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Mehta

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(54) **NON-CLOG SHREDDER**

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(51) **Int. Cl.**
E03D 9/10 (2006.01)

(52) **U.S. Cl.** **4/319**; 241/46.01; 241/46.11; 241/46.17; 415/121.1

(58) **Field of Classification Search** 4/319; 241/43, 45, 86, 88.1, 88.2, 89.4, 152.2, 46.01, 241/46.02, 46.06, 46.11, 46.17; 415/121.1
See application file for complete search history.

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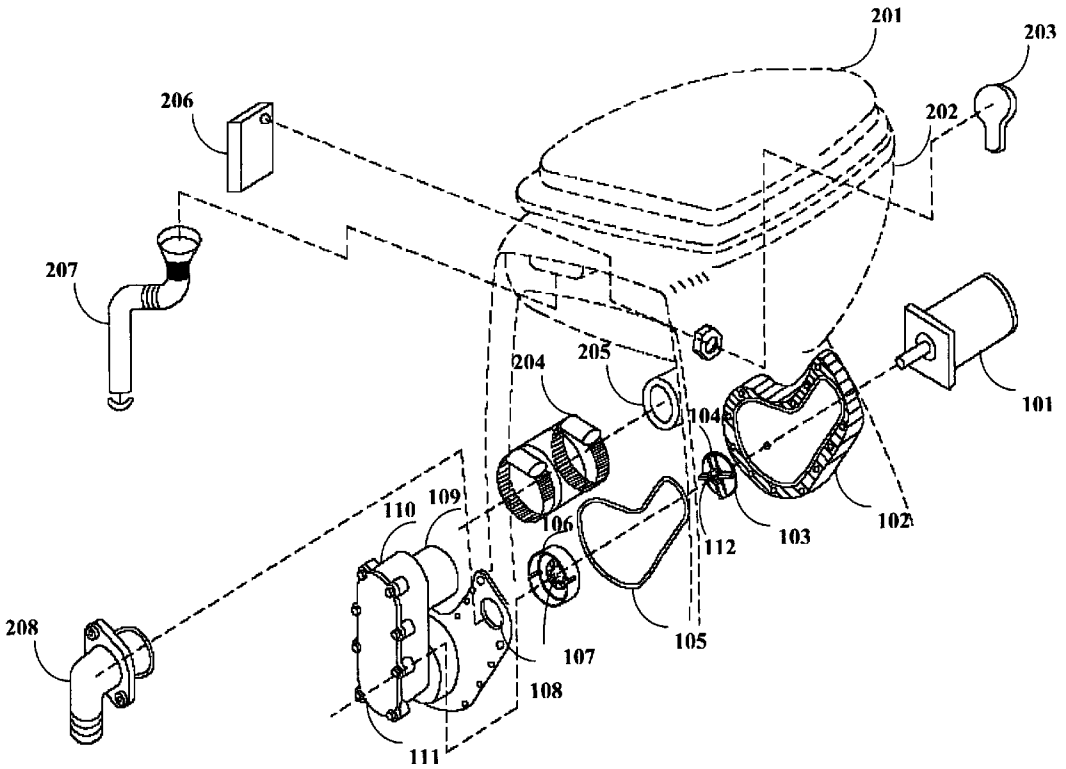
(57) **ABSTRACT**

Disclosed herein is a non-clog shredder that is used to shred solid matter entrained in a non-homogenous liquid-solid feed. In one embodiment of the invention, the shredder is located at the bottom of a toilet bowl and is used to shred solid disposable products such as napkins and diapers that are discarded in the toilet bowl. The shredder comprises a generally cylindrical cup that is open at one end, with a circular end-cap at the other end. The end-cap has an axial opening that allows the feed to pass through the cup. In one embodiment of the invention, the opening has recesses and/or teeth on the periphery of the opening. An impeller disposed against the circular end plate creates suction for transfer of the waste through the shredder. A cutting blade on the impeller assembly projects axially through the opening in the end-cap.

