator 48 has a central, slurry receiving aperture 80 surrounded by a receiving region 70 (FIG. 1A) defined by a generally conical shaped upper stator abrasive surface 82 and by a generally peripheral stator abrasive surface 84 which itself surrounds the receiving region 70.

The stator 48 has a plurality, four in the preferred embodiment, of stator recesses, such as recess 86, which provide fluid communication between the slurry receiving region 70 (FIG. 1A) and the grinding zone 72 (FIG. 1A).

Each of the stator recesses, note stator recess 86, extends generally radially from a first or receiving region end 88 to a second or grinding zone end 90.

With continued reference to FIGURES 1 and 1A and further reference to FIGURES 4 and 5, the rotor 68 is a unitary abrasive structure. The rotor has a central receiving region surface 100, for the lower portion of the central receiving region 70 (FIG. 1A), which supports the impeller 74, consisting of a base plate 120 and vertical vanes 121, and a peripheral generally conical shaped abrasive surface 102 extending therearound. The stator and rotor peripheral abrasive surfaces 84 and 102 interact to define the grinding zone 72 (FIG. 1A) therebetween.

The rotor 68 has a plurality of recesses, eight in the preferred embodiment such as recess 104, which provide a path for the pellets between the slurry receiving region 70 (FIG. 1A) and the grinding zone 72 (FIG. 1A).

Each rotor recess, note rotor recess 104, has a receiving region end 106 and a grinding zone end 108. Further, each rotor recess has an upstream portion 110 in the direction of the rotation which is larger than the pellets and a trailing portion 112 which is smaller than the upstream portion. The trailing portion 112 wedges the pellets against the stator peripheral abrasive surface 84 and into the grinding zone 72 (FIG. 1A).

With reference to FIGURES 1, 1A, 4 and 5, the impeller 74 is mounted on the rotor 68 for rotation therewith. The impeller 74 includes a base plate 120 which is mounted on the rotor receiving region surface 100 and a plurality of removably attached generally vertical vanes 121. Generally vertical is to connote that the vanes extend within the slurry receiving region 70 (FIG. 1A) and between the rotor receiving region surface 100 and stator receiving region abrasive surface 82 and impel the fluid and pellets toward the rotor recesses such as recess 104. In the preferred embodiment, there are eight impeller vanes 121 each disposed adjacent the trailing edge of a corresponding one of the eight rotor recesses 104. Each vane 121 has a top or outward edge 122 which engages the stator receiving region abrasive surface 82. As the stator and rotor peripheral abrasive surfaces 84 and 102 wear, the stator receiving region abrasive surface 82 wears the outward impeller edge 122 at a corresponding rate. This maintains a fluid seal between the impeller vanes 121 and the stator receiving region surface 82 to improve the impelling action. The impeller tends to draw the slurry from the mixing means B (FIG. 1), changes the slurry flow from axial to radial, and impels the slurry with substantially even pressure into the grinding zone 72 (FIG. 1A).

As the rotor turns, the impelling action of the impeller 74 pumps the pellets and fluid into the rotor recesses 104, etc. The centrifugal force from the rotation of the rotor recesses further urges the pellets and fluid through the rotor recesses. The highest pressure is developed at the outer or second end 108 of the rotor recesses. When a rotor recess 104 aligns with a stator recess 86, the stator recess 86 provides a path to the lower pressure in the receiving region 70. This pressure differential allows pellets and fluid to flow from the rotor recess 104 into the stator recess 86 and back into the slurry receiving region 70. This creates a turbulence in the slurry receiving region 70 maintaining the pellets suspended in the fluid. Further, the pellets tend to be wedged into the grinding zone 72.

With reference to FIGURES 6A—6I, a view is taken of cutaway portions of upper stator 48 and lower rotor 68, shown for convenience as a horizontal view, as the rotor 68 rotates past the stator 48 from left to right. The view is taken in a direction from the stator grinding zone end 90 toward the stator abrasive surface 82 in the region of the stator peripheral abrasive surface 84.

In FIGURE 6A a pellet 130 is received in the rotor recess 104 and carried along the stator. When the rotor recess 104 aligns with the stator recess 86 (FIGURES 6B and 6C), the pellet tends to move toward the stator recess 86. Although some pellets may return to the receiving region 70 (FIG. 1A) through the stator recess, other pellets are caught between the recesses as they move out of alignment (FIGURES 6D and 6E). As the rotor and stator recesses move further out of alignment, the pellets are stretched and wedged into the grinding zone 72 (FIGURES 6F, 6G and 6I). The pellet is stretched between the rotor and stator recesses 104 and 86 and peripheral abrasive surfaces 102 and 84 as the recesses 104 and 86 move apart.

With particular reference to FIGURE 6H, at least one and preferably both of the stator and rotor peripheral abrasive surfaces 84 and 102 have a plurality of pores, such as pore 132, which have a median pore size of about 10—200 microns. Between pores, the abrasive surfaces have substantially smooth regions 134. Although shown separated for ease of illustration, the smooth regions 134 of the stator and rotor slide generally along each other creating a shearing interaction. This cuts the vulcanized rubber of the pellets into smaller particles, generally on the order of the size of pores 132.

As the rotor continues to rotate (FIGURE 6I), the rubber spirals outward from the rotor and stator recesses towards the edge of the rotor and stator peripheral abrasive surfaces 102 and 84. Along this path compression, rolling action, and continued interaction of the vulcanized rubber with the pores and flat surfaces comminutes the pellets into micron size particles.

The composition of the stator and rotor grinding surfaces 84 and 102 is such that the median pore size is 10—200 microns. A pore size of 50 microns has been found to be effective for comminuting vulcanized rubber to particles having by weight a median diameter of 50 microns and by number 90% of the particles having a diameter of less than 20 microns. In the preferred embodiment, the rotor and stator are constructed of silicon carbide with a grit size in the range of 36 to 60 mesh or aluminum oxide with a grit size in the range of 46 to 80 mesh. Other pore sizes may be used to obtain larger or smaller comminuted particles or when comminuting pellets of other materials. Preferably these abrasives are vitreous bonded with about 22% glass by weight, although resin bonding and other bonding techniques may be used. These compositions have an interconnected porosity. To provide for a relatively long life, the rotor and stator are a P hardness or higher, the preferred embodiment being a T hardness, as commonly defined by the grinding wheel industry. Generally, the grits will not have the smooth surfaces 134 as the stones are manufactured. To achieve these flat surfaces, the stones are lapped together to wear sharper naturally occurring edges flat. The stator and rotor recesses may be cut or molded into the stone composition.

With reference to FIGURE 7, an electric control circuit is provided to maintain the concentration of pellets in the grinding zone within a range which produces satisfactory results.

Briefly stated, the control circuit adjusts the feed rate of pellets into the mixing tank to maintain the power drawn by the rotor motor 60 substantially constant. The control increases the pellet feed rate relative to the fluid feed rate when the motor draws less than a preselected amount of power and reduces the pellet feed rate relative to the fluid feed rate when more than the selected amount of the power is drawn.

The electrical control circuit includes first and second electric power lines 150 and 152. A watt transducer 154 is connected with the rotor motor 60 to monitor the amount of power (kilowatts) drawn thereby. A digital kilowatt meter 156 is connected with the watt transducer to provide a visual display of the instantaneous amount of power being drawn by the rotor motor. A calibration circuit 158 connects the watt transducer with a maximum kilowatt selector means 160. The maximum kilowatt selection means 160 has dials, or the like, on which an operator selects a maximum power which the rotor motor is to be allowed to draw. When the amount of power monitored by the watt transducer 154 is below the amount of power selected by the operator, the maximum power selector means 160 is in its activated state. When the amount of power monitored by the watt transducer meets or exceeds the selected maximum power, the maximum power selector means takes on its deactivated state. In its activated state, the maximum watt selector means 162 closes a normally open relay contact 162 and opens a normally closed relay contact 164. The normally open maximum power selector contact 162 controls the coil of a pilot relay 170. The maximum power pilot relay 170 has a normally open contact 172, shown in the lower portion of FIG. 7 which is used in controlling the vibratory feeding means 12. When the monitored power meets or exceeds the selected maximum power, the maximum power selector means 160 takes on its deactivated state opening the normally open contacts 162 and 172 and closing the normally closed contact 164. The maximum watt selector normally closed relay contact 164 controls an indicator lamp 166 for indicating that pellets are not being fed to the mixing tank.

