PUBLISHED MAY 4, 1943. BY A. P. C.

D. BACHMANN

DEVICE FOR DISINTEGRATING OR HOMOGENIZING

Filed Dec. 31, 1940

Serial No. 372,589

3 Sheets-Sheet 1

Fig. 1

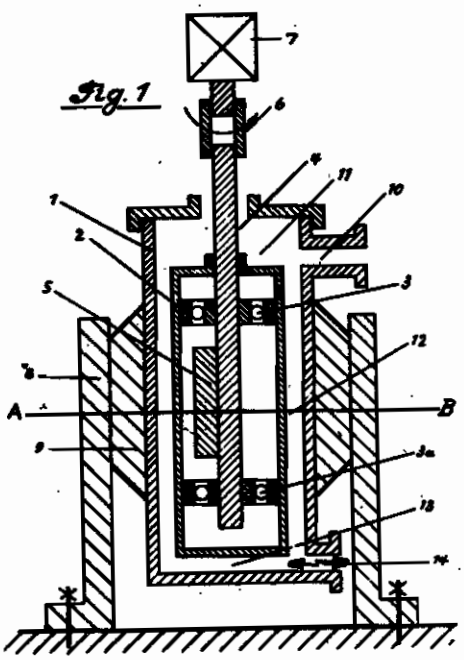

Fig. 3

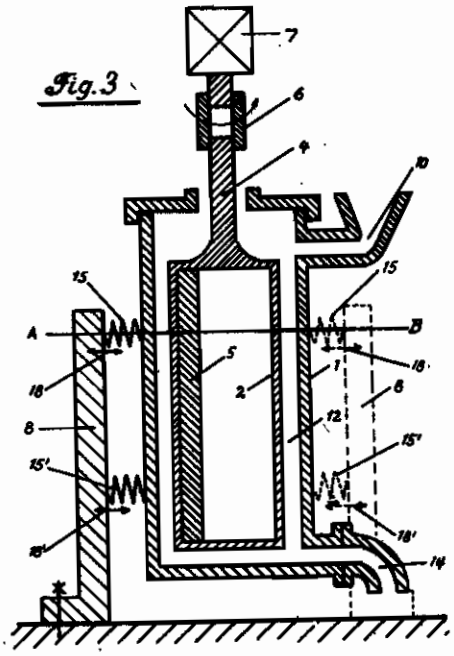

Fig. 2

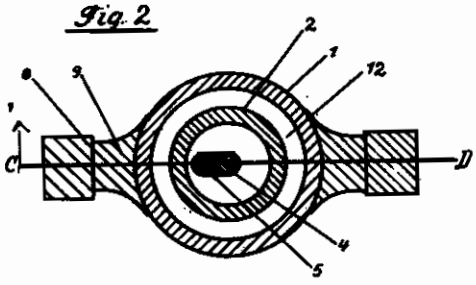

Fig. 4

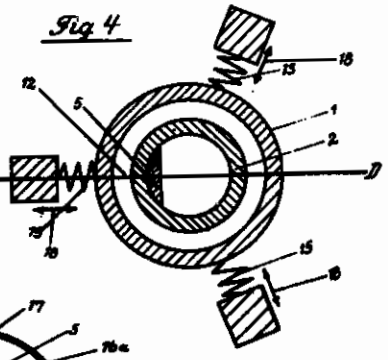

Fig. 4a

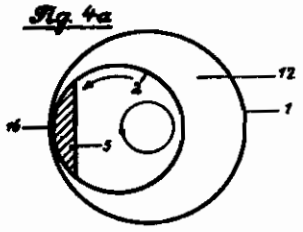

Fig. 4b

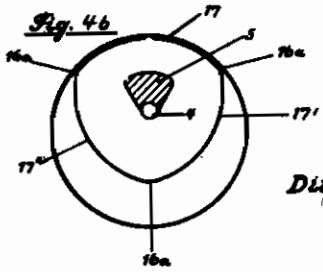

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Fig. 5

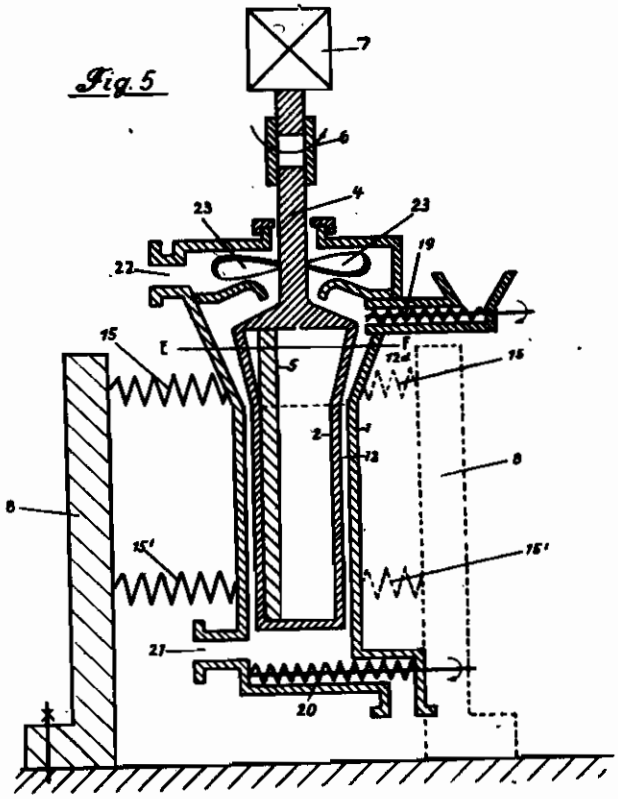


Fig. 5a

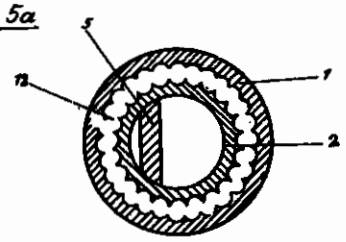


