

PILL CRUSHING SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to pill crushing systems, and more particularly relates to a pill chip guard which acts to inhibit pill chips from escaping the pill crushing chamber during the pill crushing operation. In another aspect, the invention relates to nestable cups having improved pill crushing features and interfacing dimensions which inhibit migration of the powdered pill material from reaching the top perimeters of the cups.

The grinding or crushing of pills into powder form may be necessary when, for example, the person has trouble swallowing whole pills due to throat problems. This is a common need in nursing homes and hospitals. While the very first pill crushing device was most likely the mortar and pestle (which is still used today), more technologically advanced pill crushing devices have been developed over the years (manually or electrically driven) which have various designs that offer advantages over the mortar and pestle, such as making the pill crushing operation quicker, easier and safer (e.g., by preventing cross-contamination between different Rx pills ground in succession), for example.

Some pill crushing devices utilize a pair of disposable cups which may be nested together with the pill located therebetween. As one cup is rotated relative to the other cup, the pill is ground into a powder. The top cup is removed, leaving the powdered pill inside the bottom cup. An additive such as juice or applesauce, for example, may be added to the cup and mixed with the powder to form a liquid or slurry which the patient may more easily swallow. An example of such a nested cup pill crushing device may be seen in commonly owned U.S. Patent Publication No. US 2012/0160946, the entirety of which is incorporated herein by reference. While the device of the '946 publication provides advances over the prior art, there remains a possibility that some pill chips may unintentionally escape from between the cups during the crushing operation. It would furthermore be desirable to improve the crushing of the pills into a finer powder to ensure uniform mixing with the liquid additive and ease of swallowing. It would be yet furthermore desirable to provide nesting cups having differing geometries which interface in a manner inhibiting the migration of the fine powder from reaching the top perimeters and spilling out from between the nesting cups.

SUMMARY OF THE INVENTION

In one aspect, the present invention addresses the above concern of pill chips escaping from between the cups by providing a chip guard positioned to physically block pill chips

from exiting between the nested cups during the pill crushing operation. In another aspect, the present invention provides improved nested cup designs which enhance distribution of the pill material between the facing surfaces of the cups during the crushing operation, yet also inhibit the migration of the fine powder from reaching the top open perimeters of the nesting cups. Forcing the pill material as it is being crushed to spread out between a larger surface area increases the amount of pill material subjected to the frictional grinding forces of the nested cups and thereby forms a finer powder than achieved by prior art nested cup designs. Furthermore, including interfacing cup geometries which inhibit migration of the fine powder to the open cup perimeters prevents the loss of pill material from between the open edges of the cups.

In an embodiment, the present invention provides a pill crushing machine having a bottom cup holder positioned in a main housing and a top cup holder positioned on the inside of a lid hinged to the main housing. A pair of nestable cups are provided for removable placement in the pill crushing machine. The bottom cup is placed upon the bottom cup holder with the pills to be crushed placed inside the bottom cup. The top cup is nested inside the bottom cup with the pills located between the nested bottom and top cups and the lid is moved to the closed position. The machine is activated causing the bottom cup to rise up against and then rotate relative to the stationary top cup. The resultant forces and friction between the bottom and top cups cause the pills located therebetween to be crushed and ground into a powder. The lid is then opened whereupon the top cup is separated from the bottom cup wherein the pill powder is located. A liquid food additive such as juice, applesauce, pudding or the like may be mixed with the powder to form a slurry and given to the patient in a now more easily swallowed form. While described as having a rotating bottom cup and stationary top cup, it is envisioned that a machine can operate in an inverse relation wherein the top cup rotates and the bottom cup is stationary.

In the preferred embodiment, the pill crushing machine biases the nested cups toward one another. As the pills undergo the crushing operation, they begin to crack and pulverize into smaller and smaller particles that migrate radially outwardly along the facing surfaces of the cups and, depending on the amount of pill material to be crushed, potentially also up the facing side walls of the cups toward the open top perimeters thereof. In the nested condition, a small gap may exist between the open top perimeters of the bottom and top cups. This creates an area where through pill particles may escape from between the cups. This is undesirable in that any portion of the pills being crushed that do not remain in the cup are lost

and the prescribed dose is thereby being unknowingly reduced which could potentially result in adverse health effects on the patient.

