

[54] **GRAIN MILL**

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[58] Field of Search **241/152 A, 157, 244, 245, 241/248, 250, 259.1, 259.3, 296**

[56] **References Cited**

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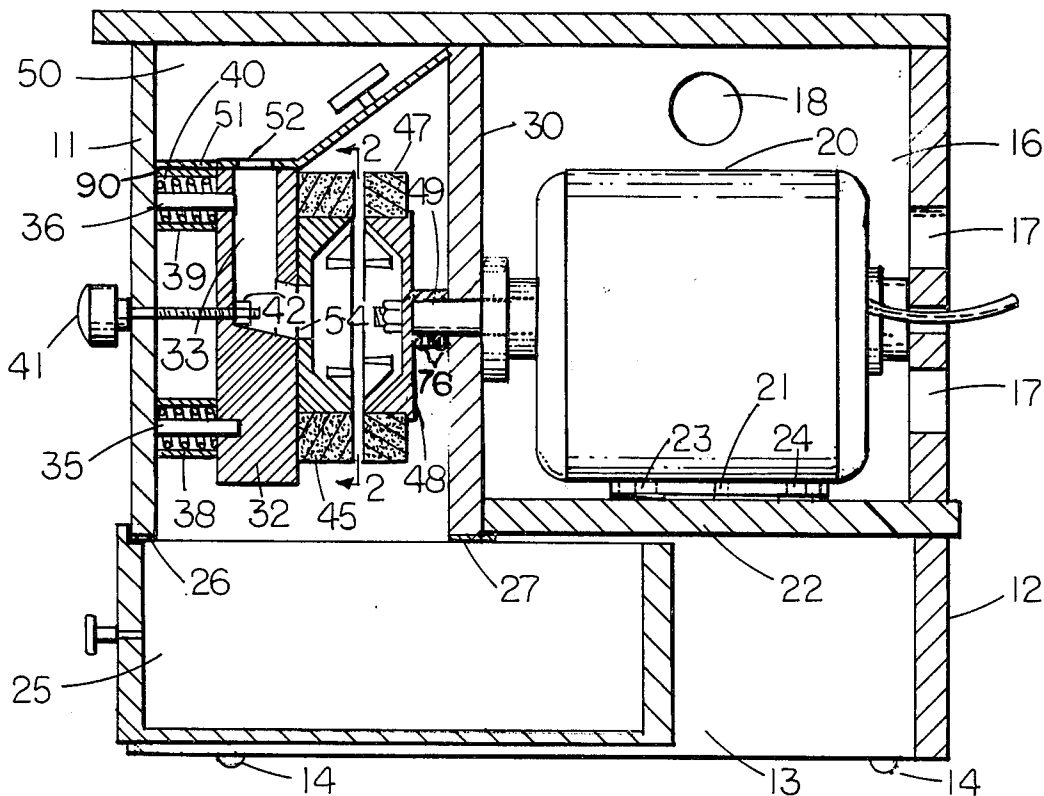
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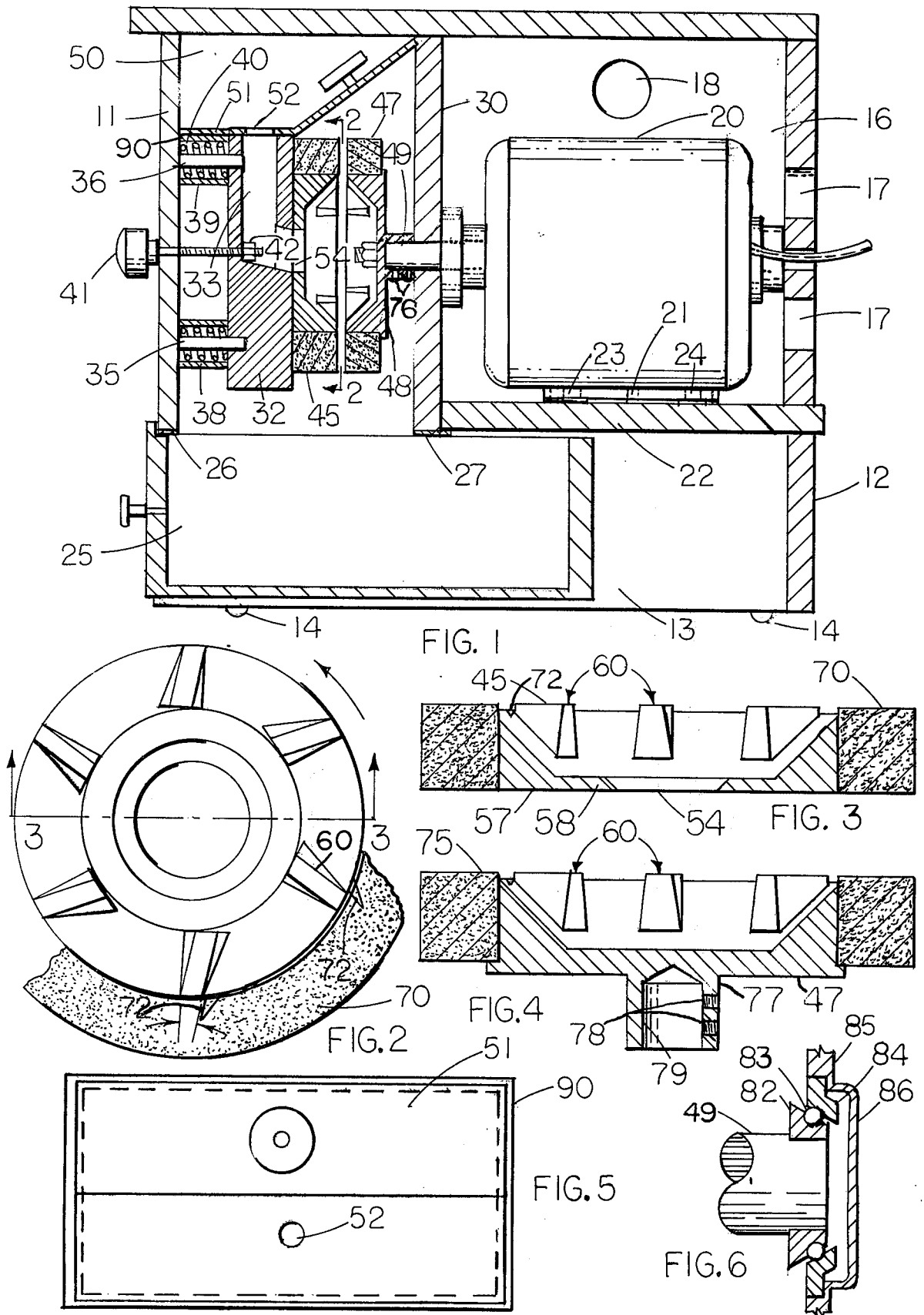
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[57] **ABSTRACT**