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Fig. 6

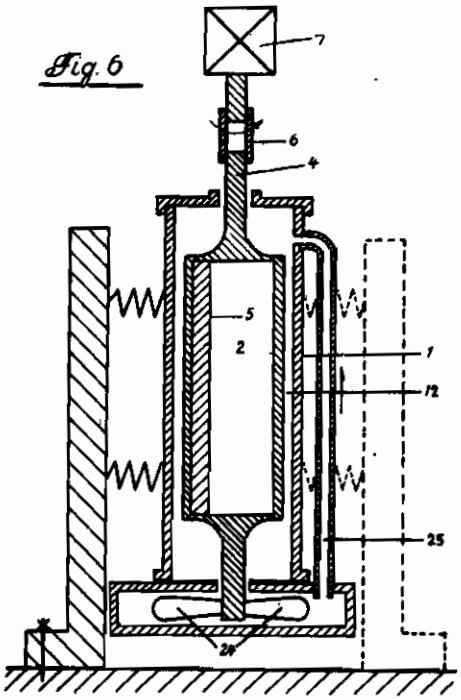



Fig. 8

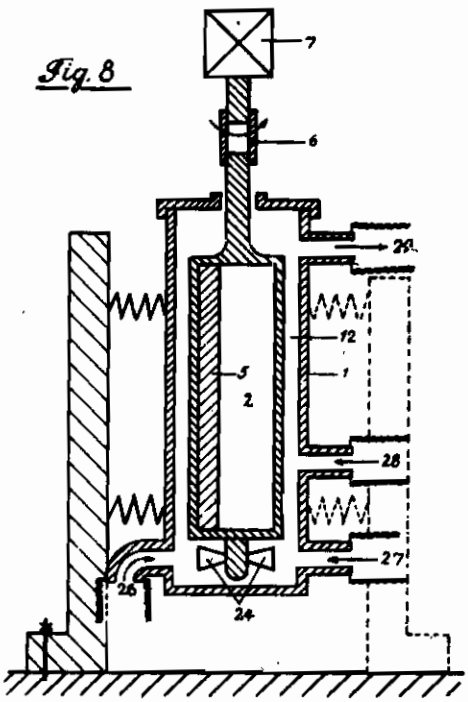
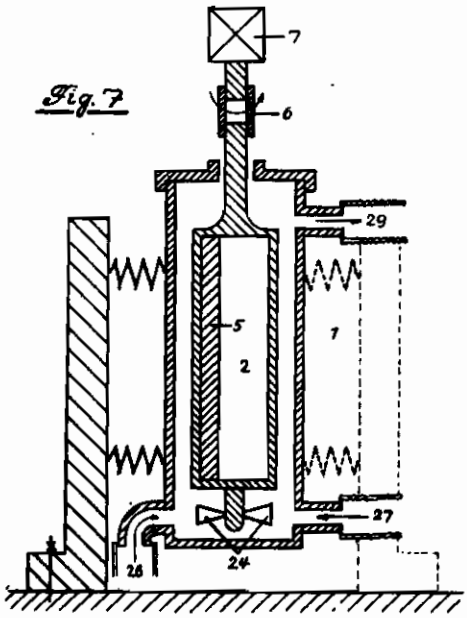



Fig. 7

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# ALIEN PROPERTY CUSTODIAN

## DEVICE FOR DISINTEGRATING OR HOMOGENIZING

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Application filed December 31, 1940

The present invention relates to a device for disintegrating or homogenizing solid and liquid, pasty or viscous materials and for emulsifying several liquids which are insoluble in each other or for emulsifying gases in liquids.

