Nov. 2, 1971 NOBUO NAKAHARA Re. 27,214

METHOD AND APPARATUS FOR MAKING SPHERICAL GRANULES

Original Filed June 17, 1964 3 Sheets-Sheet 1

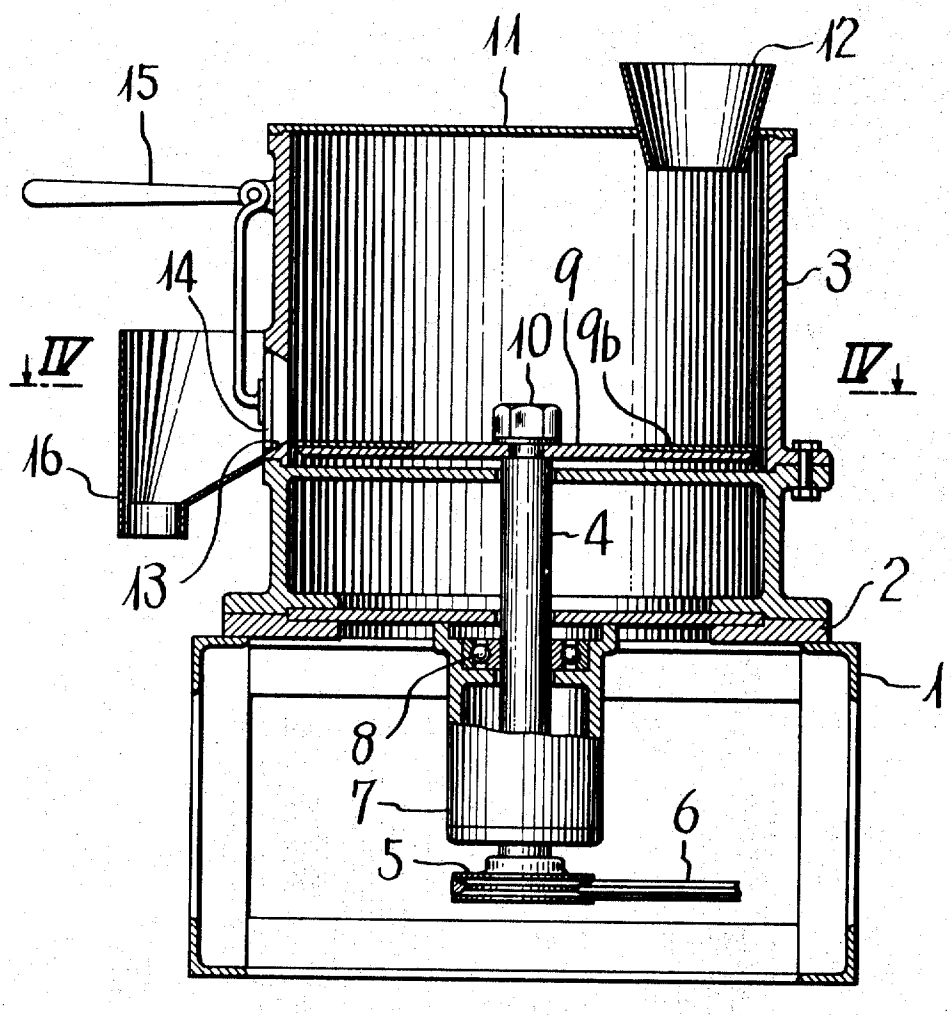


FIG. 2

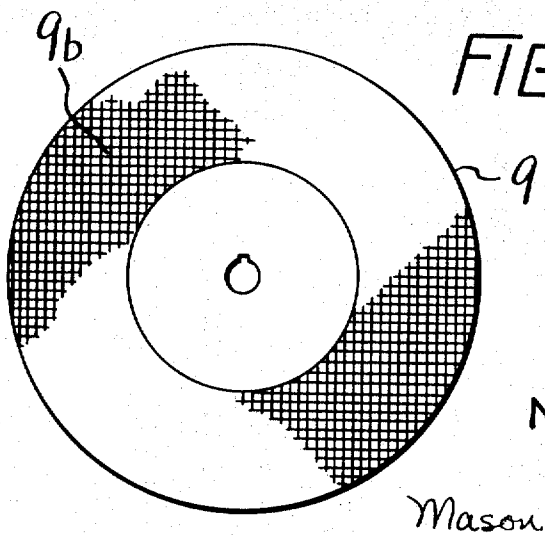


FIG. 1