A small compact mill for grinding wheat and other grains comprises annular grinding stones, one fixed and the other driven, each secured to steel cutting burrs which have their cutting edges substantially in the grinding plane and one of which receives grain through a central opening in the burrs. The grain is cut or chopped by secant or non-radial cutter elements closely facing each other and set for shearing action. These force the grain as it is cut radially outward between annular grinding stones which are secured respectively to the stationary and the driven rotary burr. The driven burr is directly connected to the drive shaft of the motor, the motor being provided with a thrust bearing to oppose the thrust between the chopping and grinding elements. A hopper above the stones supplies the feed and includes a removable bottom sealed to the sides, and is provided with a metering opening to feed grain at controlled rate into a feed channel connected with the inlet through the stationary burr.

8 Claims, 6 Drawing Figures





BACKGROUND AND PRIOR ART

The art of milling or comminuting grain by rotary grinding and/or cutting or chopping devices is extremely old and well developed. Conventionally, such mills have been ponderous and slow in operation. There is a need for a small, efficient grain grinder for making whole wheat flour and the like rapidly, grinding it very shortly or immediately before flour is to be used so as to avoid loss of vitamins and other nutrients in the whole grain. Such devices are finding favor in homes because they make it possible to have the freshly ground whole grain flour on demand, which can be made into bread and other products while the flour retains the nutrients which are too often removed in conventional milling or lost in prolonged storage in warehouses and stores.