6 Claims, 11 Drawing Sheets



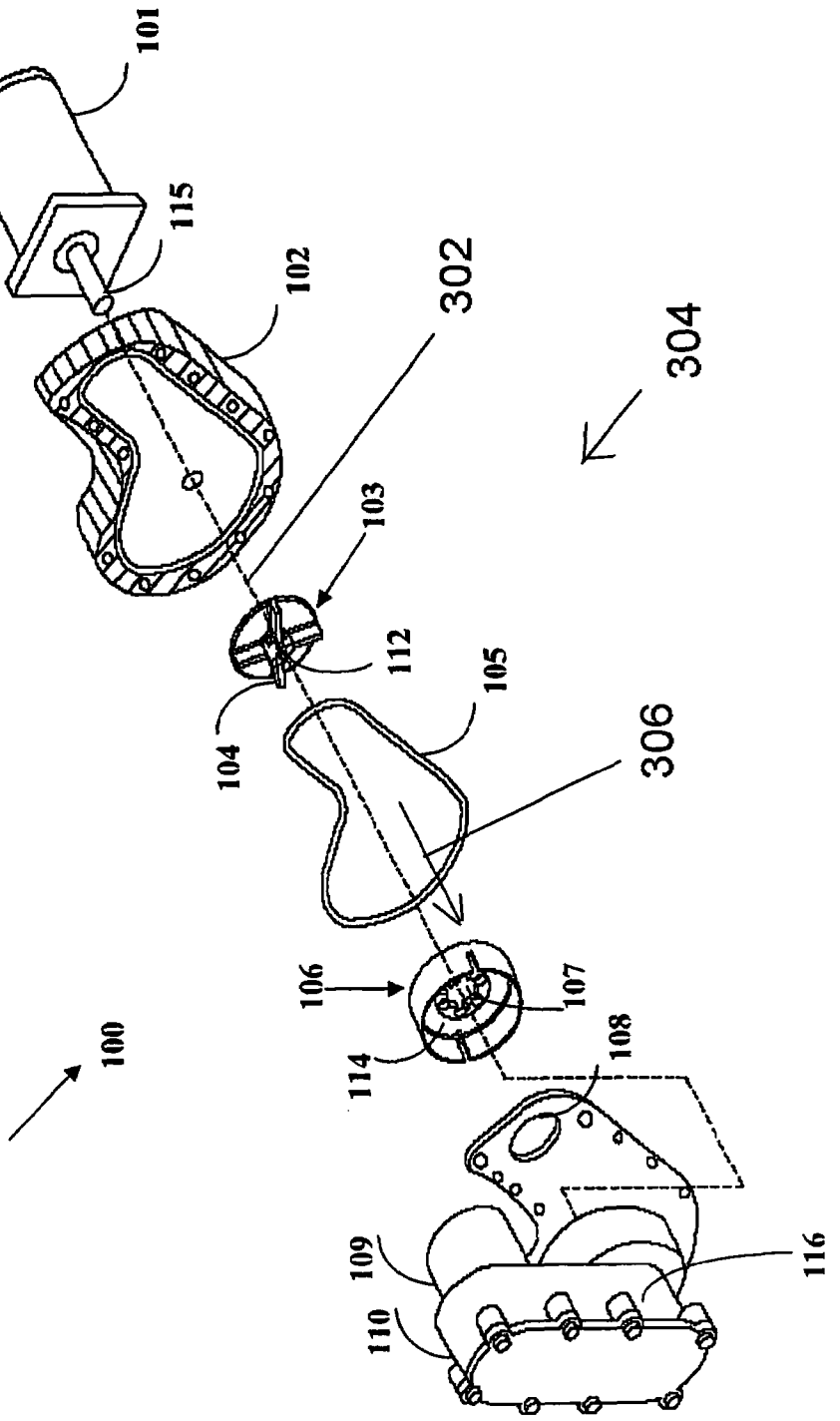

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FIGURE 1A

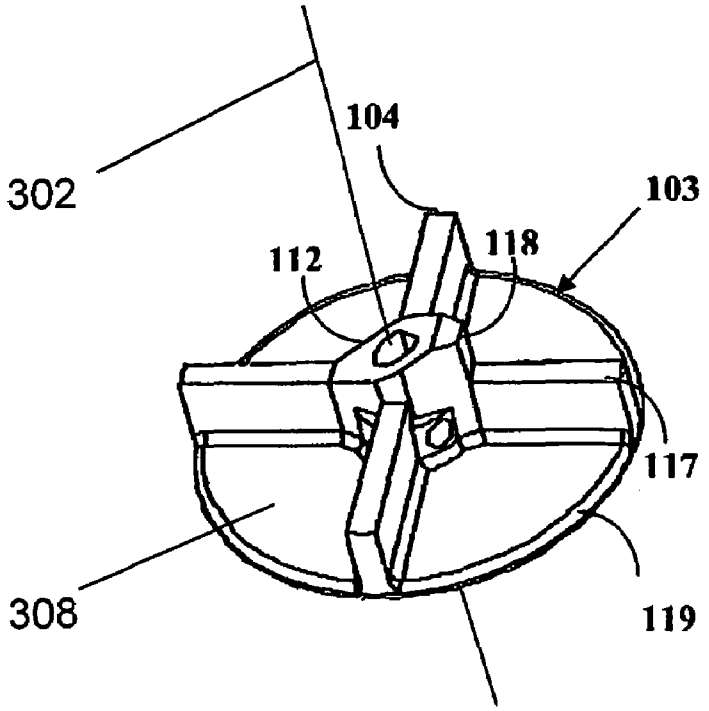


FIGURE 1B

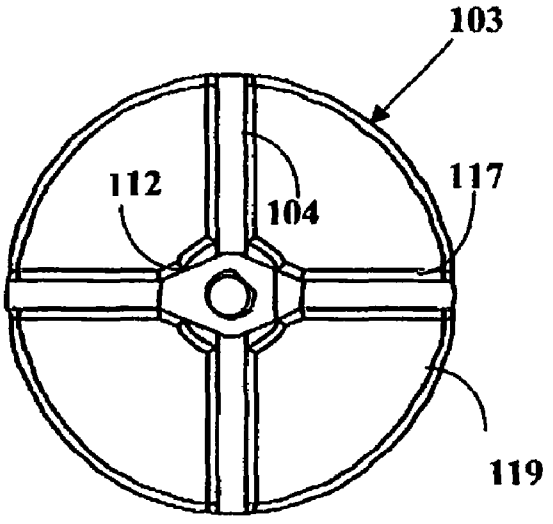


FIGURE 1C

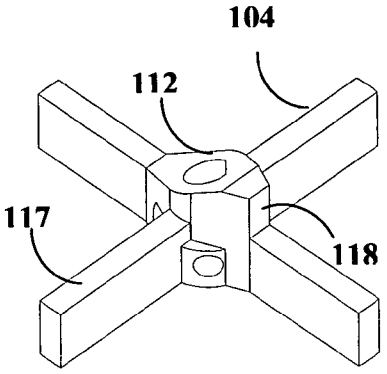
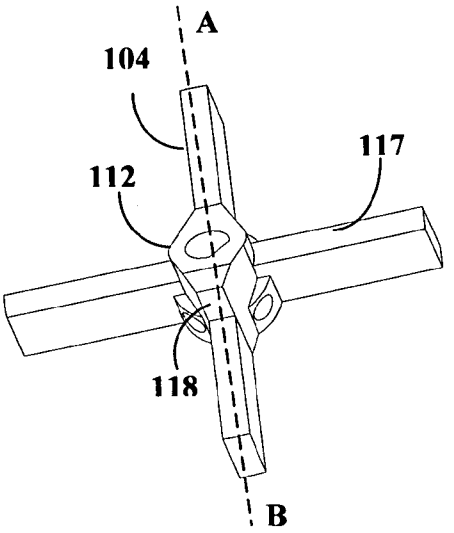


FIGURE 1D



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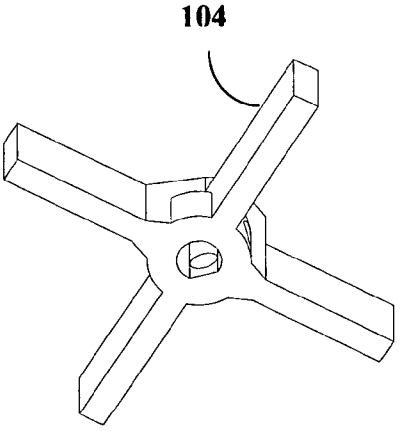

