Jan. 20, 1925. 1,523,632

F. J. E. CHINA

MINUTE DISINTEGRATION OF SUBSTANCES

Original Filed Nov. 4, 1922

Fig. 1.

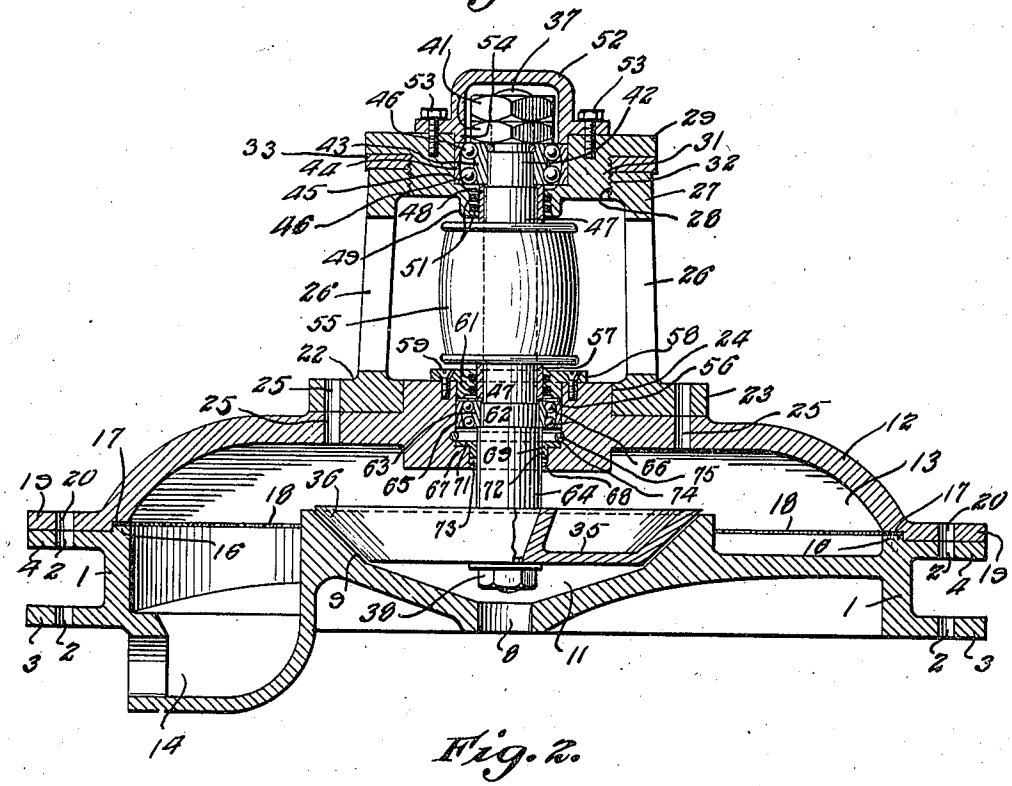
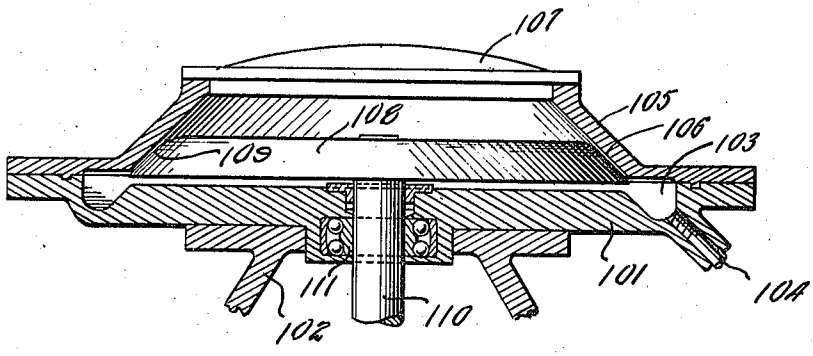


Fig. 2.



Inventor

Frederick J. E. China

By Lemmes & Lemmes

Attorneys

Patented Jan. 20, 1925. 1,523,632

UNITED STATES PATENT OFFICE.

FREDERICK JOHN EDWIN CHINA, OF ESHER, ENGLAND.

MINUTE DISINTEGRATION OF SUBSTANCES.

Continuation of application Serial No. 599,038, filed November 4, 1922. This application filed November 11, 1924. Serial No. 749,321.