Small portable mills known for many years, have been extremely low in productivity. Some of them have used stones or burrs, driven in rotation by a suitable power device. The recent U.S. Pat. to Kuest, No. 3,688,996 is one example of the prior art. Other references are U.S. Pat. Nos. 585,536; 755,989; 1,033,878; 1,435,130; and 2,284,789. The latter refers to a coffee grinder which includes secant or non-radially directed notches in cutting burrs at the burr periphery. The coffee beans are fed annularly into the cutting notches but there is essentially no grinding as distinguished from cutting. This sort of grinder is really a cutter or chopper only and is not suitable for grinding grain. U.S. Pat. Nos. 755,989 and 1,705,996 show machines designed for grinding wood pulp to make paper and the like. The first of these has horizontal grinding stones (on vertical axes). Tapering spiral channels are shown to feed the fibrous pulp material radially outward to the grinding surface which are arranged around the edges of the stones. The spiral channels are not cutters in this case. In U.S. Pat. No. 1,705,996, slots or cutting elements which act to shear the fibrous pulp are shown. The present invention has some superficial resemblance to the latter device, which has a slotted metal backing for each grinder element, providing compartments which are filled with inset grinding stone material. The grinding stone does all the cutting in this patent. By contrast, the burrs of the present invention pre-cut the grain and then force it into and between the stone surfaces which do the grinding. U.S. Pat. No. 1,435,130 shows an ore grinding or crushing machine having spiral teeth in the inner parts of the burrs. These are recessed from each other towards the center but approach each other towards the periphery of the crushing surfaces. This arrangement is not suitable for first cutting grain into smaller and smaller particles before it enters the fine grinding area between the peripheral stones, according to the present invention. Such cutting, it has been discovered, contributes very substantially to a rapid flour grinding rate and is important for purposes of the present invention. An important aspect of the present invention is the increased grinding speed which results from the cutters progressing chopping up the grain and finally forcing it radially outward between the closely facing annular grinder elements.

The prior art has also shown various means for adjusting the spacing or force of contact between grinding disks, cutting burrs and the like. In general, positive

pressure has been applied to the abrading elements as by means of adjusting screws and the like, to force the stones into the necessary grinding contact. This often results in undue stone wear. According to the present invention, a resilient force, variable in magnitude, is applied between the grinding surfaces which can be adjusted as desired to meet various requirements, as for grinding flours of different degrees of fineness and grinding difficult grains of varying hardness, without inflicting unnecessary wear on the grinding stones themselves or requiring excessive power to drive them.

The present invention will be more fully appreciated upon reference to a detailed description of a presently preferred embodiment thereof.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 shows a sectional view through a mill, according to the present invention.

FIG. 2 is an enlarged face view of one of the cutting and grinding units, taken substantially on line 2—2 of FIG. 1.

FIG. 3 is a sectional view, somewhat enlarged, taken through the cutting and grinding element of FIG. 2 substantially along line 3—3 of said Figure.

FIG. 4 is a similar sectional view of the rotating grinding member, enlarged in comparison to FIG. 1.

FIG. 5 is a top view, with the cover removed, of the feed bin, showing the structure and arrangement of the bottom thereof.

FIG. 6 is a detailed sectional view, enlarged, showing the thrust bearing arrangement for the right or rear end of the motor drive shaft.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring now to FIG. 1, the mill of this invention comprises a housing having front and rear wall members 11 and 12, and side wall members 13 supporting feet 14, attached to their bottom edges, and motor compartment 16. The latter is provided with vent openings 17, 18 to allow circulation of air and ventilation of the motor. An electric motor 20, of suitable size and speed, has its base 21 mounted on a support panel or horizontal partition 22, fastened thereto by screws 23 and 24. A bin 25, for receiving the ground flour, is slidably fitted into the lower part of the frame so that its inner or right end underlies motor compartment 16. This bin can readily be pulled out for emptying, as needed. Preferably, it is provided with dust seals 26 and 27 to confine the flour within the bin and below the mill compartment during the grinding operation.

