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**Sorensen**

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(54) **FLOW-THROUGH AGITATOR**

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Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(52) **U.S. Cl.** ..... **366/130**; 366/342

(58) **Field of Search** ..... 36/342, 343, 336, 36/129, 130, 348, 349, 605, 607, 241; 206/220, 219; 165/DIG. 529, DIG. 530; 261/DIG. 72

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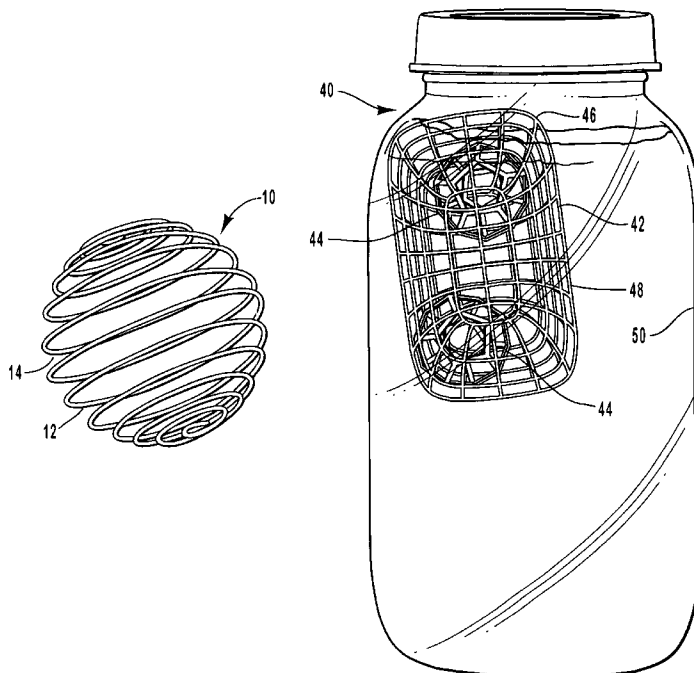
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(57) **ABSTRACT**

The present invention relates to apparatus and methods for improved mixing of powder and liquid mixtures through the use of flow-through agitator apparatus. The apparatus of preferred embodiments of the present invention comprises a wire-frame object with interstitial spaces which allow flow of liquids and powders into and out of the interior of the wire-frame object. Some embodiments further comprise and interior agitator placed within the wire-frame object which may be a solid shape or another wire-frame object.