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FIG. 3

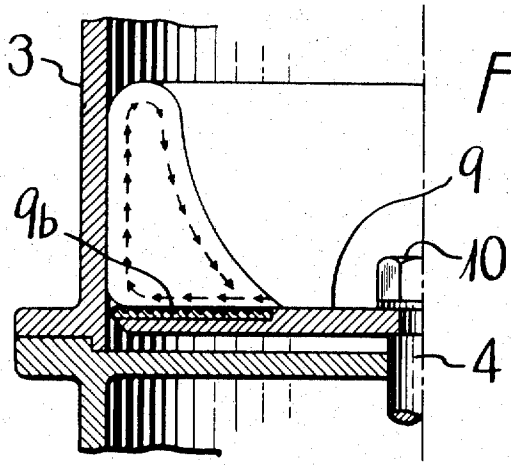


FIG. 4

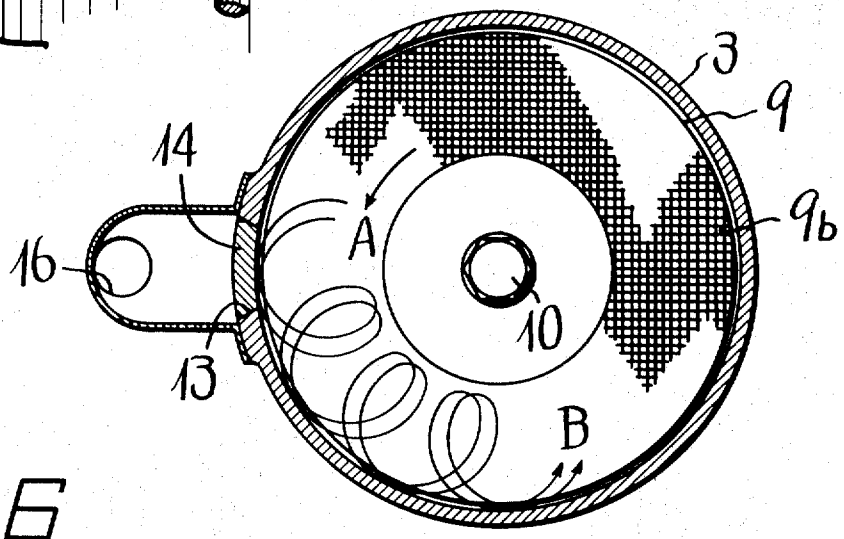


FIG. 6

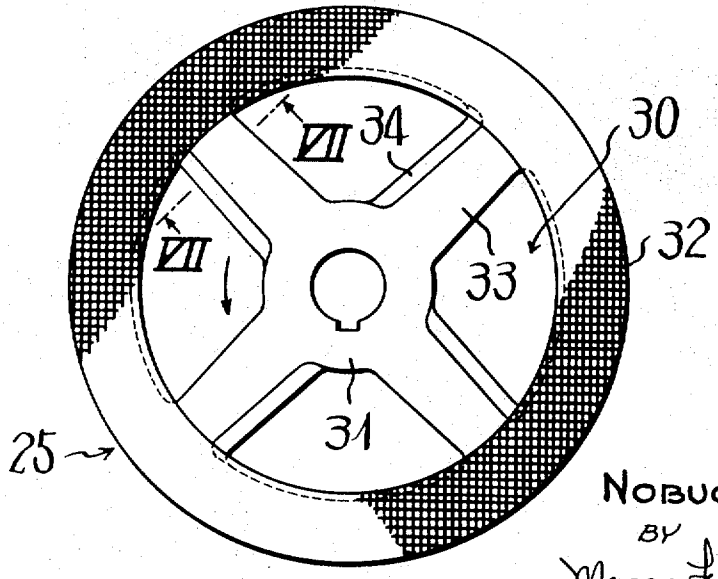
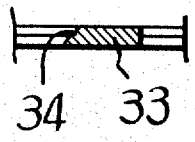