The mill or grinding equipment itself is situated in a separate and air tight compartment above flour bin 25. This compartment has a vertical rear wall 30 in addition to the front wall 11, mentioned above. A mounting block or backing member 32 for a relatively fixed, i.e. non-rotating cutting and grinding element 45 is suitably bored at 33 to receive a metered stream of grain from the hopper above. Block 32 is slidably mounted on horizontally projecting pins 35 and 36 fixed in the front wall 11. Compression springs 38 and 39 surround these pins, being placed between wall 11 and the block 32 and tending to force the block away from wall 11, so as to bring the non-rotating grinding and cutting means 45 into grinding position against a rotary grinding and cutting member 45. To resist the thrust of springs 38 and 39, an adjusting screw 41 passes through the front wall 11 and is threaded into a nut 42 inside block 32.

Thus, the stationary or so-called "fixed" element 45, to be described further below, is fixed to the right face of block 32, as seen in FIG. 1, and is in axial alignment with a rotary driven grinding member 47. The latter is secured through its steel cutting burr and hub element 48 to the shaft 49 of the drive motor 20. Shaft 49 projects through the partition wall 30 from the motor, which is in its own separate compartment, as already mentioned. A removable plate 51 serves as the bottom of the feed hopper.

An opening 52 in plate 51 is sized to provide a metered flow of grain at about the maximum rate that the mill can grind it. Of course, the passageway 33 through block 32, with its angular extension 54, plus the presence of grain being cut between the metal cutting burrs further controls the feed rate of the grain. However, the grain is effectively metered in its flow to prevent excessive build-up between the burrs. An adjustable closure slide for opening 51 may be used if desired. Feed rate can be high enough to maintain a rapid production rate, because of grinding efficiency in the milling elements 45, 47.

The stationary and driven grinding elements 45 and 47 which are mounted to mutually face each other in a grinding plane, as seen in FIG. 1, are essentially alike in their cutting burr and grinding stone surfaces. Thus, the stationary member 45 comprises a hard metal burr or central core 57 having a relatively thin central rear wall 58 in which the feed opening 54, mentioned above, is provided. Cutting teeth 60 are formed in burr 57 and within the hollow frusto-conical surface of the core member 57. These teeth are ground and finished with their outer faces substantially at the grinding or comminuting plane, so as to act as shears on the grain kernels. Teeth 60 also are arranged at a small angle with respect to the radius, as shown in FIG. 2 to propel the cut grain particles radially outward as they move between the grinders. That is, the cutting edges of teeth 60 are arranged at secant angles or along non-radial, non-tangential lines and set in a direction to propel the material being ground radially outward between elements 45 and 47 as the driven member 47 rotates. The angle between each cutting edge and a radius of the grinder is between about 8° and 15°, preferably about 10°. FIG. 2 shows the angular arrangement of teeth 60 on the stationary member 45. The teeth 60 on driven member 47 are arranged in the same way. They are thus angled in the same sense, as seen from the face of each burr, so that when the two burrs face each other the advance edges of the respective teeth cross each other like a pair of shears, at angles to cut the grain while moving it radially outward. This gives a highly effective shearing action. Each particle of grain is cut repeatedly and several times to make finer and finer particles which move radially outwardly towards the annular stone grinding surfaces. The shearing action also force-feeds the cut grain into the grinding interface between stone surfaces 70, 75, next to be described.

An annular abrasive stone 70 is secured to the periphery of burr 45 with its flat, annular grinding face lying essentially in the same plane as the cutting edges of teeth 60. To allow for stone wear, the stone may be set at first very slightly outside the cutting plane of the burr elements. This stone is formed of suitable hard abrasive material, which may be either natural or synthetic. Small non-radial or secant directed notches or slots 72 are formed in the face of the stone aligned with

or just ahead of the advance edges of cutter teeth 60 to assist further in moving the material being ground radially outward. See FIG. 2. The angle these notches or slots 72 make with the radius of the annular stone face is between 10° and 25°, preferably about 15°. These act further to help drive the material radially outward. The slots 72 are narrow and shallow; otherwise they will overload the grinding stones. Their placement in line or substantially in line with cutting edges 60 is an important feature.