**23 Claims, 3 Drawing Sheets**



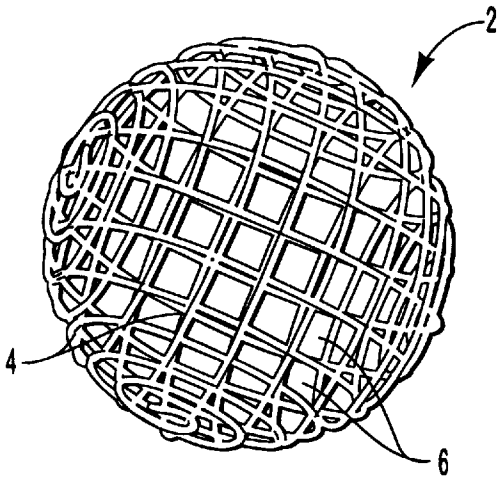


FIG. 1

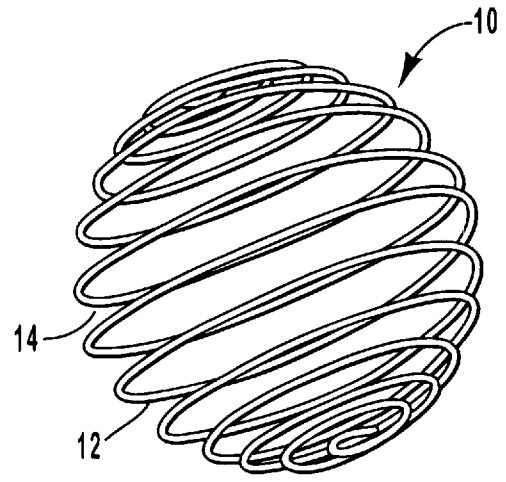


FIG. 2

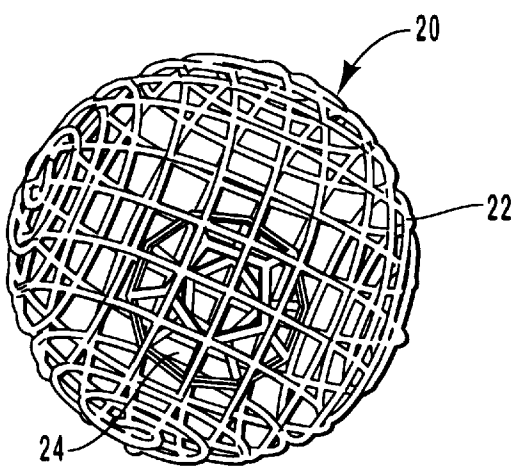


FIG. 3

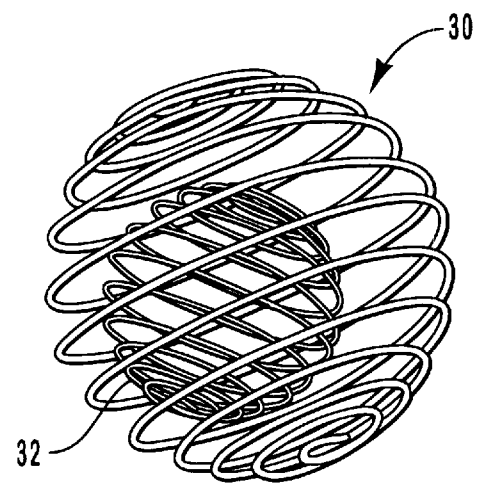


FIG. 4

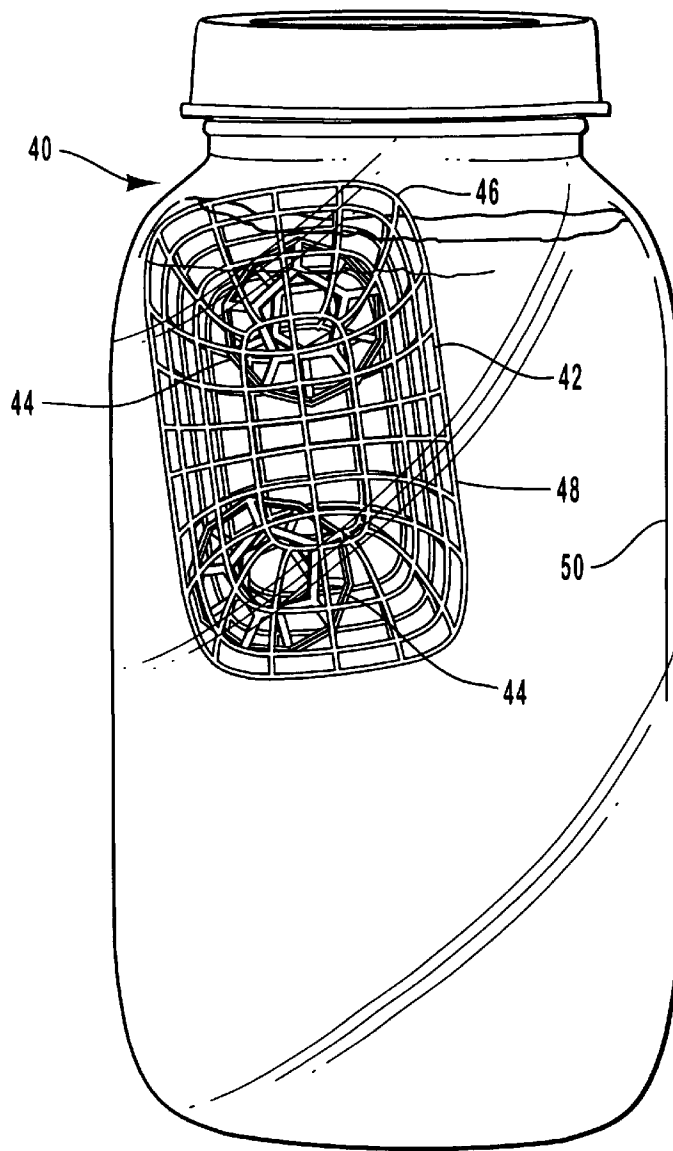


FIG. 5

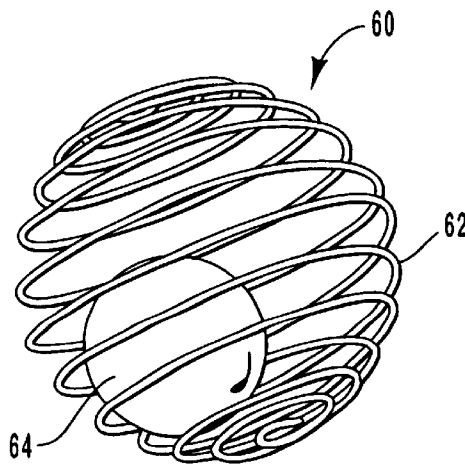


FIG. 6

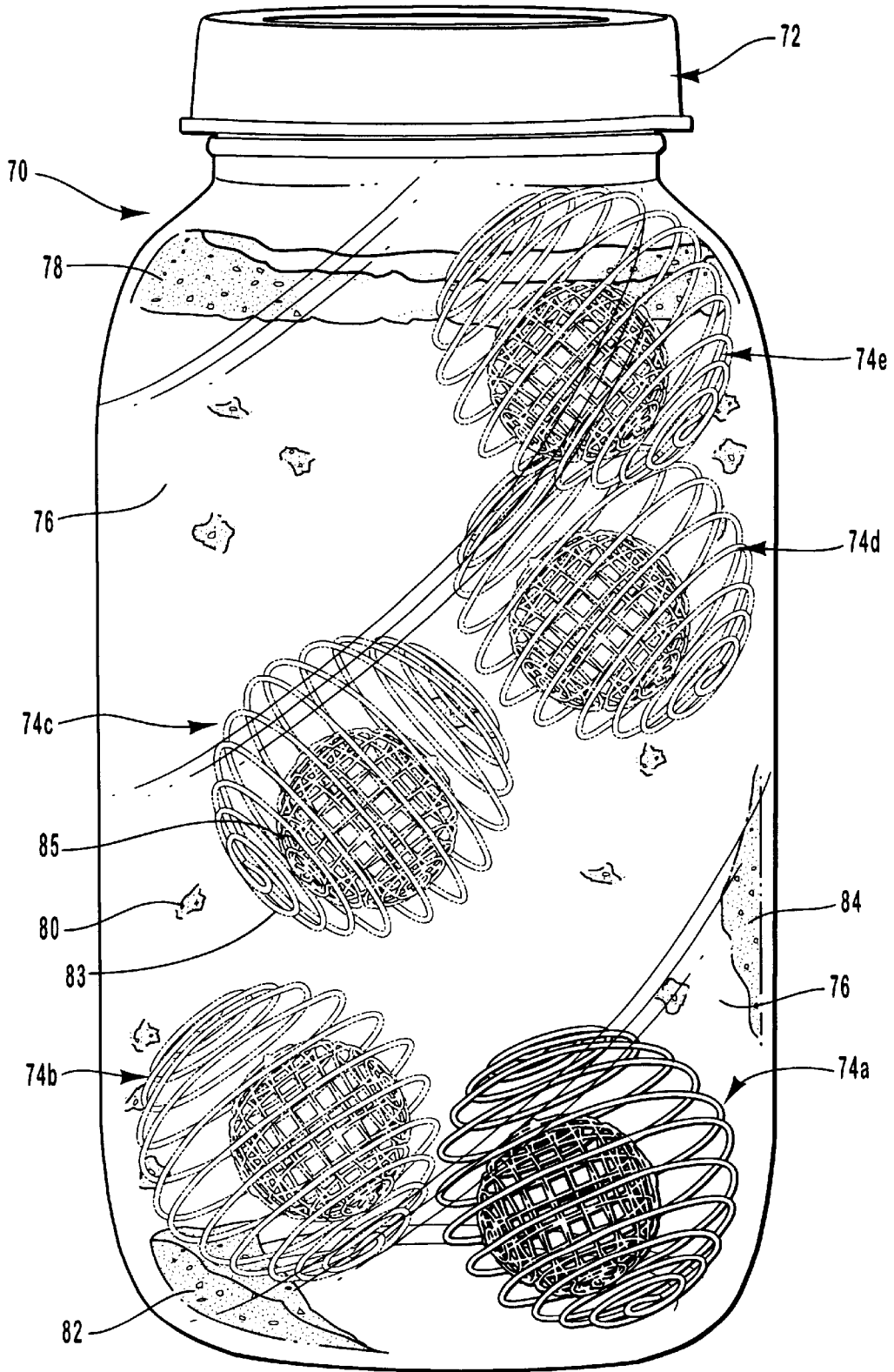


FIG. 7

**FLOW-THROUGH AGITATOR**

## THE FIELD OF THE INVENTION

The present invention relates to physically independent agitators used for mixing liquids, solid/liquid suspensions and powdered solids within containers. More particularly, the present invention relates to agitators for mixing powders with liquids to create a well dispersed, substantially homogeneous suspension.