FIG. 7



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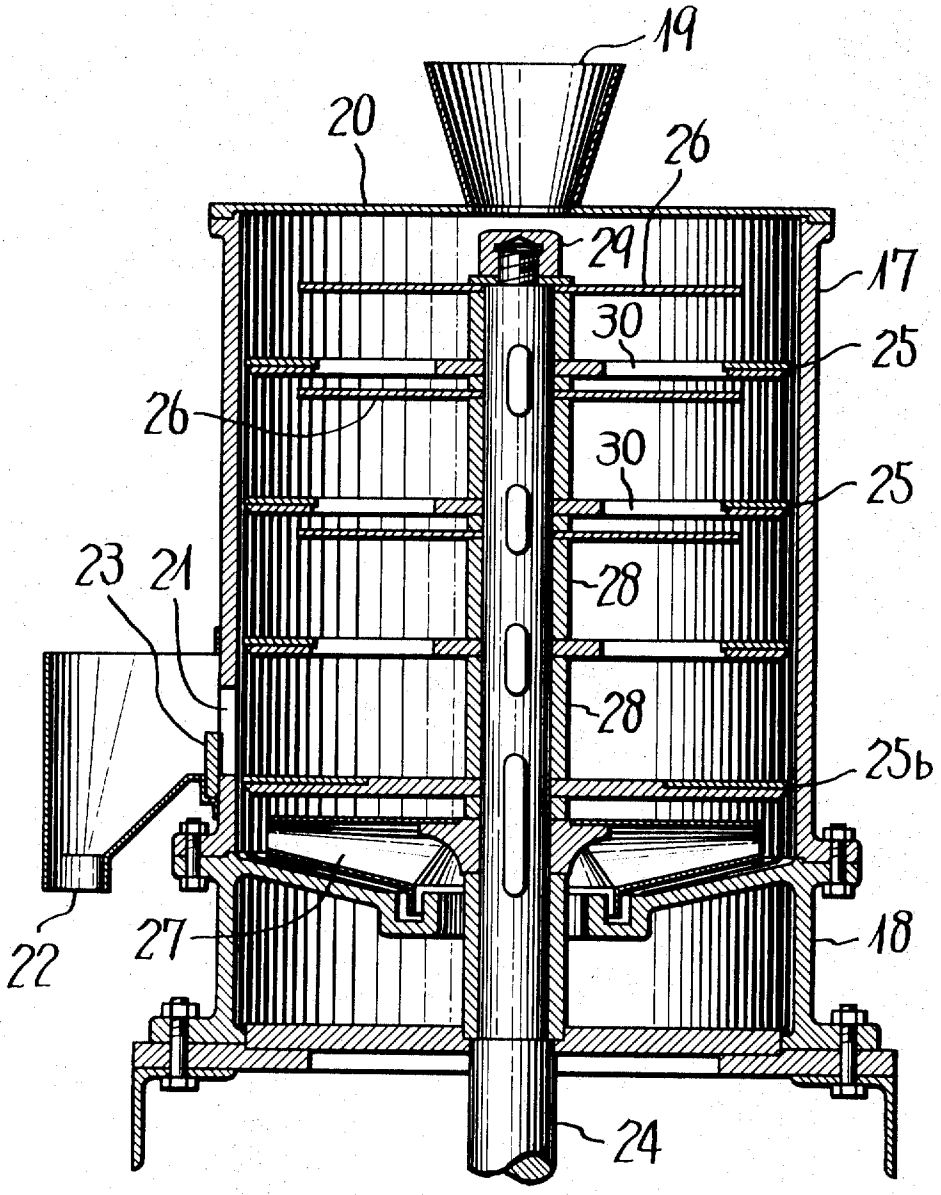
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FIG. 5



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METHOD AND APPARATUS FOR MAKING SPHERICAL GRANULES

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Int. Cl. B29c *23/00*

U.S. Cl. 264—15 8 Claims

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

A method of and apparatus for making spherical granules from extrusions of a wet mixture of powdered solid material by introducing such extrusions onto a rotating circular plate having an uneven surface. Such uneven surface propels the extrusions outwardly by centrifugal force against a stationary wall, the extrusions then falling back toward the center of the rotating plate. Such repetitive action is effective to divide the extrusions into short lengths and transform such lengths into substantially uniform spherical granules.

