

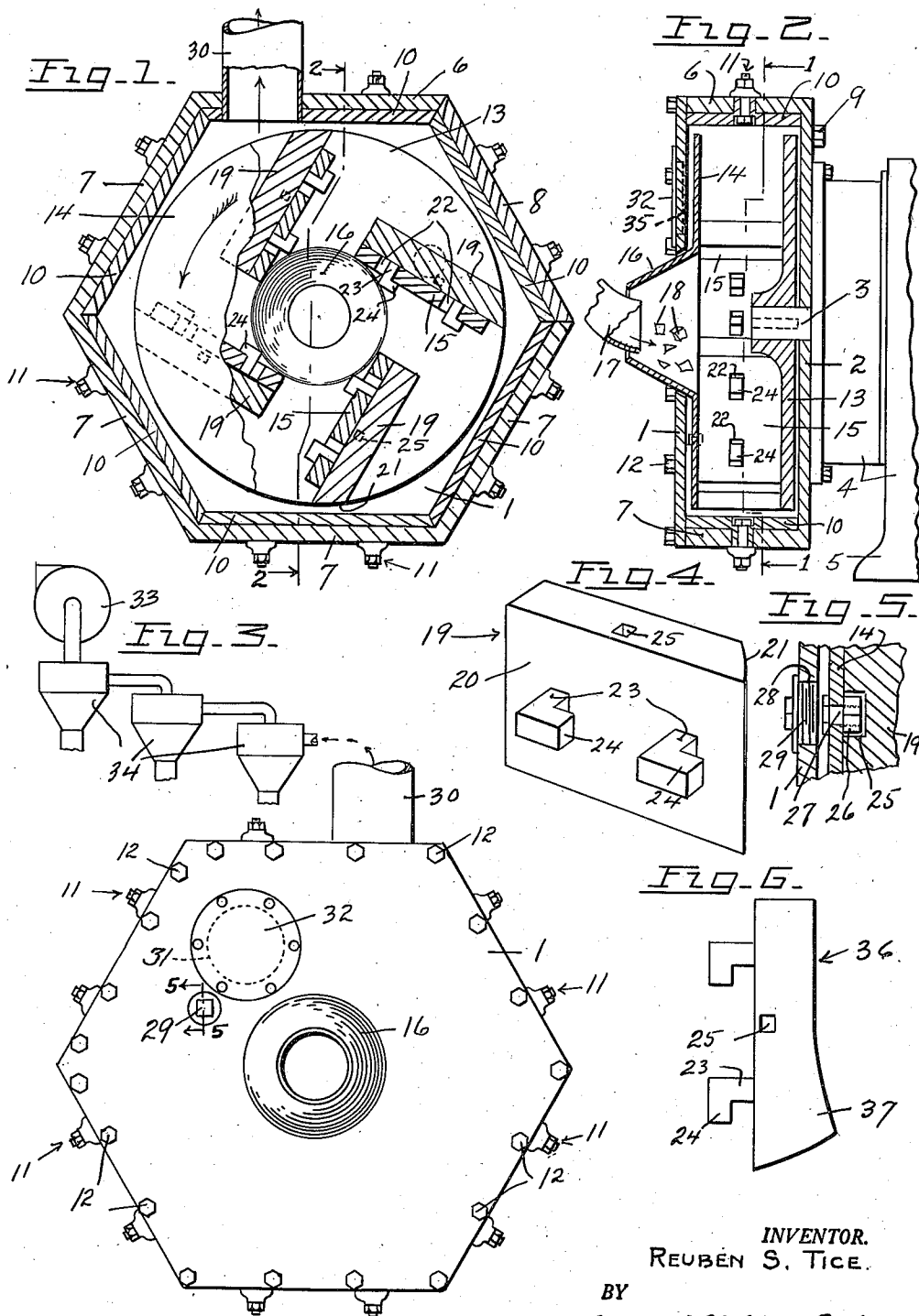
Jan. 15, 1946.

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2,392,958

MILL

Filed July 19, 1943



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2,392,958

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Application July 19, 1943, Serial No. 495,271

7 Claims. (Cl. 241—55)

This invention relates to a mill for breaking up relatively brittle material such as rock, ore, glass, etc.

The mill of this invention is the type in which a rotor is enclosed in a polygonal sided housing, and which rotor includes hammers that revolve about the rotor axis when the rotor is rotated and that coact with the housing walls for shattering the material to be broken by repeated blows delivered thereto by the hammers and walls as the material is caused to move through the mill from an inlet opening in its walls to a discharge opening. Such general type of mill is disclosed in my United States Letters Patent No. 2,152,108, of April 3, 1939.