The present invention provides a pill crushing machine with a physical barrier at the location of the nested cups perimeter gap which acts as a “chip guard” to inhibit the escape of pill particles through this gap. In a preferred embodiment, the chip guard is in the form of a ring which is movable between an active guard position and a retracted cup access position allowing easy access to the nested cups into and out of the machine. In the active guard position, the ring wall encircles and lies in close proximity to the gap between the nested cups top perimeters, thereby forming a physical barrier to pill particles which may otherwise escape from between the cups at this gap.

In yet a further embodiment, the present invention provides a pair of nestable cups for a pill crushing machine wherein the bottom cup and top cup have different side wall angles to promote improved pill crushing and inhibit migration of the powdered pill material from reaching the open gap between the cup top perimeters. The respective cup dimensions are selected so as to cause more pronounced migration of the pill particles in a radially outward direction along the facing cup walls. Radial and even migration of the pill particles between the cups is desirable in that the more cup surface area that is actively grinding against the pill particles, the more pill particles will be subject to continuous grinding which results in a finer (smaller) resultant particle size. The finer the resultant powder, the better the powder will mix with the liquid food additive which will be easier to swallow for the patient than a mixture having larger pill particles therein. Furthermore, since the interfacing geometries of the nested cup side walls are such as to inhibit the fine powder from reaching the open top perimeters of the cups, the full amount of finely powdered pill material stays between the cups, and within the bottom cup.

DESCRIPTION OF THE DRAWING FIGURES

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become apparent and be better understood by reference to the following description of the invention in conjunction with the accompanying drawing, wherein:

FIG. 1 is a perspective view of the main housing body;

FIG. 2 is a perspective view of the underside of the lid;

FIG. 3A is a perspective view to an embodiment of the pill crushing machine without the main body housing;

FIG. 3B is a front elevational view thereof;
FIG. 3C is a side elevational view thereof;
FIG. 3D is a top plan view thereof;
FIG. 4 is a cross-sectional view thereof as taken generally along the line 4-4 of FIG. 3D;
FIG. 5 is an exploded, elevational view thereof;
FIGS. 6A-6D are views of the top cup;
FIGS. 7A-7D are views of the bottom cup;
FIGS. 8A and 8B are side elevational views of the top and bottom cups in their nested condition at the beginning of the pill crushing operation and near the end of the pill crushing operation, respectively;
FIGS. 9A and 9B are enlarged, upper and lower end perspective views, respectively, of the rotator base element,;
FIGS. 10A and 10B are enlarged, upper and lower end perspective views, respectively, of the second base element;
FIG. 11 is a perspective view of the first axial translation element;
FIG. 12 is a perspective view of the second axial translation element;
FIG. 13 is a perspective view of the bottom cup holder;
FIG. 14 is a perspective view of the second axial translation element; and
FIG. 15 is an enlarged, fragmented, perspective view of a prong element.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawing, there is seen in the figures a pill crushing machine designated generally by the reference numeral 10 having a main housing body 12 and lid 14 which is hinge connected to housing body 12 via hinge elements 12a and 14a (see Figs. 1 and 2). While the housing body 12 seen in Fig. 1 is not shown in the remaining figures for the sake of clarity, it is understood that it would extend between base 13 and lid 14 (see Figs. 3A-5).

As seen in Figures 5, 6A-6D, 7A-7D, and 8A and 8B, a pair of nestable cups 16 and 18 are provided for use with machine 10 which are preferably single use and formed of a suitable plastic. In a preferred embodiment shown, bottom cup 16 and top cup 18 have different dimensions, with top cup 18 (which nests inside bottom cup 16 with pills "P" to be crushed deposited therebetween as seen in Fig. 8A) being overall generally smaller and having side walls 18a and 18b (which meet at line 18L) which are straight in the direction