Similarly, an annular stone 75 is fixed to the core or burr member of rotary grinder 47, which also has metal cutting teeth 60, identical with those on the stationary member 45. Without these slots, a typical mill grinds 20 to 30 pounds of wheat per hour. With them, the rate is about four to five times as great.

The metal core or burr of driven unit 47 has a hub portion 77 provided with threaded openings 78 for set screws 76. These lock in place the drive shaft of the motor in a socket or opening 79 formed in the back of the rotary burr.

Since the rotary grinding member 47 is thus directly connected to the motor 20 through motor shaft 49, means are provided to resist or withstand the thrust towards the motor of the grinding pressure between the abrading elements. For this purpose, the motor bearing at the right, FIG. 1, is in the form of an axial thrust bearing, as shown in FIG. 6. The end of shaft 49 rests within the inner bearing race 82, which is separated by ball bearings 83 from the outer race 84. The latter fits within a recess in the motor housing 85 and is covered by a dust cap 86. Preferably a lubricated-for-life bearing is used for this purpose. Obviously, other forms of mounting for motor 20 and its drive shaft may be used, provided they are arranged to resist the axial thrust of compression springs 38 and 39 and the axial force between the grinding and cutting surfaces of elements 45 and 47.

Referring to FIG. 5, the bottom of the feed hopper preferably is of one piece, as previously described. Its periphery is provided with a dust seal of suitable material, shown at 90 which, when the plate or hopper bottom 51 is in place in the hopper, effectively seals the flour and the dust of milling within the grinding compartment. As noted above, feed opening 52 in plate 51 can be closed by a slide, if desired. Since the flour bin also is sealed or essentially sealed during normal operation, the dust and flour do not escape from the grinding compartment under normal operating conditions.

It will be obvious to those skilled in the art that various modifications in detail and variations in specific elements may be made in the spirit of the invention. It is intended by the claims which follow to cover such modifications as far as the state of the prior art properly permits

I claim:

1. In apparatus of the character described for grinding or comminuting grain and the like, the combination which comprises a pair of mutually facing and respectively rotatable and relatively fixed grinding and comminuting elements adapted to cooperate at a grinding plane or interface, each of said elements comprising a centrally located circular cutting burr having cutting edges extending at a small angle with respect to a radius of the burr and adapted to lie substantially in said plane, said cutting edges being so directed as to tend to impel the material being ground or comminuted radi-

ally outward in said plane, each of said elements comprising also an annular abrasive grinding stone surrounding said burr and having its grinding surface arranged to lie substantially flat in said plane to receive cut material from the burr and grind said material between said grinding surfaces, said rotatable element being fixed to a driving shaft, said relatively fixed element being supported on a backing member which is axially movable with respect to said plane, resilient means for urging said backing member and relatively fixed element towards the plane, and adjustable means for resisting said resilient means, thereby to control the relative position of the relatively fixed element with respect to the rotatable element.

2. Apparatus according to claim 1 which includes metering means for feeding grain to said stones at a predetermined rate, and thrust bearing means in the drive motor for resisting the grinding thrust between the grinding surfaces.

3. A mill apparatus according to claim 1 which includes a dust-sealed feed compartment above the grinding elements and a dust-sealed flour receiving bin

below said elements.

4. Apparatus according to claim 1 in which the metal cutting or grain chopping elements in the burrs of grinding elements cross each other with shear-like action at a small angle effective to propel the grain particles radially outward, thus to enhance shearing action.

5. Apparatus according to claim 1 wherein the adjustable means consist of a single adjusting screw.

6. Apparatus according to claim 1 wherein the burr cutting elements each make an angle of 8 to 12° with respect to a radius of the burr, said elements being so directed as to impel the feed material radially outward.

7. Apparatus according to claim 1 wherein each of the annular grinding stones includes non-radial slots each making an angle of between 10 and 25° with a stone radius and in a direction to impel the feed material radially outward.

8. Apparatus according to claim 7 in which the non-radial slots in the stones are each arranged substantially in line with an advance cutting edge of the burrs.

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