To all whom it may concern:

Be it known that FREDERICK JOHN EDWIN CHINA, a subject of the King of Great Britain, residing at Esher, in the county of Surrey, England, has invented certain new and useful Improvements in Minute Disintegration of Substances, of which the following is a specification.

My invention relates to improvements in minute disintegration of substances, and in the treatment of particles, liquid or solid, suspended in a liquid, and more particularly to mills for these purposes. This is a continuation of my application filed November 4, 1922, Serial No. 599,038.

An object of my invention is to finely divide particles to an extremely small diameter, while at the same time insuring great uniformity of size of particles.

Another object of my invention is to utilize forces existing within a thin film of liquid in which particles are suspended, such film existing between closely adjacent surfaces relatively movable one past the other at high velocity.

A further object of my invention is to provide methods and apparatus for minutely disintegrating particles, which accomplish the disintegration of a large amount of substances within a short time with a minimum consumption of power.

Yet another object of my invention is to provide methods and apparatus for disintegrating particles in which there is a minimum of wear on the machine, and a minimum of heat generated by the working surfaces.

A still further object of my invention is to provide an apparatus which is simple in operation, cheap to manufacture, and easy to adjust, repair and replace.

With these and other objects in view which may be incident to my improvements, the invention consists in the parts and combinations to be hereinafter set forth and claimed, with the understanding that the several necessary elements comprising my invention, may be varied in construction, proportions and arrangement, without departing from the spirit and scope of the appended claims.

In order to make my invention more clearly understood, I have shown in the accompanying drawings means for carrying the same into practical effect, without limiting the improvements in their useful applications to the particular constructions, which for the purpose of explanation, have been made the subject of illustration.

The accompanying drawings illustrate two forms of mill constructed according to the present invention.

In the drawings:—

Figure 1 is a vertical section of a mill in which the larger end of the rotor is uppermost;

Fig. 2 is a similar view of the mill in which the larger end of the rotor is lowermost.

My invention comprises passing a thin film of liquid, with the suspended particles of liquid or solid therein, between surfaces relatively movable one past the other at high velocity. There are generated in the thin film of liquid thus acted upon forces which act upon the particles, liquid or solid, suspended in the liquid, and where the clearance between the moving surfaces is small enough and the velocity of relative movement of the surfaces is great enough, particles will be disrupted. The relative velocities of the surfaces and their distance apart, as well as the time of their operation and other factors, such as temperature at which it is carried out, determine the amount of force to which the particles are subjected. Generally speaking, the greater the speed, the greater the forces acting and the more closely adjacent the surfaces, the greater the forces acting on the particles in the film.

It is necessary that the liquid with the suspended particles therein be retarded in its passage between the relatively movable surfaces. Such retarding, however, necessarily takes place by reason of the friction between the liquid and the relatively movable closely adjacent surfaces, so that there is sufficient retarding in forms of my apparatus where the film of liquid passes freely between disks.

Referring to the drawings, and particularly to Fig. 1, I have shown a mill which comprises a base casting 1 adapted to be suitably bolted to some support (not shown). The casting 1 is formed with a lower annular flange 3, and an upper annular flange 4. The upper and lower flanges 3 and 4 are provided with bolt holes 2, through which bolts may be passed, as above set forth.

Formed within the bottom portion of the casting 1 is an input duct 8 through which the liquid containing the particles to be dis-

integrated is introduced into the machine. The particles to be disintegrated, if they are extremely hard, should ordinarily be of less diameter than the distance between the working surfaces (later to be described), otherwise such surfaces may be injured or scored.

Formed in the upper part of the casting 1 is a smooth frusto-conical working surface 9, and between the working surface 9 and the input duct 8 is comprised a conical input chamber 11.

Mounted on the casting 1 is a cover plate 12, which forms with the casting 1 an output chamber 13 from which leads an output duct 14. The casting 1 is formed with an annular shoulder 16 at its top, and the cover plate 12 is provided with an annular groove 17 in which the shoulder 16 of the casting 1 fits. Between the groove 17 and the shoulder 16, I insert suitable packing material 18.

The cover plate 12 is provided with an annular flange 19 which overlies the annular flange 4 of the casting 1; the bolts (not shown) which hold the casting 1 to a suitable support, pass through holes 20 formed in the flange 19, as well as the flanges 3 and 4 of the casting 1, and maintain the cover plate firmly in place. A careful adjustment of the relative position of the cover plate 12 to the casting 1 must be made in order to properly center the working parts.