To protect the pump motor 36, a pump motor overload control means is provided. A speed controller 180 controls the speed at which the pump motor 36 is operated. A speed selection potentiometer 182 allows the operator to select the speed at which the pump motor is to be operated and a speed indicator 184 provides a visual indication of the present pump motor speed. The speed controller produces a signal which varies in proportion to the amount of current being drawn by the pump motor 36 on a pair of terminals 186. A maximum current selector means 190 has dials, or the like, on which the operator selects a maximum current at which the pump motor is to be operated. The maximum current selector means 190 compares the selected maximum current with the current indicated on terminals 186. The maximum current selector means maintains the pump motor current below the maximum by controlling the pellet feeding means 12 to keep the slurry sufficiently fluid. When the current drawn by the pump motor 36 exceeds the maximum current, the maximum current selector means closes a normally closed contact 192 and opens a normally open contact 194. The normally closed contact 192 controls an indicator lamp 196 which indicates that the pump motor is running with less than the maximum current. The normally open maximum current selector contact 194 controls a maximum current pilot relay 200. The maximum current pilot relay 200 controls a normally open contact 202 for controlling the rate at which pellets are fed into the mixing tank. The normally open maximum power pilot relay contact 172 and the normally open maximum current pilot relay contact 202 are connected in series with the vibratory feeding means 12. A variable solid state device 204 controls the amount of power delivered to the vibratory feeder means motor 18 to control its frequency and amplitude of vibration.

FIGURES 8—13 illustrate another stator and rotor configuration in accordance with the present invention. In the embodiment of FIGURES 8—13 like elements with the embodiment of FIGURES 1—5 are denoted with the same reference numerals followed by a prime ('). Referring to FIGURE 8, there is shown a mill housing 40' which is stationarily mounted. Extending upward from the mill housing are a plurality of upward extending posts, including posts 42' and 44'. The posts extend slidably through apertures in a stator support bracket 46' which holds a stator 48'. This enables the stator support bracket to move longitudinally on the posts but prohibits it from rotating. Connected to each of the posts is a plurality of fluid cylinders, including cylinders 50' and 52' for urging the stator support bracket toward the mill housing with a selected constant force. When comminuting vulcanized rubber in a grinding zone of about 250—280 square centimeters (40 to 45 square inches), a load of 900—4500 kilograms (2000 to 10,000 pounds) has been found to produce satisfactory results for 25 centimeter (10 inch) diameter stators and rotors. A preferred load to be exerted by the cylinders 1750 kilograms (3850 pounds) of force for 25 centimeter (10 inch) diameter stators and rotors. Increases in the slurry pressure from the pump increase the preferred load. Decreases in the slurry pressure and decreases in the toughness of the comminuted material decrease the preferred load. The fluid, preferably hydraulic, cylinders continue to exert the same force as the stator moves longitudinally to compensate for wear on the stator and rotor abrasive surfaces. Because the stator and rotor are urged together by the fluid cylinders with a constant load but not held at a fixed spacing, the rotor and stator may undergo limited longitudinal movement with respect to each other as the pellets pass into the grinding zone. A mill shaft 52′ rotates a plate 66′ and a rotor 68′ in mating cooperation with the stator.

The rotor and stator define a slurry receiving region 70′ and a grinding zone 72′ therebetween. An impeller 74′ is mounted on the rotor for rotation therewith.

With continuing reference to FIGURE 8 and further reference to FIGURES 9 and 10, the stator includes a plurality of stator recesses extending outward from the receiving region 70′ into a peripheral abrasive surface 84′. Because each of the stator recesses is the same, a stator recess 86′ is described in detail and it is to be appreciated that the description applies by analogy to the other stator recesses. The stator recess 86′ has an upstream edge 210 which is first engaged as the rotor 68′ rotates. The stator 48′ has a trailing edge 212 opposite to the upstream edge 210. An enlarged portion or relief area 214 which tapers generally between the full depth of the recess 86′ to the level of the stator peripheral abrasive surface 84′ extends downstream from the stator recess tailing edge 212. The stator recess 86′ has an inside or receiving region end 216 in communication with the slurry receiving recess 86′ and an outer or grinding zone end 218 in the grinding zone 72′.

With reference to FIGURES 8, 11, 12 and 13, the rotor 68′ has a central receiving region surface 100′ disposed adjacent the slurry receiving region 70′ and a peripheral abrasive surface 102′. Extending outward from the slurry receiving region 70′ into the grinding zone 72′ are a plurality of generally P-shaped rotor recesses 104′, in the preferred embodiment 8 P-shaped rotor recesses. Because each of the plurality of rotor recesses is substantially identical, a typical rotor recess 104′ is described in detail and it is to be appreciated that the description applies by analogy to the other rotor recesses. The rotor recesses 104′ have an upstream edge 110′ in the direction of rotation and a trailing edge 112′ opposite the upstream edge 110′. The trailing edge 112′ includes a downstream enlarged portion or relief area 220 in which a recess base wall tapers or cams generally from the lowest depth of the recess 104′ toward the rotor peripheral abrasive surface 102′. The rotor recess relief area 220 has an arched perimeter, in the preferred embodiment. Each rotor recess 104′ further has a first or receiving region end 106′ disposed in fluid communication with the recess 104′, for receiving slurry, and a second or outer end 108′ separated by a small land 222 on the peripheral abrasive surface 102′ from the edge of the rotor 68′.

As the rotor 68′ and impeller 74′ rotate, the pellets are impelled outward into the rotor recesses 104′ by the impeller 74′. Centrifugal force from the rotation of the rotor 68′ accelerates the pellets with greater pressure toward the outer end 108′ of the rotor recesses 104′. As the rotor recesses 104′ come into alignment with the stator recesses 86′, the stator recesses 86′ provide a return path for some of the fluid and pellets to the receiving region 70′. Other pellets become wedged or cammed between the stator recess relief area 214 and either the rotor recess relief area 220 or the rotor peripheral abrasive surface and other pellets become wedged between the rotor recess relief area 220 and the stator recess relief area 214 or the stator peripheral abrasive surface 102′. With continued rotation, the pellets are stretched and wedged into the grinding zone 72′ and are comminuted as described above.

The invention has been described with reference to the preferred alternate embodiments. Obviously, alterations and modifications will occur to others upon reading and understanding the preceding detailed description of the preferred and alternate embodiments. It is intended that the invention be construed as including all such alterations and modifications which come within the scope of the appended claims.

Claims

1. A comminuting apparatus having a rotor and a stator which have opposing surfaces that define a receiving region therebetween and peripheral abrasive surfaces that define a grinding zone therebetween, an urging means for urging at least one of the stator and the rotor toward the other, and means for rotating the rotor about an axis, characterized by:

at least two recesses (86, 86′) on said stator (48) with an orientation in an outward flow direction from said axis, at least the same number of similarly oriented recesses (104, 104′), on said rotor and an outward sloping portion (112, 220) at an outward end of said rotor recesses oriented in a direction generally opposed to the direction of rotation about said axis;

supplying means (A) for supplying a mixture of fluid and vulcanized rubber or rubber-like pellets to be reduced in size to said receiving region; and,

pressurizing means (74, 74′) for increasing the pressure along said rotor recesses (104, 104′) disposed within the receiving region (70).

2. The apparatus of claim 1 further characterized by said pressurizing means including an impeller (74, 74′), a plurality of generally vertically disposed vanes (121) on said impeller extending substantially from said rotor to and into engagement with an abrasive surface (82) of the stator receiving region such that the stator receiving region abrasive surface grinds the impeller vanes at a rate commensurate with the rate of wear between said rotor and stator peripheral abrasive surfaces to maintain a fluid seal between said impeller vanes and said stator receiving region abrasive surface to provide the pressure increase along the rotor recesses.

3. The apparatus of claim 1 or 2 including a mill housing (40) and a support bracket (46) on the mill housing mounted for movement in the axial direction but fixed in the rotational direction, and further characterized by said means for urging at least one of the stator and rotor toward the other including at least one fluid cylinder (50, 52)

operatively connected between said bracket and said mill housing for urging at least one of stator and rotor peripheral abrasive surfaces (84, 102) toward the other with a constant pressure, to maintain the force between said stator and rotor peripheral abrasive surfaces substantially constant as the peripheral abrasive surfaces wear, said fluid cylinders allowing said stator and rotor to undergo limited movement as the pellets pass from the rotor recesses (104) into the grinding zone.

4. The apparatus of any preceding claim further characterized by said peripheral abrasive surfaces (84, 102) surrounding said receiving region to define a grinding zone (72) therebetween, said rotor recess having a first end (106) in fluid communication with said receiving region and terminating at a second end (108) at the outward end of said recess and on the rotor peripheral abrasive surface to provide a path for the pellets from said receiving region (70) to the grinding zone, said rotor recess further having an upstream edge (110) generally in a direction of rotation and a trailing edge (112) generally opposite said upstream edge, said trailing edge having said outward sloping portion (112, 220) at least generally adjacent said rotor recess second end.

5. The apparatus of any preceding claim further characterized by at least one stator (86) extending from the receiving region (70) outward into the stator peripheral abrasive surface (84), to provide a return path for fluid and pellets pumped to a higher pressure by centrifugal force of the rotating rotor back to the receiving region causing turbulence and assisting in maintaining the pellets and fluid in a slurry.

6. The apparatus of any preceding claim further characterized by said rotor and stator peripheral abrasive surfaces (84, 102) being disposed along a truncated conical region.