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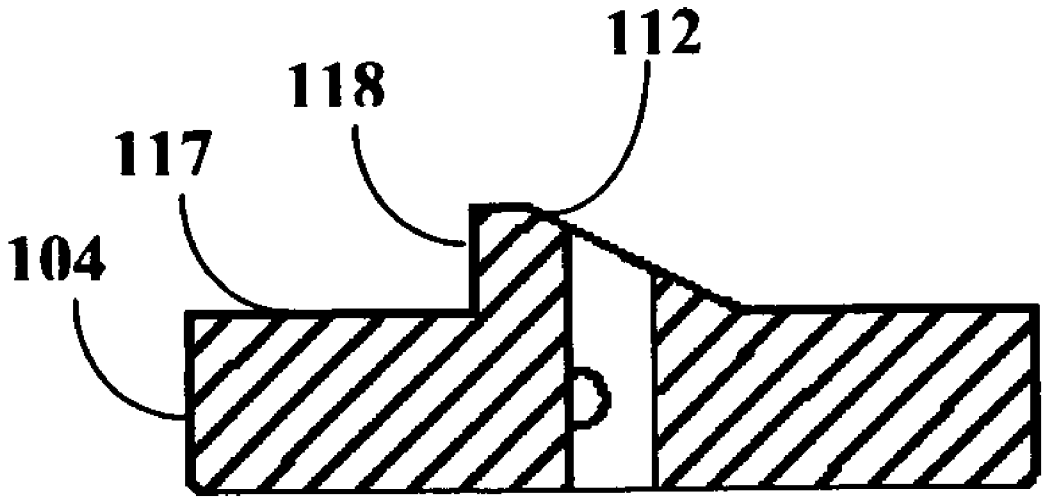


FIGURE 1G

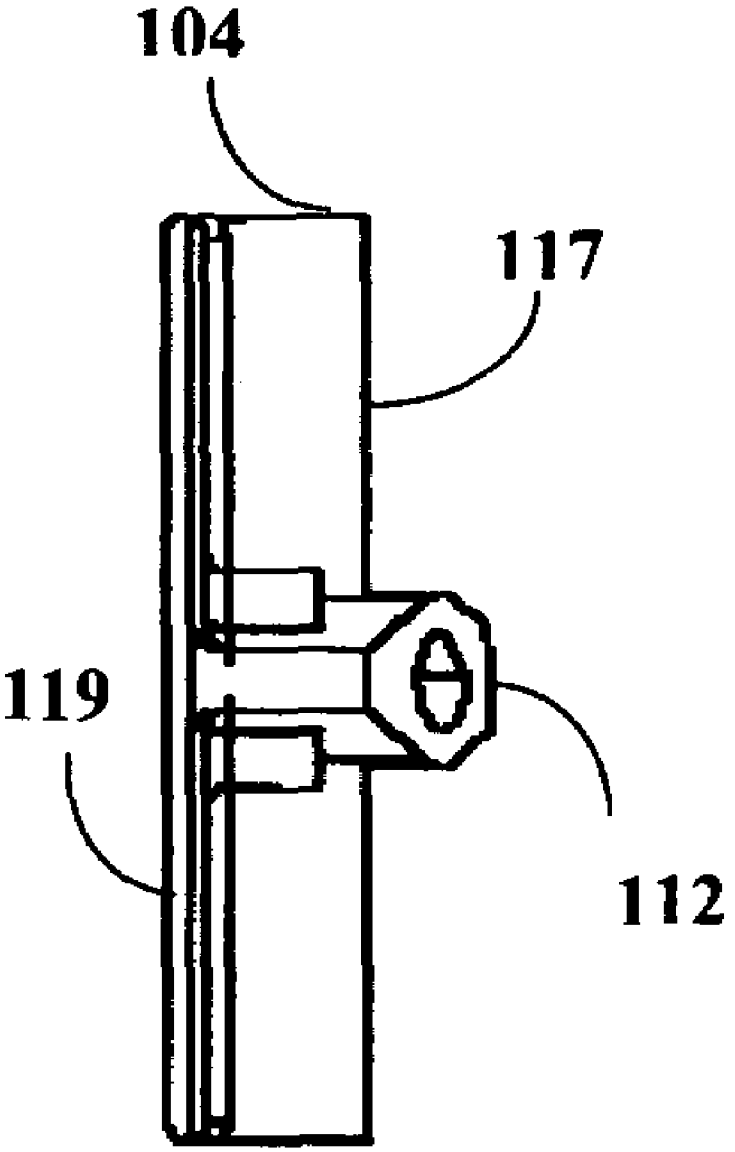


FIGURE 1H

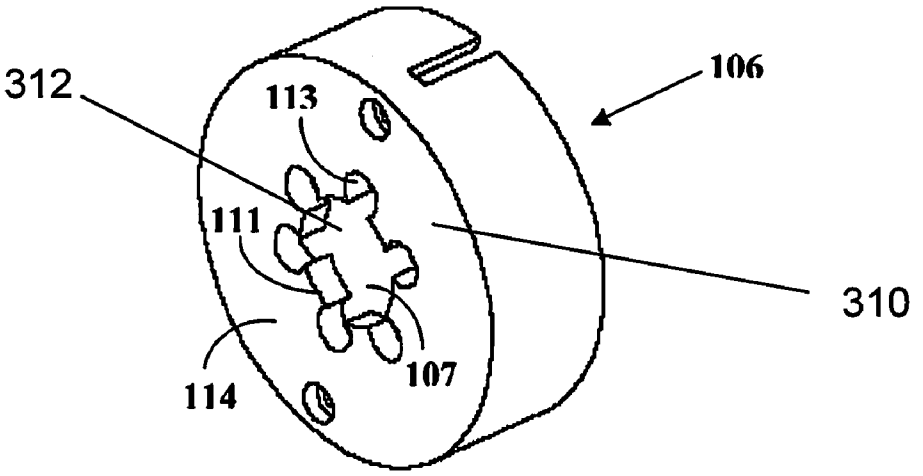
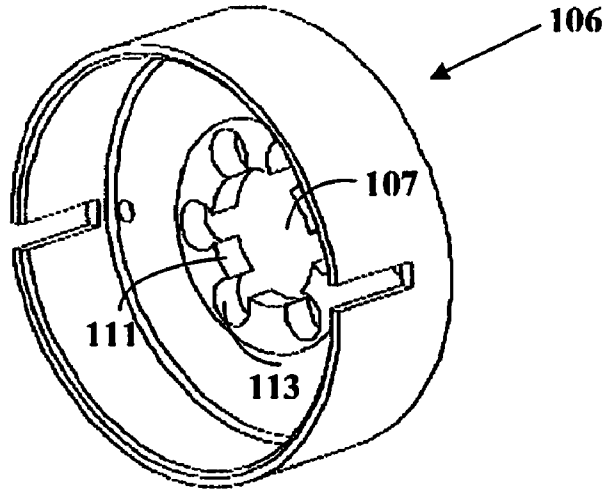