Some of the objects of this invention are to provide a mill of the above general type so designed as to be simple, economical to make, and in which the parts that are subjected to abrasive wear will last longer than heretofore and will function without loss of efficiency up to the time they require replacement, and which mill is also adapted to be quickly adjusted for delivering broken material in different sizes as may be desired, from microscopic particles appreciably smaller than that classifiable by screens to larger easily classifiable particles.

Other objects and advantages will appear in the drawing and description.

In the mill of this invention it is pertinent to note that it functions mainly as an impact mill, breaking up material by sharply delivered blows, and it does not break up the greater mass of material by a grinding action, as in some mills that are provided rotor vanes and stationary grids, or ridges on the housing walls past which the vanes move with a very small clearance.

In the drawing,

Fig. 1 is a part sectional, part elevational view of a mill illustrating the invention, and the sectional portion of which is taken substantially along the line 1—1 of Fig. 2.

Fig. 2 is a sectional view of the mill as seen from line 2—2 of Fig. 1.

Fig. 3 is an elevational view of the front or feed side of the mill, and in this view a classifying system is diagrammatically indicated including a suction fan or suction blower. The mill is shown in this system.

Fig. 4 is a perspective view of one of the hammers.

Fig. 5 is an enlarged fragmentary sectional view taken through the housing wall along line 5—5 of Fig. 3.

Fig. 6 is an edge view of a hammer that may

be used in the mill without change in the latter. This hammer is very slightly different from that of Fig. 4.

In detail this mill comprises a polygonal sided housing having coaxial opposed end walls 1, 2 (Fig. 2). The end wall 1 which may be termed the front wall, is formed with a central circular opening, and a shaft 3 coaxial with said opening rotatably extends through the rear wall 2 into the housing. This shaft 3 may terminate within the housing at a point substantially intermediate the walls 1, 2. A housing or casting 4 that includes a base 5 may be secured to the rear wall 2 for supporting the mill with its central axis horizontal. The shaft 3 may be directly connected with a motor in said housing 4 for rotating shaft 3, or the said shaft may have a pulley secured thereto for a belt connection with a line shaft pulley. The particular manner of driving shaft 3, and consequently the rotor that is adapted to be secured thereon between end walls 1, 2, is immaterial, so long as a source of power may be connected with shaft 3 for rotating it at the desired speed or speeds.

The sides of the housing are preferably six in number, making the housing hexagonal sided. The sides are of the same size and each includes an outer wall and an inner wall or liner, the latter being preferably of hardened metal specially resistant to abrasive wear by rocks, ore, glass, and the like.

Five of the outer side walls of the housing commencing with the top wall 6 and including the next four walls 7 in succession counterclockwise around the housing as seen in Fig. 1, are formed integrally, or are welded together, and may also be welded to the rear wall 2. The last or sixth side wall 8 which is adjacent the top wall 6, is preferably removably secured to the rear wall 2 by a plurality of spaced stud bolts, one of which is indicated at 9 in Fig. 2.

The liners or inner walls 10 are separable from each other and from the end walls of the housing, there being a liner for each outer side wall. Bolts and nut connections 11 removably secure each liner to each outer side wall adjacent thereto.

The front end 1 of the housing is removably secured to the outside walls 6, 7, 8 of the housing by bolts 12 (Fig. 3). Thus the side wall 8 and its liner may be removed from the housing without removal of the bolt and nut connections 11, and without removal of the front wall 1 from the housing, but upon removal of the front end wall

1, any or all of the liners 10 may be removed for replacement.

Secured on the end of shaft 3 that is in the housing is an annular disk 13 which disk is close to the end wall 2. Opposed to disk 13 is a second disk 14, the latter being adjacent the front end 1 and being rigidly connected to disk 13 by cross members 15 (Figs. 1, 2).

The disk 14 is formed with a central circular opening that is coaxial with shaft 3 and with the circular opening in front end 1 (Fig. 2) and a frusto-conical member 16 having its larger diameter end substantially coincident with the central opening in said disk 14 extends through the central opening in end 1. Thus member 16 is coaxial with the central aligned openings in end 1 and in disk 14 and may be formed integrally with disk 14 or may be secured to the latter by any suitable means. A feed chute or conduit 17 from any source of supply of the material to be broken may extend into the smaller diameter end of member 16 for feeding such material 18 (Fig. 2) to between disks 13, 14 centrally thereof.