7. The apparatus of claim 4, 5, or 6 further characterized by said rotor recess further including an enlarged portion (220) extending downstream from said trailing edge (112'), said rotor recess enlarged portion having a sloping base wall of diminishing depth away from said rotor recess upstream edge (110').

8. The apparatus of claim 1—5 or 7 further characterized by said stator and rotor peripheral abrasive surfaces (84', 102') being disposed generally horizontally.

9. The apparatus of any of claims 5—8 further characterized by said stator recess (86') having an enlarged portion (214) extending generally peripherally from a trailing edge (212).

10. The apparatus of claim 9 further characterized by said stator recess enlarged portion having diminishing depth in the downstream direction, whereby pellets are wedged between the stator and rotor recess enlarged portions.

11. The apparatus of any of claims 2—10 further characterized by said impeller (74) being connected with said rotor (68) for rotation therewith, each of said impeller vanes (121) having a radially outer edge which is disposed substantially adjacent said rotor peripheral abrasive surface, and each impeller vane being disposed adjacent a downstream edge (112) of one of said rotor recesses.

12. The apparatus of a preceding claim further characterized by said supplying means including:

a hopper (10) for holding pellets to be comminuted;

pellet feeding means (12, 14, 16, 18) for feeding the pellets into a mixing tank (30) at a selectable rate;

fluid feeding means (20, 22) for feeding a fluid into the mixing tank;

agitator means (32) for mixing the pellets and fluid in the mixing tank into a slurry;

pumping means (34) for pumping the pellet and fluid slurry from the mixing tank to a slurry receiving region (70);

said fluid feeding means feeding fluid into the mixing tank at substantially the same rate that the pumping means pumps fluid to the receiving region to maintain the level of fluid in the mixing tank substantially constant; and,

concentration control means for maintaining the concentration of pellets in the slurry generally constant.

13. The apparatus of claim 12 further characterized by said concentration control means including means (154) for sensing the torsional load on the rotating means, said load sensing means being operatively connected with said pellet feeding means (12) for adjusting the rate at which pellets are fed to the mixing tank such as to maintain a generally constant torsional load on the rotating means.

14. The apparatus of claim 12 or 13 further characterized by said pellet feeding means being a vibratory feeder (12), and said load sensing means being operable to start and stop said vibratory feeder in response to the load exceeding and falling below a preselected load.

15. The apparatus of claim 14 further characterized by said concentration control means including means (190) for sensing the torsional load on said pumping means (36), said pump load sensing means being operatively connected with said pellet feeding means (12) for adjusting the rate at which pellets are fed to said mixing tank to maintain a generally constant torsional load on the pumping means.

16. The apparatus of any preceding claim further characterized by at least one of said stator and rotor peripheral abrasive surfaces being constructed of a material having a median pore size of about 10—200 microns.

17. The apparatus of claim 16 further characterized by said median pore size being about 50 microns.

18. A method of comminuting with the apparatus of claim 4 characterized by:

receiving the slurry of vulcanized rubber or rubber-like pellets with a median diameter of at least 3 mm and water in said receiving region (70) disposed between said rotor (68) and stator (48);

urging the pellets along said outward extending recesses (104) in said rotor abrasive surface (102) surrounding the receiving region by rotating said rotor, said rotor recess having a sloping portion (112, 220) along said trailing edge relative to the direction of rotation;

wedging the pellets between said rotor recess sloping portion and said stator peripheral abrasive surface (84) surrounding the receiving region and into the grinding zone (72) defined between the rotor and stator peripheral abrasive surfaces;

continuing rotation of said rotor comminuting the pellets in a single pass into particles between said stator and rotor peripheral abrasive surfaces until the particles have a median diameter of less than 50 microns.

19. The method of comminuting of claim 18 further characterized by said stator having a plurality of stator recesses (86) extending from said receiving region (70) into said stator peripheral abrasive surface (84), such that rotation of the rotor and impeller (74) urges received pellets and fluid into the rotor recesses, centrifugal force increases the pressure along the rotor recess (104) and achieves the highest pressure adjacent an outer end (108) of the rotor recess, when the rotor and stator recesses come into alignment, the higher pressure at the outer end of the rotor recess relative to the lower pressure in the receiving region causing the stator recess to provide a return path for pellets and fluid agitating the pellets and fluid in the receiving region maintaining the pellets suspended in the fluid.

Patentansprüche

1. Zerkleinerungsmaschine mit einem Rotor und einem Stator, welche sich gegenüberliegende Oberflächen aufweisen, die zwischen sich einen Aufnahmebereich bestimmen, und abrasive Umfangsflächen, die zwischen sich eine Zerkleinerungszone bestimmen, mit einer Druckeinrichtung, um wenigstens eines der Elemente Stator und Rotor zu dem anderen hin zu drücken, und mit einer Einrichtung zum Rotieren des Rotors um eine Achse, gekennzeichnet durch

wenigstens zwei Ausnehmungen (86, 86') an dem Stator (48) mit einer Orientierung in einer Strömungsrichtung von der Achse nach außen, wobei wenigstens die gleiche Anzahl von ähnlich orientierten Ausnehmungen (104, 104') an dem Rotor vorgesehen ist, und wobei ein nach außen geneigter Bereich (112, 120) an einem äußeren Ende der Rotorausnehmungen vorgesehen ist, der in einer Richtung im wesentlichen entgegengesetzt zur Rotationsrichtung um die Achse orientiert ist,

durch eine Zufuhreinrichtung (A) zum Zuführen einer Mischung aus einem Fluid und vulkanisierten Gummipellets oder gummiartigen Pellets, deren Größe verringert werden soll, an den Aufnahmebereich, und

durch eine Druckeinrichtung (74, 74') zum Erhöhen des Druckes längs der Rotorausnehmungen (104, 104'), die innerhalb des Aufnahmebereichs (70) angeordnet sind.

2. Maschine nach Anspruch 1, dadurch gekennzeichnet, daß die Druckeinrichtung ein Laufrad (74, 74') aufweist, daß eine Vielzahl von im wesentlichen vertikal angeordneten Schaufeln (121) an dem Laufrad sich im wesentlichen von dem Rotor zu und in Anlage mit einer abrasiven Fläche (82) des Stataufnahmebereichs derart erstreckt, daß die abrasive Fläche des Statoraufnahmebereichs die Laufradschaufeln in einem Ausmaß abschleift, das gleich groß ist wie das Ausmaß des Verschleißes zwischen den abrasiven Umfangsflächen des Rotors und des Stators, um eine Fluiddichtung zwischen den Laufradschaufeln und der abrasiven Fläche des Statoraufnahmebereichs aufrechtzuerhalten, um den Druckanstieg längs der Rotorausnehmungen zu erbringen.

3. Maschine nach Anspruch 1 oder 2, mit einem Mühlengehäuse (40) und einem Stütztrager (46) auf dem Mühlengehäuse, der angeordnet ist für eine Bewegung in Axialrichtung, der aber in Rotationsrichtung fest ist, dadurch gekennzeichnet, daß die Einrichtung zum Drücken wenigstens eines der beiden Elemente Stator und Rotor gegen das andere wenigstens einen Fluidzylinder (50, 52) umfaßt, der wirksam verbunden ist zwischen dem Stützträger und dem Mühlengehäuse, um die abrasive Fläche (84, 102) wenigstens eines der Elemente Stator und Rotor zu der anderen mit einem konstanten Druck zu drücken, um die Kraft zwischen den abrasiven Umfangsflächen des Stators und des Rotors im wesentlichen konstant zu halten, wenn sich die abrasiven Umfangsflächen abnützen, und daß die Fluidzylinder ermöglichen, daß der Stator und der Rotor eine begrenzte Bewegung durchführen können, wenn die Pellets von den Rotorausnehmungen (104) in die Mahl- oder Zerkleinerungszone gelangen.

4. Maschine nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die abrasiven Umfangsflächen (84, 102) den Aufnahmebereich umgeben, um eine Mahl- oder Zerkleinerungszone (72) dazwischen zu bestimmen, daß die Rotorausnehmung ein erstes Ende (106) in Fluidverbindung mit dem Aufnahmebereich aufweist und mit einem zweiten Ende (108) am äußeren Ende der Ausnehmung und an der abrasiven Umfangsfläche des Rotors endet, um einen Weg für die Pellets von dem Aufnahmebereich (70) zu der Mahl- oder Zerkleinerungszone zu schaffen, daß die Rotorausnehmung ferner einen stromaufwärtsgelegenen Rand (110) im wesentlichen in Rotationsrichtung und einen hinteren Rand (112) im wesentlichen entgegengesetzt zu dem stromaufwärtsgelegenen Rand aufweist, und daß der hintere Rand den nach außen geneigten Bereich (112, 220) wenigstens ungefähr angrenzend an das zweite Ende der Rotorausnehmung aufweist.