Mounted on the top of the casting 1 is a supporting structure 22. The supporting structure 22 is provided with a flange 23 at its lower end, which is adapted to lie in contact with the top of the cover plate 12. The inner periphery of the flange 23 of the support piece 22 is adapted to abut against an annular shoulder 24 formed on the cover plate 12. A series of holding bolts (not shown) pass through holes 25 formed in the cover plate 12 and the flange 23, and hold the support member 22 in position. The support member 22 has preferably integrally formed therewith upwardly extending support spiders 26 which terminate at their upper extremity in a ring member 27, the interior surface of the ring member being screw-threaded, as indicated at 28.

A bearing support piece 29 is provided on its downwardly extending annular portion 31 with screw-threads 32 which are adapted to engage with the screw-threads 28 of the ring member 27, permitting the bearing support 29 to be adjusted. A lock nut 33 is provided to lock the bearing support 29 in any adjusted position. It is through this adustment of the bearing support piece that the distance between the working surfaces (to be later explained) is effected.

My mill is provided with a conical rotor 35 having a smooth frusto-conical working surface 36 adapted to lie adjacent the smooth frusto-conical working surface 9 of the casting 1, and equi-distantly spaced therefrom. The rotor 35 is mounted on a shaft 37 and held securely on the shaft by means of a bolt 38; on the upper end of the shaft 37 are adapted to be screwed locking nuts 41. Below the locking nuts 41 the shaft 37 has a slightly enlarged portion 42 over which is adapted to fit an inner upper ball race 43. An outer upper ball race 44 is adapted to fit in a cylindrical aperture 45 formed in the bearing support 29. Between the inner and outer ball races are two series of balls 46.

Below the portion 42 the shaft is slightly enlarged, as indicated at 47, and around the upper part of the portion 47 of the shaft is fitted a collar 48 whose upper end contacts with the upper inner ball race 43. The bearing support 29 is provided with a downwardly extending annular shoulder 49 having annular packing glands 51 therein, in which is packed suitable packing to prevent leakage of lubricant from the bearing. A journal box cover 52 is bolted by means of bolts 53 to the bearing support 29. The journal box cover 52 has a downwardly projecting annular lip 54, and the upper outer ball race 44 is firmly held between the annular lip 54 and the shoulder 49 formed on the bearing support member 29.

The bearing structure comprising the inner and outer upper bearing races and the balls operates as a thrust and radial bearing. The bearing will withstand thrust in either direction. One type of bearing commercially known as the "skefko" bearing, which is made in Sweden, I have found particularly good, as this type of bearing can withstand thrust and at the same time can be operated at exceedingly high speed without overheating or play.

On the portion 47 of the shaft 37 is a drive pulley 55 which is keyed to the shaft and against which the lower end of the collar 48 rests. The cover plate 12 is provided with an annular recess 56 within which is mounted the lower bearing and packing structure which I will now describe.

Mounted on the portion 47 of the shaft extending below the pulley 55 is a collar 57 whose upper end is adapted to engage the lower end of the pulley 55. The collar is mounted within a packing gland comprising a plate 58 which lies over the upper end of the annular recess 56, and is bolted, by means of bolts 59, to the upper side of the cover plate 12. The plate 58 is provided with two annular recesses 61 on its inner periphery within which is placed a suitable packing to form a tight packing joint around the collar 57.

Mounted below the collar 57 on an enlarged portion 62 of the shaft 37 is an inner ball race 63, whose lower end rests against the shoulder formed between the portion 62

of the shaft and an enlarged lower portion 64 of the shaft. The upper portion of the inner ball race 63 is in contact with the lower portion of the collar 57. Arranged to slidably fit within the walls of the annular recess 56 is an outer ball race 65. Between the inner and outer ball races are balls 66.

To prevent leakage of lubricant through the lower opening of the annular recess 56, through which the portion 64 of the shaft 37 passes, I have formed the annular recess 56 with an inwardly projecting annular shoulder 67. Below the shoulder 67 the inner walls of the recess 56 are inwardly tapered at 68 adjacent the point at which the portion 64 of the shaft 37 passes through the lower part of the cover plate 12.

Fitting around the portion 64 of the shaft is a packing plate 69 having a shoulder 71 lying above the shoulder 67 of the cover plate 12, with its outer periphery in engagement with the inner periphery of the annular recess 56. The packing plate 69 is formed with a downwardly extending lip 72 which fits around the portion 64 of the shaft 37. Between the lower edge of the downwardly extending lip 72 and the sloped walls 68 in the cover plate, I have inserted packing material 73 to prevent leakage of lubricant.