It is already known that some of the aforenamed operations may be carried out in rotating crushing devices. When such devices which resemble for instance a simple slide bearing are applied there is made use of the shearing strain and the friction power produced between a rotating shaft and the bearing bushings for comminuting the solid substances suspended in a liquid. The solid matter is introduced by means of a pump into the centre of the bearing and leaves the device at the ends in the ground condition. Only a limited pressure can, of course, be applied in the bearings of such crushing mills, because otherwise the device would be seized up.

In devices of another kind the material is treated by a body oscillating in the interior of a crushing cylinder which additionally is caused to rotate so that the material to be ground adheres to the inner periphery of the crushing cylinder and an action of the oscillating body is enabled. The oscillating body is suspended in two elastically mounted bearings and the amplitude is limited by a special device in such a manner that the grinding device does not come in contact with the wall of the apparatus. A device of said kind has the drawback that owing to the limitation of the amplitude,—i. e., the non-contact with the wall of the crushing device—it is not possible to crush the material as finely as possible, since, on the one hand, owing to the non-contact with the wall of the crushing device, the material to be crushed is subjected only to a small shearing strain and friction power and, on the other hand, particles of a certain size may slide between the oscillating body and the crushing cylinder and in consequence thereof are not comminuted.

Furthermore, a cone-shaped mill is known wherein a conical revolving body performs revolving and rocking movements in a correspondingly shaped casing; these movements are independent from each other and are caused by separate drives. The revolving body is pressed by a special device to the inner wall of the vessel. Such a cone-shaped mill is not satisfactory because two separate drives are required and the crushing mechanism is complicated.

The present invention related to a device wherein all the afore-named operations may be carried out with good success. The device consists of a casing having a circular interior cross section mounted in a non-rotatable manner and provided with an inlet and an outlet, and of a crushing body situated in the casing which rotates or rolls therein. This crushing body is of a similar shape as the hollow space of the casing, but its exterior diameter is everywhere somewhat smaller than the corresponding inner diameter of the casing. The movement of the crushing body resembles an oscillating movement within the casing; during this movement the crushing body comes in contact with the inner periphery of the casing along a line or plane with adjustable coupling pressure.

The casing is, therefore, the only bearing for the crushing body. On moving, the crushing body comes in contact with the casing; during the revolving or rolling movement of the crushing body the contact is further and further displaced. The material to be treated is conveyed in an axial direction through the space between casing and crushing body. If liquid substances are treated there is formed, in a similar manner as in the case of a slide bearing, a thin film of smeary material wherein the subdivision process takes place.

The rolling or eccentrically rotating motion of the crushing body is caused by mounting an unbalanced mass as exciter in the interior of the crushing body. According to this arrangement the force of the out-of-balance mass can be transmitted by way of ball bearing or slide bearing to the crushing body. It is thus attained that the crushing body is rolled off on the inner periphery of the hollow body without any space between the two bodies being formed. According to the size of the entire device the out-of-balance mass must rotate more or less rapidly so that the crushing body may perform the said motions. The number of revolutions is between about 120 and 6000 per minute. Even if a larger exciter mass and high numbers of revolution are applied it is not to be feared that the crushing body seizes because the crescent-shaped space between both always allows the crushing body and the mass to be treated to turn aside.

The out-of-balance mass of the crushing body may be tightly connected with said body in such a manner that the crushing body itself rotates. The casing is either resiliently mounted or arranged; but it may also be rigidly fixed or clamped.

If the casing is elastically suspended the entire body performs oscillations which are caused by the motion of the crushing body as an out-of-

balance mass. In order to accelerate the material to be treated to pass through the device, the axis of the casing is vertical or substantially vertical; but it is likewise possible to arrange this axis in an inclined or horizontal manner.

