DEVICES FOR GRINDING SOLID MATERIALS
IMMERSED IN A LIQUID MEDIUM

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The present invention relates to a device for grinding solid materials immersed in a liquid medium of any character and temperature, the hardness of the solid materials to be ground being however relatively low, i.e., such that they can be cut with an ordinary knife.

The grinding apparatus according to this invention is particularly and advantageously used in the disintegration of foodstuffs such as raw or cooked fruits or vegetables for preparing mashess, pies, soups, compote (stewed fruits) etc., especially in the preparation of large amounts of foodstuff for communities or animals.

Devices of this general type are already known which comprises a vertical rotor having a set of helical blades rotating either within a stationary tubular wall, or within a diffuser coaxial with the rotor but rotating in the opposite direction. This turbine-like assembly is immersed in the mixture to be ground and the materials are thus strongly stirred and subjected to a grinding action by the rotor blades. However, these apparatus are not entirely satisfactory because the helical blades of the rotor will produce mainly an upward movement in the mixture so that the solid materials are ground more by a continuous stirring than by an actual cutting action; as a result, the efficiency of these apparatus is frequently considered as relatively low in the present state of the art.

The grinding apparatus according to this invention is characterized in that it comprises in combination a centrifugal turbine rotor open at the bottom and driven from suitable power means, and a stationary diffuser annulus mounted concentrically to the rotor and consisting of a set of blades inclined in the direction opposite to that of the rotor blade inclination, said stationary blades being spaced at angular intervals and extending from the outer periphery of the rotor inwards so as to leave a free central space adapted to receive the solid materials and the liquid medium, both of which are drawn in from above by the suction effect produced by the rotor blades before they are discharged from the apparatus, the outer edges of the rotor blades and the inner edges of the diffuser annulus being relatively sharp and acting as cutters or knives adapted to cut and grind the solid materials.

According to another possible feature of the apparatus at least one stationary stop member is provided in the free central space of the rotor in the vicinity of the path of movement of the inner edges of the rotor blades, this stop member having preferably an outer sharp edge adapted to co-act with the inner edges of the rotor blades to improve the cutting action of the device.

According to another feature of the present invention the inner face of each turbine rotor blade carries a rib extending substantially at right angles therefrom in a direction opposite to the direction of rotation, the inclination of this rib being such that its free end is turned upwardly so that each rib will form with the relevant blade a dished open upwardly and toward the direction of rotation of the rotor; consequently, the purpose of these ribs is not only to exert a mechanical action but to increase to a substantial degree the upward suction and the outward delivery of the mixture of solid and liquid substances.

Other characteristics and advantages of the device of this invention will become apparent as the following description proceeds with reference to the accompanying drawings forming part of this specification and illustratively diagrammatically by way of example a few forms of embodiment of the invention.

In the drawings:

Fig. 1 is a perspective view showing the grinding apparatus of this invention;

Fig. 2 is a fragmentary, part-sectional and elevational view of the lower portion of the apparatus;

Fig. 3 is a fragmentary plane view from below showing in horizontal section the lower portion of the apparatus;

Fig. 4 is an isometric view of a detail showing the shape of a rotor blade;

Fig. 5 is a perspective view of the stationary annulus constituting the diffuser member of the apparatus;

Figs. 6 and 7 are fragmentary elevational views of two alternate embodiments of the lower portion of the apparatus;

Fig. 6a is a fragmentary elevational view showing diagrammatically a turbine rotor blade;

Figs. 8 and 9 are a part-sectional, side-elevation view with parts broken away, and a plan view from below, respectively, showing a modified embodiment of the grinding apparatus of the invention.

The grinding apparatus illustrated comprises a cylindrical housing 1 enclosing completely the electromotor for driving the grinding members positioned in the lower portion of the housing, this lower portion being adapted to be immersed more or less in the liquid medium in which the solid materials to be ground are contained. This housing 1 comprises a pair of vertical outer slideways 2 having mounted thereon a pair of slides 3 carrying arms 4 whereby the apparatus may be suspended above a container. By properly adjusting the position of the slides 3 along the slideways 2 the degree or depth of immersion of the operating lower portion of the device in the liquid containing the materials to be ground may be adjusted at will.

The rotary shaft of the electromotor extends through the lower or bottom wall of the housing 1 and carries a plate (not shown) having detachably mounted thereon by means of bolts 5 a disc 6 provided with blades 7.