To hold the packing plate 69 pressed against the packing 73, I have formed an annular groove 74 in the wall of the recess 56. Within this groove I mount a split ring 75 whose elasticity, when sprung into position, keeps the packing plate 69 pressing against the packing 73. The packing gland thus formed is adapted to ordinarily stand a considerable number of pounds pressure without leakage. This packing gland near the lower portion of the cover plate not only serves to prevent lubricant from leaking out of the lower bearing structure, but at the same time provides means for preventing liquid within the output chamber 13 of the mill from passing into the lower bearing, should any considerable pressure be generated in this output chamber.

Adjustment of the clearance between the fixed working surface 9 and the rotating working surface 36 of the rotor 35 can be very easily and accurately effected, by loosening the lock nut 33 on the threaded portion 31 of the bearing support 29 and rotating the bearing support 29 until the exact adjustment is obtained. The working surfaces are held equi-distantly and fixedly spaced when the lock nut 33 is screwed in place.

The whole upper bearing structure is either raised or lowered by rotating the bearing support 29. The outer upper ball race 44 is moved with the bearing support and through the balls 45, carries the inner ball race 43 with it. The inner ball race is held against longitudinal displacement on the shaft by the collar 48, whose lower end abuts the fixed pulley 55, and by the lock nuts 41. By reason of the fact that the lower inner ball race 63 is held against longitudinal movement on the shaft by the collar 57 and the shoulder formed at the upper extremity of the portion 64 of the shaft, the lower inner ball race 63 must move with the shaft. The balls 66 cause the outer ball race 65 to slide either up or down within the annular recess 56 in accordance with the adjustment of the shaft.

It will be apparent, by reason of the bearing mountings and the shaft structure, that when the upper bearing support 29 is either raised or lowered, the lower bearing moves with it.

One of the support spiders 26 is made of less arcuate breadth than the other support spiders to permit a belt to pass readily over the pulley 55. A suitable source of power moves the belt and imparts rotation to the pulley 55 to cause the rotor 35 to rotate. The screw threads which are formed on the upper bearing support 29 are in such a direction that the normal direction of rotation of the pulley will cause the upper bearing support 29 to unscrew in case the lock nut 33 is not tightly adjusted to prevent such an occurrence. This gives an added factor of safety, for should the proper tightening of the lock nut 33 not be effected, the normal operation of the machine will tend to gradually increase the distance between the smooth conical working surfaces, thus preventing injury to the machine.

In operation, the particles to be acted upon are suspended in a suitable liquid medium, such as water. The particles to be acted upon or to be disintegrated may be either liquid or solid particles. The liquid, with the suspended particles therein, is introduced through the input duct 8 and passes into the input chamber 11. The rotor is moving at a high rate of speed, and the liquid, with the suspended particles, is sucked in between the working surfaces and ejected into the output chamber. During the brief time that the liquid, with the suspended particles, takes in passing from the input chamber through the film and into the output chamber, the particles, if velocities and clearances are properly adjusted, will have been disrupted and found to be of much smaller diameter. It has been difficult to investigate exactly what happens within the film, and exactly what forces are at work, but certain evidence has been obtained in the following manner:

It has been found that in a mill designed according to my invention and having two concentric co-axial and co-acting conical working surfaces, the material dealt with has produced curved or stream-line markings on

the concave conical working surface of the stator. It is not clear whether these markings are produced chemically or mechanically. In all probability a combination of effects has been at work. These markings, however, give an indication of the path of the particles through the mill. On investigating the markings, it has been found that they offer a simple means of deducing the actual velocity of the particles within the film.

From the thickness of the film, length of path of the particles as shown by the markings on the stator, general dimensions of the mill, rate at which the liquid is passing through the film, and clearance between the working surfaces, the velocity of the particles along their path within the film can be calculated.

The mean of a number of experiments shows that this velocity with this form of mill is less than one-half the peripheral velocity of the rotor. Now the velocity of any particle within the film depends chiefly on the following factors:

(1) Revolution-speed of the rotor.
(2) Diameter of the rotor.
(3) Angle of the rotor.
(4) Thickness of the film.
(5) Speed of the liquid through the film (the liquid being either pumped or sucked through the film space).
(6) Viscosity of the liquid.