from lower wall segment 18b to upper perimeter flange 18c (seen best in the cross-section of Fig. 6D and 8A and 8B). Upper wall segment 18a extends at an angle A1 of about 100° with respect to perimeter flange 18c, and lower wall segment 18b extending at an angle A2 of about 170° with respect to upper wall segment 18a. Rather than being straight, upper wall segment 16a of bottom cup 16 includes having an outwardly curved surface having a radius of about 1.380mm and a lower wall segment 16b (which meets upper wall segment 18a at line 18L) having an inwardly curved surface having a radius of about 1.662mm. The inwardly curved lower wall segment 16b interfaces closely with top cup lower segment wall 18b to promote fine grinding of the pill particles therebetween while the outwardly curved surface of bottom cup upper wall segment 16a interfaces with the sharper angled (i.e., more vertically inclined than the lower wall segment) straight upper wall segment 18a of top cup 18 so as to create a large enough space to inhibit pill powder migration as explained further below. The cup bottom walls 16d and 18d are of a non-planar configuration and include a radial pattern of fluted sections 16d' and 18d', respectively. Top cup perimeter flange 18c includes a plurality of annularly spaced, upwardly-facing (in a direction away from bottom wall 18d) protrusions 18e, and bottom cup perimeter flange 16c includes a plurality of annularly spaced, downwardly-facing (in a direction toward bottom wall 16d) protrusions 16e, the purpose of which is described below.

Lid 14 includes a top cup holder 20 having a geometry complimentary to the geometry of the respective inside surfaces of the top cup 18 to be removably placed thereon which thus forms a mating fit between the two when the top cup 18 is removably mounted onto the top cup holder 20. In a further preferred embodiment, a spring loaded plunger 21 may be provided at approximately the center of top cup holder 20 which biases the top cup 18 against the bottom cup 16 when the lid is closed. To prevent rotation of top cup 18 during the pill crushing operation, top cup protrusions 18e may be aligned and engaged with complementary spaced, respective recesses 20a formed about the perimeter of top cup holder 20 (see Fig. 2).

Bottom cup 16 may be removably positioned within complementary shaped bottom cup holder 22. To ensure that bottom cup 16 will rotate together with bottom cup holder 22 during the pill crushing operation, bottom cup protrusions 16e may align with and be engaged with complementary spaced respective recesses 22a formed about the perimeter of bottom cup holder 22.

Bottom cup holder 22 (Figs. 3-5 and 13) includes a bottom wall 22a, side wall 22b and top perimeter edge 22c having a plurality of annularly spaced recesses 22d which may align with and engage protrusions 16e of bottom cup 16 when placed therein. Bottom cup holder 22 fits within the complementary shaped center recess 24a of rotator base element 24 (see also Figs. 9 A and 9B). Rotator base element 24 includes a lower wall segment 24b which is radially spaced from a center stem 24c having a plurality of annularly spaced vanes 24d extending radially outwardly therefrom (see Fig. 9B). Bottom cup holder 22 includes a plurality of annularly spaced rib elements 22e which may align with and engage a like plurality of annularly spaced openings 24e formed along the lip 24f and extending partly down the side wall 24g thereof (see Fig. 9A). As such, bottom cup holder 22 is rotationally fixed to rotator base element 24.

Rotator base element 24 may be rotationally fixed to a second base element 26 via vanes 24d aligning with and fitting within respective walled slots 26b which radially extend from center aperture 26a (see Figs. 4, 9B and 10A). Second base element 26 includes a lower annular wall segment 26c defining a center bore 26d (see Fig. 10B). A third base element 36 (see Figs. 4, 5 and 12) includes a center stem portion 36c which telescopes into center bore 26d of second base element 26. As seen best in Fig. 12, third base element 36 further includes a ring element 36a which lies concentrically radially outwardly of center stem portion 36c which forms an annular channel 36d therebetween. With center stem portion 36c inserted into center bore 26d, annular wall segment 26c resides within annular channel 36d (see Fig. 4).

Third base element is seen to further include a shoulder portion 36b and stem portion 36e having a center bore 36g into which the output shaft of a drive motor (not shown) positioned there beneath may extend. Shoulder portion 36b is further seen to taper in a spiral fashion from a minimum width portion 36b' to a maximum width portion 36b'' which forms a step 36b''' for reasons explained below.