5. Maschine nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß wenigstens eine Statorausnehmung (86) sich von dem Aufnahmebereich (70) nach außen in die abrasive Umfangsfläche (84) des Stators erstreckt, um

einen Rückweg für das Fluid und die Pellets, die durch Zentrifugalkraft des rotierenden Rotors auf einen höheren Druck gepumpt werden, zurück zu dem Aufnahmebereich zu schaffen, wobei eine Turbulenz bewirkt und die Aufrechterhaltung der Pellets und des Fluids in einer Aufschlämmung unterstützt wird.

6. Maschine nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die abrasiven Umfangsflächen (84, 102) des Rotors und des Stators längs eines abgestumpften konischen (kegelstumpfartigen) Bereichs angeordnet sind.

7. Maschine nach Anspruch 4, 5 oder 6, dadurch gekennzeichnet, daß die Rotorausnehmung einen vergrößerten Abschnitt (220) umfaßt, der sich stromabwärts von dem hinteren Rand (112′) erstreckt, und daß der vergrößerte Abschnitt der Rotorausnehmung eine geneigte Bodenwand von sich verringernder Tiefe weg von dem stromaufwärtsgelegenen Rand (110′) der Rotorausnehmung aufweist.

8. Maschine nach Anspruch 1 bis 5 oder 7, dadurch gekennzeichnet, daß die abrasiven Umfangsflächen (84′, 102′) des Stators und des Rotors im wesentlichen horizontal angeordnet sind.

9. Maschine nach einem der Ansprüche 5 bis 8, dadurch gekennzeichnet, daß die Statorausnehmung (86′) einen vergrößerten Abschnitt (214) aufweist, der sich im wesentlichen in Umfangsrichtung von einem hinteren Rand (212) aus erstreckt.

10. Maschine nach Anspruch 9, dadurch gekennzeichnet, daß der vergrößerte Abschnitt der Statorausnehmung eine sich verringernde Tiefe in Richtung stromabwärts aufweist, wodurch die Pellets zwischen den vergrößerten Abschnitten der Stator- und der Rotorausnehmung eingeklemmt werden.

11. Maschine nach einem der Ansprüche 2 bis 10, dadurch gekennzeichnet, daß das Laufrad (74) mit dem Rotor (68) zur Drehung mit diesem verbunden ist, daß jede Laufradschaufel (121) eine radial äußere Kante aufweist, welche im wesentlichen angrenzend an die abrasive Umfangsfläche des Rotors angeordnet ist, und daß jede Laufradschaufel angrenzend an einen stromabwärtsliegenden Rand (112) einer der Rotorausnehmungen angeordnet ist.

12. Maschine nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Zuführeinrichtung umfaßt:

einer Trichter (10) zur Aufnahme der zu zerkleinernden Pellets,

eine Pelletzufuhreinrichtung (12, 14, 16, 18) zum Zuführen der Pellets in einen Mischtank (30) mit einer wählbaren Rate,

eine Fluidzufuhreinrichtung (20, 22) zum Zuführen eines Fluids in den Mischtank,

eine Rühreinrichtung (32) zum Vermischen der Pellets und des Fluids in dem Mischtank in eine Aufschlämmung,

eine Pumpeinrichtung (34) zum Pumpen der Aufschlämmung aus den Pellets und dem Fluid von dem Mischtank zu einem Aufnahmebereich (70) für die Aufschlämmung,

wobei die Fluidzufuhreinrichtung das Fluid in den Mischtank im wesentlichen mit derselben Rate zuführt, wie die Pumpeinrichtung Fluid in den Aufnahmebereich pumpt, um den Fluidspiegel in dem Mischtank im wesentlichen konstant zu halten, und

eine Steuereinrichtung für die Konzentration, um die Konzentration der Pellets in der Aufschlämmung im wesentlichen konstant zu halten.

13. Maschine nach Anspruch 12, dadurch gekennzeichnet, daß die Konzentrationssteuereinrichtung eine Einrichtung (154) aufweist zum Abtasten der Torsionsbelastung auf der rotierenden Einrichtung, und daß die Belastungsabtasteinrichtung wirksam verbunden ist mit der Pelletzufuhreinrichtung (12), um die Rate einzustellen, in welcher die Pellets an den Mischtank zugeführt werden derart, daß eine im wesentlichen konstante torsionsbelastung auf der rotierenden Einrichtung aufrechterhalten wird.

14. Maschine nach Anspruch 12 oder 13, dadurch gekennzeichnet, daß die Pelletzufuhreinrichtung ein Vibrationsaufgeber (12) ist, und daß die Belastungsabsteinrichtung operabel ist, um den Vibrationsaufgeber ansprechend auf die Belastung zu starten und zu stoppen, wenn sie eine vorgewählte Belastung übersteigt oder unter eine vorgewählte Belastung abfällt.

15. Maschine nach Anspruch 14, dadurch gekennzeichnet, daß die Konzentrationssteuereinrichtung eine Einrichtung (190) umfaßt zum Abtasten der Torsionsbelastung an der Pumpeinrichtung (36), und daß die Pumpbelastungsabtasteinrichtung betriebsmäßig verbunden ist mit der Pelletzufuhreinrichtung (12) zum Einstellen oder Anpassen der Rate, mit welcher die Pellets dem Mischtank zugeführt werden, um eine im wesentlichen konstante Torsionsbelastung an der Pumpeinrichtung aufrechtzuerhalten.

16. Maschine nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die abrasiven Umfangsflächen wenigstens der Elemente Stator und Rotor aus einem Material bestehen, das eine mittlere Porengröße von etwa 10 bis 200 µm aufweist.

17. Maschine nach Anspruch 16, dadurch gekennzeichnet, daß die mittlere Porengröße etwa 50 µm beträgt.

18. Verfahren zum Zerkleinern mit der Maschine nach Anspruch 4, gekennzeichnet durch Aufnahme der Aufschlämmung aus Pellets aus vulkanisierten Gummi oder gummiartigen Material mit einem mittleren Durchmesser von wenigstens 3 mm und Wasser in dem Aufnahmebereich (70), der zwischen dem Rotor (68) und dem Stator (48) angeordnet ist, Zwingen der Pellets längs der sich nach außen erstreckenden Ausnehmungen (104) in der abrasiven Fläche (102) des Rotors, die den Aufnahmebereich umgibt, durch Rotieren des Rotors, wobei die Rotorausnehmung einen geneigten Abschnitt (112, 220) längs des hinteren Randes relativ zur Drehrichtung aufweist,

Einklemmen der Pellets zwischen dem geneigten Bereich der Rotorausnehmung und der abrasiven Umfangsfläche (84) des Stators, die den Aufnahmebereich umgibt, und in die Mahl- oder Zerkleinerungszone (72), die zwischen den abrasiven Umfangsflächen des Rotors und des Stators bestimmt ist, und

kontinuierliche Rotation des Rotors, wobei die Pellets in einem einzigen Arbeitsgang in Teilchen zwischen den abrasiven Umfangsflächen des Stators und des Rotors zerkleinert werden, bis die Teilchen einen mittleren Durchmesser von weniger als 50 µm aufweisen.

19. Verfahren zum Zerkleinern nach Anspruch 18, dadurch gekennzeichnet, daß der Stator eine Vielzahl von Statorausnehmungen (86) aufweist, die sich von dem Aufnahmebereich (70) in die abrasive Umfangsfläche (84) des Stators erstrekken, derart, daß eine Rotation des Rotors und des Laufrades (74) aufgenommene Pellets und Fluid in die Rotorausnehmungen zwingt, daß die Zentrifugalkraft den Druck längs der Rotorausnehmung (104) vergrößert und den höchsten Druck angrenzend an das äußere Ende (108) der Rotorausnehmung erreicht, wenn die Rotor- und Statorausnehmungen in Ausrichtung zueinander gelangen, und daß der höhere Druck am äußeren Ende der Rotorausnehmung gegenüber dem geringeren Druck in dem Aufnahmebereich bewirkt, daß die Statorausnehmung einen rückweg die Pellets und das Fluid erbringt, wobei die Pellets und das Fluid in dem Aufnahmebereich aufgerührt werden, wodurch die Pellets in dem Fluid suspendiert bleiben.

Revendications

1. Appareil de broyage comportant un rotor et un stator ayant des surfaces opposées qui définissent une zone de réception entre elles, ainsi que des surfaces périphériques abrasives qui définissent une zone de broyage entre elles, un moyen d'impulsion destiné à pousser au moins un des éléments que constituent le stator et le rotor, vers l'autre de ces éléments, ainsi qu'un moyen destiné à faire tourner le rotor autour d'un axe, caractérisé par:

au moins deux cavités (86, 86') définies sur le stator (48) avec une orientation dans une direction d'écoulement vers l'extérieur à partir de cet axe, au moins le même nombre de cavités orientées de la même manière (104, 104'), sur le rotor et une partie inclinée vers l'extérieur (112, 220) à une extrémité extérieure des cavités du rotor, étant orientées dans une direction généralement opposée au sens de rotation autour de l'axe précité;

un moyen d'alimentation (A) destiné à acheminer, à la zone de réception, un mélange d'un fluide et de pastilles d'un matière de la nature du caoutchouc ou de caoutchouc vulcanisé dont la granularité doit être réduite; et

un moyen de mise sous pression (74, 74') destiné à accroître la pression le long des cavités de rotor (104, 104') et qui est disposé à l'intérieur de la zone de réception (70).

