

[54] METHOD AND APPARATUS FOR
COMMUNUTING

[76] Inventor: Richard N. Crandall, 17792 Lewis
Dr., Huntington Beach, Calif. 92647

[22] Filed: Nov. 8, 1971

[21] Appl. No.: 196,421

[52] U.S. Cl. 241/15, 241/41, 241/46 B,
241/46.11, 241/162, 241/257 R

[51] Int. Cl. B02c 18/40

[58] Field of Search 241/15, 21, 25, 27,
241/29, 38, 41, 42, 43, 46 R, 46 A, 46 B,
46.11, 46.17, 155, 162, 244, 257 R, 257 G

[56] References Cited
UNITED STATES PATENTS

2,853,249	9/1958	Wilder	241/257 G
2,963,232	12/1960	Smith	241/162 X
3,591,095	7/1971	DiStefano	241/41
983,055	1/1911	Hosmann	241/41
1,961,862	6/1934	Park	241/41
2,495,983	1/1950	Richards	241/257 G

2,888,213	5/1959	Hubner et al.	241/162 X
3,291,399	12/1966	Sheperd	241/41 X
2,954,938	10/1960	Higer	241/41

Primary Examiner—Granville Y. Custer, Jr.
Attorney—J. F. McLellan

[57] ABSTRACT

A trash grinder has a chamber with a fixed cylindrical wall containing a rotatable abrasive cone with a water impeller under the base of the cone. Water is admitted to the impeller and to the grinding chamber along with trash. The trash forms a frusto-conical mass which rotates about its own axis and about the axis of the cone and works its way down the chamber under the force of gravity. The inertia of the mass causes relative grinding motion of the mass and discrete grinding elements of the cone which reduces the mass into fine particles that form a slurry along with the water, which slurry is ejected by the impeller. The slurry can be used for disposal in a sewage system.

14 Claims, 17 Drawing Figures

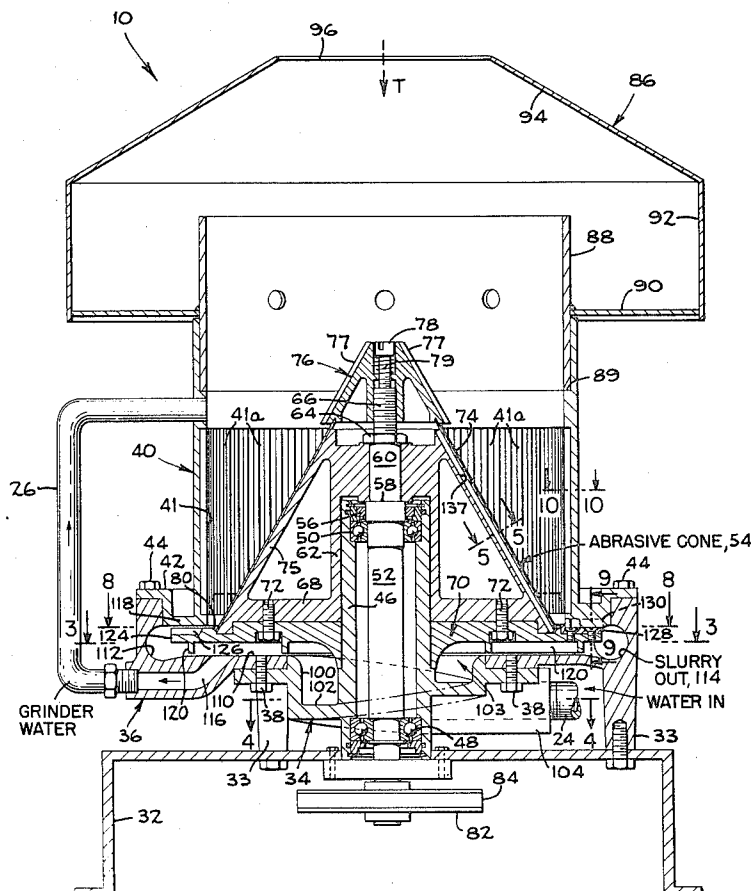
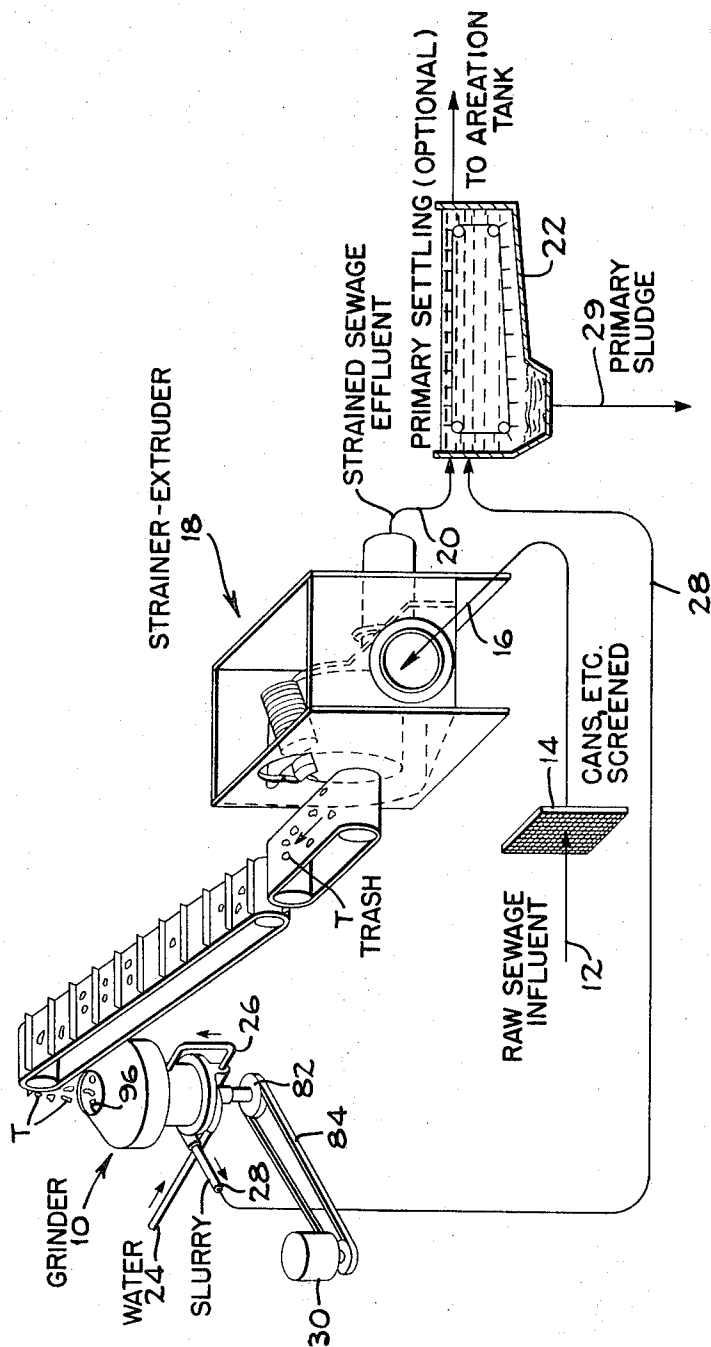