The disc 6 and blades 7 constitute the rotor of a centrifugal turbine adapted to rotate in the direction of the arrow F (see Fig. 3), this rotor being open at the bottom. Each blade 7 consists of a portion of a cylinder having its generatrix parallel to the rotor axis; besides, these blades are placed at spaced angular intervals and form spiral portions extending from the outer periphery of the rotor inwards, as shown.

However, these blades 7 do not extend to the centre of the rotor and are simply located in an annular zone so as to leave a free central space having substantially the shape of a cylinder of revolution in which the generatrix consists of the inner edges of, and has the same height as, the blades 7. The dimensions of the rotor and blades are so designed that the volume of the central space thus formed will have the same order of magnitude as the largest pieces of solid materials to be ground.

The outer edges 7a of blades 7 are cut to a sharp angular profile so that the blades will act somewhat like movable cutters or knives. The lower edges of the blades are joined to the inner edges 7b through a chamfered or bevelled portion 7c in the direction of rotation indicated by the arrow F.

On the other hand, the inner face of each blade 7 is formed with an integral rib 8 substantially at right angles
thereto which extends in a direction opposite to the direction of rotation F of the rotor. These ribs 8 are so inclined that their free ends are upturned in the direction of the disc 6. Thus, each rib 8 will form with the relevant blade 7 a dihedral open upwardly in the direction of rotation F, the edge A—B of this dihedral forming an angle of about 90° with the horizontal A—a (Fig. 6a), i.e., with the lower edge of the corresponding blade 7. Besides, the shape and position of these ribs 8 are clearly shown in Figs. 2, 3, and 6a.

The rotor thus constituted of the disc 6 and blades 7 (the arrangement illustrated comprising three blades, although any other suitable number of blades may be contemplated) is surrounded by a stationary diffuser annulus consisting of a set of fixed blades 9 also inclined but in the direction opposite to that of the blades 7, so that the rotor and annulus assembly will co-act as in a centrifugal pump, the blades 9 constituting baffle means whereby the particles of solid materials are thrown with force outwardly by the centrifugal rotor.

Similarly, the outer edges of the blades 9 are relatively sharp so as to act as cutters or knives. The inner edges of these blades 9 are coincident with a cylindrical surface concentrical with the rotor; besides, these inner edges are positioned as close as possible to the path of the outer edges of the rotor blades 7.

The stationary diffuser annulus consists of a simple relatively thin sheet metal cylinder 10 having cut therein a number of spaced slits 11 forming strips 12 pressed or bent somewhat in the fashion of shutter slits or bonnet louvers to form the inclined blades 9 of the diffuser annulus. This original method of making the diffuser annulus is particularly simple and economical. Moreover, if the sheet metal from which the cylinder 10 is made is sufficiently thin the inner edges of the blades 9 do not require any further sharpening operation to act as knives or cutters.

The stationary diffuser annulus 10 may be secured directly and detachably on the lower portion of the housing 1 for example by means of bolts. It is also possible to secure this annulus on the lower portion 1a of the housing 1 by simply clamping it between this lower portion and a lower inlet member 13 detachably mounted as shown by way of example in Fig. 2. To this end, the lower, outlaid portion 1a of the housing 1 has a circular groove formed therein which is engaged by the upper edge of the annulus 10, and a similar groove formed in the upper edge of the inlet member 13 is adapted to receive the lower edge of the annulus 10. This inlet member 13 is also provided with outer radial arms 14 which may be mounted by means of bolts or screws 16 engaging suitable projections 15 at the lower end of the housing.

Thus, the diffuser annulus is clamped between the lower end 1a of the housing 1 and the inlet member 13, the clamping action resulting from the screwing of the bolts or screws 16. To prevent the annulus 10 from rotating in case of a fortuitous loosening of the bolts 16, the upper edge of the annulus 10 may be formed with a radial outer lug 17 engaging a recess 18 of corresponding shape formed in the lower portion 1a of the housing 1, and the lower edge of the annulus 10 may also carry a radial inner lug 19 engaging a corresponding recess formed in the upper edge of the inlet member 13.

A stationary stop member 20, parallel to the rotor axis, is mounted in the free central space of the rotor in close vicinity of the path of the inner edges 7a of the blades 7. The lower portion 20a of the stop member is bent at right angle and extends outwardly so as to be clamped between one of the arms 14 of the inlet member 13 and the relevant projection 15.

The grinding apparatus described hereinafore operates as follows:

The apparatus rests upon the edge of the container through the medium of the adjustable arms 4 so that the lower portion of the apparatus will be immersed in the liquid containing the solid materials to be ground. Then, the electromotor of the apparatus is started and the rotor will rotate in the direction of the arrow F and produce an upward suction in the free central space intermediate the blades 7, so that the solid materials and one portion of the liquid medium will be raised along the path indicated by the arrows f in Fig. 2. This suction effect is obviously caused by the rotor movement in combination with the stationary diffuser annulus, this assembly acting somewhat like a pump.