## BACKGROUND

Agitators are commonly used in aerosol paint cans to mix the pigment with the suspension fluid. Many designs exist which are tailored to optimize mixing action and to agitate hard to reach areas of the paint containers. Various shapes of agitators exist which disperse paint pigment throughout a suspension medium. Multi-pronged agitators, spherical agitators, multi-faceted hemispherical agitators and disc-shaped agitators with conical projections exist for agitation of pigment particles in paint containers. These agitators are typically sealed within an aerosol paint container and activated by shaking the container. Movement of the agitators induced by shaking the container displaces and disperses the pigment particles into suspension. This is necessary because the pigment particles settle to the bottom of the container when the paint has rested in a stationary position for a significant period of time. Due to this specific pigment dispersion application, these agitators are specifically designed for dispersion of an agglomeration of particles at the bottom of a container. These agitators are most often discarded in the paint container in which they are used. Consequently, these agitators do not perform optimally for dispersion of powders which typically float at the top of a suspension liquid before mixing. They are also generally small in size with complex surfaces making them easy to lose and difficult to clean in preparation for repeated use. In addition, the small size and heavy weight result in a small cross-section to screen or disperse powders.

Agitators also exist for powdered food supplements that are added to and mixed with liquids. Baby formulas and nutritional supplements often require an agitation or dispersion device for optimal mixing and dispersion. Often dispersing elements are attached to specific containers for mixing of contents placed therein. These attached or fixed agitators may have a semi-permanent connection to a container or may be manufactured integrally with a given container. However, these attached elements often create cracks and crevices which are difficult to clean. Furthermore, attached devices often do not allow sufficient movement of the dispersing element for optimal mixing. Another disadvantage of known fixed dispersing elements is their inability to be transferred between commonly-used containers.

Powdered compositions for mixing with liquids such as dietary supplements, drink mixes, baby formulas and others are often difficult to mix into a smooth, homogeneous suspension. The powdered composition often clumps forming aggregations of powder surrounded by a thick layer of paste that inhibits liquid from penetrating into the clump. These clumps may float, sink to the bottom of the container or remain suspended at some level in the fluid. Powder may also stick to the sides or bottom of a container and resist mixing by simple shaking. In most cases, an agitator is necessary for complete dispersion of clumps and aggregations on the container walls. No single, known agitation element is effective at reaching clumps and aggregation at

the top, middle and bottom of a container while being easily removed from the container for ease of cleaning or for subsequent use in another container.

## SUMMARY AND OBJECTS OF THE INVENTION

The present invention relates to improved apparatus and methods for agitation of liquid/powder mixtures during the mixing process. The apparatus of some embodiments of the present invention comprises an object with a wire-frame shape through which liquids and fine-grained solids may pass. The wire-frame object may be constructed of a variety of materials including wound metal wire, molded plastic materials or almost any other material that will substantially retain its shape after repeated impact with a container.

The shape of the agitator object may also vary widely including, but not limited to, cubes, spheres, ellipsoids, pyramids, polyhedrons, cylinders and others. However, the shape must be formed by a wire frame that allows flow of material through and around the object. The flow of material whether liquid or powder, through the object creates turbulent eddy currents within and around the object that break up aggregations of material and disperse particles throughout the suspension medium.

Agitation is improved in some embodiments of the present invention by the use of one or more additional interior objects placed inside a wire-frame object. These interior objects may be solid or may also be wire-frame objects. The additional motion of the interior object inside the primary object creates further turbulence and dispersion which more quickly and effectively mixes the solids with the liquid suspension medium. Impacts of objects within the primary wire-frame object also serve to break up smaller clumps in the mixture.

Because the agitation objects are free to move throughout the mixing container, they are able to reach aggregations of powder at any level in the mixture and create greater turbulence. Initially, powders will accumulate at the surface of the liquid medium and form large clumps. Stationary mixing fins and protrusions are largely ineffective at dispersing these clumps and simple shaking without agitators frequently causes clumps to become more dense and difficult to ultimately disperse into an acceptable particle size. The physically-dependent agitator objects of the present invention, however, may be directed toward the surface accumulations by tilting the top of the container outward and effectuating a spinning action on the container to move the agitators through the accumulations and break them into smaller and smaller masses. After the large clumps have been dispersed, smaller aggregations may still be present in the mixture. These are typically well dispersed throughout the medium and found at every level of the mixture. At this point in the mixing process, the wire-frame agitators may be directed throughout the mixture by random oscillation of the container or by direction to specific areas that require further mixing.