It may furthermore be suitable that the space between crushing body and casing is of different size. The space may preferably be constructed so that it narrows in the direction from the inlet to the outlet; or the walls of both parts may be moulded at the top in such a manner that profiles are set up. It is also possible to insert between casing and crushing body one or several cup-shaped bodies, for instance shells, of a similar construction, whereby the rolling off surface can be enlarged by a multiple.

Moreover it may be suitable to hollow out spaces between the hollow body and the revolving or rolling-off rotating body; in these hollow spaces there are mounted devices for the production of a flow serving to move the material, for instance stirrer blades, centrifugal pumps, worms or the like. Preferably such hollow spaces are provided near the end of the crushing body.

In view of the simple construction of the casing and the crushing body different kinds of building material may be applied, for instance also hard porcelain. In order to keep the wear and tear as low as possible, also in the case of a dry crushing, both parts are suitably made of a material which is resistant to wear and tear and the exciter mass is not too large. According to the conditions whether the crushing operation has to take place chiefly in the one end or the other of the device the out-of-balance mass may be mounted in the longitudinal direction nearer to the one end or the other; it may also be removable in the sense of the axis of the casing. If a wet crushing and an emulsifying operation take place the liquids applied and in some cases also the material to be crushed act as a smear and considerably diminish the wear and tear, so that in these cases large out-of-balance masses may also be used.

In the accompanying drawings there is illustrated an apparatus suitable for the invention.

Figs. 1, 3 and 5 to 8 are longitudinal sections of the device and

Figs. 2, 4, 4*a* and 4*b* are cross sections.

Figs. 1 and 2 show the fundamental construction of the device according to the invention in which the crushing body and the casing are mounted vertically. Fig. 1 is a section as seen on line C—D of Fig. 2 and Fig. 2 is a cross section of the same construction as seen on line A—B of Fig. 1. The arrangement is, of course, the same in case of an inclined or horizontal direction. In these figures the casing 1 has the form of a hollow cylinder and the cylindrical form of the revolving crushing body 2 corresponds to this form. Instead of the cylindrical form all other forms of a circular cross section may be applied, for instance balls, segments of a sphere, cones and truncated cones. A shaft 4 carrying the out-of-balance mass 5 rotates in the bearing 3 and 3*a* within the crushing body 2. The shaft 4 is driven by a motor 7 by way of an elastic coupling 6. The casing 1 is rigidly connected by ledges 9 with frame 8 constructed so as to be free from oscillations or with girders. The material to be treated, for instance a suspension of solid substances in a liquid is introduced through the pipe socket 10 into the chamber 11 above the crushing body 2, is passed through the space 12 between the crushing body and the casing in a downward direction into the chamber 13 and leaves the device through the outlet tube 14. On rotating the out-of-balance mass 5 round the shaft 4, the crushing body 2 comes into an eccentric rotating motion and continuously rolls off thereby along the inner wall of the casing 1. The material within the space 12 is continuously ground and crushed thereby. The material, for instance a suspension, may also be caused to flow in a reverse direction from 14 to 10. In this case the suspension is pumped in at 14 with application of pressure, it rises through the space 12 in an upward direction and leaves the mill at 10.

In Figs. 3 and 4 a modification of the rotating body 2 is illustrated. Fig. 3 is a section as seen on line C—D of Fig. 4 and Fig. 4 is a cross section of this device as seen on the line A—B of Fig. 3. According to these constructions the out-of-balance mass 5 is tightly connected with the crushing body; the mass itself may be altered in a simple manner by adjusting pins. The casing 1 is elastically suspended by springs 15 and 15'. When the mass 5 is caused to rotate the body 2 is continuously in contact with the inner wall of the casing 1 owing to the rotating force of the mass 5, as it is illustrated on an enlarged scale in Fig. 4*a*; the line of contact 16 and in consequence thereof also the crescent-shaped space 12 continuously advances between the two bodies. In the space 12 the material running or flowing in a downward direction is crushed or intimately mixed.

The action may still be enhanced by externally shaping the crushing body so that it comes in contact with the inner wall of the casing 1 on a plane 17 instead of the line 16 (see Fig. 4*b*). If for instance a dry or pasty material or two liquids to be emulsified pass the apparatus between the crushing body and the casing there may be produced on the one hand high peripheral velocities of the crushing body and high relative velocities between the crushing body and the material and on the other hand high pressures may be caused to act upon the material within the space by a corresponding selection and arrangement of the out-of-balance mass so that owing to both steps a shearing force is produced which allows the material to be subdivided as finely as possible.