FIG. 1



INVENTOR
RICHARD N. CRANDALL

BY *F. W. Anderson*
C. E. Tripp
ATTORNEYS

FIG. 2

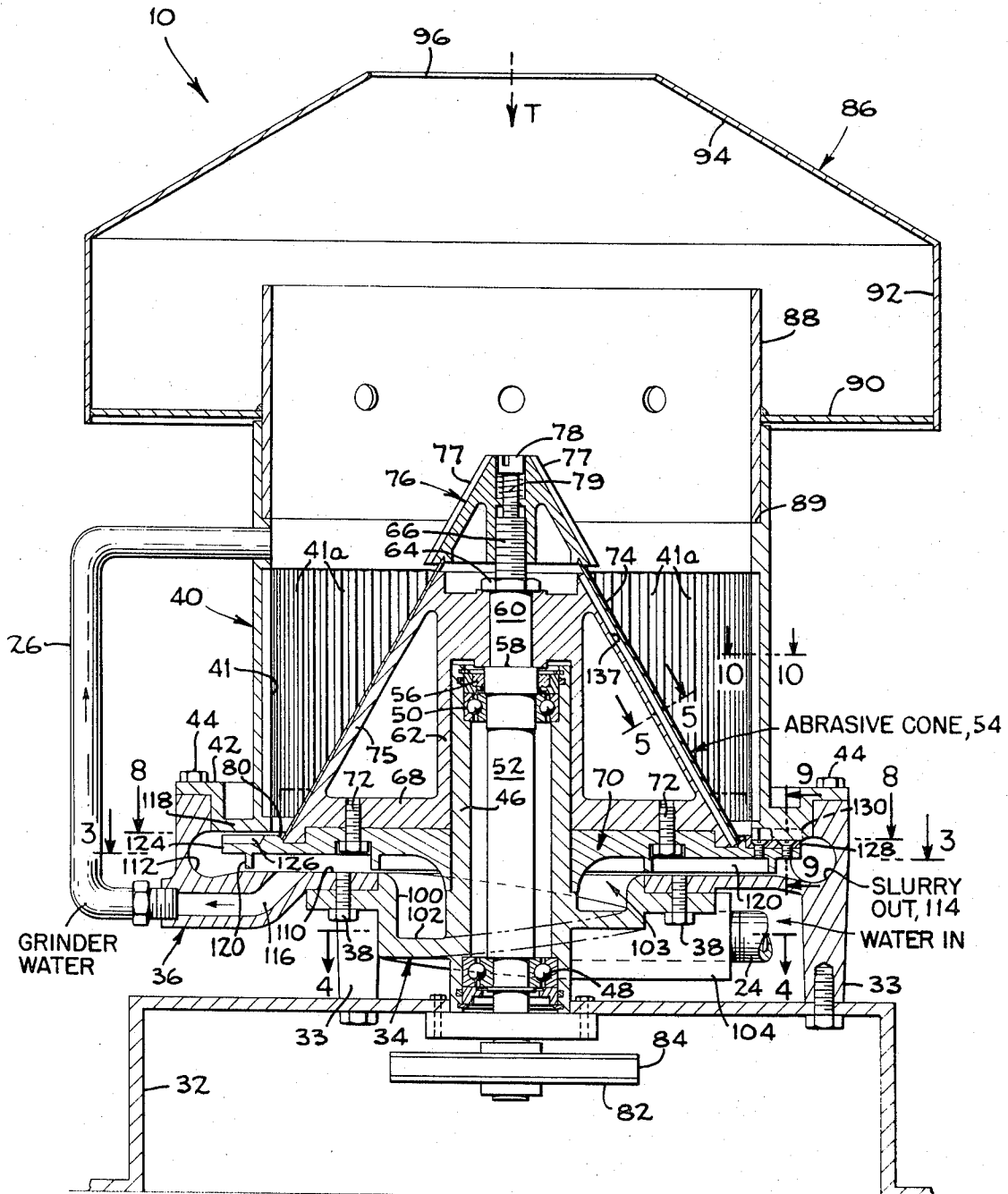


FIG. 3

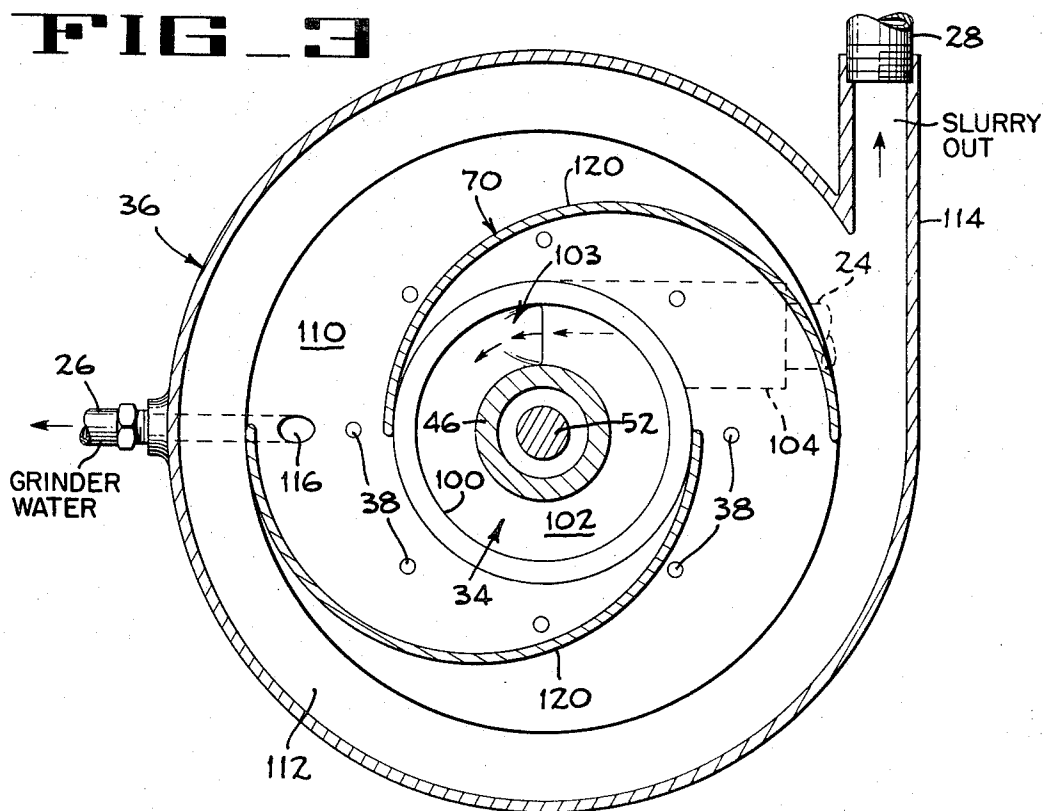


FIG. 4

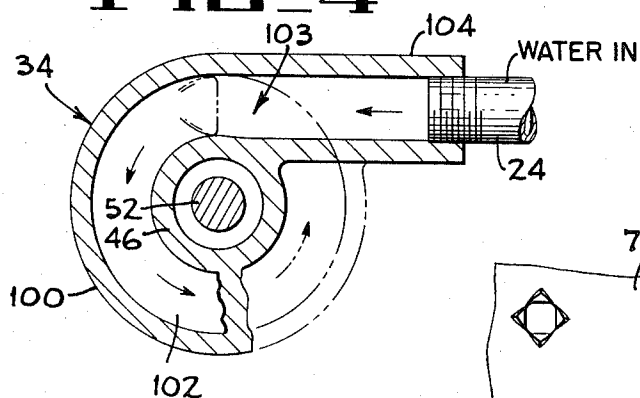


