

[54] **TABLET DISRUPTOR DEVICE**

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[52] U.S. Cl. **241/46.06, 241/188 R, 241/258, 259/96**

[51] Int. Cl. **B02c 18/10, B02c 13/18**

[58] Field of Search.....**241/258, 46.06, 46.17, 46.08, 241/DIG. 27, 199, 220, 98, 168, 188 R, 188 A, 185 A; 259/95, 96, 108**

[56] **References Cited**

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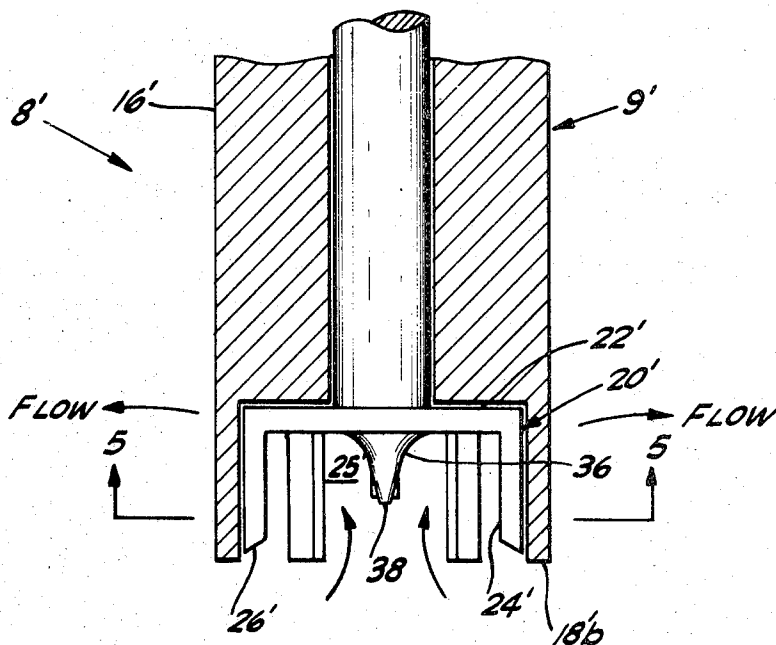
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Primary Examiner—Donald G. Kelly
Attorney—Thomas L. Peterson et al.

[57] **ABSTRACT**

A disruptor device particularly suited for rapidly grinding up pharmaceutical tablets in a liquid and agitating the mixture to dissolve the active ingredients of the tablets in the liquid for subsequent chemical analysis. The device comprises a rotatable shaft extending through a hollow member which is formed at its lower end with a series of circularly arranged spaced teeth. The shaft carries at its lower end a rotor provided with a plurality of teeth which are surrounded by the teeth on the hollow member. Rotation of the rotor draws the tablet and liquid upward into the rotor and propels the mixture radially outward through the teeth in the hollow member whereby the tablet will be severed and broken into pieces by the shearing action between the two sets of teeth. Some of the teeth on the outer hollow member are shorter than the other teeth thereon so as to provide entrance openings for large particles to enter the head of the device. An inverted conical shaped deflector is provided on the bottom of the rotor to eliminate stagnant eddy currents within the rotor.