Powder/liquid mixtures are often susceptible to aeration during mixing as simple shaking entraps air in the container under waves at the surface of the liquid causing bubbles to be entrained in the liquid. This may be acceptable for some mixtures, but can be extremely undesirable for others. For example, baby formulas, if entrained with air often cause excessive burping and discomfort for the child consuming the formula. The agitator objects of some embodiments of the present invention are physically independent of the container allowing a user to keep them immersed in the

liquid while rotating the container gently. This gentle rotating action causes the objects to roll or tumble around the container thereby dispersing the solids in the suspension without causing air to be entrained in the liquid. This reduces frothing and the consumption of unnecessary air by the consumer of the mixture.

In addition, the rotation of the agitator causes a mixing turbulence or screening effect which aids in mixing. Because the liquid passes through the rotating agitator, a chopping action is created which breaks up chunks better than a solid agitator. The agitator within an agitator embodiment increases the chopping action. As some of the breaking up of constituents occurs as the agitator collides with the walls of the container, the collisions between the agitator within an agitator embodiment also increase the breaking up action. The relatively large size of the agitator not only increases surface area for collisions, but also prevents swallowing of the agitator when the liquid is consumed. The size of the agitator or number can be altered to fit the container. Small containers will necessitate small agitators.

Accordingly, it is an object of some embodiments of the present invention to provide apparatus and methods for improved mixing of powders and liquids.

It is another object of some embodiments of the present invention to provide apparatus and methods for better reducing and dispersing clumps in mixtures.

#### BRIEF DESCRIPTION OF THE DRAWINGS

In order that the manner in which the above-recited and other advantages and objects of the invention are obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are not therefore to be considered to be limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

FIG. 1 is a perspective view of a spherical, wire-frame agitator apparatus of the present invention;

FIG. 2 is a perspective view of a spherical, coiled, wire-frame agitator apparatus of the present invention;

FIG. 3 is a perspective view of an agitator apparatus of the present invention with a polyhedral, grid-pattern, wire frame interior agitator;

FIG. 4 is a perspective view of a spherical, coiled, wire-frame agitator apparatus of the present invention with an interior coiled spherical agitator;

FIG. 5 is a perspective view of a cylindrical, wire-frame agitator apparatus of the present invention with interior agitators in a container;

FIG. 6 is a perspective view of a spherical, coiled, wire-frame agitator apparatus of the present invention with a solid interior agitator; and

FIG. 7 is perspective view of a container with an agitator of the present invention shown in various positions in a chain of movement.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The figures listed above are expressly incorporated as part of this detailed description.

It will be readily understood that the components of the present invention, as generally described and illustrated in

the figures herein, could be arranged and designed in a wide variety of different configurations. Thus, the following more detailed description of the embodiments of the system and apparatus of the present invention, as represented in FIGS. 1 through 7, is not intended to limit the scope of the invention, as claimed, but it is merely representative of the presently preferred embodiments of the invention.

The currently preferred embodiments of the present invention will be best understood by reference to the drawings, wherein like parts are designated by like numerals throughout.

In reference to FIG. 1, an embodiment of the present invention is shown wherein an agitator object 2 is formed of wire-frame elements 4 that are arranged to form a defined shape. In this exemplary embodiment the shape is a sphere, however, nearly any shape that can be formed of wire-frame elements, narrow rod-like elements or substantially perforated surfaces will prove adequate.

In the context of this disclosure, the term "wire-frame" shall refer to narrow, solid elements which may be combined to form a shape having an interior space within. "Wire-frame" may also refer to a solid surface which has been substantially perforated such that only slender portions of the solid surface remain between holes or voids in the surface.

Between the wire-frame elements 4 are voids or interstitial spaces 6 through which small and fine-grained solids and liquids may pass. Shapes, such as the spherical shape shown in FIG. 1 may be constructed of wire-frame elements which represent longitudinal and latitudinal circles or other curves or lines found on the surface of a particular shape. Wire-frame elements may be separate elements welded or otherwise bonded together to form a shape or may be parts of a single structure such as, but not limited to, a single molded plastic article.