FIGURE 1I



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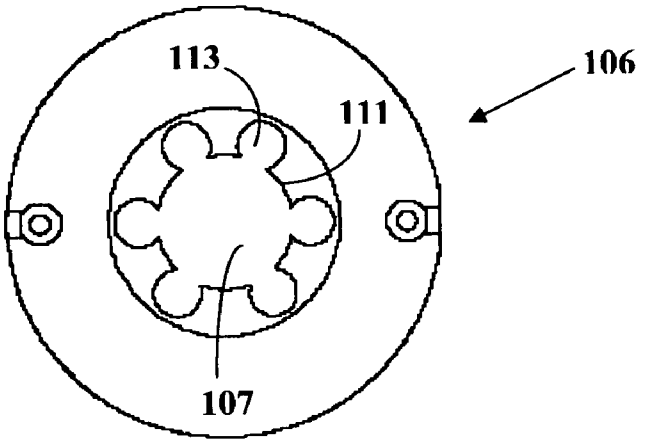

FIGURE 1K

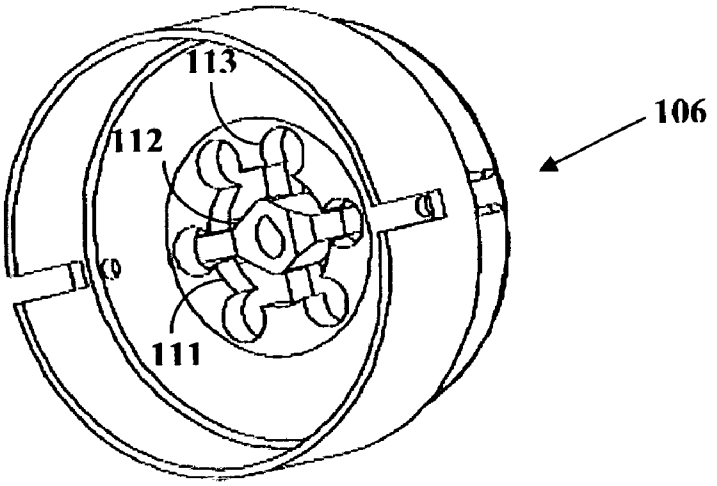

FIGURE 1L