2. Appareil selon la revendication 1, caractérisé en ce que le moyen de mise sous pression comprend une roue mobile (74, 74'), plusieurs pales (121) disposées généralement verticalement sur la roue mobile en s'étendant pratiquement depuis le rotor jusqu'à une surface abrasive (82) de la zone de réception du stator pour venir s'y engager, de telle sorte que cette surface abrasive de la zone de réception du stator rectifie les pales de la roue mobile à une vitesse proportionnelle à la vitesse d'usure se produisant entre les surfaces périphériques abrasives du rotor et du stator dans le but de maintenir un joint étanche aux fluides entre les pales de la roue mobile et la surface abrasive de la zone de réception du stator en assurant ainsi l'élévation de pression le long des cavités du rotor.

3. Appareil selon la revendication 1 ou 2, comprenant un logement de broyeur (40), ainsi qu'une console support (46) montée sur le logement du broyeur pour se déplacer dans la direction axiale, mais en étant empêchée de tourner, cet appareil étant également caractérisé en ce que le moyen destiné à pousser au moins un des éléments que constituent le stator et le rotor, vers l'autre de ces éléments, comprend au moins un cylindre à fluide (50, 52) relié activement entre la console précitée et le logement de broyeur en vue de pousser l'une vers l'autre au moins une des surfaces périphériques abrasives (84, 102) du stator et du rotor avec une pression constante, de façon à maintenir pratiquement constante la force s'exerçant entre les surfaces périphériques abrasives du stator et du rotor à mesure que ces surfaces périphériques abrasives s'usent, les cylindres à fluide permettant, au stator et au rotor, de subir un mouvement limité à mesure que les pastilles passent des cavités (104) du rotor dans la zone de broyage.

4. Appareil selon l'une quelconque des revendications précédentes, caractérisé en ce que les surfaces périphériques abrasives (84, 102) entourent la zone de réception pour définir une zone de broyage (72) entre elles, la cavité de rotor comportant une première extrémité (106) en communication d'écoulement de fluide avec la zone de réception et se terminant à une seconde extrémité (108) à l'extrémité extérieure de cette cavité et sur la surface périphérique abrasive du rotor afin de définir un parcours pour les pastilles depuis la zone de réception (70) jusqu'à la zone de broyage, cette cavité de rotor comportant en outre un bord d'amont (110) généralement dans une direction de rotation, ainsi qu'un bord arrière (112) généralement à l'opposé de ce bord d'amont, ce bord arrière comportant une partie inclinée vers l'extérieur (112, 220) au moins généralement adjacente à la seconde extrémité de la cavité de rotor.

5. Appareil selon l'une quelconque des revendications précédentes, caractérisé en ce qu'au moins une cavité de stator (86) s'étend vers l'extérieur à partir de la zone de réception (70) dans la surface périphérique abrasive (84) du stator, afin de définir un parcours de retour pour les pastilles et le fluide pompés à une pression plus élevée à l'intervention de la force centrifuge du rotor en rotation, vers la zone de réception, provoquant

ainsi un turbulence, tout en facilitant le maintien des pastilles et du fluide à l'état d'une bouillie.

6. Appareil selon l'une quelconque des revendications précédentes, caractérisé en ce que les surfaces périphériques abrasives (84, 102) du stator et du rotor sont disposées le long d'une zone tronconique.

7. Appareil selon la revendication 4, 5 ou 6, caractérisé en ce que la cavité de rotor comprend également une partie élargie (220) s'étendant vers l'aval à partir du bord arrière (112'), cette partie élargie de la cavité du rotor comportant une paroi de base inclinée dont la profondeur diminue à partir du bord d'amont (110') de la cavité du rotor.

8. Appareil selon les revendications 1—5 ou 7, caractérisé en ce que les surfaces périphériques abrasives (84', 102') du stator et du rotor sont disposées généralement horizontalement.

9. Appareil selon l'une quelconque des revendications 5—8, caractérisé en ce que la cavité de stator (86') comporte une partie élargie (214) s'étendant généralement dans le sens périphérique à partir d'un bord arrière (212).

10. Appareil selon la revendication 9, caractérisé en ce que la partie élargie de la cavité de stator a une profondeur diminuant vers l'aval, de telle sorte que les pastilles soient coincées entre les parties élargies des cavités de stator et de rotor.

11. Appareil selon l'une quelconque des revendications 2—10, caractérisé en ce que la roue mobile (74) est solidarisée au rotor (68) en vue de tourner avec celui-ci, chacune des pales (121) de cette roue mobile comportant un bord extérieur radial qui est disposé pratiquement à proximité de la surface périphérique abrasive du rotor, tandis que chaque pale est disposée à proximité d'un bord d'aval (112) d'une des cavités de rotor.

12. Appareil selon une des revendications précédentes, caractérisé en ce que le moyen d'alimentation comprend:

une trémie (10) destinée à contenir les pastilles à broyer;

un moyen d'alimentation de pastilles (12, 14, 16, 18) destiné à acheminer les pastilles dans une cuve de mélange (20) à une vitesse pouvant être sélectionnée;

un moyen d'alimentation de fluide (20, 22) destiné à acheminer un fluide dans la cuve de mélange;

un moyen d'agitation (32) destiné à mélanger les pastilles et le fluide en une bouillie dans la cuve de mélange;

un moyen de pompage (34) destiné à pomper la bouillie de pastilles et de fluide de la cuve de mélange dans une zone de réception de bouillie (70);

le moyen d'alimentation de fluide acheminant le fluide dans la cuve de mélange pratiquement à la même vitesse que celle à laquelle le moyen de pompage pompe le fluide vers la zone de réception afin de maintenir pratiquement constant le niveau de fluide dans la cuve de mélange; et

un moyen de contrôle de concentration destiné à maintenir généralement constante la concentration des pastilles dans la bouillie.

13. Appareil selon la revendication 12, caractérisé en ce que le moyen de contrôle de concentration comprend un moyen (154) destiné à détecter la sollicitation de torsion exercée sur le moyen de mise en rotation, ce moyen de détection de sollicitation étant solidarisé activement au moyen d'alimentation de pastilles (12) en vue de régler la vitesse à laquelle les pastilles sont acheminées à la cuve de mélange, de façon à maintenir une sollicitation de torsion généralement constante sur le moyen de mise en rotation.

14. Appareil selon la revendication 12 ou 13, caractérisé en ce que le moyen d'alimentation des pastilles est un alimentateur vibrant (12), tandis que le moyen de détection de sollicitation peut fonctionner pour faire démarrer et arrêter cet alimentateur vibrant en réponse à la sollicitation dépassant et descendant en dessous d'une sollicitation présélectionnée.

15. Appareil selon la revendication 14, caractérisé en ce que le moyen de contrôle de concentration comprend un moyen (190) destiné à détecter la sollicitation de torsion exercée sur le moyen de pompage (36), ce moyen destiné à détecter la sollicitation exercée sur la pompe étant solidarisé activement au moyen d'alimentation de pastilles (12) en vue de régler la vitesse à laquelle les pastilles sont acheminées à la cuve de mélange dans le but de maintenir une sollicitation de torsion généralement constante sur le moyen de pompage.

16. Appareil selon l'une quelconque des revendications précédentes, caractérisé en ce qu'au moins une des surfaces périphériques abrasives du stator et du rotor est réalisée en une matière ayant une grosseur moyenne de pores d'environ 10—200 microns.

17. Appareil selon la revendication 16, caractérisé en ce que cette grosseur moyenne de pores est d'environ 50 microns.

18. Procédé de broyage à l'aide de l'appareil selon la revendication 4, caractérisé en ce qu'il comprend les étapes qui consistent à:

collecter la bouillie constituée d'eau et de pastilles d'une matière de la nature du caoutchouc ou de caoutchouc vulcanisé ayant une diamètre moyen d'au moins 3 mm, dans la zone de réception (70) disposée entre le rotor (68) et le stator (48);

pousser les pastilles le long des cavités s'étendant vers l'extérieur (104) dans la surface abrasive (102) du rotor qui entoure la zone de réception, moyennant une mise en rotation du rotor, ces cavités de rotor comportant une partie inclinée (112, 220) le long du bord arrière par rapport au sens de rotation;

coincer les pastilles entre la partie inclinée de la cavité de rotor et la surface périphérique abrasive (84) du stator entourant la zone de réception, et dans la zone de broyage (72) définie entre les surfaces périphériques abrasives du rotor et du stator;

continuer à faire tourner le rotor pour broyer les pastilles en particules, en une seule passe, entre ces surfaces périphériques abrasives du stator et du rotor, jusqu'à ce que les particules aient un diamètre moyen inférieur à 50 microns.