FIG. 5

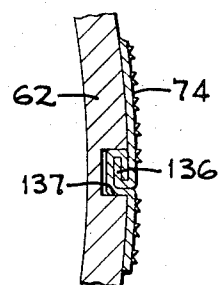


FIG. 7

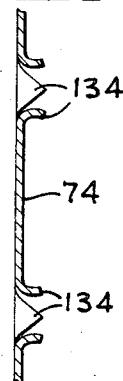


FIG. 6

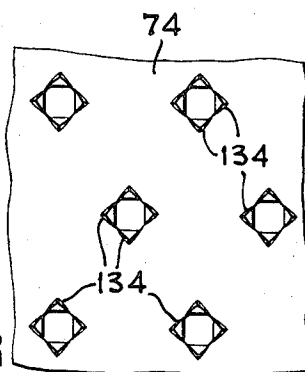


FIG. 8

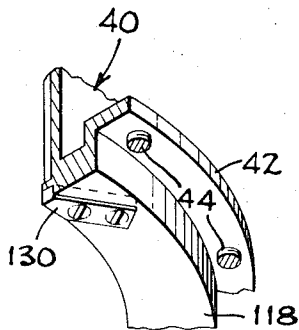
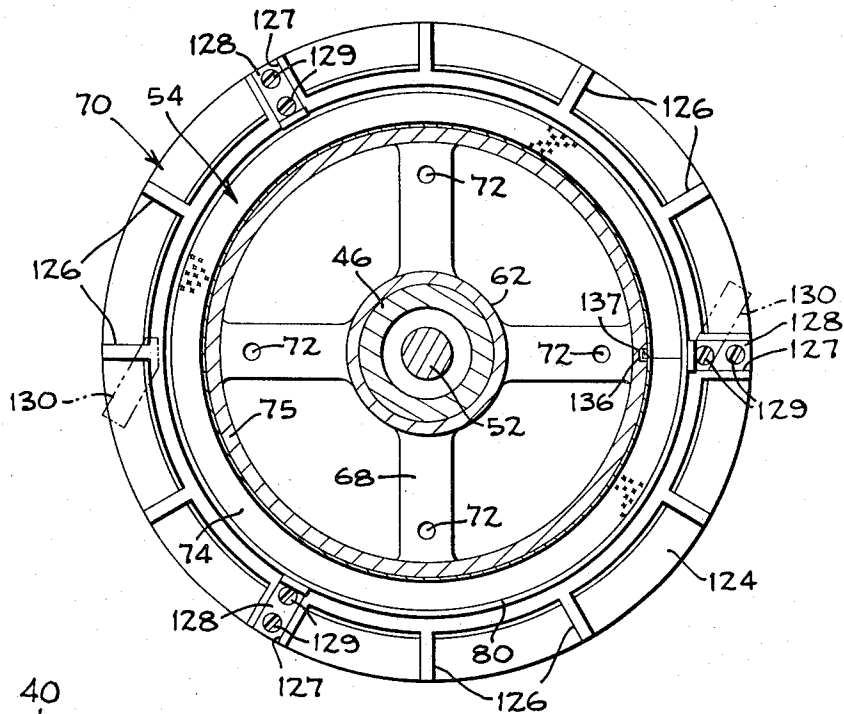