The present invention relates to a method and apparatus for making granules and particularly to methods and appparatuses available both for making spherical granules directly from wet mixtures of solids in powdered form and liquids, and for transforming wet granules in cylindrical, square and other irregular shapes which are made by granulators, screw type extruders and the like, into spherical granules.

In order to make spherical granules, the so-called "pellets," it has been customary to use rotary drum type pelletizers, rotary pan type pelletizers and so forth.

In these machines, a drum or a pan rotates slowly into which material in powdered form is fed and rolled in accordance with the rotation of the drum or the pan and it is finally agglomerated to spherical granules by the addition of liquids which act as binding agents.

In these cases, granules can be made on a relatively large scale, but strictly speaking, the granules obtained are not spherical and they are different to a large extent in size and not uniform.

Accordingly, in order to obtain uniform size granules, screening process is absolutely required after the granulation or the pelleting.

Thus, it can be said that these methods and apparatuses or machines are not suitable for making spherical granules in uniform size, particularly for making small spherical granules in uniform size on a commercial basis.

In order to make spherical granules, a so-called "pill making machine" has been widely used in the pharmaceutical industry.

The machine can make rather correct spherical granules in uniform size, but it has only small capacity for its motive power and dimensions required and it cannot make small spherical granules having a diameter under 2.0 mm. due to its mechanism.

One of the objects of the present invention is to provide an apparatus for making small spherical granules in uniform size rapidly in batch system.

Another object of the invention is to provide the same apparatus operated in continuous system.

Other objects and advantages of the invention, including novel structural features, will be apparent from the following description when read in connection with the accompanying drawings, in which:

FIG. 1 is a sectional, side elevational view of the apparatus in accordance with the invention;

FIG. 2 is a plan view showing an example of an indented plate shown in FIG. 1;

FIG. 3 is a sectional, side elevational view of certain parts shown in FIG. 1, showing how material fluidizes on the indented plate;

FIG. 4 is a plan view in horizontal section taken approximately on the line IV—IV in FIG. 1, showing how the material travels on the indented plate along the inner surface of the wall of the casing;

FIG. 5 is a sectional, side elevational view of a second embodiment of the invention;

FIG. 6 is a plan view showing an example of the indented plates shown in FIG. 5; and

FIG. 7 is a sectional, side elevational view taken approximately on the line II—II in FIG. 6.

An embodiment of the invention is illustrated in FIGS. 1, 2, 3 and 4.

The apparatus, as shown in FIG. 1, comprises a base or frame **1** which may be supported at a convenient distance above the floor, a flat ring **2**, and a vertical casing **3**.

A rotor assembly is placed for rotation on a vertical axis in the casing **3** and the rotor assembly is driven by a vertical shaft **4** turning at high speed through a pulley **5** driven by a belt **6** from a separate drive motor, not shown.

The vertical shaft **4** is adapted to rotate within a ball bearing casing **7** which carries a ball bearing **8**. The ball bearing **8** serves as the means for supporting the shaft **4**.

The rotor assembly comprises an indented plate **9** which is keyed to the shaft **4** and fixed by a nut **10**.

The indented plate **9** is positioned horizontally and its peripheral edge rotates adjacently to the inner surface of the wall of the casing **3**.

And the indented plate **9** as best seen in FIG. 2 is round, flat and relatively thin, but provided with unevenness **9b** on its peripheral upper surface with which material is in contact.

The unevenness **9b**, in the present instance, is made by suitable crossing grooves and serves as the means for cutting and rubbing material.

An the unevenness **9b**, as shown in FIG. 4, is attached by some suitable means like a bolt or binder, to the basic plate and it makes complete the indented plate **9**.

The vertical casing **3** is shaped to cylindrical form to which a lip **11** is attached, the lip **11** being provided with a hopper **12**.

