March 15, 1938. R. C. HOPKINS 2,111,364

ROTARY CUTTING, MIXING, AND ATTRITION MILL

Filed June 29, 1936 2 Sheets-Sheet 1

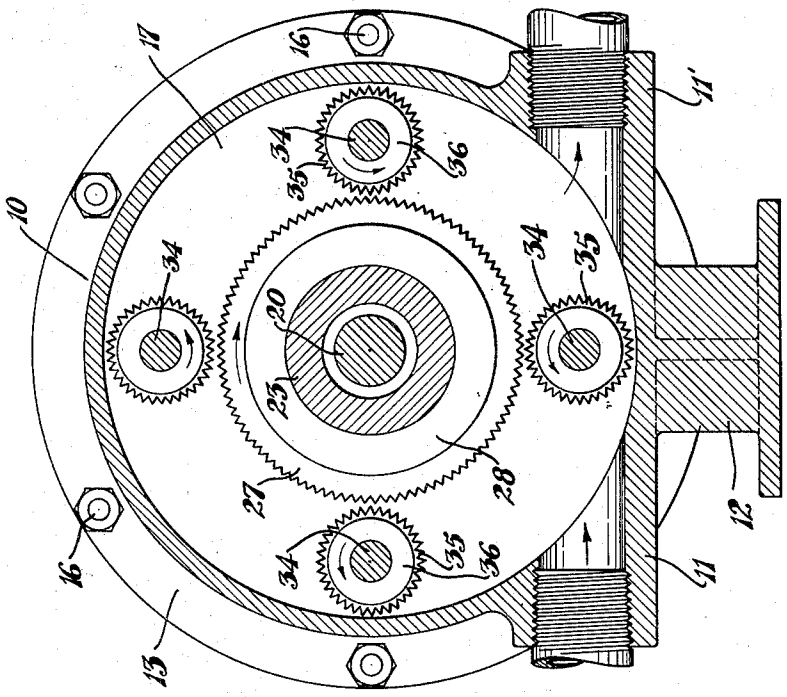


Fig. 1

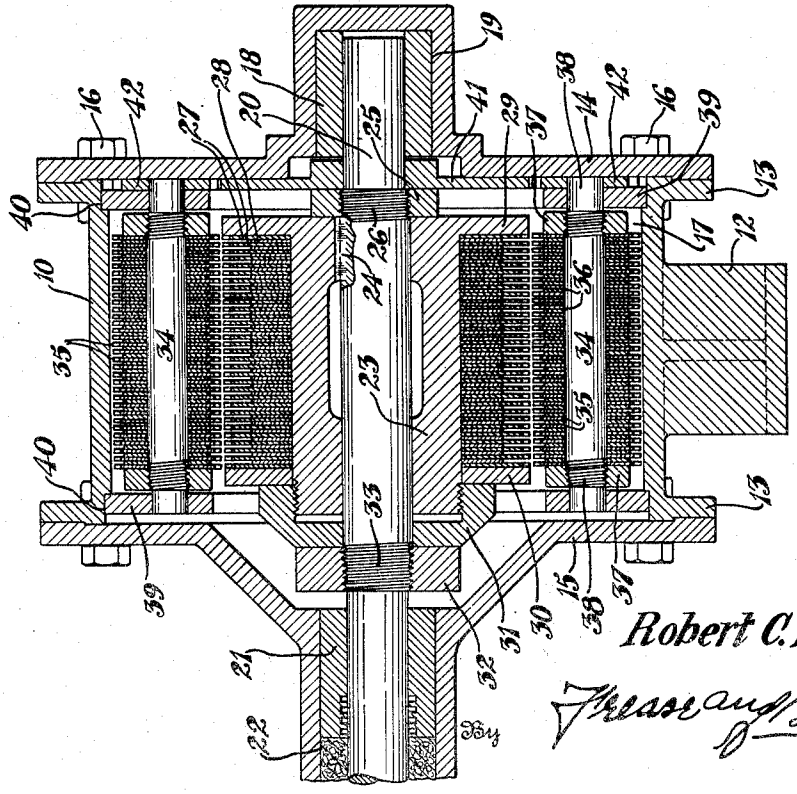


Fig. 2

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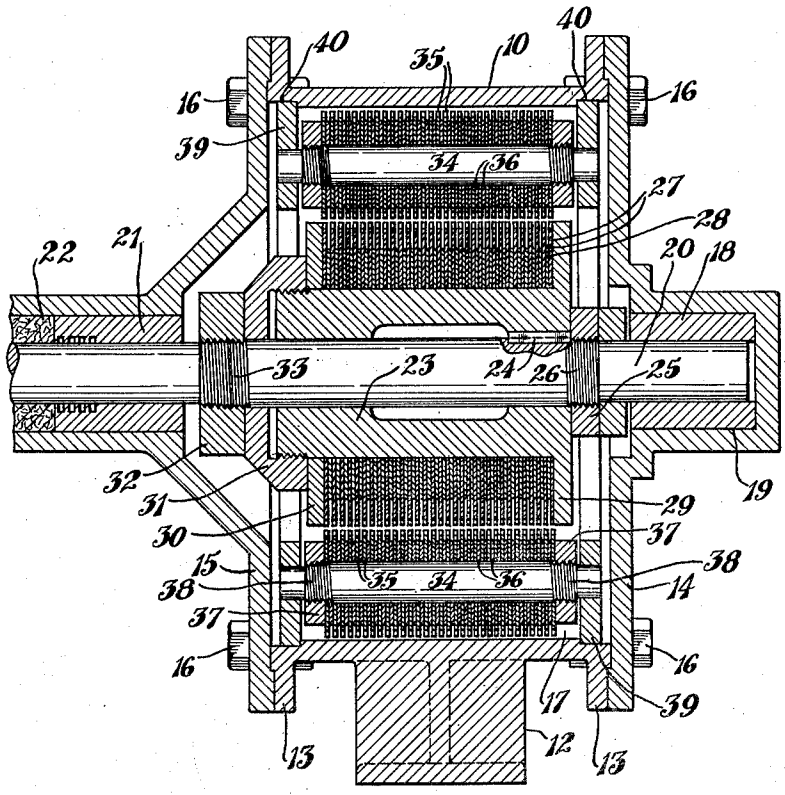


Fig. 3

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ROTARY CUTTING, MIXING, AND ATTRITION MILL

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3 Claims. (Cl. 83—6)

The invention relates to mills for pulverizing, breaking up, mixing and screening the heavy particles of oils, paints, pigments and other mineral, vegetable and animal matter in fluid state or capable of being ground and mixed with oils, water or other liquids, and the present invention is an improvement upon my prior Patents No. 1,764,020, granted June 17, 1930, No. 1,775,721, granted September 16, 1930 and No. 1,796,104, granted March 10, 1931, which disclose the use of rotary gang saws for cutting, macerating and mixing the semisolids which may be contained in the liquids fed into the mill.

The above named patents show housings divided by partition walls into a series of attrition chambers within which the liquid materials are given a spinning motion by means of rotary gang saws, whereby the heavier particles are separated by centrifugal force and brought into contact with the running saw teeth in the cycle from the inlet to the outlet of the mill.

It has been found that by taking advantage of the particles of solids or semisolids held in suspension in the liquid, advantageous results may be obtained. Liquids such as oil, water and the like are almost noncompressible and when considerable inertia is developed in the liquid and these particles are brought into contact with the rapidly rotating peripheral portion of the rotary unit, the inertia serves the purpose of an anvil, even though the particles are in a state of flotation.

To accomplish the maximum milling effect of the particles, it is thus necessary to set up a high turbulence and counterflow in the liquid which will have the effect of high frequency contact of the particles with the rotary unit.

The object of the improvement is therefore to provide a mill including a chamber having inlet and outlet ports for the liquid to be milled and means within the chamber for producing increased turbulence and countercurrents so as to establish a flexible resistance to the flow of the liquid through the chamber.

A further object is to provide a mill of this character in which the turbulence and counterflow set up by the master and secondary rotary units will cause high frequency contact of the particles of solids or semisolids suspended in the liquid with the rotary units, whereby these particles will be macerated, ground and mixed with the liquid.