The cross members 15, in addition to holding disks 13, 14 rigidly together for rotation as a unit, may also support the hammers. These cross members 15 may be rectangular plates secured at two of their opposite edges to disks 13, 14 and they extend tangentially from a circular line substantially coincident with the central opening in disk 14 toward the outer edges of the disks 13, 14. The outer ends of plates or members 15 preferably terminate a short distance inwardly of the outer edges of said disks 13, 14 and the latter are preferably of substantially the same outside diameter with their peripheries relatively close to the liners 10, but slightly spaced therefrom, as seen in Fig. 1.

Each of the hammers 19 may comprise a relatively thick plate of metal specially hardened to resist the abrasive wear of material 18, such as rocks, ore, glass, etc. Hammers 19 are of rectangular contour, each being formed with a flat side 20 (Fig. 4) that is adapted to lie flat on the outwardly facing side of each plate 15, and in which position the two opposite side edges of each hammer are respectively adjacent disks 13, 14 and the outer end edge 21 of each hammer adjacent the peripheries of disks 13, 14 is of a contour (in the direction of the thickness of each hammer) that substantially corresponds with the curve of the said peripheries.

One convenient means for removably securing the hammers to the plates 15 respectively, is to form each plate 15 with a pair of spaced openings 22 disposed on a line intermediate the disks 13, 14, and to provide each hammer 19 with spaced projections 23 having right angle outer ends 24. The ends 24 extend toward the outer ends 21 of the hammers and openings 22 are adapted to pass the ends 24 therethrough, after which the hammer is slipped on plate 15 outwardly toward the outer edges of the disks and thus the ends 24 will extend over the edges of openings 22 to hold the hammer against the plates 15.

To hold each hammer from sliding back to a position in which the ends 24 are over openings 22 I provide a recess 25 in the edge of each hammer that is adjacent the disk 14. Each such recess may be square or polygonal sided to receive a centrally apertured and threaded similar sided member 26 (Fig. 5) and the disk 14 is apertured at a point adapted to register with each such threaded aperture when each hammer is positioned so that the hooked ends 24 hold them against plate 15. A headed bolt 27 is then in-

serted through each such opening in disk 14 and is threaded into each member 26.

By the foregoing structure each hammer is held to plate 15 adjacent thereto when the mill is inoperative. No stress is taken by bolts 27 except the weight of the uppermost hammer, such as is indicated in Fig. 1, and then only when the mill is stopped, since centrifugal force will hold the hammer to the plates by means of the projections 23 and ends 24 when the hammers are being revolved.

A single method of removing the hammers is to provide an opening 28 in front end 1 adjacent the side 8 at a point scanned by the bolts 27 when the disks and hammers are revolved. This opening may be normally closed by a plug 29, but to remove any hammer the plug is removed and the disks turned until the desired bolt 27 is opposite the said opening. The side 8 and its liner being removed, the hammer adjacent such open side may be readily removed from its member 15 and taken from the mill through the opening upon removal of bolt 27 through the opening in side 1. A new hammer can then be quickly installed through the same open side of the housing and plug 29 reinserted.

Formed in side wall 6 may be a discharge opening in which is secured a discharge conduit 30. Or an opening 31 (Fig. 3) may be formed in end wall 1 for a discharge conduit similar to conduit 30. The opening 31 may be closed by a plate 32 (Fig. 3) when conduit 30 is used, or the opening for conduit 30 may be closed by such plate when opening 31 is used.

Since the opening 31 is in end 1 the disk 14 will generally extend over the opening so that the only material in the mill that reaches said opening is such material as passes over the edge of disk 14 to between said disk and end 1.

A suction fan or blower 33 (Fig. 3) may be connected with either conduit 30 or a conduit (not shown) communicating with 31, as the case may be, for withdrawing such material from the housing as is sufficiently small and light to be so withdrawn, although the action of the hammers themselves and their relation to the central opening in disk 14 functions as a blower for causing radial outward movement of broken particles of material in the housing.

Where a classification of materials is desired, I may insert one or more conventional cyclone classifiers 34 in the conduit leading to the fan or blower 33 (Fig. 3), and material that is coarser than desired may be returned to the chute or conduit 17 for repassage through the mill.

The fineness to which the material passing through the mill is reduced may be determined to a considerable degree by the closeness with which the outer ends of the hammers clear the liners 10. The closer said ends are to the liners the finer will the material be broken, since the material will more frequently strike the hammers and liners with each revolution of the hammers. Also a finer material will be drawn from the mill through opening 31 than through conduit 30, and a screen 35 (Fig. 2) may be in the opening 31 for preventing undesirably large pieces from passing through said opening.

The speed at which the hammers revolve as disks 13, 14 are rotated may vary. In some instances the disks may be rotated at 1000 R. P. M. and at other times they may be rotated at say 3600 R. P. M., or at any other desired speed.