FIG. 11

FIG. 9

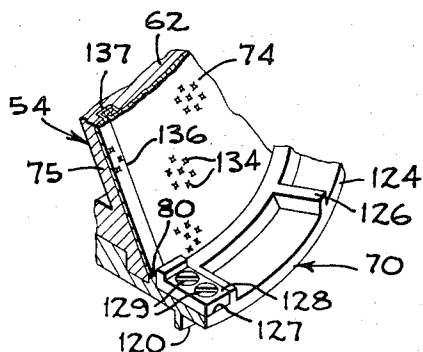
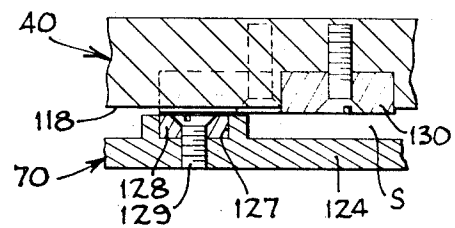


FIG. 12

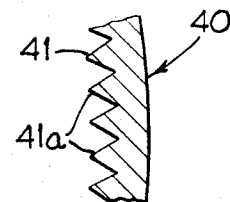
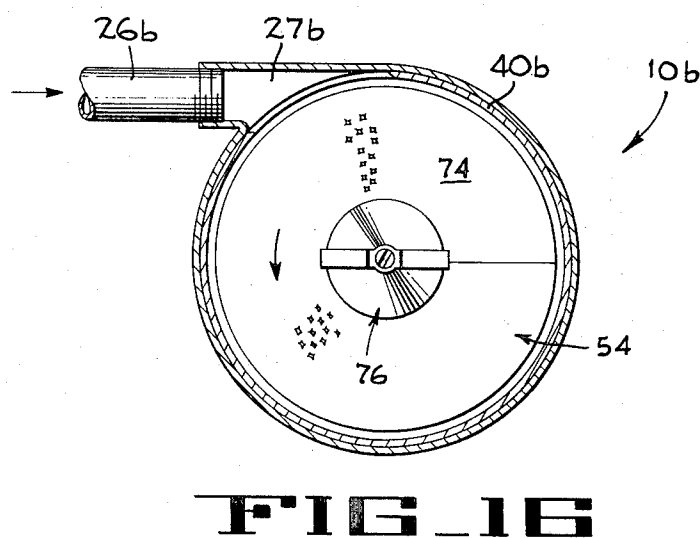
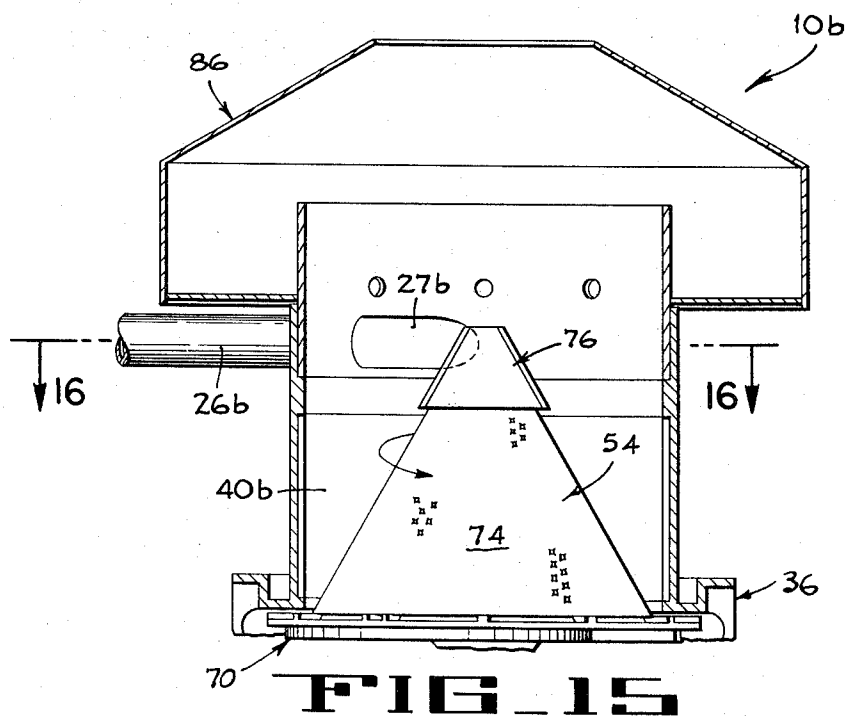