A window **13** for discharge of material is provided on the side in the lower part of the casing **3** and positioned so that its lower edge may be approximately on the same level with the upper surface of the indented plate **9**.

A cover **14** for the window **13** is attached to a handle **15** and the cover **14** is closed to the window **13** while treating material, but can be opened outwardly by an

operating assembly comprising the handle **15** when material is discharged.

A chute **16** is attached to the side wall of the vertical casing **3** and it serves as the means for collecting discharged material toward a suitable receptacle, not shown.

In operation, material is initially fed by hand, a vibrating feeder and other suitable means through the hopper 12 into the apparatus and then the material falls by gravity on the upper surface of the indented plate **9** which rotates at high speed within the casing **3**.

Next, the material on the plate **9**, as shown by arrows in FIG. 3, is first thrown out by a centrifugal force caused by the rotation of the plate **9** toward the periphery of the plate **9** and then it goes up along the inner surface of the wall of the casing **3**.

And after the material loses the centrifugal force, it falls by gravity toward the center of the plate **9**.

In FIG. 4, in accordance with the rotation of the plate 9 turning in the direction as shown by an arrow A, the material travels in the path of arrows B and it eddies along the inner surface of the wall of the casing **3**.

Accordingly, if cylindrical granules in random length as material are fed to the apparatus, the granules are first cut to uniform length, and rotated and revolved in the casing **3** by the action of the unevenness **9b** on the plate **9** and finally transformed into uniform spherical granules.

In this case, the cylindrical granules must be so made that they have plasticity suitable for being transformed into sphere before the treatment of the apparatus.

In order to make such cylindrical granules, liquids may be added to the material in its granulation.

Further, if the plate **9** has no unevenness **9b** on its upper surface, the material cannot be cut or transformed into spherical granules.

Therefore, it can be said that the unevenness **9b** serves as an important factor in the present apparatus.

One of the features of the apparatus is that unexpected large mass or granules are not produced because the material on the plate **9** is continuously thrown out radially viewed from the center of the plate **9** by a centrifugal force and each of cylindrical granules can be separated so as not to be agglomerated.

If wet mixtures of solids in powered form and liquids as material are fed to the apparatus, the material is first dispersed radially and outwardly on the plate **9** and then by the same motion caused by the unevenness **9b** of the plate 9 as described in detail before, it can be granulated and at the same time the granulated material can be further transformed into spherical granules of uniform size.

When the material is finished to spherical granules, the spherical granules can be discharged from the window **13** designed for the discharge of material by opening the cover **14** operated by the handle **15**. The material may then collect in a receptacle, not shown, through the chute 16.

A second embodiment of the apparatus of the invention is illustrated in FIGS. 5, 6 and 7.

In FIG. 5 the apparatus comprises a casing, means for feeding material, means for discharging material and a rotor assembly.

The casing is composed of a vertical case **17** and mounted on a frame **18** which may be supported at a convenient distance above the floor.

The means for feeding material into the apparatus comprises a hopper **19**, the hopper **19** being attached to a lip 20 placed at the top of the case **17**.

The means for discharging material is composed of a window **21** for discharge of material, the window **21** being positioned on the side in the lower part of the casing **17**.

A chute **22** is attached to the window **21** so that the discharged material can be smoothly collected into a suitable receptacle, not shown.

A cover **23** is also attached to the window **21** and so formed that the discharged material may overflow its upper edge.

The rotor comprises a vertical shaft **24**, special type indented plates **25**, an indented plate **25b**, covering plates **26**, a fan **27**, collars **28** and a nut **29**.

The vertical shaft **24** rotates at high speed through a pulley driven by a belt from a separate drive motor, which is not shown, manner of which is similar to the one as shown in FIG. 1.

The special type indented plates **25** are composed of two pieces at least and three pieces in FIG. 5 and keyed to the shaft **24** so that they can rotate with the shaft **24**.

Each of the three pieces of the plates **25** is round, flat and relatively thin as shown in FIG. 6 and provided with openings **30**.