The hammer 36 shown in Fig. 6 is adapted to be secured to any plate 15, and this hammer is

the same as hammers 19 except that it is thickened at 37 at its outer end. This type of hammer may be standard for all work, whether fine or coarser material is to be produced, but it is particularly adapted for use when there is small clearance between the ends of the hammers and the liners 10 so as to compensate for parasitic abrasive wear on the hammers at their outer ends.

With the hammers arranged as shown in Fig. 1 between disks 13, 14, the abrasive wear on the hammers is such as to ultimately produce a concavity on the exposed sides of the hammers, but which concavity does not reduce the efficiency of the mill for pulverizing material. This concavity is both transversely and longitudinally of the flat exposed side of each hammer and as it extends over substantially the full area of such side the wear on the hammers is relatively slow.

There is practically no detrimental wear on disks 13, 14 or on the ends of the housing, and the liners 10 are long wearing and easily replaceable.

The hammers are revolved in the direction of the arrows 38 in Fig. 1, and while the housing for the rotor is generally vertical as seen in Fig. 2, it need not necessarily be supported in this position since in some instances, a horizontal or slanted position is desirable. However, the substantially tangential arrangement of the hammers between disks and the substantially center inlet in the housing to the inner ends of the hammers are quite important, although I do not wish to be limited to this exact structure.

In the claims the use of the term "polygonal sided" in referring to the housing is to be understood as defining the inner surfaces of the inner walls 10 that face radially inwardly toward the rotor. The outer walls 6, 7, 8 of the housing support the inner walls or liners 10 and may also be arranged to meet the requirements for a polygonal sided housing but the actual arrangement of the said outer walls is more or less immaterial.

The drawings and description are to be considered illustrative of the invention and not restrictive thereof.

Having described the invention, I claim:

1. A mill of the character described comprising a polygonal-sided drum-like housing having parallel coaxial end walls one of which is formed with an inlet opening substantially centrally thereof for material to be broken; a pair of opposed disks respectively closely adjacent said end walls to preclude passage of relatively coarse particles of said material between each disk and the wall adjacent thereto and rotatable about the central axis of said end walls; an opening substantially coaxial with said inlet opening formed in the disk adjacent said latter opening; a plurality of hammers between said disks equally spaced from each other and from said axis; said opening in said disk being circular and said hammers extending substantially tangentially of the edges of said circular opening to substantially the outer edges of said disks; means for securing said hammers to said disks for revolving therewith about said axis; means for so revolving said disks; and an outlet opening formed in one of the walls of said housing spaced outwardly of said inlet opening for discharge of broken material from said housing, the sides of said housing being substantially equally spaced from said axis.

2. A mill of the character described comprising a polygonal-sided drum-like housing having opposed end walls; a shaft rotatably extending

through one of said end walls into said housing; a pair of spaced opposed disks within said housing secured to said shaft for rotation with the latter; a plurality of equally spaced hammers secured between said disks for rotation therewith about the axis of said shaft when the latter is rotated and means for so rotating said shaft in one direction; means for conducting material to the path of travel of said hammers during revolution thereof about said axis for breaking by said hammers, and a discharge opening formed in one of the walls of said housing for discharge of such material from said housing after breakage thereof by said hammers; said disks being circular and coaxial, and said hammers being rectangular plates positioned within the confines of the peripheries of said disks with one of their edges adjacent the peripheral edges of the disks and extending inwardly from said latter edges generally toward the axis of said shaft, each of said plates being solid and of substantially uniform thickness for about half its length commencing from its inner edge that is nearest said axis, and the remainder being progressively thicker in direction toward its outer edge that is opposite said inner edge, the increased thickness of said remainder being on the leading side of each plate during its revolution in said direction and the opposite side of each plate being planar.

3. A mill of the character described comprising a polygonal-sided drum-like housing having opposed end walls; a shaft rotatably extending through one of said end walls centrally thereof into said housing; a pair of spaced opposed disks within said housing secured to said shaft for rotation therewith; a plurality of equally spaced members rigidly connecting said disks each removably supporting a hammer element thereon; a plurality of such hammer elements; means removably securing each such element to each of said members; said hammer elements extending between said disks at right angles and generally radially outwardly relative to the axis of said shaft; a conduit extending through one of said end walls into said housing for conducting material to be broken to said hammers; a discharge outlet formed in one of the walls of said housing for discharge of broken material from the housing; the said spaced members being plates extending between said disks respectively formed with openings intermediate the said disks; the means for securing said hammer elements to said plates comprising projections thereon extending through said openings and provided with hooked end portions integral therewith extending over the sides of said plates opposite the hammer elements respectively secured thereto; and means for revolving said shaft in a direction in which the said hammer elements are leading with respect to said plates the said openings in said plates being of sufficient width to permit passage of said hooked end portions therethrough when said projections are moved to one of the sides of said openings.