FIG. 10



METHOD AND APPARATUS FOR COMMUNUTING FIELD OF THE INVENTION

This invention relates to comminuting and more particularly to a vertical chamber grinder which is particularly effective for grinding trash, including rags, paper, etc.

DESCRIPTION OF PRIOR ART

The U.S. Pat. No. 2,246,224 to Streander, June 17, 1941, shows a grinder associated with a sewage disposal system.

The U.S. Pat. to Wormser, No. 2,781,915, Feb. 19, 1957 shows horizontal, toothed rolls for comminuting in a grinding chamber.

The U.S. Pat. to Cosgrave Nos. 238,859, Mar. 15, 1881; Meyer 241,557, May 17, 1881; Hall 1,132,258, March 16, 1915; Turucz 1,826,157, Oct. 6, 1931; Wagner 3,132,815, May 12, 1964 show a horizontally disposed abrasive grinding drum for comminuting materials.

SUMMARY OF THE INVENTION

Although it may have other uses, the grinder of the present invention is particularly useful for grinding trash that includes materials that tend to clog ordinary grinders such as rags, paper, etc., such trash being characteristic of material that is strained out of sewage disposal systems.

In accordance with the present invention, trash including these difficult materials is converted into fine particles in a slurry without clogging, balling up or reducing the capacity of the grinding operation. This is accomplished by providing a fixed, cylindrical grinding chamber in which rotates an abrasive cone with its apex up. The trash is admitted to the chamber along with a certain amount of water so that a slurry can be formed. The trash soon forms itself into frusto-conical bodies of composite material which are rotated about their own axes by the abrasive cone, and which have satellite or planetary motion with the cone. However, the inertia of these masses of material and their friction with the chamber sidewalls impede their rotation with the abrasive cone so there is an effective grinding action. Also, the rotation of the masses about their own axes constantly presents new faces of the masses to the cone so that the mass is progressively worn away about its periphery. The geometry of the grinder causes the mass to move downwardly under the force of gravity towards the base of the cone and by the time the base of the cone is reached, the mass will have been pulverized into particles which mix with the water to form a slurry. The slurry is pumped out for disposition in a sewage disposal system or other locations. Hard objects are flung by the rotating abrasive cone against the sidewalls of the cylindrical chamber (usually) whereupon they ricochet out of the chamber and are caught by a catch basin surrounding the upper portion of the chamber. It is a feature of the invention that the cylindrical walls of the chamber are free of major obstructions, vanes, blades or the like of the type which would interfere with the composite axial and planetary rotation of the mass during the grinding operation described above.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram showing utilization of the grinder of the invention in a sewage disposal system.

FIG. 1A is a side elevation of the grinder.

FIG. 2 is a vertical section through the grinder on line 2—2 of FIG. 1A.

FIG. 3 is a section taken on line 3—3 of FIG. 2 showing the impeller.

FIG. 4 is a section taken on line 4—4 of FIG. 2 showing the water inlet casing.

FIG. 5 is a section taken on line 5—5 of FIG. 2 showing the cone construction.

FIGS. 6 and 7 are details of the abrasive cone element.

FIG. 8 is a section taken on line 8—8 of FIG. 2 showing the impeller and its teeth.

FIG. 9 is a section taken on line 9—9 of FIG. 2 through those teeth.

FIG. 10 is a section taken on line 10—10 of FIG. 2 showing the chamber wall.

FIGS. 11 and 12 are exploded partial perspectives of the impeller and chamber base grinding teeth.

FIG. 13 is a diagram illustrating the mode of operation of the present invention.

FIG. 14 is a similar diagram distinguishing the advantages of a chamber of the present invention over an inferior construction.

FIGS. 15 and 16 show a modified form of the invention.

TYPICAL SEWAGE DISPOSAL UTILIZATION

FIG. 1 is a diagram showing how a grinder 10 of the present invention can be utilized in a sewage disposal system although the slurry discharged from the present invention can be disposed of in other manners. Raw sewage influent enters the system at 12 and passes through a coarse screen 14 for large objects such as cans, etc. Line 16 conducts the incoming sewage to a strainer extruder 18, the form illustrated in FIG. 1 being apparatus such as that of the U.S. Pat. to Crandall No. 3,570,671, issued Mar. 16, 1971, and assigned to the FMC Corporation. The strainer extruder 18 removes trash T from the influent, which trash is conducted by a conveyor system to the grinder 10. The strained sewage effluent leaving the strainer-extruder 18 enters by means of line 20, a primary settling tank 22, although the disposition of such liquid is not critical to the present invention.