In the present instance, there are four of the openings **30** of each plate **25**, the openings **30** being made to leave arms **33** between the center part **31** and the peripheral part **32** of the plate **25**, as best seen in FIG. 6. The peripheral part **32** is provided with an uneveness similar to that at **9b** of FIGURE **4** forming cross grooves in plate **25**.

And these openings **30** serve as the hole of the droppage of the material.

The arms **33** are shaped to knife edges toward the direction of the rotation of the plate **25**, as shown in FIG. 7.

In the present instance, the plate **25** rotates counterclockwise, as shown by an arrow in FIG. 6.

The knife edges are designed not to crush the material which is being granulated when it drops from the openings **30**.

Further, an indented plate **25b** positioned in the lowest part is similar to the plate **9** in FIG. **2** and provided with no opening so that the material may not drop under the plate **25b**. The plate **25b** also causes the material to be exhausted smoothly from the discharged material window **21** by the centrifugal force of its rotation as described more fully hereinafter.

The covering plates **26** are composed of two pieces at least in the apparatus.

In the present instance, there are three of these plates **26** as shown in FIG. 5 and each of them is keyed to the shaft **24** so that it can rotate with the shaft **24**.

These plates **26** are round, flat and relatively thin and provided with no openings, diameters of which are approximately the same as the outside diameter of the openings **30** of the plate **25**.

And these covering plates **26** are positioned over the corresponding plates **25** so that they can cover the openings **30**, by which the material is first kept on the peripheral part **32** of the plate **25** and the material does not drop instantly from the openings **30**.

The fan **27** is positioned under the lowest indented plate **25b** and keyed to the shaft **24**, and it rotates with the shaft **24**.

This fan **27** is aimed to suck air from the lower part of the apparatus and to blow air up from the clearance between the peripheral edge of the plate **25b** and the inner surface of the wall of the case **17** so that the material may not drop under the plate **25b** and also not clog the inner surface of the wall of the case **17**.

The collars **28** are composed of some pieces suitable for placing the fan **27**, the special type indented plates **25**, the indented plate **25b** and the covering plates **26** at their right positions and all of them are easily detachable from the shaft **24**.

The nut **29** is screwed into the top of the shaft **24** and it secures to the shaft **24** the covering plates **26**, the special type indented plates **25**, the indented plate **25b**, and the fan **27** which are each rightly positioned by the collars **28** so that all of them can rotate together in accordance with the rotation of the shaft **24** and also can be easily detached from the shaft **24** by removal of the nut **29** for cleaning of the apparatus.

The operation of the second embodiment is, in principle, similar to that of the first embodiment shown in FIGS. 1, 2, 3 and 4; but it is featured by the fact that

the second embodiment can be executed in continuous system, while the operation of the first embodiment is generally executed in batch system.

Accordingly, how the continuous operation is executed is explained hereunder.

If material is fed continuously to the apparatus, the material initially drops on the peripheral part **32** of the plate **25** at top position and begins to be made into spherical granules by the motion of the indented plate **25**.

When the material becomes too much to be kept on the periphery **32**, it begins to overflow the openings **30** of the plate **25** and drops on the periphery of the second position indented plate **25** by the aid of the next covering plate **26**.

On the third plates **25** and **26**, the material goes through the same process as above.

But on the fourth indented plate **25**b which is located in the lowest part, the material is exhausted to the chute **22** through the window **21** for discharge of material and is finally collected in a receptacle, not shown, by the aid of the centrifugal force caused by the rotation of the plate **25**b.

The window **21** is provided with the cover **23** having suitable size to regulate the quantity of the discharged material.

It will thus be seen that the structure and operation of the apparatus and their methods have been fully described, and spherical granules can be made uniformly by the apparatus.

While two preferred embodiments of the invention have been illustrated by way of example in drawings and particularly described, it is to be understood that many different modifications and changes may be made without departing from the principles of the invention or the scope of the claims.