In the present case, instead of dividing the space between the rotary gang saws and the inner wall of the housing into attrition chambers by means of partition walls, a plurality of secondary or accessory units of rotary gang saws or other suitable toothed or corrugated members are located around and spaced between a central rotary unit of similar construction and the inner wall of the housing, a free running clearance being provided between all of said secondary units and the main unit and also between said secondary units and the inner wall of the housing.

The main rotary unit is arranged to be power driven and motion for the secondary or accessory units may be imparted by flow current set up by the motion of the main or central rotary unit or if desired, these secondary units may be power driven. In each case, however, the direction of movement of the secondary units around their axes is opposite to the direction of movement of the main or central unit around its axis, that is to say, if the main or central unit rotates in clockwise direction, all of the secondary units will be rotated in counterclockwise direction or vice versa.

The above and other objects may be attained by providing a housing having a chamber provided with inlet and outlet ports, said chamber being preferably substantially circular in cross section and having a central or main rotary unit concentrically mounted therein which may be in the form of a gang of rotary saws having means for driving the same, and one or more secondary rotary units which may be in the form of gangs of rotary saws of smaller diameter located within the housing around the main rotary unit, there being a clearance between each secondary rotary unit and the main rotary unit, as well as between the secondary unit and the wall of the chamber, the secondary unit or units being arranged to be rotated in a direction opposite to the rotation of the main rotary unit, which motion may be imparted by flow current set up by motion of the main rotary unit or by direct drive.

An embodiment of the invention thus set forth in general terms is illustrated in the accompanying drawings, in which

Figure 1 is a transverse sectional view through a mill constructed in accordance with the invention, the main and secondary rotary units being shown in the form of gangs of rotary saws;

Fig. 2 is a longitudinal sectional view through the mill shown in Fig. 1;

Fig. 3 is a transverse sectional view through a mill constructed in accordance with the invention and showing the secondary gang saws adapted to be rotated by flow current set up by the main gang saw unit.

Similar numerals refer to similar parts throughout the drawings.

The mill includes a housing 10 which may be of substantially cylindrical form provided with the inlet and outlet ports 11 and 11' respectively, which may be located near the bottom of the housing and tangential thereto and on opposite sides of the base or pedestal 12.

The ends of the cylindric housing 10 may be provided with-peripheral flanges 13 by means of which the heads 14 and 15 may be connected to the housing as by bolts 16, forming a chamber 17 within the housing of substantially cylindric smooth interior shape.

A bearing 18 may be located in the central socket 19 formed in the head 14, within which may be journaled one end of the shaft 20, upon which the main or central rotary unit is carried, the other end of the shaft extending through a bearing 21 and stuffing box 22 carried at the other head 15 of the housing and providing a liquid tight joint.

This main rotary unit may be in the form of a gang of rotary saws and for this purpose a hub 23 may be fixed upon the shaft 20 as by the key 24, a nut 25 being located upon the threaded portion 26 of said shaft to engage the adjacent end of the hub 23 to position the same relative to the shaft.

A plurality of disk saws 27 is mounted upon the hub 23, these disk saws being spaced by means of the disks 28 which may be of substantially the same thickness as the saws and preferably of a diameter less than the saws. This gang of alternate disk saws and spacing disks may be located from the flange 29 fixed upon one end of the hub 23 to a point near the other end of the hub, at which point a ring flange 30 may be located upon the hub and clamped against the adjacent end of the gang of disk saws and spacing disks as by the nut 31 threaded upon the adjacent end portion of the hub 23, thus clamping the gang of saws and spacing disks tightly between the flange 29 and ring flange 30 of the hub, a jam nut 32 being preferably located upon the threaded portion 33 of the shaft for locking engagement with the nut 31.

Each of the secondary rotary units may be in the form of a similar gang of disk saws, preferably of considerably smaller diameter than the main unit. Each of these secondary units is mounted upon a shaft 34 and may comprise a plurality of disk saws 35 spaced apart by the disks 36 of smaller diameter and clamped together as by the nuts 37 located upon the threaded portions 38 near each end of the shaft 34.