6 Claims, 5 Drawing Figures



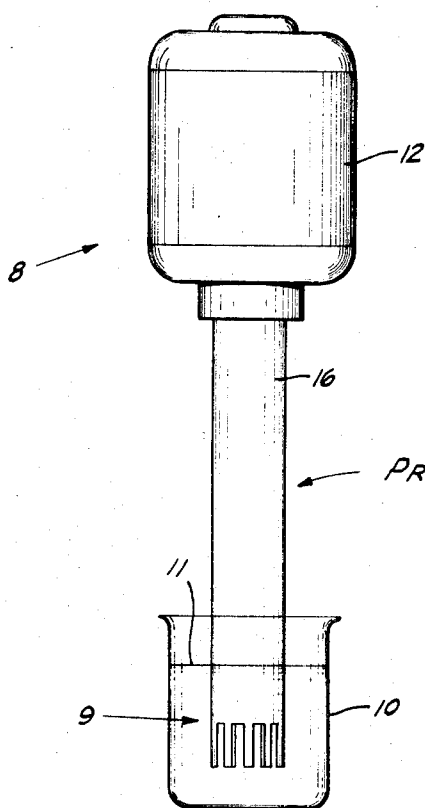


Fig 1

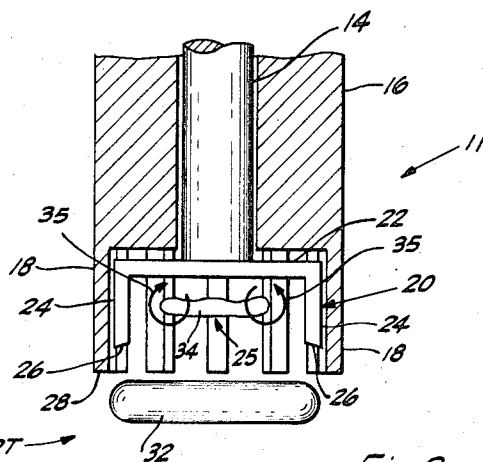


Fig 2

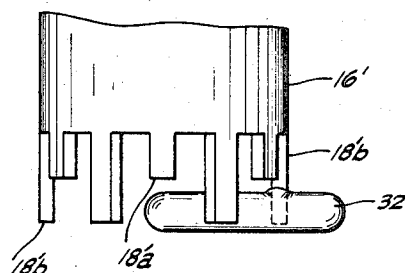


Fig 4

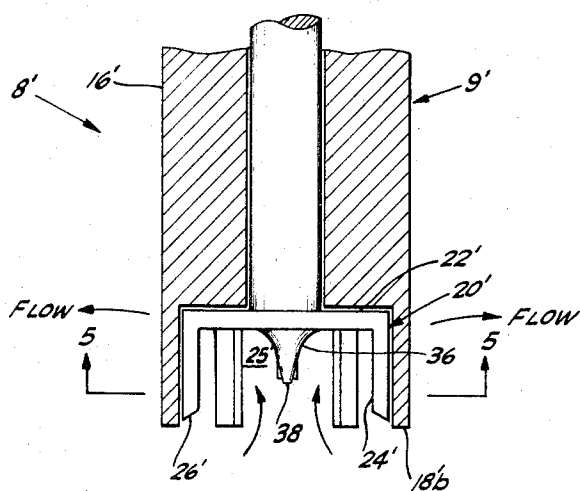


Fig 3

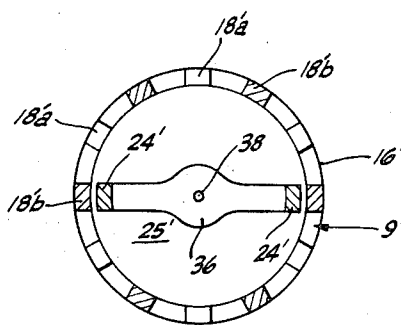


Fig 5

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TABLET DISRUPTOR DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to grinding or disrupting devices and, more particularly, to a device which is particularly suited for rapidly grinding up pharmaceutical tablets in a liquid and agitating the mixture to dissolve the active ingredients of the tablets in the liquid for subsequent chemical analysis.

2. Description of the Prior Art

In view of the high cost of labor and the shortage of skilled technicians, substantial efforts have been made in recent years to develop automated chemical analyzers, particularly in the field of clinical chemistry. More recently a need has arisen for automated chemical analyzers capable of determining quantitatively the active ingredients in pharmaceutical tablets or capsules in order that close quality control may be maintained on the manufacture of these products. An initial function which must be performed by such an analyzer is the severing and breaking up of the tablets into small pieces and the dissolving of the active ingredients of the tablets in a suitable liquid. This function must be performed efficiently and rapidly in order that subsequent steps of filtration, reagent addition, mixing, and sample analysis may be performed without delay. Heretofore a commercially available Waring blender or shaking machines have been employed for dispersing and dissolving tablets in solvents for chemical analysis. However, such devices are relatively slow and inefficient in performing this function.

We have attempted to utilize a commercially available device called the Willems Polytron for grinding up and dissolving pharmaceutical tablets in liquid but have found the device not to be sufficiently efficient and rapid to be practical for use in a high speed automated chemical analyzer. Such commercial device is similar to that disclosed in U.S. Pat. No. 2,789,800 to Willems. The commercial device includes a hollow outer shaft and a central shaft extending axially through the outer shaft. The outer shaft is formed at its lower end with a plurality of circularly arranged, spaced teeth. The inner shaft carries at its lower end a rotor comprising a laterally extending arm having a pair of downwardly extending teeth at opposite ends thereof which are in close radial proximity to the teeth on the outer shaft. Upon rotation of the inner shaft, a mixture into which the head of the device is immersed will be drawn upwardly into the rotor and radially outward between the relatively rotating teeth whereby solid particles in the mixture will be subjected to a shearing action between the teeth. The mixture will thus be continuously recirculated through the head of the device, effecting a disruption of the solid particles and dissolution of the same into the liquid. For reasons which will be discussed later herein, the Willems Polytron is not fully effective for rapid and efficient grinding up and dispersing of pharmaceutical tablets or capsules of conventional size.