What is claimed is:

1. The spherical granule making apparatus comprising a vertical cylindrical casing having a hopper for feeding of material at its top and a window for discharge of material on its side in its lower part, a vertical shaft rotating in the casing, a plurality of plates having cross grooves fixed on the vertical shaft of which peripheral edges rotate adjacently to the inner surface of the wall of the casing, each of said plates having arms between a peripheral and center part forming openings for droppage of material, a plurality of covering plates which are round, flat and relatively thin, and positioned so that each of them may cover the openings of the corresponding plate, an indented plate which is positioned horizontally in the lowest part and on the same level with the lower edge of the window for discharge of material, peripheral edge of said indented plate rotating adjacently to the inner surface of the wall of the casing and a fan placed right under the lowest indented plate.

2. A spherical granule making apparatus of claim **1** in which the fan, placed right under the indented plate in the lowest part, feeds air from the lower part of the casing to the upper part of the casing.

3. The method of making spherical granules, comprising the steps of

forming extrusions of a wet mixture of powdered solid material, said extrusions having a maximum diameter proximating the desired diameter of the spherical granules,

introducing said extrusions onto a horizontal circular plate having an uneven peripheral upper surface and disposed with its peripheral edge adjacent to the inner surface of a surrounding stationary wall, in a limited quantity such that on rotation of the plate the material will be distributed in a ring on the outer portion of the plate adjacent the wall,

and rotating said plate at a high speed such that the uneven surface of the rotating plate propels the material outward by centrifugal force against the stationary wall and upward along such wall, where the material loses its centrifugal force and falls by gravity back toward the center of the rotating plate,

and thereby effecting a fluid flow of the material in a ring along the inner surface of the stationary wall, in repetitive eddies outward on the uneven surface of the plate, upward along the wall, and back toward the center of the plate,

the fluidized eddy flow so produced being effective to divide the extrusions into short lengths and transform such lengths into substantially uniform spherical granules.

4. The method of claim 3 in which said spherical granules are discharged by centrifugal force through an outlet of said stationary wall.

5. The method of claim 4 in which said extrusions are cylindrical.

6. The method of claim 5 in which said extrusions in said eddy flow repetitively travel from a point on said indented plate near its center across to its periphery.

7. The method of making spherical granules from non-spherical particles of a wet mixture of powdered solid material, starting with the particles in the form of extrusions or like bodies having a cross section with a maximum dimension proximating the desired diameter of the spehrical granules to be produced, comprising the steps of

introducing the particles in said form onto a horizontal circular plate having an uneven peripheral upper surface and disposed with its peripheral edge adjacent to the inner surface of a surrounding stationary wall, in a limited quantity such that on rotation of the plate the material will be distributed in a ring on the outer portion of the plate adjacent the wall,

and rotating said plate at a high speed such that the uneven surface of the rotating plate propels the material outward by centrifugal force against the stationary wall and upward along such wall, where the material loses its centrifugal force and falls by gravity back toward the center of the rotating plate,

and thereby effecting a fluid flow of the material in a ring along the inner surface of the stationary wall, in repetitive eddies outward on the uneven surface of the plate, upward along the wall, and back toward the center of the plate,

such fluidized eddy flow being effective to divide long particles and transform the material into substantially uniform spherical granules.

8. Apparatus for making spherical granules from non-spherical particles of a wet mixture of powdered solid material, which particles are in the form of extrusions or like bodies having a cross section with a maximum dimension proximating the desired diameter of the spherical granules to be produced, comprising

a stationary cylindrical wall defining a casing,

a horizontal circular plate mounted for rotation on a vertical axis with its pheripheral edge adjacent to the inner surface of said cylindrical wall, and adapted to support a ring of material on its outer portion adjacent said wall,

said plate having an uneven peripheral upper surface for contact with material being treated in the casing,

means to rotate such plate within said casing at a high speed sufficient to distribute the material on the plate in such a ring and to cause said uneven surface to propel material in contact with it outward by centrifugal force against said wall and upward along said wall to a level at which the material loses its centrifugal force and falls by gravity back toward the center of the plate,

such rotation thereby effecting a fluid flow of the material being treated in a ring along the inner surface of the wall and in repetitive eddies outward on the uneven surface of the plate, upward along the wall, and back toward the center of the plate,

the fluidized eddy flow so produced being effective to

divide elongated particles into short lengths and transform the material into substantially uniform spherical granules.

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U.S. Cl. X.R.

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