The centrifugal force, under ordinary circumstances, plays an important factor in regulating the time during which the particles are subjected to the disruptive forces existing within the film, as well as the magnitude of such forces. As nearly as can be determined, the disruptive forces are at least in part due to the shearing action which occurs within the film. There is no true grinding action, in the ordinary sense of the term, taking place within the mill. This latter fact permits of large output with small utilization of power, and saves wear and tear on the working parts. There is but slight heating of the mill for a long continued operation at high speed, which shows that but little force is dissipated in production of heat.

By reason of the fact that the working surfaces are held fixedly spaced, there can be no accidental touching of the working surfaces, and hence injury to the mill. The exact thickness of the film for any one operation, once determined, will not vary during the operation, for any changes in the relative pressures existing between the input chamber and the output chamber will not affect the adjustment.

The mill shown in Fig. 2 comprises a base 101 carried by a support 102 and formed with an annular channel 103, which has a delivery outlet 104. Above the base member 101 is a body member 105 that has an internal cone surface 106 constituting one of the coacting working surfaces. The body member is surmounted by an inlet cover 107. A rotor 108 having a conical working surface 109 is carried by a vertical shaft 110, the upper end of which is mounted in a suitably designed bearing 111 carried by the member 101, while its lower end may be mounted on an adjustable foot step. The shaft may be rotated by means of a pulley and belt, or in any other convenient manner.

While I have shown and described the preferred embodiment of my invention, I wish it to be understood that I do not confine myself to the precise details of construction herein set forth, by way of illustration, as it is apparent that many changes and variations may be made therein, by those skilled in the art, without departing from the spirit of the invention, or exceeding the scope of the appended claims.

I claim:—

1. A method of disintegrating particles suspended in a liquid comprising, subjecting a very thin film of the liquid with the suspended particles therein to the action of closely adjacent non-contacting fixedly spaced smooth surfaces relatively movable one past the other at high velocity, and retarding slightly the ejection of the film from its confines while on said smooth surfaces to increase internal friction in the film, whereby the particles are disintegrated by reason of the disruptive forces within the film itself, which increase with the increase of the relative velocities of the moving surfaces and decrease with the increase in the thickness of the film.

2. A method of disintegrating particles suspended in a liquid comprising, subjecting a very thin film of the liquid with the suspended particles therein to the action of closely adjacent non-contacting fixedly spaced smooth surfaces relatively movable one past the other at a velocity exceeding 150 feet per second, and retarding slightly the ejection of the film from its confines while on said smooth surfaces to increase internal friction in the film, whereby the particles are disintegrated by reason of the disruptive forces within the film itself which increase with the increase of the relative velocities of the moving surfaces and decrease with the increase in the thickness of the film.

3. A method of disintegrating particles suspended in a liquid comprising, subjecting a very thin film of the liquid with the suspended particles therein to the action of closely adjacent non-contacting fixedly spaced smooth surfaces relatively movable one past the other at a velocity of from 150 to 600 feet per second, and retarding slightly the ejection of the film from its confines

while on said smooth surfaces to increase internal friction in the film, whereby the particles are disintegrated by reason of the disruptive forces within the film itself, which increase with the increase of the relative velocities of the moving surfaces, and decrease with the increase in the thickness of the film.

4. A method of distintegrating particles suspended in a liquid comprising, subjecting a very thin film of the liquid with the suspended particles therein to the action of non-contacting fixedly spaced smooth surfaces approximately two-thousandths of an inch to twenty-thousandths of an inch apart, and relatively movable one past the other at a velocity of from 150 feet to 600 feet per second, and retarding slightly the ejection of the film from its confines while on said smooth surfaces to increase internal friction in the film, whereby the particles are disintegrated by reason of the disruptive forces within the film itself, which increase with the increase of the relative velocities of the moving surfaces, and decrease with the increase in the thickness of the film.

5. A method of disintegrating particles suspended in a liquid comprising, subjecting a very thin film of the liquid with the suspended particles therein to the action of closely adjacent non-contacting fixedly spaced smooth surfaces relatively movable one past the other at high velocity, the diameter of the particles being less than the distance between the surfaces, and retarding slightly the ejection of the film from its confines while on said smooth surfaces to increase internal friction in the film, whereby the particles are disintegrated by reason of the disruptive forces within the film itself, which increase with the increase of the relative velocities of the moving surfaces and decrease with the increase in the thickness of the film.

In testimony whereof I affix my signature.

FREDERICK JOHN EDWIN CHINA.