SUMMARY OF THE INVENTION

According to the principal object of the present invention there is provided an improved device for disrupting and dissolving pharmaceutical tablets in a liquid.

According to the principal aspect of the present invention, there is provided a device similar to the beforementioned Willems Polytron in which some of the teeth on the outer shaft are longer than the other teeth thereon so as to provide enlarged entrance openings for solid particles to enter into the head of the device for disruption and mixing with the liquid. Also, an inverted cone-shaped element is provided on the bottom of the rotor to establish a streamlined liquid flow pattern through the head of the device to eliminate any stagnant eddy currents within the rotor.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevational view of the prior art Willems Polytron with the head thereof shown positioned in a container of solution;

FIG. 2 is a partial longitudinal sectional view through the head of the device illustrated in FIG. 1;

FIG. 3 is a longitudinal partial sectional view through the head of a tablet disruptor device constructed in accordance with the present invention;

FIG. 4 is a side elevational view of the lower end of the outer shaft illustrated in FIG. 3; and

FIG. 5 is a horizontal sectional view taken along line 5—5 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing in detail, FIGS. 1 and 2 illustrate the prior art Willems Polytron device, generally designated 8, with its lower end or head 9 positioned in a container 10 holding a solvent 11. The device 8 includes an electric motor 12 which drives a central shaft 14 mounted within an outer hollow shaft 16. The outer shaft 16 is suitably secured to the housing of the motor 12 to form a stator. The lower end of the shaft 16 is formed with a series of circularly arranged spaced teeth 18 concentric with the longitudinal axis of the shaft 14.

A rotor 20 is fixedly mounted on the end of the shaft 14. The rotor includes a laterally extending arm 22 symmetrically mounted with respect to the axis of rotation of shaft 14. A pair of downwardly extending teeth 24 are formed at opposite ends of the arm providing therebetween a downwardly facing open suction space 25. The outer surfaces of the teeth 24 lie in close radial proximity to the inner surfaces of the teeth 18 on the outer shaft 16. As can best be seen in FIG. 2, the lower ends 26 of the teeth 24 on the rotor are recessed behind or above the lower ends 28 of the teeth 18 on the outer shaft 16.

In operation of the prior art device 8, the shaft 14 and thus the rotor 20 is rotated at a high speed by the motor 12. Rotation of the rotor draws liquid up into the suction space 25 in the rotor and outwardly between the teeth on the rotor and stator whereby solid particles in the liquid are severed and broken into pieces by the shearing action between the two sets of teeth. However, our tests of the prior art device 8 in grinding up and dissolving pharmaceutical tablets has revealed two distinct problems. One, the normal size pharmaceutical tablet, designated 32, often adheres by suction to the end of the head of the device 8, as seen in FIG. 2, so that the tablet is not disintegrated. Also, once a tablet is partially disintegrated particles thereof, such as in-

licated by numeral 34, become trapped by the eddy currents, indicated by arrows 35, in the suction space 25 within the rotor and will not recirculate for further shearing action by the teeth of the device. Thus, disruption and dissolving in liquid of pharmaceutical tablets by the device 8 is generally unreliable and, at best, takes at least 30 seconds to 2 minutes to accomplish.

Reference is now made to FIGS. 3-5 which illustrate the head of a tablet disruptor device constructed in accordance with the present invention. In this device the basic structure is as previously described in connection with the device 8 and like numbers primed are used to indicate like or corresponding parts. The stator or outer shaft 16' of the device 8' of the present invention differs primarily from the stator 16 in the device 8 in that every second tooth 18'a is shorter in the axial direction than the next adjacent tooth 18'b so that the longer teeth 18' are positioned alternately with respect to the shorter teeth 18'a about the stator 16'. Preferably, as shown, the shorter teeth 18'a are about one half as long as the longer teeth 18'b. Thus, there are provided between the lower ends of the longer teeth 18'b enlarged entrance spaces for the capsule 32 allowing the capsule to become effectively subjected to the grinding action of the teeth on the rotor and stator without adhering to the end of the device by suction.