Wire-frame elements may also take the form of a single coiled wire-like element, as shown in FIG. 2, where a single wire element 12 is wound in a spiral pattern to form a spherically shaped object 10. Object 10 has voids 14 between successive winds of element 12 through which solids and liquids may pass. The spiral wind of this embodiment of the present invention works advantageously to allow substantial elastic deformation of the spherical shape. This deformation causes adjacent portions of the spiral element to move relative to each other creating a crushing action which breaks up aggregations of powder which may stick thereto or become lodged there between. Contact between adjacent portions of the spiral element 12 and contact with container surfaces also causes standing vibrations of spiral element 12 which dissipate into the surrounding liquid inducing vibration of the liquid and associated dispersion of particles therein.

Wire-frame elements may be composed of many materials, however low-corrosion metals and plastics are preferable because of their elastic deformation characteristics and their resistance to corrosion. Of these materials, hard plastics and stainless steels are most preferable.

Another embodiment of the present invention, depicted in FIG. 3 employs an interior agitator 24 placed in the interior space of a primary agitator object 20. In the particular embodiment shown in FIG. 3, interior agitator 24 is a wire-frame object similar to primary agitator 20, but smaller in size. Interior agitator 24 is preferably about half the size of primary agitator 20 to allow significant motion of interior agitator 24 within primary agitator 20. However, smaller sizes of interior agitators are also effective and multiple

interior agitators may also improve dispersion. Use of an interior agitator **24** increases contact between wire-frame elements creating a crushing or grinding action which breaks up aggregations of powder. This grinding action is especially helpful in dispersing smaller aggregations of powder that become immersed in the liquid portion of the mixture. Grinding action is further enhanced when the interior agitator has protrusions which may enter the interstitial spaces in the primary agitator. This can be achieved when an interior agitator **24** takes the shape of a dodecahedron or other polyhedron with protruding pyramidal shapes. Interior agitators with bumps or other short protrusions may also be used. This configuration allows interior agitator **24** to protrude into the interstitial spaces in primary agitator **20** and push powder aggregations out into the mixture.

Interior agitators **32** may also be used in spiral wound embodiments **30** as shown in FIG. 4 where a spherical spiral wound primary agitator **30** contains an interior spherical wound agitator **32**. Deformation of the spiral wound primary agitator **30** around the smaller interior agitator **32** also increases grinding action and turbulent flow of liquid which accelerates dispersion of particles throughout the liquid portion of the mixture. Interior agitators may also be constructed of a material with higher density or mass than their primary agitators to cause an acceleration differential between the two agitators that induces relative motion and liquid currents within and around the agitators. This induced motion and current further accelerates particle dispersion within the mixture and promotes a homogeneous mixture.

In reference to FIG. 5, a further embodiment of the present invention comprises a compound agitator **40** with a substantially cylindrical primary wire-frame agitator **42** having a plurality of interior agitators **44**. Primary cylindrical agitator **42** takes the shape of a round cylinder which may have flat or chamfered ends or may have rounded ends **46**, as shown in FIG. 5, to better contact the corners of a specific container. Rounded ends **46** may have a specific radius that matches the radius of rounded corners at the top or bottom of a container. Interior agitators **44** may be spherical or may be polyhedral with pyramidal projections to facilitate dispersion and prevent fouling of the interstitial spaces of the primary agitator. Other shapes including spheroids and irregular shapes may also be effective. The round cross-sectional shape of primary cylindrical agitator **42** promotes a rolling motion of primary agitator **42** when the container is moved in a horizontal circular motion. This causes primary agitator **42** to roll around the interior surface of the container thereby crushing large aggregations of powder while the rolling action induces turbulent currents in the liquid which promote homogeneous dispersion of particles. Vibration induced by contact of wire-frame elements **48** with container surfaces **50** and interior agitators **44** and the establishment of standing vibratory waves in wire-frame elements **48** further induces dispersion of particles within the mixture.

Solid interior agitators may also be used in conjunction with spiral wound primary agitators as depicted in FIG. 6 where a compound agitator **60** comprises a primary spiral wound agitator **62** with an interior solid spherical agitator **64** placed therein.