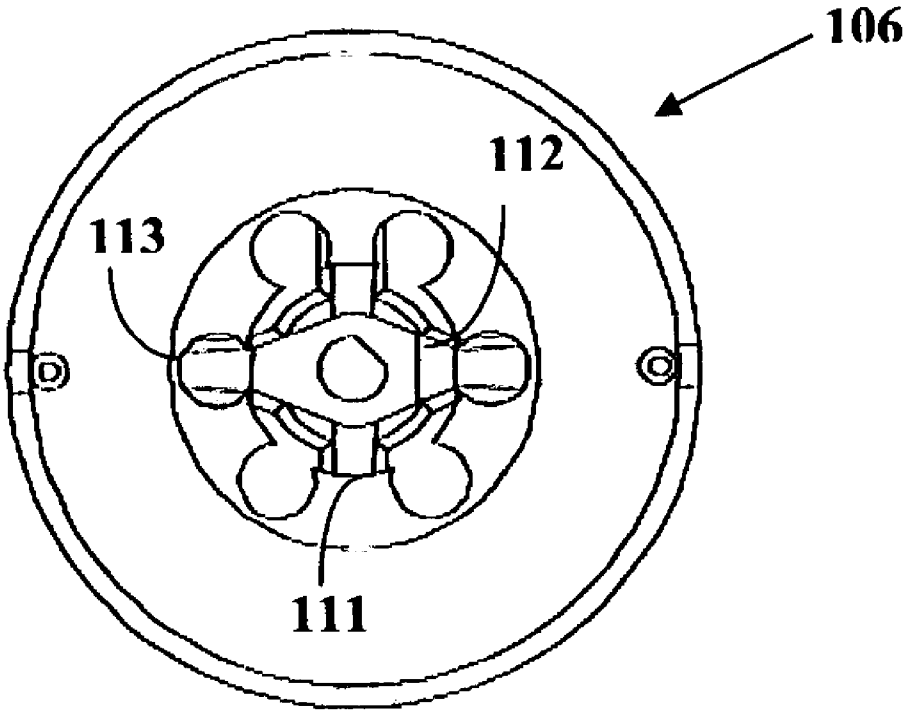

FIGURE 1M

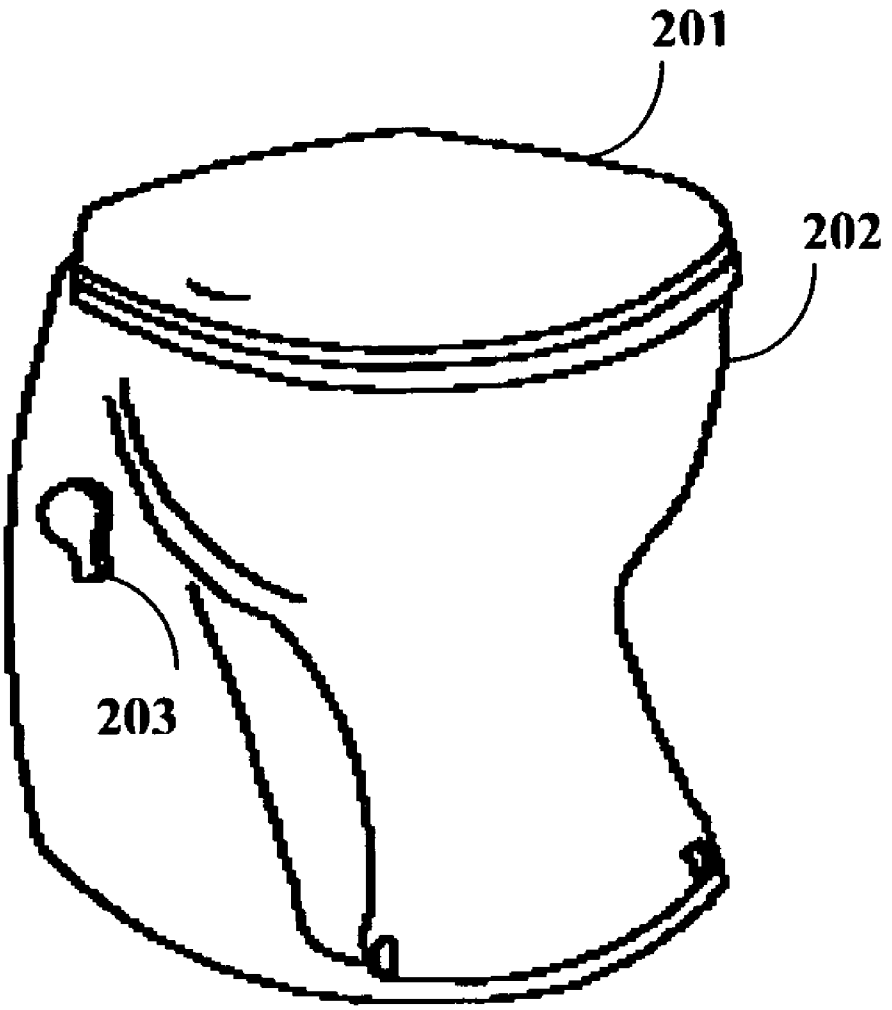

FIGURE 2A

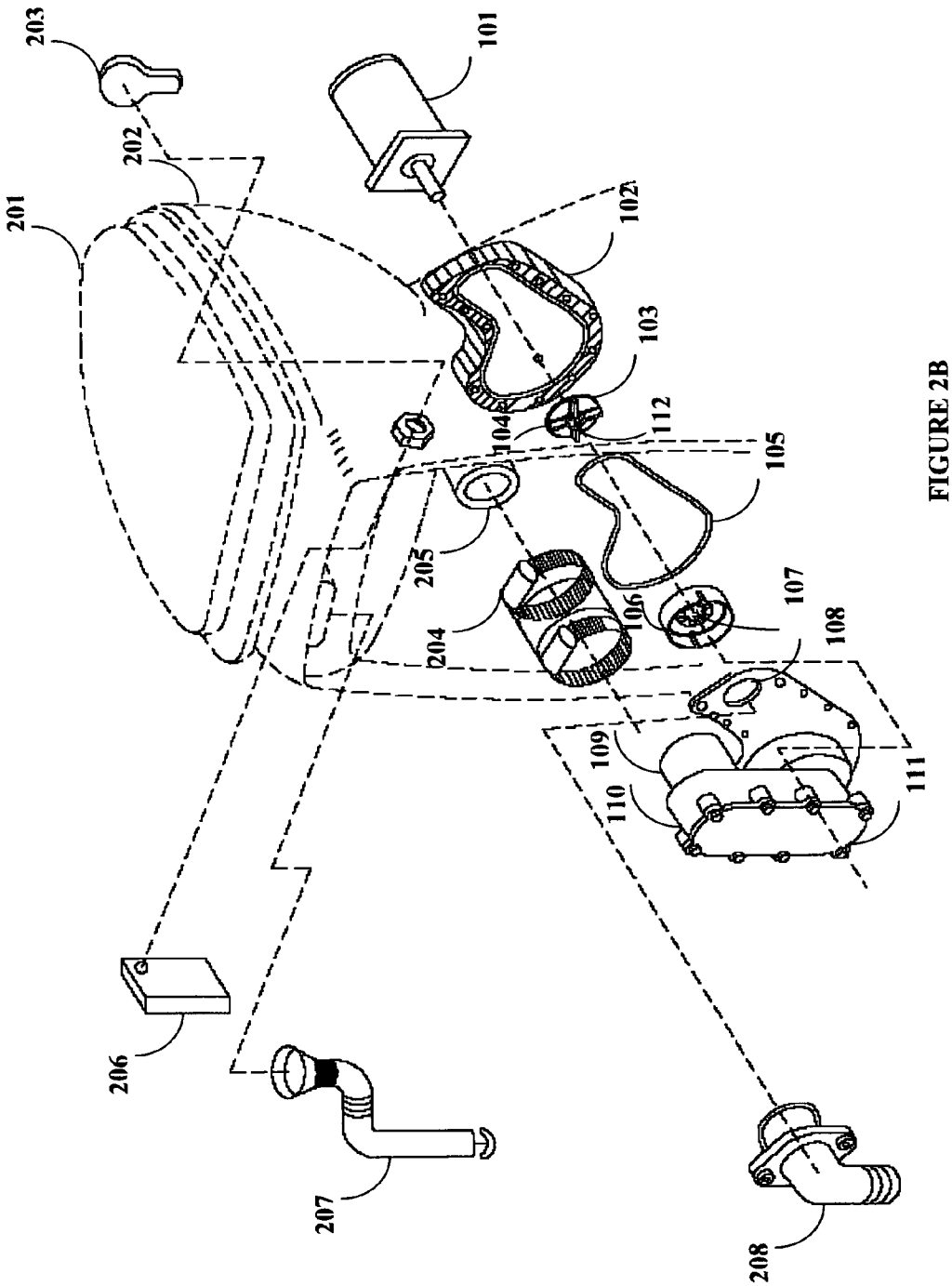
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FIGURE 2B