Then, the solid and liquid materials are entrained by the leading edges 7b of the rotor blades 7 and forced along a circular path as defined by the inner edges of these blades. The solid materials move along a path representing less than one revolution in this space, because they impinge against the stationary stop member 20 which causes them to engage the blades 7 and to be projected thereby at a high speed against the inner cutting edges of the blades 9 of the diffuser annulus 10. During their travel the solid materials are torn to smaller fragments by the outer cutting edges 7a of blades 7. On the other hand, these solid materials are also crushed between the baffle means constituted by the blades 9 of the diffuser annulus 10. This passage through the diffuser annulus 10 will obviously reduce the velocity of the particles or fragments of solid materials which are ejected in the direction of the arrows f1 at a relatively low speed into the surrounding mixture in the container.

Since the edge 15 of the lower portion of the housing 1 acts as a downwardly-directed deflector, the solid particles are thus projected downwards and may be drawn up again by the grinding apparatus, so that a continuous grinding action is obtained.

The ribs 8 formed integrally on the blades 7 are advantageous in that they promote and increase the suction effect already provided by the blades 7 alone. Thus, these ribs 8 will prevent the pump-like arrangement from failing to draw up material when desired for any possible reason, for example when the disintegration of the solid materials has already been carried out to a considerable extent and the mixture in the container has attained a pasty condition. In fact, in this case it is much more difficult to establish a proper suction and a stationary, clogging head may develop in the vicinity of the front portion of the rotor blades 7.

In the device according to the present invention this serious drawback cannot occur because the inner ribs 8 of the rotor blades 7 will increase considerably the suction action produced by the rotor, actually because these ribs form with the blades 7 upwardly-open dihedrons in the direction of rotation of the rotor. Moreover, these ribs 8 exert a direct action on any stationary bed of material likely to be formed in the apparatus.

With the detachable mounting of the rotor and diffuser annulus these elements may be easily removed after each run for cleaning and inspection purposes. Similarly the mounting and setting of the various members is extremely simple and easy.

Of course, the apparatus according to the present invention may be constructed with any desired modifications of shape and details as will be appropriate to the specific cases and applications contemplated. Thus the outer edge of the stationary stop member 20 may be formed with a serrated or sawtooth contour, as shown by way of example in Fig. 6. If desired, the stationary outer annulus acting as a diffuser may differ from the construction shown and described. In fact, this annulus may be formed with considerably longer blades; in any case these blades may be in greater num
ber than the rotor blades. Of course, the inner edges of the blades formed in the diffuser annulus or like member must be relatively sharp, but if desired these edges may also be beveled, low-tooth or serrated profile as shown in the modified embodiment of Fig. 7, wherein the outer edges 7c of the rotor blades 7 are formed with teeth registering with those of the diffuser blades 9. This serrated profile may be preferred in certain cases, particularly for grinding leaf-vegetables, for example.

On the other hand, the detachable mounting of the various operating members of the device may differ from the arrangement shown and described by way of example in the drawings; besides, the system employed for suspending the housing may also differ from the structure illustrated.

Thus, Figs. 8 and 9 show a modified embodiment of the grinding apparatus wherein the various members are simplified and reduced in size so that the apparatus is made portable and more easily handled. The housing 1 proper is reduced and the lower end of the rotary shaft 22 extends through the bottom 1a of this housing and has a screw-threaded portion engaged by a correspondingly tapped female portion of the centrifugal turbine rotor 6a. This rotor is also simplified since the disc 6a carries only two peripheral blades 23 of extremely simple shape in that only their leading edges 23a are bent inwardly.

Surrounding this rotor are the stationary blades 9 of the diffuser annulus 10 which are inclined in the direction opposite to that of the leading edges 23a of the blades 23. The diffuser annulus 10a consists essentially of a slotted and pressed sheet cylinder, substantially as in the example illustrated in Figs. 1 to 5. However, the lower portion of this annulus is formed with an inner flange 24 extending beneath the annular zone constituting the path of movement of the rotor blades 23. On the other hand, the upper portion of the diffuser annulus is formed with an outer flange 25 in which notches 26 each associated with a ramp 27 are provided, as shown in Fig. 9. Each notch 25 corresponds to a lug 28 formed on the inner face of the outerlaid edge 1b of the lower portion 1a of the housing. According to a known fixation system these lugs 28 and notches 26 of the flange 25 are adapted to co-act like a bayonet fastening device to permit the quick-release mounting of the diffuser annulus on the housing 1.