The use of an embodiment of the present invention may be shown in reference to FIG. 7 where a container **70** with a removable lid **72** is shown with a compound agitator **74** therein. Liquid **76** is placed in container **70** followed by an amount of powder which initially forms a pile **78** on the top surface of liquid **76**. Because pile **78** has a limited surface area in contact with liquid **76**, dissolution and dispersion of

the powder is not immediate. Shaking will cause limited break up of pile **78**, but typically creates clumps and aggregations **80** which are difficult to disperse. Some powders may also form bottom-adhered aggregations **82** at the bottom of container **70** or side-adhered aggregations **84** on the sides of container **70**.

Agitator **74** may be moved throughout container **70** by simple shaking, rotation, circular motions or other oscillations or random movement. Agitator **74** can be easily directed to a specific location within container **70** by a combination of tipping and circular movement of container **70** thereby causing centrifugal forces to propel agitator **74** to a desired location. After a few seconds of practice one can direct agitator **74** to any location in container **70** where powder may accumulate.

Movement of agitator **74** through pile **78** and aggregations **80**, **82** and **84** initially helps to quickly disperse pile **78** and aggregations **80**, **82** and **84** into smaller accumulations or aggregations **80** which are quickly dispersed throughout liquid **76**. Subsequent movement and rotation will cause agitator **74** to contact and impact aggregations **80** and further disperse them into basic particles. This is achieved very efficiently by embodiments of the present invention which directly impact aggregations **80**, pinch and grind aggregations **80** between adjacent wire-frame elements, grind between agitator **74** and container **70**, and disperse through induced currents formed in liquid **76** from movement of parts of agitator **74**.

Agitator **74** may be activated by shaking whereby agitator **74** will be propelled along a random path similar to that shown in FIG. 7, where agitator **74a** begins at a position at the bottom right side of container **70** after which it is propelled to the left to position **74b** where agitator **74** impacts the side wall of container **70** causing elastic deformation of primary agitator **83** upon impact and relative movement between primary agitator **83** and interior agitator **85**. Relative movement between primary and interior agitators creates high velocity turbulence and eddy currents within primary agitator **83** which break up nearby aggregations **80** and disperse particles throughout the liquid/powder mixture. Vibration of agitator elements induced by the impact also transfer high-frequency energy into liquid **76** helping to disperse particles evenly.

After impact agitator **74** bounces off container **70** and accelerates toward position **74d** where the acceleration further induces mixing currents in liquid **76**. At position **74d** another impact occurs again breaking up accumulations and aggregations **80** as with the first impact. Agitator **74** may then bounce to position **74e** near the top of container **70** where it may contact any remaining portions of pile **78** and disperse them into liquid **76**.

Circular motions of container **70** can be used to cause agitator **74** to roll around the interior of container **70** thereby inducing a grinding action on the walls of container **70**. This action helps to disperse side-adhered aggregations **84** that may be present. Rolling can also induce a steady vibration of agitator **74** as wire-frame elements **83** contact container **70**. These vibrations dissipate into liquid **76** and promote dispersion of particles and erosion of aggregations **80**.

In some embodiments of the present invention, lid **72** may have a drinking orifice therein through which a user may drink the mixture that has been mixed in container **70**. A user may drink directly from container **70** through an orifice in lid **72** or may use a straw or other device to drink therefrom. However, in preferred embodiments, an orifice in lid **72** will be configured so as to retain agitators within container **70**

and prevent ingestion of agitators. Typically, this configuration may be achieved through the use of orifices that are smaller than the agitators used in the containers.

The physical independence of the agitators of the present invention allows them to access any area or level of the container where powder may aggregate. Physical independence also allows the agitators to be removed for cleaning or reuse in another container. Agitators may be left in the container during use or easily removed with a fork or similar device.

The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrated and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

I claim:

1. A physically independent agitator for mixing a composition of ingredients, said agitator comprising:

an object insertable within a hand-held, shakeable container and composed of a framework having a hollow interior wherein said framework is arranged to provide voids to allow for flow of liquids, powders, and other materials into and out of said hollow interior of said object; and

an interior agitator located within said hollow interior.

2. The agitator as set forth in claim 1, wherein said interior agitator is smaller than said object.

3. The agitator as set forth in claim 2, wherein said interior agitator is less than one half the size of said object.

4. The agitator as set forth in claim 1, wherein said interior agitator has a higher density than said object.

5. The agitator as set forth in claim 1 wherein said interior agitator has a solid shape.

6. A physically independent agitator for mixing a composition of ingredients in a hand-held, shakeable container, the agitator comprising:

an object insertable within an interior of said hand-held, shakeable container and composed of a framework having a hollow interior wherein said framework is arranged to provide voids to allow for flow of liquids, powders, and various other said compositions of materials into and out of said hollow interior of said object;

an interior agitator having a wire-frame spheroid framework contained within said hollow of said object, said interior agitator also physically independent of said object.