It may be advantageous to shape the crushing body in such a manner that it comes in contact with the inner wall of the casing on a plane instead of a line in those cases where the crushing body is rolled off within the casing instead of rotating therein. In this case the crushing body, illustrated in cross section, has several surfaces 17, 17' and 17'', each of which exactly corresponds with a section of the inner wall of the casing 1 and between which the edges 16*a* formed have been rounded.

The rigid arrangement of the casing in a frame mounted so as to be free from oscillations, as illustrated in Figs. 1 and 2 is suitable if only small forces are produced by the out-of-balance mass and the number of revolutions of the crushing body. In the case of high forces of the mass it is advisable to suspend the casing in an elastic manner, as it is illustrated in Figs. 3 and 4 so as to avoid a transmission of the oscillations produced on to the base, by a more or less strong pressing operation of the springs 15 and 15' against the casing and the frame 8, illustrated by arrows 18 and 18' in Figs. 3 and 4, the pressure between the crushing body and the casing may be adjusted. As the casing, when being elastically suspended, is an oscillating device, the

oscillation of casing and crushing body may be adjusted by regulating the elastic force so that the exciting force of the mass of the crushing body gets ahead of the oscillation of the casing by an exact phase angle. The pressures between both parts may thus be regulated as desired. If the number of revolutions of the crushing body is equal to the natural frequency of the elastically suspended casing the pressure between both parts has attained a minimum value.

Fig. 5 diagrammatically illustrates by way of example a device suitable for the dry crushing operation. Fig. 5*a* shows a cross-section of this device as seen on line E—F of Fig. 5. The space 12 between casing 1 and crushing body 2 is narrow in the centre and bottom of the device. The upper parts of the bodies 1 and 2 are suitably cone-shaped so that the space 12 enlarges somewhat in the upward direction at 12*a*, thus the coarsest of the grains can just enter. At this part profiles are set up on the surfaces of the casing and the crushing body. The material introduced is thus pre-crushed at the top of the device. It is thus possible to introduce also coarse-grained material and then to grind it very finely in a narrow space. The material to be treated is introduced through a laterally mounted worm 19 and leaves the device by passing through worm 20. If it is intended to grind the material as finely as possible a wind sifter may be mounted as follows: At 21 a current of air is introduced and eliminated again at 22; the finely ground grain is removed by said current of air in counter-current to the direction of passage of the material to be ground. The movement of the sifting current may be produced or accelerated by fans 23 at the upper part of the crushing body 2. Any insufficiently comminuted grain leaves the device through the worm 20 and may be reconducted into the apparatus. If no wind sifter is mounted, the worm 20 may likewise be omitted and the opening 21 may then serve as outlet of the material.

The device according to the present invention may likewise be used for a long lasting grinding in a closed vessel, that is for a discontinuous operation. In that case there is applied a device similar to that illustrated in Fig. 3, the difference being that means are provided which keep the material to be treated in a continuous circulation within the space 12; this may, for instance, be effected as illustrated in Fig. 6 where shaft 4 upon which the crushing body 2 with the out-of-balance mass 5 are mounted is elongated at the bottom part and provided at said part with pump blades 24 by which the suspension to be treated is conveyed through the tube 25 to the top of the device so that the material is kept in a continuous circulation while body 2 rotates.

If the material to be treated has during its treatment to be mixed with other substances, for instance if a gas has to be mixed with a liquid, or if during a grinding operation liquid has to be added, a device as illustrated in Fig. 7 may be used. At the bottom part of the crushing body a small fan or air screw 24 is mounted by the motion of which the two liquids, introduced at the same level through the connection pieces 26 and 27, are mixed. If, however, one of the liquids to be mixed is of a higher specific gravity than the other, the heavier liquid is suitably introduced at 26 as shown in Fig. 8. Owing to the fact that in Fig. 8 the heavier liquid enters the space 12 only somewhat towards the top of the device it cannot deposit below the body 2. After having passed the space 12 an emulsion of the two liquids leaves the device at 29. The tubes 26, 27, 28 and 29 are connected with the inlet tubes for the liquid by flexible hose pieces. During the emulsifying operation there are suitably applied very high numbers of revolution and small out-of-balance masses. Any undesirable rise of temperature which may occur when the device operates may be avoided by mounting in known manner a refrigerator suitably so that the cylindrical casing is externally cooled. When there is operated in a continuous manner, cooling is generally not necessary. On the other hand it is also possible to operate with additional application of heat. In this case the casing is externally heated, for instance by a heating coil.

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