This mounting is effected by placing the notches 26 in radial alignment with the lugs 28; then, the diffuser annulus is raised and rotated to bring the ramps 27 beneath the lugs 28. The slope of these ramps 27 is sufficient to afford a proper wedging of the flange 25 against the lugs 28.

This grinding apparatus operates exactly like the one previously described, but it is designed to be constructed with smaller over-all dimensions and to be used as a portable device. To this end the upper portion 1c of the housing 1 is formed with a tapered wall 29 surrounding a handle 30 secured on the upper portion 1c, as shown. Preferably, the handle 30 is formed as the handle 30, and the tapered wall 29 has a cut-out portion at its lowest end. However, the edges of this cut-out portion extend outwardly so as to form a kind of screen or ganulet 31 to surround and protect the operator's hand and wrist. This screen or ganulet includes a flat front bottom 35 and the lateral walls 31 of the screen extend downwards beyond this bottom 35 to form ribs 36. Each rib creates a shoulder on the housing 1 and is provided with a slot or notch 37 adapted to engage the edge of the container 38 in which the apparatus is to be placed for use. Thus, the operator may keep the apparatus within the container by causing the major portion of the front wall 35 to be supported by the latter, so that during the operation of the apparatus the operator is not compelled to support the entire weight of the apparatus with his arm since it will be sufficient to maintain the apparatus in proper position by means of the handle 30.

The wall 1c of the housing 1 on the lowermost side of the handle 30 carries a tumbler switch 33 controlling the circuit for energizing the electro motor. This switch 33 is connected to permit the continuous operation of the apparatus, but another control switch, for example a push-button switch 34, may be provided for operating the apparatus intermittently, i. e., during the time periods in which this push-button is depressed. Preferably, this push-button switch 34 is mounted on the handle 30 so that the operator may actuate it with the hand holding the apparatus. Thus, the operation of the apparatus described hereinabove and illustrated in Figs. 8 and 9 may be either continuous or intermittent since it will be sufficient to depress the push-button switch 34 with one finger of the hand holding the handle 30. Therefore, the turbine may be actuated by pulses, this feature being particularly convenient in certain applications.

Although the embodiments of the invention have been described and shown herein with many constructional details, it will be readily understood by anybody conversant with the art that many modifications and alterations may be brought thereto without departing from the spirit and scope of the invention.

What I claim as new is:
1. Apparatus for grinding solid materials immersed in a liquid medium, comprising in combination a rotary disc driven from a motor, inclined blades disposed at spaced intervals and rigid with said rotary disc on the inner face thereof to constitute a centrifugal turbine rotor a free space being formed between any pair of adjacent blades, each space being open downwards and adapted to receive the solid materials and the liquid drawn upwards by the rotor blades, a stationary diffuser annulus concentrical to said rotor and comprising sets of blades inclined in a direction opposite to that of said rotor blades, the outer edges of said rotor blades and the inner edges of the blades carried by said diffuser annulus being relatively sharp and positioned very close to one another to act as cutters adapted to cut and grind the solid materials thrown and held against said diffuser annulus by said rotor blades.
2. Grindng apparatus according to claim 1, further comprising at least one stationary stop member disposed in the free central space of the rotor in the vicinity of the rotor blades and formed preferably with an outer sharp edge adapted to co-act with the inner edges of the rotor blades for properly cutting and grinding the solid materials.
3. Grindng apparatus according to claim 1, further comprising on the inner face of each rotor blade of the turbine a rib extending at right angles thereto in a direction opposite to the direction of rotation of the rotor, and being so inclined that its free end is directed upwardly, whereby each rib will form with the relevant blade a kind of dihedron open upwardly and in the direction of rotation of the rotor.
4. Grindng apparatus according to claim 1, further comprising a housing enclosing completely a motor driving the said rotor of the turbine, a pair of arms slidably mounted on said housing for suspending same above a container, the driving shaft of said motor extending through the bottom wall of the housing, said rotor being detachably mounted on the lower end of the motor shaft, the diffuser annulus, the stationary stop member in the free central space of the rotor and the lower inlet member being also detachably assembled and secured as a unit on the lower edge of the housing.
5. Grindng apparatus according to claim 1, further comprising a housing enclosing completely a motor driving the said rotor of the turbine, a gripping handle carried by said housing, a shoulder on said housing and notches
formed therein whereby the apparatus may be suspended from the edge of a container.

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