The ends of the shafts 34 may be journaled in the bearing rings 39 which may be fitted into annular sockets 40 formed in the ends of the housing 10. Although these shafts may be journaled in any other suitable and well known manner within the housing, the construction illustrated is preferred as it provides a suitable oil tight bearing for the shafts.

The secondary units are so located with reference to the main unit and the housing that a running clearance is provided between the teeth of the secondary units and those of the main unit as well as between the teeth of the secondary units and the inner walls of the housing, and as shown in Fig. 1, one of the secondary units is located between the inlet 11 and the outlet 11'.

Any suitable driving means may be applied to the shaft 20 to drive the main rotary unit at a high rate of speed and in the opposite direction from the inflow of oil, as shown in Fig. 1, and flow current set up by the motion of the main unit may be imparted to the secondary units to drive them in the opposite direction, as shown by the arrows on Fig. 1. In the case of some heavier liquids there may be enough resistance to reduce the motion of the secondary or auxiliary units to such a degree that the motion thereof would be too slow to be of any value, and in such cases the secondary units may be directly driven in opposite direction to the main unit by any usual and well known means, such as the master gear 41 fixed upon the shaft of the main rotary unit and meshing with the pinions 42 fixed upon the shafts of the secondary units.

In the operation of the improved rotary mill, as liquid is passed through the same between the main and secondary rotary units, resistance to the flow of the liquid is set up by the rotation of the several rotary units, producing a turbulence which is fairly beyond description, while at the same time permitting the flow of liquid through the housing from the inlet to the discharge ports thereof.

The liquid being acted upon by different tangential directions from the main rotary unit and also from the tangential resultant of the secondary rotary units produces a condition of opposing forces from all directions acting to accomplish the work of milling, dispersing and mixing the solid or semisolid particles in the liquid.

The turbulence and counterflow set up by the rotating units causes high frequency contact of the particles of solids or semisolids with the cutting edges of the rotary units and the inertia of these particles in fluid suspension serve the purpose of an anvil as the particles are contacted by the rapidly rotating units.

It is found that a flexible fluid resistance is established by the use of these secondary rotary units and that they counteract the spinning motion which results by dividing the housing chamber into a series of attrition chambers by means of solid partitions such as shown in my prior patents above referred to.

I claim:

1. A rotary mill including a housing having a substantially cylindric, smooth interior, a main gang saw unit centrally located within and upon the axis of the cylindric housing, secondary gang saw units located between the main gang saw unit and the inner walls of the housing on axes parallel to the axis of the main gang saw unit, the teeth of the secondary gang saw units being in close proximity to the teeth of the main gang saw unit and running closely adjacent to the inner wall of the housing, means for rotating the main gang saw unit, the secondary gang saw units being rotated by flow current set up by the main gang saw unit, inlet and outlet means located tangentially to the housing, one of said secondary gang saw units being located between the inlet and outlet means, the main gang saw unit being rotated in the opposite direction from the inflow.

2. A rotary mill including a housing having a substantially cylindric, smooth interior, a main gang saw unit centrally located within and upon the axis of the cylindric housing, secondary gang saw units located between the main gang saw unit and the inner walls of the housing on axes parallel to the axis of the main gang saw unit, the teeth of the secondary gang saw units being slightly spaced radially from but in close proximity to the teeth of the main gang saw unit and

running closely adjacent to the inner wall of the housing, means for rotating the main gang saw unit in one direction and means for rotating the secondary gang saw units in the opposite direction, inlet and outlet means located tangentially to the housing, one of said secondary gang saw units being located between the inlet and outlet means, the main gang saw unit being rotated in the opposite direction from the inflow.

3. A rotary mill including a housing having a substantially cylindric, smooth interior, inlet and outlet means to the housing, a main gang saw unit centrally located within, and upon the axis of the cylindric housing, the periphery of said main gang saw unit being considerably spaced from the inner wall of the housing forming a flow path there-between, secondary gang saw units located on axes parallel to the axis of the main gang saw unit and forming the only obstruction in said flow path, one of the secondary gang saw units being located between the inlet and the outlet means, the combined diameters of the main gang saw unit and of two secondary gang saw units being slightly less than the inner diameter of the cylindric housing, and means for rotating the main gang saw unit in a direction opposite to the inflow.

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