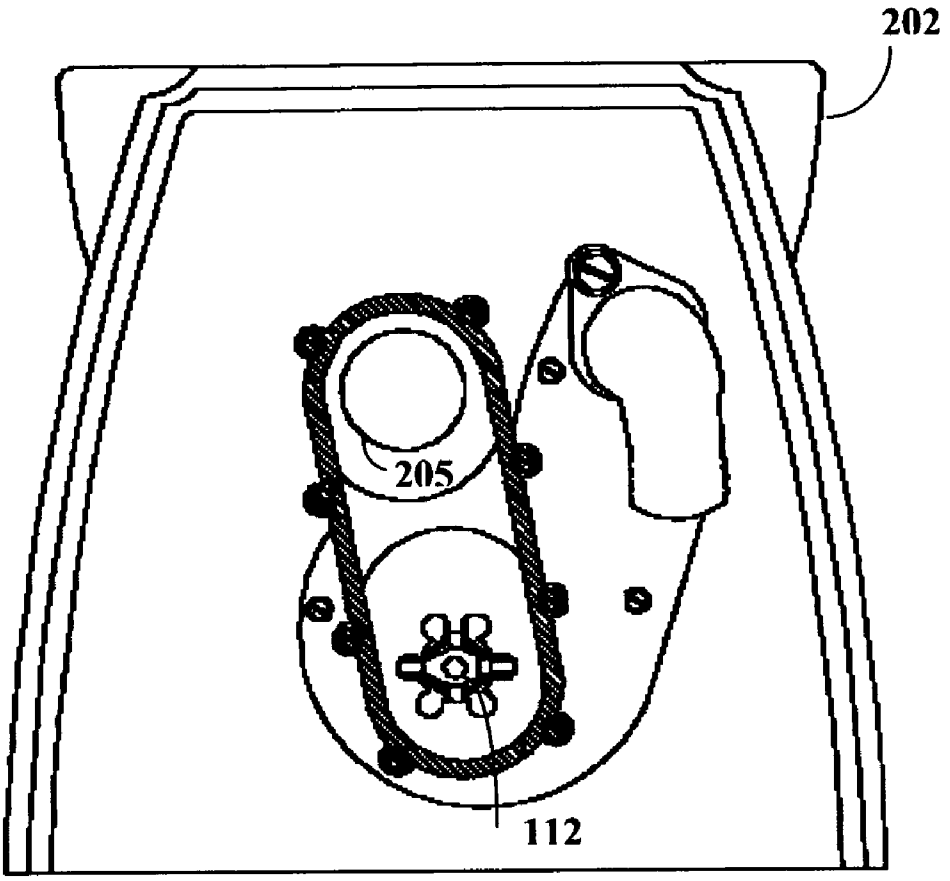

FIGURE 2C

NON-CLOG SHREDDER

BACKGROUND OF THE INVENTION

The present invention, in general, relates to a shredder for shredding semi-solid or particulate matter entrained in a non-homogenous liquid-solid flow. The shredder disclosed herein finds an application in process industries, for example in the ore, paper, pulp, food and fiber industries for macerating particulate or solid material in an incoming liquid-solid feed.

An example of the application of the shredder disclosed herein is in marine and recreational vehicle toilets. These toilets are designed to accept waste, such as human waste and toilet paper which can be easily flushed down the toilet. But if products such as feminine hygiene and diapers are discarded in the toilet, the toilet often clogs. Repeated attempts to flush such products down the toilet may eventually be successful but it results in excessive usage of fresh water. In one embodiment of the invention disclosed herein, the shredder is located downstream of the toilet bowl discharge line of a marine or recreational vehicle toilet to prevent clogging of toilets, especially when products such as feminine hygiene products and baby diapers are discarded in the toilet bowl.

In general, there is an unsatisfied market need for shredding solid matter in an incoming liquid-solid feed without clogging the line transporting such flow.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A illustrates the exploded view of the shredder.

FIG. **1**B illustrates the impeller assembly.

FIG. **1**C illustrates the plan view of the impeller assembly.

FIG. **1**D, FIG. **1**E and FIG. **1**F illustrate different isometric views of another embodiment of the impeller.

FIG. **1**G illustrates the sectional view of the impeller taken along section line A-B of FIG. **1**E.

FIG. **1**H illustrates the side elevation view of the impeller assembly.

FIG. **1**I illustrates the isometric view of the cup.

FIG. **1**J illustrates another isometric view of the cup.

FIG. **1**K illustrates the plan view of the cup.

FIG. **1**L illustrates the side elevation view of the cup.

FIG. **1**M illustrates an isometric view of the impeller assembly abutting the cup with the cutting blade projecting through the circular opening in the cup.

FIG. **2**A illustrates the perspective view of the self-contained toilet system.

FIG. **2**B illustrates the exploded view of the self-contained toilet system with the built-in shredder.

FIG. **2**C is a cross-sectional rear view of the self-contained toilet system with built-in shredder.

DETAILED DESCRIPTION OF THE INVENTION

The method and apparatus of this invention, including all its embodiments are herein referred to as a shredder.

FIG. **1**A illustrates the exploded view of the shredder **100**. The shredder housing **110** comprises an inlet line **109**, also referred to herein as inlet **109**, through which the liquid-solid feed enters the reservoir **116** located in the front section of the shredder housing **110**, a generally cylindrical cup **106** that is open at the upstream end with respect to the incoming liquid-solid flow and capped at the other end by a circular end-cap **114** with an axial opening **107** through which the cutting blade **112** projects in an upstream direction **306** into the cup **106**, an impeller assembly **103** mounted on a shaft **115**, and a motor **101** that drives the shaft **115**. The cup **106** including the end-cap **114** is stationary and does not rotate. Shaft **115** has an axis of rotation **302**.

An O-ring **105** on the discharge side of the shredder **100** provides a seal between the front section of the housing **110** and the rear section of the housing **102**.

FIG. **1**B illustrates one embodiment of the impeller assembly **103**. The impeller assembly **103** consists of impellers **104** rigidly affixed to the impeller plate **119** and extending radially from the center of the impeller plate **119** towards the circumference of the impeller plate **119** and perpendicular to the upstream face **308** of the impeller plate **119** with the cutting blade **112** located at the center of the impeller **104**. In one embodiment of the invention shown in FIG. **1**B, the impeller assembly **103** consists of two impellers **104** positioned at right angle to each other with an integrally machined or cast cutting blade **112**. In another embodiment of the invention, the cutting blade **112** may be cast separately from the impeller **104** and thereafter rigidly affixed to the impeller **104**. In the assembled position, the impeller assembly **103** is positioned with the impeller **104** adjacent to and abutting the downstream surface **310** of the end-cap **114** with the cutting blade **112** projecting through and upstream of the axial opening **107** in the end-cap **114**. With the shedder in operation, the cutting surface **118** of the cutting blade **112**, also referred to herein as the blade cutting surface **118**, shreds solid matter in the liquid-solid feed as the feed approaches the opening **107** in cup **106**. The surface **117** of the impeller **104**, also referred to herein as the impeller cutting surface **117**, rotates adjacent to and immediately downstream of the end-cap **114**. The relative motion of the impeller cutting surface **117** over the downstream surface **310** of the end-cap **114** in a shredding engagement shreds the solid matter in the liquid-solid feed at the downstream surface of the opening **107**, and in one embodiment of the invention where the opening has a plurality of recesses **113**, also at the downstream surface of the recesses **113**. The blade cutting surface **118** is oriented generally parallel to the axis of rotation **302** and the impeller cutting surface **117** is oriented generally normal to the axis of rotation **302**. The impeller assembly **103** is located in the housing **110** of the shredder **100**. The shaft **115** is connected at one end to the center of the impeller plate **119** and to the variable speed motor **101** at the other end. In one embodiment of the invention, impellers **104** shown in FIG. **1**D through **1**F are axially mounted at one end of the shaft **115**, with the other end of the shaft **115** connected to the motor **101**. In one embodiment of the invention, the speed of the motor **101** is adjustable. For example, the motor **101** speed may be adjusted to provide a cutting blade **112** rotational speed of approximately 2600 revolutions per minute.