19. Procédé de broyage selon la revendication 18, caractérisé en ce que le stator comporte plusieurs cavités (86) s'étendant de la zone de réception (70) dans la surface périphérique abrasive (84) du stator, de telle sorte que la rotation du rotor et de la roue mobile (74) ait pour effet de pousser les pastilles et le fluide collectés dans les cavités du rotor, la force centrifuge élevant la pression le long de la cavité de rotor (104), en assurant l'obtention de la pression maximum à proximité d'une extrémité extérieure (108) de la cavité de rotor, lorsque les cavités du rotor et du stator viennent se placer en alignement, la pression plus élevée établie à l'extrémité extérieure de la cavité de rotor vis-à-vis de la pression plus faible établie dans la zone de réception, ayant pour effet d'amener la cavité de stator à définir un parcours de retour pour les pastilles et le fluide, avec agitation des pastilles et du fluide dans la zone de réception et maintien des pastilles en suspension dans le fluide.

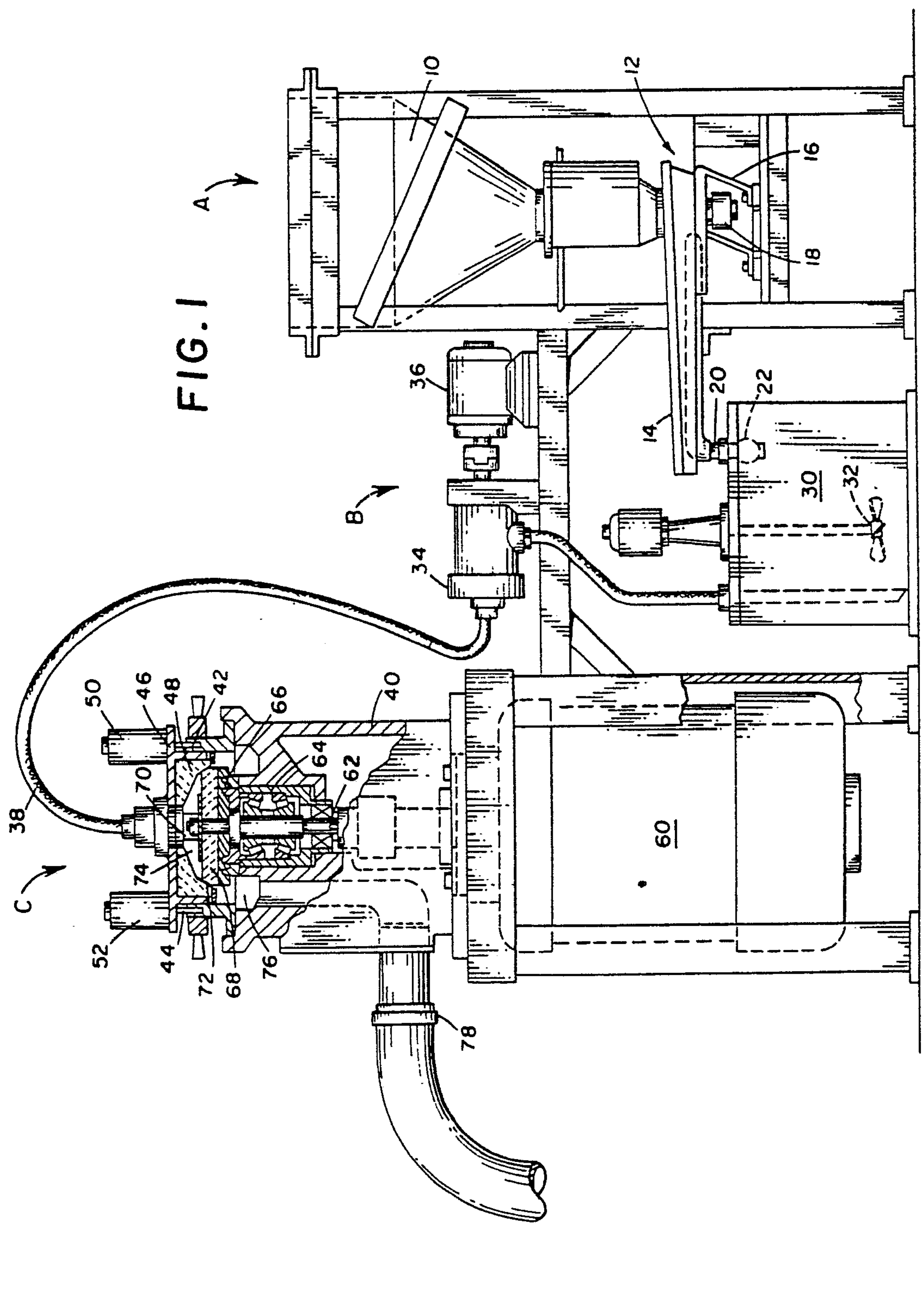

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FIG. I

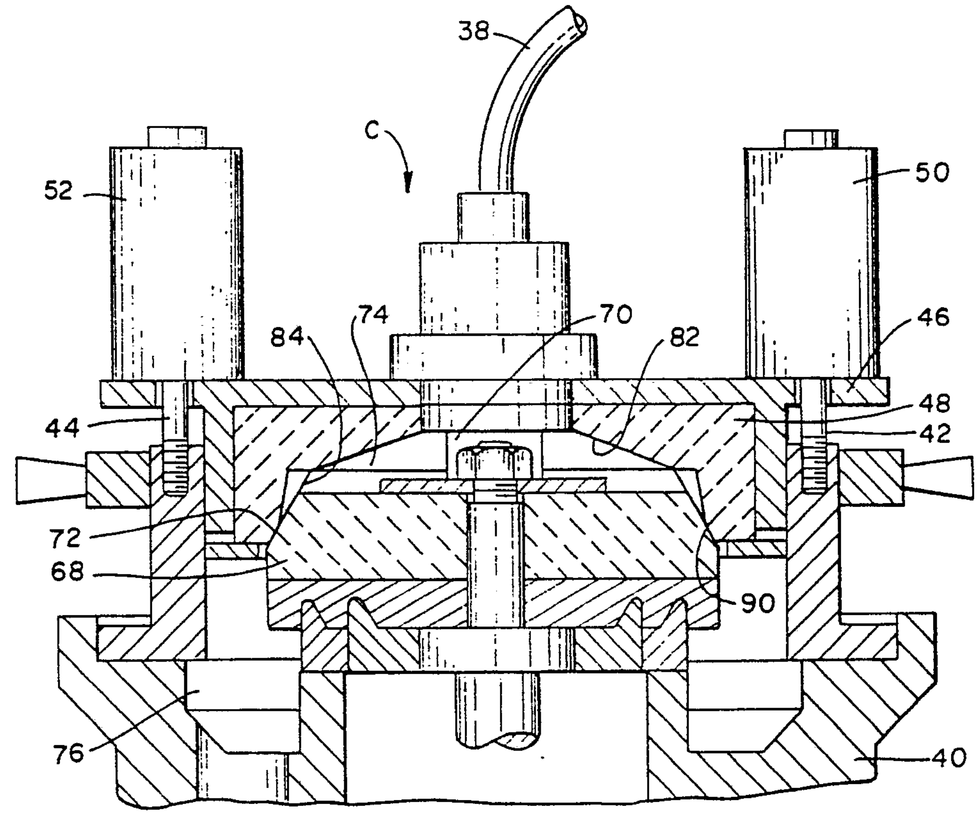


FIG. 1A

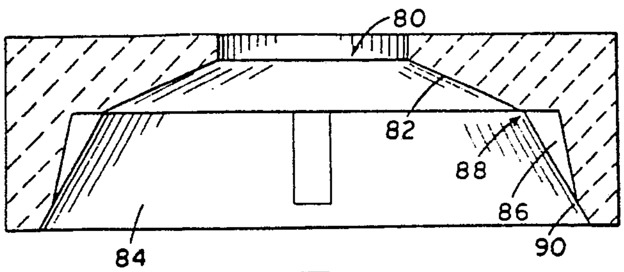


FIG. 3

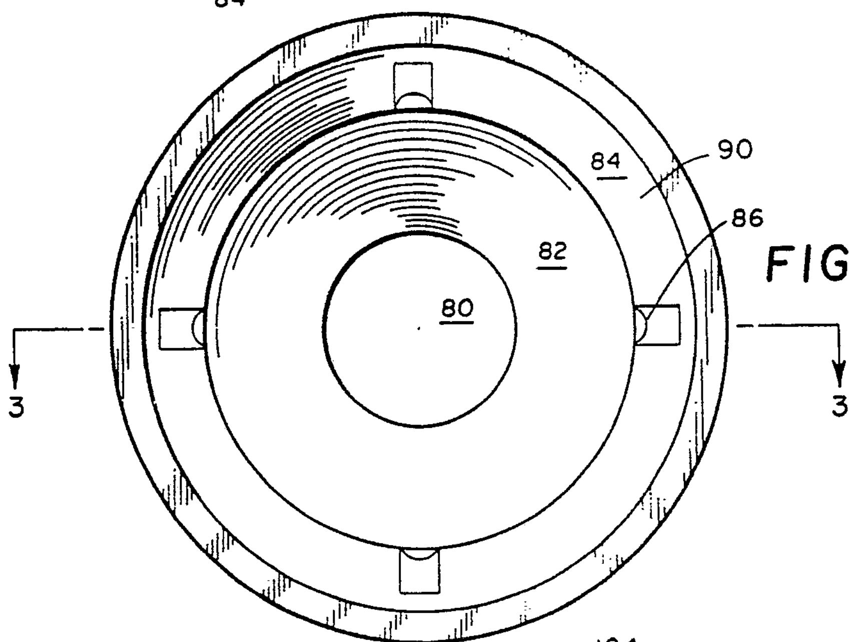


FIG. 2

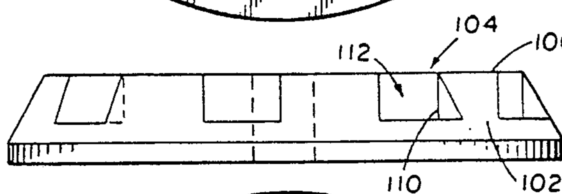


FIG. 4

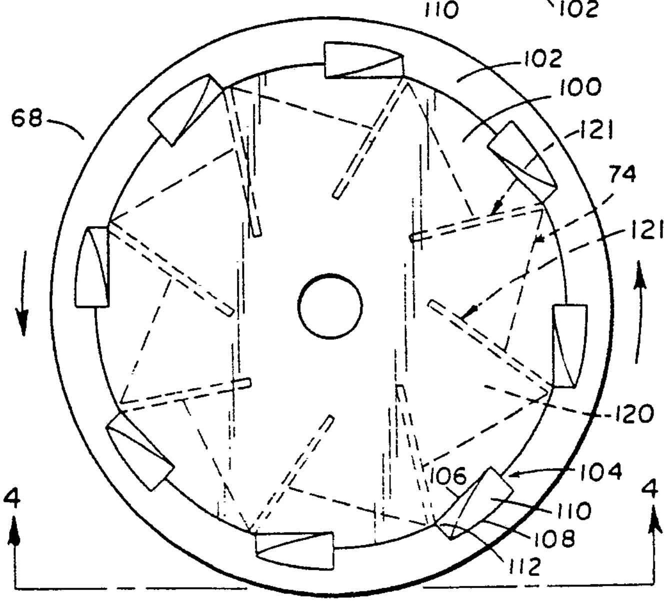


FIG. 5

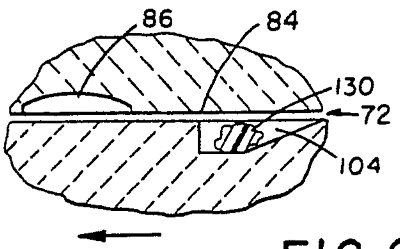


FIG.6A

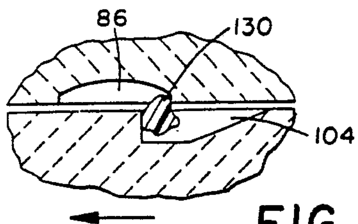


FIG.6B

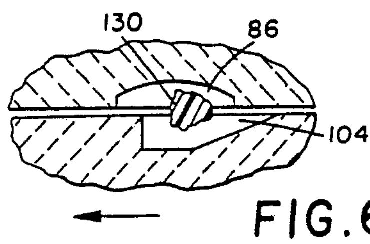


FIG.6C

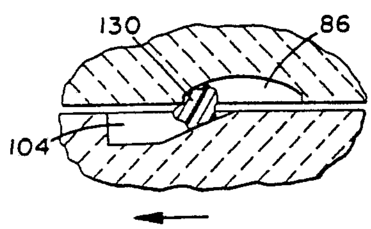


FIG.6D

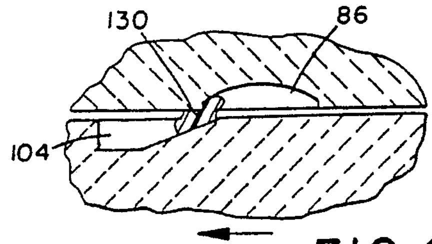


FIG.6E

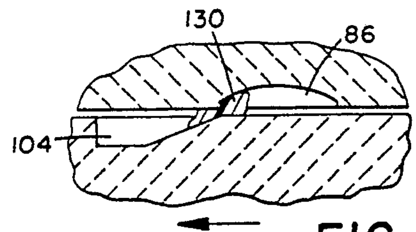


FIG.6F