Referring to the grinder 10, a supply of water enters the grinder by line 24 and an auxiliary supply of water enters the grinder by a line 26 leading directly to the grinder chamber, by means to be described in detail presently. The trash is formed into masses which are progressively abraded away until they form a fine slurry of ground material with the water, which slurry leaves the grinder by means of line 28. In the system being illustrated, a grinder 10 of the present invention will grind the trash, including rags, paper and the like into such a fine slurry that it forms settleable solids and these settleable solids can be introduced by the line 28 into the primary settling tank 22. Thus the ground up solids appear as primary sludge in the settling tank discharge conduit 29.

GENERAL CONSTRUCTION OF THE GRINDER

Referring to FIGS. 1A and 2, the grinder 10 of the present invention is a compact vertical grinder device driven by the electric motor 30. In the form shown, a hollow base 32 mounts the motor 30 as well as mounting the grinder 10 by means of the legs 33 bolted to the

base (FIG. 2). The bottom portion of the grinder includes a water inlet casing 34 to which is secured an impeller casing indicated generally at 36 by means of bolts 38. A cylindrical grinding chamber 40 has a lower flange structure 42 which is secured to the periphery of the impeller casing 36 by bolts 44. The water inlet casing 34 has an upwardly projecting sleeve 46 which carries lower bearings 48 and upper bearings 50 for mounting the shaft 52 of an abrasive cone assembly indicated generally at 54. A water seal 56 is provided between the shaft and the sleeve 46 above the bearing 50. The bearing and seal details are of conventional design and are not critical to the invention.

The shaft 52 has a shoulder 58 below an extension 60 of the shaft, which extension receives a cone support sleeve 62 that also surrounds the base sleeve 46. A nut 64 mounted on a threaded end 66 of the shaft extension 60 clamps the cone support sleeve 62 to the shaft 52 for rotation with the shaft. The base flange 68 of the cone 54 mounts an impeller 70 by means of bolts 72. A replaceable abrasive cone 74 fits snugly over a conical flange 75 of the cone 54 and is held on that flange by a clamping cone 76 which is formed with ribs 77 (FIG. 2). A bolt 78 is threaded into the shaft extension 66 and presses against the clamping cone 76 by means of a compression spring 79 and hence retains the upper end of the abrasive cone 74. The lower end of the abrasive cone 74 rests on an annular shoulder 80 formed near the periphery of the impeller 70. The cone 74 and the chamber wall 40 form a "wedge-shaped" annular grinding chamber.

The shaft 52 and hence the abrasive cone assembly 54 are driven by means of a pulley 82 and a V-belt 84 driven by the motor 30, as best seen in FIGS. 1 and 1A.

A cover and catch basin assembly indicated generally at 86 fits over the top of the chamber 40. This assembly includes a sleeve 88 that forms an extension of the chamber 40 and telescopes therewith, resting on a shoulder 89 formed in the wall of chamber 40. A catch basin for hard objects is formed surrounding the sleeve 88 by means of a flat bottom plate 90 and a peripheral ring 92. The top of the cover assembly 86 is partially closed by a conical plate 94 which has a central opening 96 for receiving the trash T. The catch basin assembly is provided to catch hard or nongrindable objects that are flung or ricocheted out of the grinding chamber by rotation of the abrasive cone assembly 54 (FIG. 13).

The construction of the water casing inlet 34 is shown in FIGS. 2 and 4. This casing has a peripheral sidewall 100 and a helical bottom wall 102 that surround the base sleeve 46 to provide an inlet chamber 103. The water inlet pipe 24 connects to an inlet port 104 that leads tangentially into the chamber 103 of the water casing 34, which construction causes a swirling of the water around the casing and directs it upwardly to the lower face of the impeller assembly 70.

The impeller casing 36 includes a bottom wall 110 (FIGS. 2 and 3) surrounded by a partially toroidal slurry chamber 112. A tangential slurry discharge pipe 114 (FIG. 3) leads from the slurry chamber 112. Also, an auxiliary water outlet port 116 leads down from the impeller casing wall 110 and connects to the grinder chamber water pipe 26, previously described. A lower wall 118 of the base flange structure 42 for the grinding chamber 40, previously described, forms an upper wall of the slurry chamber 112 as well as providing a slurry

grinding surface, as will be mentioned in detail presently.

As seen in FIGS. 2 and 3, the underside of the impeller 70 is formed with curved vanes 120 which trail in their direction of rotation in a manner which pumps water directed upwardly from the water inlet casing 34 out through the slurry discharge pipe 114. The impeller 70 has a peripheral flange 124 that fits closely with the wall 118 of the grinder chamber (FIGS. 2 and 9) there being a gap about one-sixty-fourth inch to one-thirty-second inch between these elements, for the already noted sewage systems but the gap may also be somewhat larger or smaller for other applications. This gap directs the slurry from the bottom of the grinding chamber to the slurry discharge chamber 112. The peripheral flange 124 of the impeller 70 has circumferentially spaced, upwardly facing vanes or blades 126 (FIG. 12). In between the vanes 126 are formed pockets 127 (FIGS. 8 and 9) that mount hardened jaws 128 (see also FIG. 12) that are replaceably retained by flathead screws 129. Cooperating hard metal shear plates 130 (FIGS. 9 and 11) are screwed in a similar manner to the downwardly facing wall 118 of the grinding chamber 40 as seen in FIGS. 9 and 11. The complete assembly of impeller vanes and hardened jaws appears also in FIG. 8.