FIG. **1**C illustrates the plan view of the impeller assembly **103** showing the impeller **104** and the cutting blade **112** at the center of the impellers **104**.

FIG. **1**D, FIG. **1**E and FIG. **1**F illustrates another embodiment of the invention where the impeller assembly comprises only the impeller **104** and the cutting blade **112**.

FIG. **1**G illustrates the sectional view of the impeller assembly **103** showing the impeller **104**, cutting blade **112**, cutting surface **118** and impeller surface **117** that abuts the downstream surface of opening **107** and recesses **113**.

FIG. **1**H illustrates the side elevation view of the impeller assembly **103**, the impeller **104**, cutting blade **112** and impeller plate **119** as shown in FIG. **1**B.

FIG. **1**I illustrates an isometric view of the generally cylindrical cup **106** that is open at one end and has a circular end-cap **114** at the other end. The end-cap **114** has an axial opening **107** opening that provides a conduit **312** for transfer

of the feed through the end-cap **114**. In one embodiment of the shredder, cutting teeth **111** are located along the circumference of the opening **107**. The axial opening **107** may be of any generally circular shape. In another embodiment of the invention, the opening **107** is in the shape of a circle with a plurality of recesses **113**. In another embodiment of the invention, cutting teeth **111** are located on the periphery of the opening **107**. In yet another embodiment of the invention, the cutting teeth **111** and recesses **113** are located alternately on the periphery of the opening. The relative motion of the section of the impeller blade **112** that projects through opening **107**, namely the blade cutting surface **118**, with respect the stationary cutting teeth **111** in a shredding engagement, shreds the solid material in the incoming liquid-solid feed as the feed moves through the opening **107**. The recesses **113** also provide a conduit for transfer of the incoming feed through the end-cap **114**.

FIG. **1**J illustrates another isometric view of the cup **106** showing the axial opening **107**, cutting teeth **111** and recesses **113** located along the periphery of the opening **107**.

FIG. **1**K illustrates the plan view of the cup **106** with the axial opening **107**, and the recesses **113** and cutting teeth **111** located along the periphery of the axial opening **107**.

FIG. **1**L and FIG. **1**M illustrates the impeller assembly **103** in the assembled position with the impeller assembly **103** adjacent to and abutting the end-cap **114** of cup **106** with the cutting blade **112** projecting through the opening **107** in cup **106**.

FIG. **2**A illustrates the perspective view of the self-contained toilet system, with the built-in shredder **100**. The toilet consists of a seat cover **201**, a hand lever **203** and a toilet bowl **202**.

FIG. **2**B illustrates an example of the exploded view of a self-contained toilet system with the built in shredder **100**. A seat cover **201** is positioned above the toilet bowl **202**. The shredder **100** is positioned below the toilet bowl **202**. An inlet port **109** accepts the contents of the toilet bowl **202** when the flush is actuated. The shredded waste is discharged through the outlet **108** of the shredder **100**. The flush can be either manually operated using a hand lever **203** control or electronically activated using an electronic timer control circuit **206** powered off a wall switch. A solenoid valve (not shown) regulates water consumption during each flush by controlling the inlet water pressure. The hand lever **203** operates a crank (not shown) that is connected to a crank lever. Micro-switches are placed in various locations with respect to crank lever positions. Multi-functional operation of the crank lever is achieved using these micro switches. The hand lever **203** also activates the flush. The electronic timer control circuit **206** sequences the flush by first bringing water in through the intake hose **207**, emptying the toilet bowl **202** and re-filling the water in the toilet bowl. A discharge connector **204** is connected to the inlet port **109** of the front section of the shredder housing **110**. The outlet **205** of the toilet bowl **202** is connected to the discharge connector **204**.

FIG. **2**C is a cross-sectional rear view of the self-contained toilet system with a built-in shredder **100** showing the outlet of the toilet bowl **205**, cutting edge **112**, the semi-circular recesses **113**, and the shredder outlet **108**.

When the motor **101** is turned on, the rotation of the impeller over the downstream surface **114** of the cup **106** acts as a centrifugal pump **304**, creating suction to effect the transfer of the incoming liquid-solid feed from the reservoir **116** located in the front section of the housing **110** through the opening **107**. As the feed moves towards and through the opening **107**, the solid material in the feed is shredded by the following: the cutting edge **118** of the rotating cutting blade **112**, the cutting surface **117** of the rotating impeller **104** as the solid material in the feed moves to a point immediately downstream of the opening **107** and the recesses **113**, and by the rotation of the impeller **104** with respect to the stationary cutting teeth **111** located on the periphery of the opening **107**. The centrifugal action of the impeller **104** throws the shredded feed to the rear section of the housing **102** from where the shredded waste is discharged through outlet nozzle **108** located at the upper part of the rear section of the housing **102**

In one embodiment of this invention, the apparatus comprises a toilet bowl **202**, a discharge opening at the bottom of said toilet bowl **205** and the shredder **100** positioned at the bottom of the toilet bowl **202**. When a flush hand lever **203** is actuated, the waste from the toilet bowl feeds through the shredder inlet line **109** to the upstream reservoir **116** located in the front section of the housing **110**. The outlet **108** of the shredder **100** is coupled to and in fluid communication with the exterior discharge opening of the toilet bowl **202**.