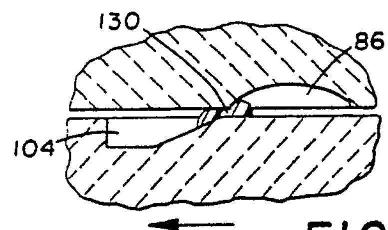


FIG.6G

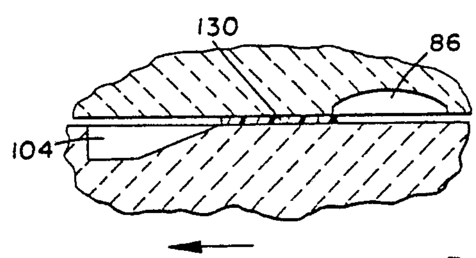


FIG.6I

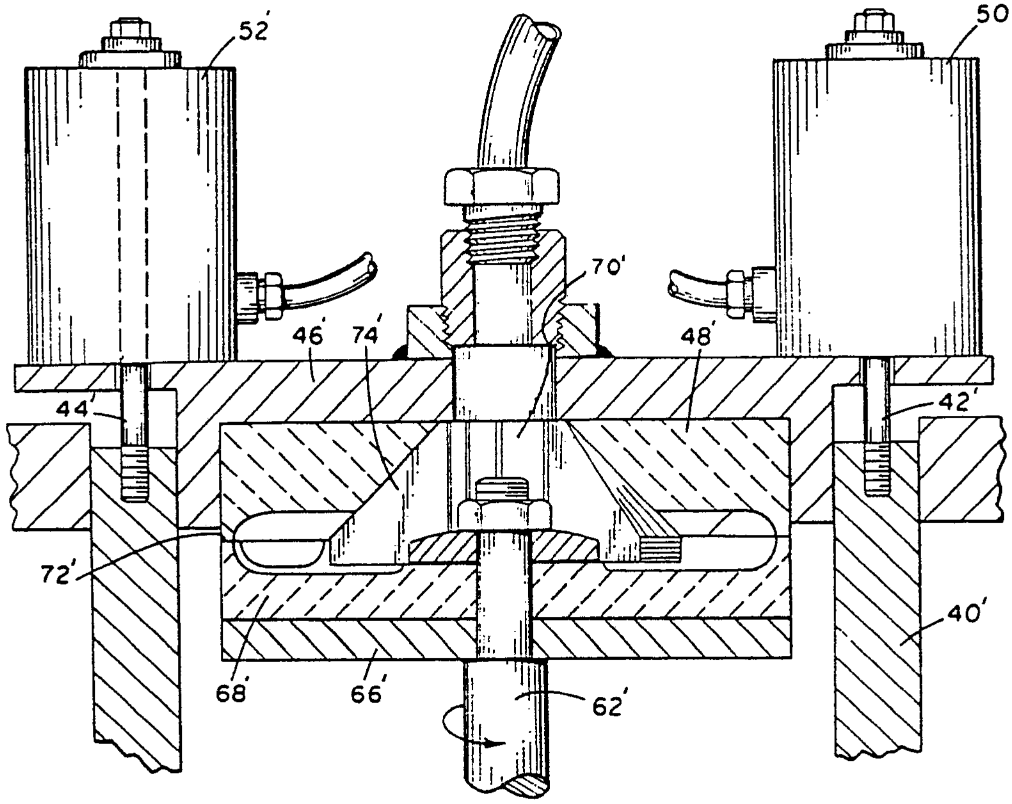


FIG. 8

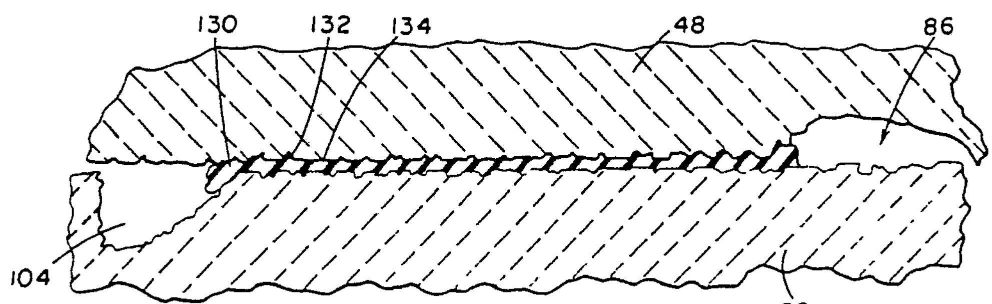
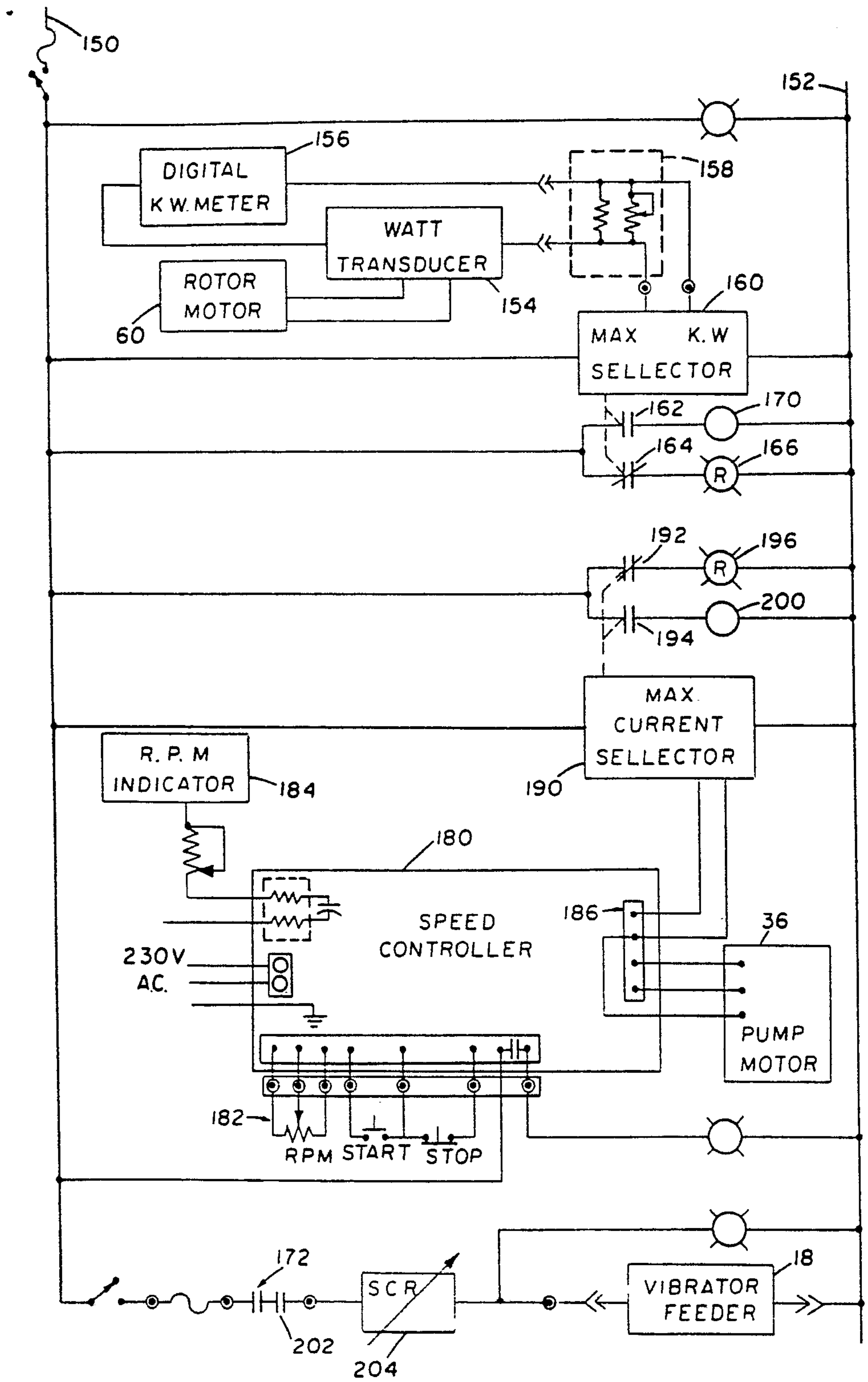


FIG.6H


150
152
156
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K.W. METER
158
WATT
TRANSDUCER
ROTOR
MOTOR
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MAX K.W
SELLECTOR
162
170
164
166
R
192
196
R
200
194
MAX.
CURRENT
SELLECTOR
190
R. P. M
INDICATOR
184
180
SPEED
CONTROLLER
186
36
230V
AC.
PUMP
MOTOR
182
RPM
START
STOP
172
SCR
VIBRATOR
FEEDER
18
202
204

FIG.7

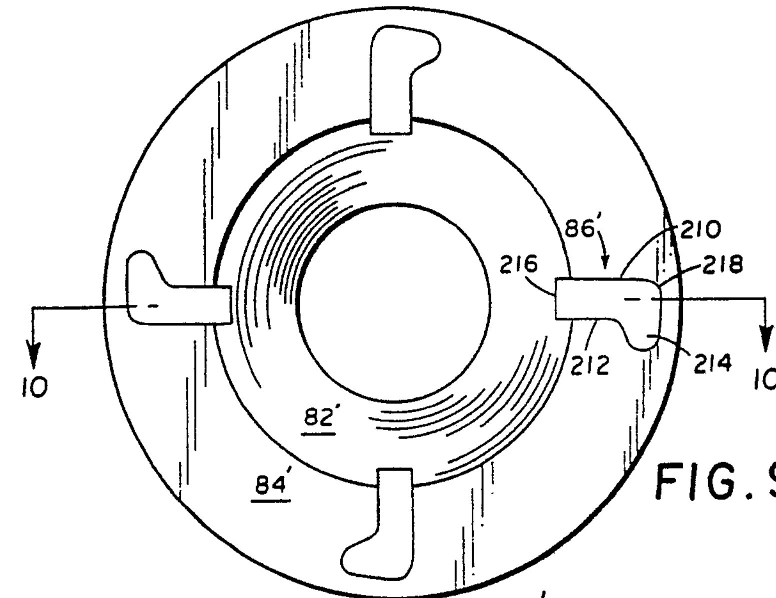

FIG. 9

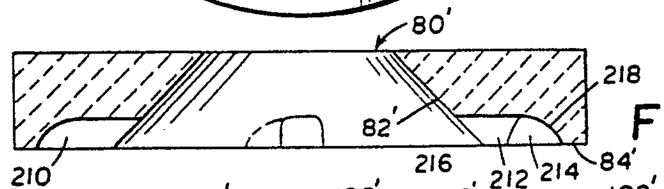

FIG. 10

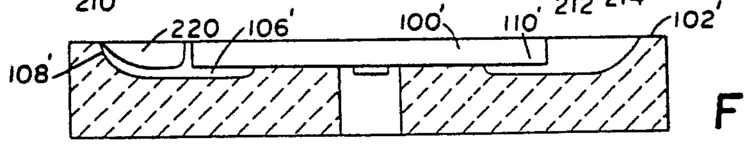

FIG. 12

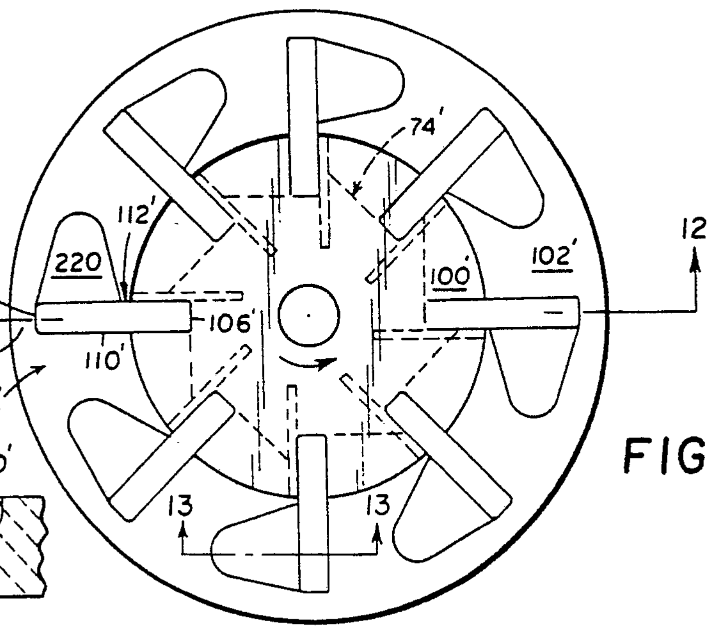

FIG. 11

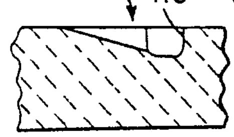

FIG. 13