Any material that has not been completely comminuted into particles by the action of the abrasive cone and the cylindrical grinding chamber 40 will have the comminution thereof completed so that a consistent slurry is produced by the close coaction of the hardened impeller jaws 128 and the hardened blades 130 on the grinding chamber. The spacing between these members is quite small being in the order of one one-thousandth inches. The resulting slurry works itself out through this small spacing as well as through the larger spacing S between the flanges 124 and 118 (FIG. 9) and is impelled by the impeller 70 into the slurry discharge chamber 112. The action of the impeller vanes 120 on the impeller provide a pumping action on the water and circulates it around the slurry casing 112 and out the slurry discharge port 114 (FIG. 3). These vanes also force water up the pipe 26 into the grinding chamber 40.

FIGS. 5, 6 and 7 show details of the abrasive cone 74. This cone is made of hard, high tensile carbon or stainless steel that is punched out in a manner known in the art to provide discontinuous projections, discrete elements or sharp teeth 134. The cone material is seamed at 136 (FIG. 5), the seam fitting in a notch 137 formed in the conical wall of the abrasive cone assembly, thus providing a positive drive for the abrasive cone 74. As mentioned, the cone 74 is retained in place by the conical nut 76 and the bolt 78, so that when the cone teeth are worn down past their point of usefulness the cone 74 is readily replaced by a new cone. Thus the unit can be maintained at its best operating efficiency with small equipment replacement cost.

In a typical installation of the type described the grinding chamber 40 will have a diameter of about 10 inches and the abrasive cone 74 will be about 6 inches high and will be rotated at about 4,000 RPM.

An important feature of the present invention is that the inner wall 41 of the cylindrical grinding chamber 40 does not contain radial projections of the type that will interfere with rotational translation of a mass of material M, (FIG. 13) being acted upon by the abrasive

cone 74. However, the rotation of the mass of material M about its own axis, in response to the frictional forces exerted thereon by the cone (in response to the force of gravity acting on the mass) is facilitated by the serration of the wall 41 of the grinding chamber. These serrations are shown at enlarged scale in the fragmental section of FIG. 10 and are provided, in the form illustrated, by forming saw toothed serrations 41a in that wall. These serrations are about one-fourth inches deep in the size given above. They have the additional function of breaking up water films that might form on the chamber wall 40 and thus reduce friction with the mass M as described previously. Again it is to be pointed out that these serrations do not project sufficiently to impede the rotational motions of the frusto-conical masses formed in the grinding chamber, but in fact, facilitate those motions by serving as partial "gear teeth" that insure rotation of the masses about their own axes in response to the high friction grinding action of the individual abrading elements of the abrasive cone against them.

OPERATION

The operation of the grinder 10 of the present invention can best be described in conjunction with the diagram of FIG. 13.

Trash T comprising grindable particles P (which may include rags and paper) as well as hard or intractable articles O are admitted to the grinding chamber 40 through the opening 96 in the combined cover and catch basin 86. The trash T is thoroughly churned in with the water W admitted from the pipe 26 previously described. The rotation of the abrasive cone 74 soon aggregates the trash into a plurality of frusto-conical masses, one of which is indicated generally at M, although it is understood that the mass shown in FIG. 13 represents an idealized configuration, presented for purposes of explaining the present understanding of the mode of operation of the grinder.

It will be noted that the upper radius r of the mass M is greater than its lower radius r' whereas the relative dimensions of the upper and lower radii R and R' of the abrasive cone 74 are reversed. Rotation of the abrasive cone 74 is indicated by the circular arrow a at the upper end thereof and causes rotation of the mass M about its own axis, as indicated by the curved arrow b on that mass. The latter rotation is facilitated by the cog action of the serrations 41a (FIG. 10) of the wall and grinder chamber 40. However, due to the differences in radii just described; the fact that the chamber wall 40 is cylindrical and due to the inertia of the mass M, the mass cannot rotate as if it were positively "geared" to the abrasive cone 74. Thus there is an effective relative motion between the abrasive cone and the mass which produces a differential grinding action on the mass, with such action being greatest at the lower radii r' and R' of the engaged elements. This removes material faster from the bottom of the mass M than from the top and hence the force of gravity on the mass (indicated by the vertical arrow d) causes the mass to constantly work its way down towards the slurry outlet gap S at the bottom of the chamber.

In addition to the rotations just described, there is a planetary motion of the mass M upon the axis of the grinder illustrated by the curved arrow c and this rotation further assists in causing the mass M to constantly present new faces to the discrete abrading elements or

projections of the abrasive cone, as well as assisting in clearing the grinding chamber for reception of new material. Because the wall of the grinding chamber 40 is generally cylindrical, and since the abrasive cone assembly 54 is disposed with its apex up, the action of frictional forces against the wall of the chamber do not tend to cause the mass M to move up and out of engagement with the abrasive cone but rather facilitate the action of gravity, as indicated by the small arrow d , in causing the mass M to move down and in constant engagement with the cone during abrasion.

Intractable objects O, such as stones or the like, are flung from the cone against the chamber wall 40 and ricochet from that wall out into the catch basin, as illustrated by the trajectory arrows in FIG. 13. The retaining cap 76 is ribbed at 77 (FIG. 2) to additionally fling hard objects clear. As a result of this construction, trash, even though it includes rags, is quickly formed into a mass and is rotated about its own axis as well as about a planetary axis and constantly presents new faces to the discrete discontinuous grinding elements of the cone, while moving down toward the base of the cone. This provides rapid and efficient comminution of these difficult to grind materials, producing particles of such a small size that their comminution is readily completed (as necessary) by the interaction of the impeller and grinding chamber base, including the blades or jaws 128, 130 shown in FIGS. 8, 9, 11 and 12.