4. A mill of the character described comprising a polygonal-sided drum-like housing having opposed vertical end walls; a shaft rotatably extending through one of said end walls centrally thereof into said housing; a pair of spaced opposed disks within said housing secured to said shaft for rotation therewith; a plurality of equally spaced members rigidly connecting said disks each removably supporting a hammer element thereon; a plurality of such hammer elements;

means removably securing each such element to each of said members; said hammer elements extending between said disks at right angles and generally radially outwardly relative to the axis of said shaft; a horizontally extending conduit extending through one of said end walls into said housing for conducting material to be broken to said hammers; a discharge outlet formed in one of the walls of said housing for discharge of broken material from the housing; said conduit being generally of frusto-conical shape with its larger diameter end secured to one of said disks coaxial with the axis of said shaft; the end wall adjacent said last mentioned disk being formed with an opening, and said conduit rotatably extending through said opening; the said disk to which said conduit is secured being formed with an opening coaxial with the larger diameter end of said conduit and of substantially the same diameter as said latter end and means for feeding material directly into the lower side of said conduit at a point outwardly of the said end wall through which it extends whereby said conduit will function as a distributor for said material.

5. A mill of the character described comprising a drum-like housing having opposed end walls connected by side walls, said side walls being provided with a plurality of uniform sized radially inwardly facing planar striking surfaces in edge to edge relationship around the central axis of the housing and equally spaced from said axis, a pair of spaced opposed disks within said housing coaxial with the latter and respectively positioned relatively close to said end walls to prevent lodgement and passage of coarse material between said disks and said end walls, a shaft rotatably extending through one of said end walls coaxial therewith supporting said disks for rotation with said shaft, a central circular opening formed in one of said disks and a frusto-conical member secured at its larger diameter end to said last mentioned disk at the edges of said opening and rotatably extending through the end wall of the housing that is adjacent thereto to outside said housing, an opening formed in said last mentioned housing coaxial with the opening in said disk for passing said member therethrough, an outlet in said housing spaced radially outwardly of the opening in said disk, and a plurality of equally spaced hammers between said disks extending tangentially from the edges of the said opening in one of said disks to the peripheral edges of the disks.

6. A mill of the character described comprising a drum-like housing having opposed end walls connected by side walls, said side walls being provided with a plurality of uniform sized radially inwardly facing planar striking surfaces

in edge to edge relationship around the central axis of the housing and equally spaced from said axis, a pair of spaced opposed disks within said housing coaxial with the latter and respectively positioned relatively close to said end walls to prevent lodgement and passage of coarse material between said disks and said end walls, a shaft rotatably extending through one of said end walls coaxial therewith supporting said disks for rotation with said shaft, a central circular opening formed in one of said disks and a frusto-conical member secured at its larger diameter end to said last mentioned disk at the edges of said opening and rotatably extending through the end wall of the housing that is adjacent thereto to outside said housing, an opening formed in said last mentioned housing coaxial with the opening in said disk for passing said member therethrough, an outlet in said housing spaced radially outwardly of the opening in said disk, and a plurality of equally spaced hammers between said disks extending tangentially from the edges of the said opening in one of said disks to the peripheral edges of the disks, the outer edges of said disks and the outer ends of said hammers being relatively close to said striking surfaces and equally spaced therefrom, and means for rotating said shaft for revolving said hammers about the axis of said shaft with their inner ends nearest said opening in said disk leading their outer ends.

7. A mill of the character described comprising a drum-like polygonal-sided housing having parallel opposed vertical end walls, a pair of opposed disks within said housing respectively positioned closely adjacent said end walls and parallel therewith, members connecting said disks, a horizontal shaft supporting said disks for rotation therewith, coaxial openings respectively centrally in one of said disks and in the end wall adjacent thereto, a plurality of hammers between said disks extending from the central opening in said one disk to the outer periphery thereof, an opening formed in one of said end walls radially spaced from the axis thereof, means carried by one of said disks accessible through said last mentioned opening for releasably securing said respective hammers to said members when said disks are revolved to position each hammer opposite said opening, and an additional opening formed in one of the side walls of said housing for removal of the said hammers through said additional opening when said means is actuated for releasing said hammers from said members respectively, a closure for said last mentioned opening.

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