When the flush hand lever **203** is actuated, motor **101** is turned on and waste from the toilet enters the shredder **100** through the inlet line **109**. The cutting blade **112** rotates along the upstream surface of the stationary circular end-cap **114** to shred the incoming particulate matter in the liquid-sold feed. The feed containing the shredded particulate matter passes through the opening **107**; and, in one embodiment of the invention, through the opening **107** and recesses **113** located on the periphery of the opening **107**. The rotation of the impeller blades **104** creates suction to transfer the waste from the upstream reservoir **116** of the shredder to the outlet **108** of the shredder **100**. The shredder **100** shreds solid wastes such as feminine hygiene and baby diaper products in addition to human sewage and toilet paper. The shredded feed is discharged through the discharge nozzle **208**.

The following example illustrates the working of the shredder **100** in a toilet application. Ms. Jenny goes to a restroom to use the toilet facilities, and needs to dispose off a soiled sanitary napkin. She wraps the soiled sanitary napkin and puts it into the waste basket. Even though quite simple and cost-effective, this conventional method poses a threat of infection to other toilet users through atmospheric dispersal of microbial germs and such disposal also emits an unpleasant odor. If the restroom is equipped with the shredder, Ms. Jenny need not dispose it off in the wastebasket. She can flush the soiled sanitary napkin down the toilet bowl **202**. When the flush hand lever **203** is activated, a shredder **100** mounted inside the toilet bowl **202** is also activated. The rotation of the cutting blade **112** and the impeller **104**, and the rotation of the impeller **104** with respect to the cutting teeth **111** on the opening **107** shreds the soiled sanitary napkin inside the toilet bowl **202**, and the shredded waste is flushed out without clogging the toilet system.

What is claimed is:

1. A shredder for shredding solid matter in an incoming liquid-solid feed, the shredder comprising:

a housing;

an inlet defined by said housing for receiving the incoming feed;

an end-cap contained within said housing, said end-cap having a downstream surface, said end-cap defining an axial opening communicating through said end-cap, said axial opening in fluid communication with said inlet, said axial opening defining a conduit for transfer of the feed through said end-cap;

an impeller assembly located within said housing, said impeller assembly comprising:

a rotatable shaft having an axis of rotation, said axis of rotation being coaxial with said axial opening in said end-cap;

a circular impeller plate mounted axially on said shaft, said impeller plate having an upstream face;

a plurality of impellers attached to said upstream face of said impeller plate, said plurality of impellers extending radially about said axis of rotation of said rotatable shaft, said plurality of impellers, said rotatable shaft and said end-cap in combination defining a centrifugal pump, each of said plurality of impellers having an impeller cutting surface opposite to said upstream face of said impeller plate, each said impeller cutting surface being generally normal to said axis of rotation, said end-cap defining a plurality of recesses along a periphery of said axial opening of said end-cap, each said impeller cutting surface located adjacent to and abutting said end-cap downstream surface proximal to said plurality of recesses, wherein rotation of said impeller cutting surface proximal to said downstream surface of said end-cap defines a shredding engagement;

a cutting blade integrally affixed to said impellers and extending axially in an upstream direction from said impeller cutting surfaces, said cutting blade defining a blade cutting surface, said blade cutting surface oriented generally parallel to said axis of rotation and normal to said impeller cutting surfaces, said cutting blade projecting through said axial opening, said plurality of recesses and said axial opening in combination defining a plurality of stationary cutting teeth, wherein said plurality of recesses and said plurality of cutting teeth are located alternately along said periphery of said axial opening, said blade cutting surface defining a rotating motion proximal to said stationary cutting teeth, wherein said rotating motion of said blade cutting surface proximal to said stationary cutting teeth defining a shredding engagement within said axial opening; and

a motor connected to said shaft and configured to rotate said shaft.

2. The opening of claim **1** wherein said recesses are semi-circular, elliptical, or rectangular in shape.

3. The shredder of claim **1** wherein a speed of said motor is variable.

4. A shredder for shredding solid matter in a liquid-solid feed in a toilet system, comprising:

a toilet bowl;

an outlet defined by said toilet bowl;

a housing;

an inlet in said housing for receiving the incoming feed, said inlet being in fluid communication with said outlet;

an end-cap contained within said housing, said end-cap having a downstream surface, said end-cap defining an axial opening communicating through said end-cap, said axial opening being in fluid communication with said inlet, said axial opening defining a conduit for transfer of the feed through said end-cap;

an impeller assembly located within said housing, said impeller assembly comprising:

a rotatable shaft having an axis of rotation, said axis of rotation being coaxial with said axial opening in said end-cap;

a circular impeller plate mounted axially on said shaft, said impeller plate having an upstream face;

a plurality of impellers attached to said upstream face of said impeller plate, said plurality of impellers extending radially about said axis of rotation of said rotatable shaft, said plurality of impellers, said impeller plate, said rotatable shaft and said end-cap in combination defining a centrifugal pump, each of said plurality of impellers having an impeller cutting surface opposite to said upstream face of said impeller plate, each said impeller cutting surface being generally normal to said axis of rotation, said end-cap defining a plurality of recesses along a periphery of said axial opening of said end-cap from said upstream surface to said downstream surface, each said impeller cutting surface being located adjacent to and abutting said end-cap downstream surface proximal to said plurality of recesses, wherein rotation of said impeller cutting surface proximal to said downstream surface of said end-cap defines a shredding engagement;

a cutting blade integrally affixed to said impellers and extending axially in an upstream direction from said impeller cutting surfaces, said cutting blade defining a blade cutting surface oriented parallel to said axis of rotation and normal to said impeller cutting surfaces, said cutting blade projecting through said axial opening, said plurality of recesses and said axial opening in combination defining a plurality of stationary cutting teeth, wherein said plurality of recesses and said plurality of cutting teeth are located alternately along said periphery of said axial opening, said blade cutting surface defining a rotating motion proximal to said stationary cutting teeth, wherein said rotating motion of said blade cutting surface proximal to said stationary cutting teeth defining a shredding engagement within said axial opening; and

a motor connected to said shaft and configured to rotate said shaft.

5. The shredder of claim **4** wherein said recesses on said opening in said end-cap are semi-circular, elliptical, or rectangular in shape.

6. The shredder of claim **4** wherein a speed of said motor is variable.

* * * * *