FIG. 14 is a simplified diagram of a grinder of the same general type as that in the present invention but showing a reversal of parts wherein the abrasive cone 54a is cylindrical and the grinding chamber 40a is inferior to that of the present invention and a frictional force is engendered on the mass M that urges the mass upwardly along the grinding chamber wall as shown by the arrow d' instead of helping it move toward the bottom to more confined zones thereof.

MODIFIED FORM

FIGS. 15 and 16 show a modified grinder 10b which differs from that previously described in only one important respect. In this modification, the parts are like the grinder previously described except that here the grinder water or auxiliary water input 26b enters the grinding chamber 40b by means of a tangentially disposed inlet port 27b, best seen in FIG. 16. If desired, the inlet 27b can be large enough to admit the trash to be ground along with water. This construction assists in imparting a swirling action to the material in the grinding chamber.

Thus it will be seen that in accordance with the present invention, a grinding or comminuting apparatus is provided which consistently converts trash, including paper, rags, sticks or other grindable materials into small particles incorporated into a water slurry. Objects such as rags, strings or the like which cause difficulties in grinders, are formed into a frusto-conical mass which constantly presents new faces to the relatively moving abrasive cone and results in the formation of small particles which form a slurry with water admitted to the grinding chamber. The construction of the coacting impeller and chamber bottom grinding jaws, running at close clearances, provides further comminution of the particles ground away from the mass in the grinding chamber proper, so that the solids included in the slurry are very small size and can be handled by a sewage disposal system if necessary.

Although the best mode contemplated for carrying out the present invention has been herein shown and described, it will be apparent that modification and variation may be made without departing from what is regarded to be the subject matter of the invention.

What I claim is:

1. Apparatus for grinding trash comprising:

means defining an upwardly open grinding chamber of circular cross-section having a base portion and a fixed, vertically oriented and generally cylindrical chamber wall, said chamber wall being free of any inwardly directed projections that would prevent rotation of trash across the inner surface of said chamber wall;

means for admitting water into said chamber;

a cone mounted within said chamber for rotation about a vertical axis, the base of said cone being located adjacent said base portion whereby said cone defines with said chamber wall an annular trash grinding zone having a downwardly convergent cross-section, the conical surface of said cone including a multiplicity of discrete, outwardly projecting pointed teeth operative upon rotation of said cone to tear away and separate small size particles from trash in said grinding zone;

slurry discharge means located adjacent said base portion for collecting and discharging a slurry of water and small size trash particles from said chamber; and

means for rotating said cone.

2. Apparatus according to claim 1 wherein said slurry discharge means includes a slurry discharge conduit in communication with the bottom of said grinding zone for carrying away said slurry, and wherein said apparatus further includes means for admitting supplemental water into said slurry discharge conduit for dilution of said slurry.

3. Apparatus according to claim 1 wherein said slurry discharge means includes a slurry discharge conduit in communication with the bottom of said grinding zone for carrying away said slurry, and further includes an impeller mounted to the base of said cone adjacent said base portion of said chamber.

4. Apparatus according to claim 3 and including first shear jaws carried upon the upper face of said impeller, and complementary second shear jaws carried by said means defining said chamber, said first and second shear jaws cooperating on rotation of said cone to further abrade any said small size trash particles engaged by said upper vanes.

5. Apparatus according to claim 4 and including means for admitting water to the underside of said impeller, and wherein said underside of said impeller includes downwardly projecting, radially outwardly extending lower vanes in communication with said slurry

discharge conduit and operative upon rotation of said cone to thrust water from adjacent said underside of said impeller radially outwardly into said slurry discharge conduit.

6. Apparatus according to claim 1 and including means for admitting water to the underside of said impeller, and wherein said means for admitting water into said grinding chamber includes a conduit extending from the underside of said impeller to the upper portion of said grinding chamber.

7. Apparatus according to claim 1 wherein said means for admitting water into said grinding chamber empties into the upper portion of said chamber, and wherein said chamber wall includes surface irregularities operative to prevent water build-up on said chamber wall upon rotation of said cone.

8. Apparatus according to claim 1 wherein said cone comprises a conical spindle, a complementary conical hardened steel sheath fitted over said cone and having punched out portions constituting said pointed teeth, and means detachably securing said sheath to said conical spindle.

9. Apparatus according to claim 8 wherein said last mentioned means comprises an externally ribbed conical cap member surmounting said sheath.

10. Apparatus according to claim 1 and including a deflector wall superjacent the upper end of said chamber and an annular pocket adjacent said deflector wall and surrounding said upper end of said chamber for deflecting and collecting any trash ricocheting out of said chamber.

11. Apparatus according to claim 10 wherein said deflector wall is inclined relative to a horizontal plane to facilitate deflection of ricocheting trash.

12. Apparatus according to claim 1 wherein said inner surface of said chamber wall includes shallow vertical serrations.

13. The method of grinding trash comprising the steps of mixing trash with water; forming said mixture into at least one generally downwardly tapering conical mass; rotating said mass about its own axis and also in planetary fashion about a vertical axis located externally of the mass; engaging said rotating mass with a conical body having discrete, discontinuous abrading elements to tear away small size particles from the bottom of said mass at a rate greater than the top of said mass whereby said mass sinks downwardly and is progressively converted into a slurry of water and finely ground particles; and pumping off said slurry.

14. The method of claim 13 including the step of adding supplemental water to said slurry during the pumping step to facilitate passage of said slurry through conduits and the like.

* * * * *