A first axial translation element 30 having internal threads 30a, terminating on both ends at thread ledges 31a and 31a' (Fig. 11), and external splined surface 30c (see Figs. 4, 5 and 11) is fixed to second base element 26, e.g., via screws passed through holes 30b which align with respective holes 26f (see also Fig. 10B). A second axial translation element 34 is provided having threads 34a on the outer wall surface thereof and terminating in a ledge portion 34b (Fig. 14) at one end and at a stop portion 34d (Fig. 5) at the opposite end. The lower surface 34c is seated against shoulder portion 36b of third base element 36 (Fig. 12) with ledge portion 34b abutting step 36b' ". Second axial translation element 34 resides within first axial translation element 30 with threads 30a engaging threads 34a (see Fig. 4).

Third base element stem portion 36e extends into a center bore 40a of a housing mount 40 with stem clips 36f (Fig. 12) engaging and fixing third base element 36 to mount 40. Shoulder portion 36b is thus seated upon ledge 40b of housing mount 40. First axial translation element 30, second base element 26, second axial translation element 34, and third base element 36, when connected accordingly (discussed above) define a cup holder fixture.

A chip guard 50 (Figs. 4 and 5) is provided which encircles the nesting cups 16, 18 within machine 10. In Fig. 4, cups 16, 18 are not shown for the sake of clarity, but would reside in the space "S" between top cup holder 20 and bottom cup holder. The juncture of the cup perimeters wherein gap "G" is formed (Fig. 8) would reside in area indicated by reference arrow SG in Fig. 4. With chip guard wall segment 50a located radially outwardly of space SG, any pill fragments "F" which could otherwise escape through this area are physically blocked by the chip guard.

In a preferred embodiment, chip guard 50 has a length extending from top cup holder base wall 20a to a position along rotator base element outer side wall 24e. A ring element 52 is provided which attaches to chip guard 50 via clips 50b integrally formed in the chip guard 50. One or more spring loaded plunger elements 54 connect ring 52 to second base element 26 at holes 26'. As such, spring loaded plunger elements 54 act to bias ring 52 and hence also chip guard 50 toward and against top cup holder base 20a. If desired, one or more notches 50c may be provided adjacent the top edge 50d which provide open access to the nested cups. In an alternate embodiment, plunger elements 54 may be electronically controlled whereby they may be signaled to retract when desired which acts to pull ring 52 and chip guard 50 down (toward housing base 13). The retracted position of chip guard 50 would provide access to the cup sitting in bottom cup holder 22.

In yet another embodiment, chip guard 50 may be fixed to and move together with lid 14 such that when lid 14 is opened, chip guard 50 is lifted away from bottom cup holder 22. Likewise, when lid 14 is closed in preparation for pill crushing operation, guard 50 is lowered into its physical blocking position adjacent gap G.

To crush one or more pills, bottom cup 16 is placed in bottom cup holder 22. Pills "P" are placed inside bottom cup 16 and a top cup 18 is placed (nested) inside bottom cup 16 with the pills P located therebetween (Fig. 8). Lid 14 is closed and latched at 15 (Figs. 3A-3D). The motor (not shown) is activated which rotates third base element 36 as described above. Referring to Fig 12, rotation of third base element 36 in a clockwise direction "CW" causes step 36b" to push against ledge portion 34b which causes rotation of second axial translation element 34 in the same direction. First axial translation element 30 is prevented from rotating

with second axial translation element 34 due to one or more prongs 31 which extend from ledge 40b of housing mount 40.

As seen best in Fig. 14, each prong 31 includes a radially inward extension 31a which terminates in a splined face 31b. Splined face 31b meshes with the splined surface 30c of first axial translation element 30 and, since the splines extend in a longitudinal direction (parallel to housing axis X-X), first axial translation element 30 is prevented from rotating while splined face 31b is in meshing engagement with splined surface 30a. However, since first axial translation element 30 is threadedly engaged to second axial translation element 34 as explained above, first axial translation element 30 will ride along the threads in an upward, axial direction toward lid 14 until thread ledge 31a' releasably engages stop portion 34d to apply a brake. And since bottom cup holder 22 is rotationally fixed to second base element 26, which in turn is rotationally fixed to rotator base element 24, which in turn is rotationally fixed to bottom cup holder 22, they too will all rotate together with bottom cup holder 22 while translating in the same upward, axial direction. This axial translation presses bottom cup 16 up against top cup 18 (which itself is biased toward bottom cup 16 by spring loaded plunger 21 as described above).