7. The agitator as set forth in claim 6, wherein the shape of said object promotes a rolling motion of said object around said interior of said hand-held, shakeable container.

8. The agitator as set forth in claim 6, wherein the shape of said object is spherical.

9. The agitator as set forth in claim 6, wherein the shape of said object is polyhedral.

10. The agitator as set forth in claim 6, wherein said framework of said object forms a spiral coil.

11. The agitator as set forth in claim 6, wherein said framework of said object and said interior agitator deflects elastically upon impact thereby promoting break up of clumps and dispersion of particles therein.

12. The agitator of claim 6, wherein said interior agitator is an object with a solid surface.

13. The agitator of claim 6, wherein said interior agitator is a solid sphere.

14. The agitator of claim 6, wherein said interior agitator is a solid object with protrusions that may project into said voids during mixing action.

15. A mixer for mixing a composition of ingredients comprising:

a hand-held, shakeable container for holding a liquid/powder mixture;

a lid removably coupled to said hand-held shakeable container, wherein said lid serves to allow said mixer to form a completely enclosed mixing area when said lid is coupled to said hand-held, shakeable container; and

a physically independent agitator object removably placed within said hand-held, shakeable container, said physically independent agitator object being free from any structural connection to said hand-held, shakeable container and having narrow rod-like elements defining a shape with interstitial spaces between said elements and a hollow interior space within said shape,

wherein liquids, powders, and various other said compositions of ingredients may be mixed by flowing into and out of said hollow interior space of said physically independent agitator object as said physically independent agitator is allowed to move freely to every location within said enclosed mixing area, restricted only by the boundaries making up said enclosed mixing area.

16. The mixer as set forth in claim 15, further comprising an interior agitator located within said hollow interior space of said physically independent agitator object to provide further mixing capabilities of said mixer.

17. The mixer as set forth in claim 15, wherein said lid comprises a hole for dispensing the liquid/powder mixture and said hole is smaller than said agitator object such that said agitator object will not pass through said hole.

18. A method for mixing a composition of ingredients, said method comprising:

placing a composition of ingredients into a hand-held, shakeable container;

placing a physically independent agitator into said hand-held, shakeable container,

said physically independent agitator object being free of any structural connection to said hand-held, shakeable container, said physically independent agitator comprising an object having a framework with a plurality of significant voids therein;

securing a removable lid to said hand-held, shakeable container, wherein said lid serves to allow said hand-held, shakeable container to form a completely enclosed mixing area when said lid is coupled to said hand-held, shakeable container; and

shaking said container in a manner that propels said agitator through said composition of ingredients, wherein said composition of ingredients flows into and out of said voids thereby mixing said composition of ingredients and forming a substantially homogeneous mixture as said physically independent agitator is allowed to move freely to every location within said enclosed mixing area, restricted only by the boundaries making up said enclosed mixing area.

19. A method for mixing as set forth in claim 18, where said composition of ingredients is a powder mixed with another powder.

20. A method for mixing as set forth in claim 18, where said composition of ingredients is a liquid mixed with a powder.

21. A method for mixing as set forth in claim 18, where said ingredient is a liquid and is mixed with a liquid.



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22. A physically independent agitator for mixing a composition of ingredients in a container, the agitator comprising:

an object composed of a framework having a hollow interior wherein said framework is arranged to provide voids to allow for flow of liquids, powders, and various other said compositions of materials into and out of said hollow interior of said object; and

an interior agitator comprising a wire-frame spheroid.

23. A mixing apparatus comprising:

a physically independent agitator object removably and interchangeably placed within a variety of hand-held, shakeable containers having an enclosed mixing area therein, said physically independent agitator object

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being free of any structural connection to said hand-held, shakeable container and having a framework comprising narrow rod-like elements defining a shape with interstitial spaces between said elements and a hollow interior space within said shape,

wherein liquids, powders, and various other said compositions of ingredients may be mixed by flowing into and out of said hollow interior space of said physically independent agitator object as said physically independent agitator object is allowed to move freely within said enclosed mixing area, restricted only by the boundaries making up said enclosed mixing area.

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