The rotor 20' in the device 8' of the present invention is essentially identical to the rotor 20 discussed previously except that the rotor 20' is formed with an inverted cone-shaped deflector 36 the base of which is integral with the arm 22' of the rotor and the tip 38 extends into the suction space 25' but terminates short of the lower ends 26' of the teeth 24'. As will be seen in FIG. 3, the teeth 24' on the rotor 20' are spaced a sufficient distance from the surface of the conical portion 36 of the rotor so as to provide ample space for the free flow of liquid and particles up into the suction space 25 whereby such material will be subjected to the shearing action between the teeth on the rotor and stator and propelled outwardly in a pattern as shown by the arrows in FIG. 3. The conical section 36 of the rotor 20' establishes a streamlined liquid flow pattern which eliminates the eddy currents which exist in the device 8 illustrated in FIGS. 1 and 2, thus ensuring that all particles will be rapidly and efficiently circulated through the head of the device 8'.

It is further noted that the lower ends 26' of the teeth 24' on the rotor are essentially coplanar with the lower ends of the longer teeth 18'b on the stator, thus maximizing the amount of shearing action between the teeth at the end of the head 9'.

A disruptor device as illustrated in FIGS. 3-5 has been constructed in which the outer diameter of the stator was 0.875 inch, the inner diameter of the stator was 0.625 inch, and the teeth on the stator were spaced apart 0.094 inch. The longer teeth 18'b were 0.500 inch long and the ends of the shorter teeth 18'a were recessed behind the ends of the longer teeth 0.25 inch. The outer diameter of the rotor 20' was 0.610 inch and the width of the teeth 24' on the rotor was 0.15 inch. It is understood of course that these dimensions are given by way of illustration only and not by limitation. The device having a head of the foregoing dimensions was tested for efficiency and reliability using the same type of tablet and solvent as was the beforementioned Wil-

lems Polytron and was found capable of completely and reliably disrupting and dissolving a tablet within the solvent within 5 seconds, as compared with the Willems Polytron which required at best 30 seconds to 2 minutes and was unreliable.

The effectiveness of the tablet disruptor device of the present invention is believed due to the optimizing of the head configuration in a manner to balance the conflicting requirements of providing maximum shearing surfaces between the teeth for rapidly grinding the solid particles drawn into the head while providing sufficiently large spaces between the teeth to permit large particles to enter the suction space. The use of alternating short and long teeth on the stator achieves this result. Needless to say, depending upon the size of the tablets or solid materials which are to be ground up by the device 8' of the present invention, fewer or larger number of teeth may be provided on the stator. For example, for smaller particles to be ground up, a larger number of teeth may be provided and may be spaced more closely together and the opposite would be the case for larger particles. In addition, the rotor may carry more than two teeth, particularly where smaller particles are to be ground up by the device.

Although several embodiments of the invention have been disclosed herein for purposes of illustration, it will be understood that various changes can be made in the form, details, arrangements and proportions of the various parts in such embodiments without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A device for disrupting tablets or other solid materials in a liquid comprising:
 - a hollow member;
 - a rotatable shaft extending axially through said member;
 - means for rotating said shaft;
 - a rotor fixed to one end of said shaft;
 - a series of circularly arranged spaced teeth secured to one end of said hollow member and concentric with the axis of rotation of said shaft;
 - said rotor including a plurality of teeth extending beyond said one end of said shaft, said rotor teeth being surrounded by said series of teeth and positioned in sufficiently close radial proximity thereto so that a shearing action will be produced by said teeth on solid materials drawn into engagement with said teeth by rotation of said rotor; and
 - at least some of the teeth of said series being longer in the axial direction than the other of said teeth.
2. A device as set forth in claim 1 wherein:
 - said rotor includes a laterally extending arm mounted on said one end of said shaft symmetrically with respect to said axis, said rotor teeth being remote from the center of said arm to provide a central suction space.
3. A device as set forth in claim 2 wherein:
 - said arm is formed with an inverted conical center portion concentric with said axis and extending into said suction space.
4. A device as set forth in claim 1 wherein:
 - the longer teeth of said series and said rotor teeth terminate in substantially the same radial plane.
5. A device as set forth in claim 1 wherein:

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the longer teeth of said series are positioned alternately with respect to the other of said teeth of said series.

6. A device as set forth in claim 1 wherein:
there are provided two diametrically opposed rotor 5
teeth spaced from the center of said rotor to pro-

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vide a central suction space; and
said rotor is formed with an inverted conical center
portion concentric with said axis and extending
into said suction space.

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