Spring 56 extends between rotator base element 24 and second base element 26 to provide additional biasing force of bottom cup holder 24 in the upward direction toward lid 14. This upward, linear force may act to first crack pills P located between the nesting cups. Once splined surface 30a is clear of splined face 31b, first axial translation element 30 is free to rotate together with second axial translational element 34. With bottom cup holder interconnected with first axial translation element 30, it too will rotate and cause bottom cup 16 to rotate since they are rotationally fixed together.

As discussed above, top cup 18 remains rotationally fixed via engagement of protrusions 18e with recesses 20a in lid 14. As such, bottom cup 16 rotates against and with respect to top cup 18 which provides a crushing and grinding action upon the pills P located therebetween. As seen in Figs. 8A and 8B, while the crushed pill particles are allowed to migrate in a radially outward direction, and potentially also up between the side walls 16b, 18b of the top and bottom cups, any pill chip fragments "F" (Fig. 8A) are physically blocked from escaping through gap G by chip guard 50 in the manner explained above. Of course as the pills are being ground into ever smaller particles, the cups begin to move closer together due to the bias forces discussed above. Fig. 8B illustrates the cups very close together at a point near or at the end of the pill crushing operation. The side wall spacing "SWS" between the nesting cups tapers outwardly in a direction toward the cups' top perimeters with the fine

pill powder material “PPM” migrating upwardly through this space. The enlarging side wall spacing “SWS” creates enough open area so as to allow the leading edge “LE” of the powdered pill material “PPM” to continuously cascade back down into the cup during the crushing operation such that the powder pill material “PPM” never reaches the cup open top perimeter.

While this method and apparatus has been shown and described with reference to certain preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as described.

What is Claimed is:

1. Pill crushing apparatus for use with first and second nestable cups, said apparatus comprising:

- a) a first cup holder configured to removably hold said first cup;
- b) a cup holder fixture axially aligned with said first cup holder;
- c) a rotator base element axially aligned with said cup holder fixture opposite said first cup holder, said rotator base element operably engaged with said cup holder fixture such that said cup holder fixture and said rotator base element may translate linearly with respect to each other;
- d) a second cup holder axially alignable with said first cup holder opposite said cup holder fixture and configured to releasably engage said second cup; and
- e) a chip guard adapted to encircle the perimeters of said nestable cups;

whereby, upon rotation of said rotator base element, said cup holder fixture translates said first cup holder into engagement with said second cup holder thereby causing said cup holder fixture to rotate with respect to said second cup holder and thereby imparting a grinding force against pills held between said first and second cups, and wherein said chip guard prevents ground pill material from escaping through a gap formed at the juncture of said nestable cup perimeters.

2. The apparatus of claim 1 and further comprising a spring between said cup holder fixture and said first cup holder, said spring becoming gradually compressed as said cup holder fixture moves toward and engages said first cup holder.

3. The apparatus of claim 1 and further comprising a drive shaft connected to and operable to rotate said rotator base element.

4. The apparatus of claim 1 and further comprising a housing and a lid movable between an open and closed position with respect to said housing, said second cup holder located on said lid and axially aligned with said first cup holder when said lid is in said closed position.

5. The apparatus of claim 1 wherein:

- a) said cup holder fixture further includes a first set of threads;
- b) said rotator base element further includes a second set of threads which mesh with said first set of threads on said cup holder fixture such that said cup holder fixture and said rotator base element may translate linearly with respect to each other; and
- c) a brake configured to be releasably applied to said cup holder fixture;

whereby, upon rotation of said rotator base element and when said brake is not applied to said cup holder fixture, said cup holder fixture translates linearly along said rotator base element toward said first cup holder moving said first cup holder into engagement with said second cup holder and causing said brake to be applied to the cup holder fixture and thereby allow said cup holder fixture to rotate with respect to said second cup holder and thereby impart a grinding force against pills held between said first and second cups.