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IMPACT PULVERIZER

2,991,946

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2 Sheets-Sheet 1

Fig. 1.

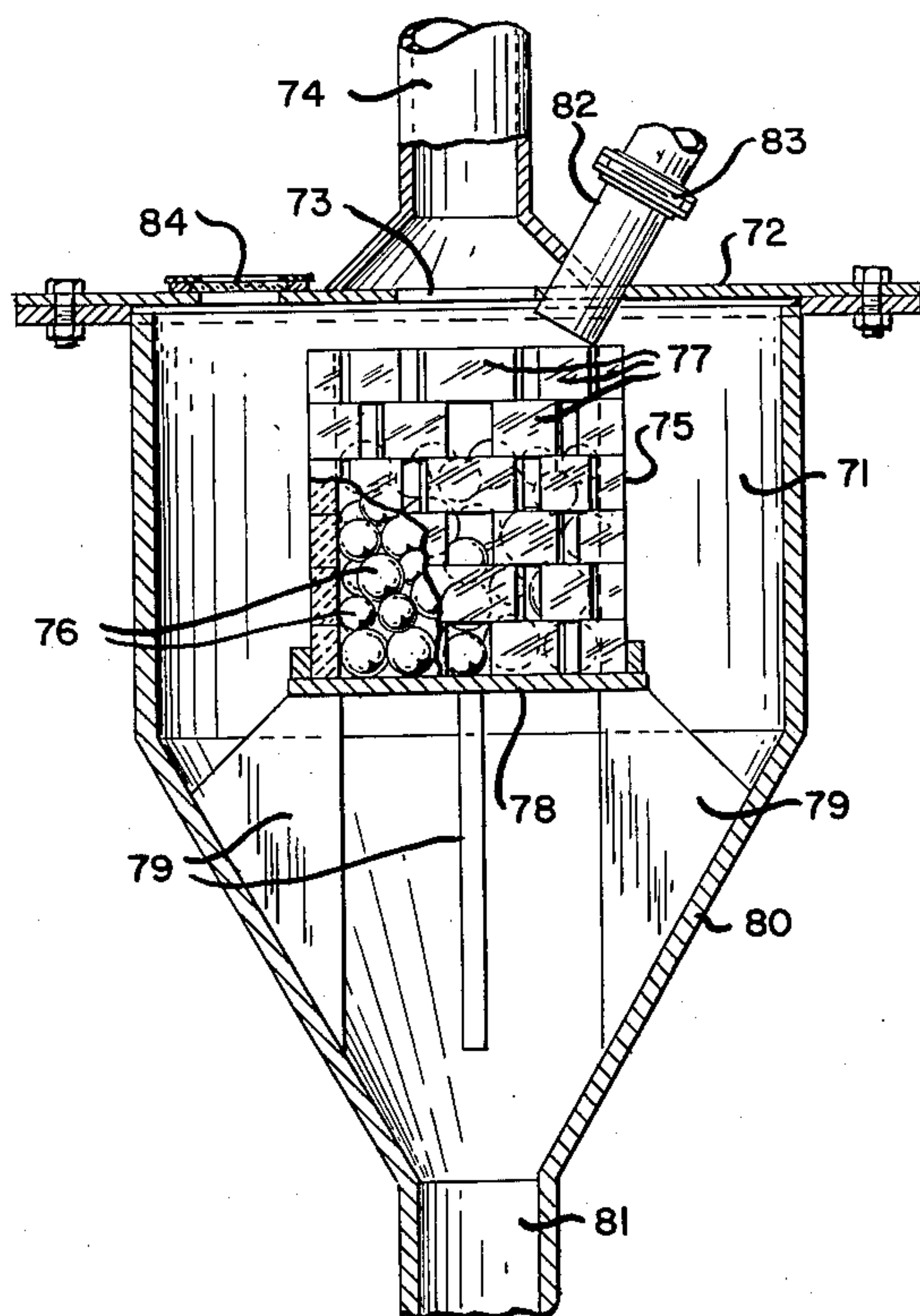
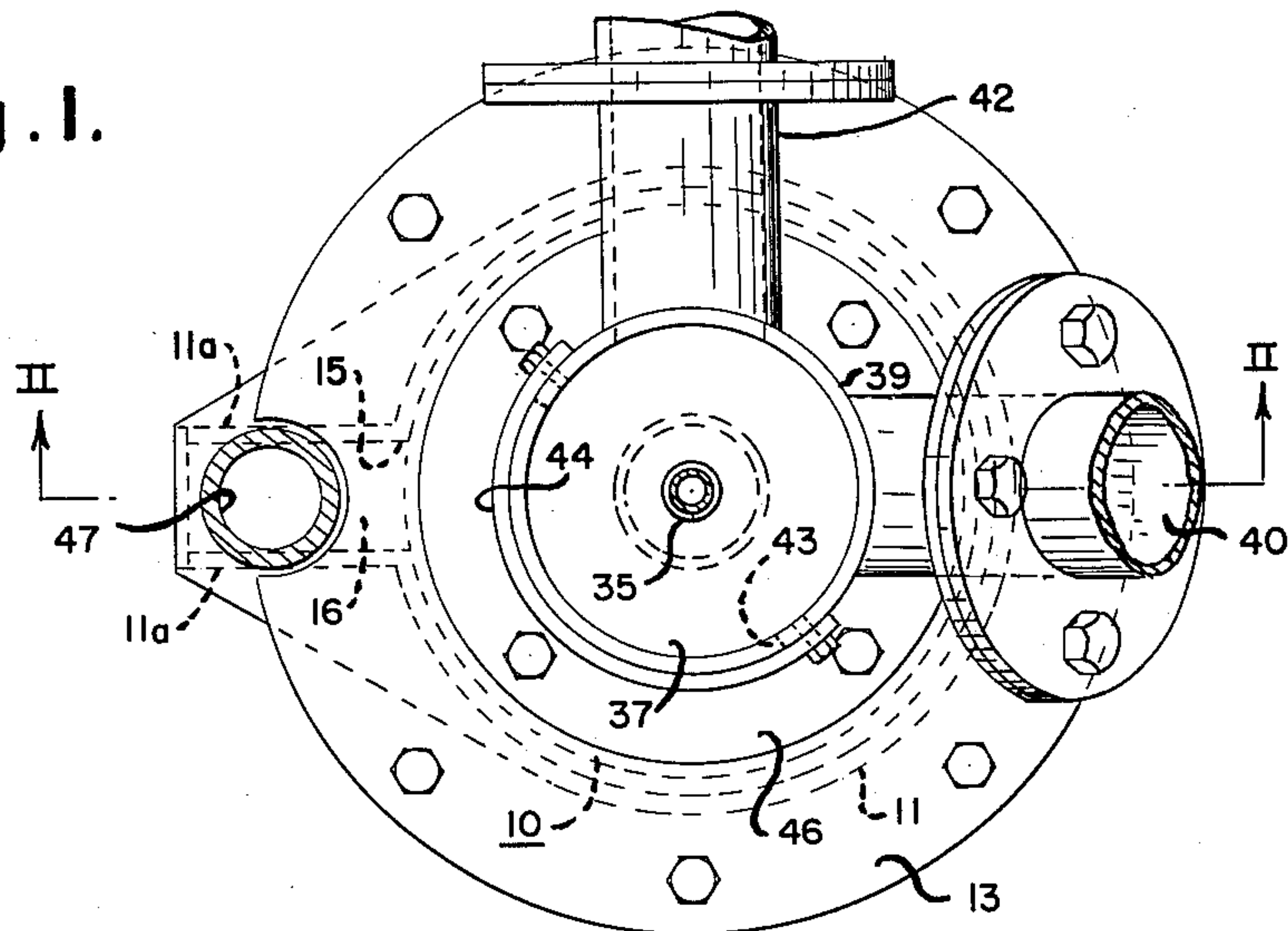


Fig. 4.

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2 Sheets-Sheet 2

Fig. 2.

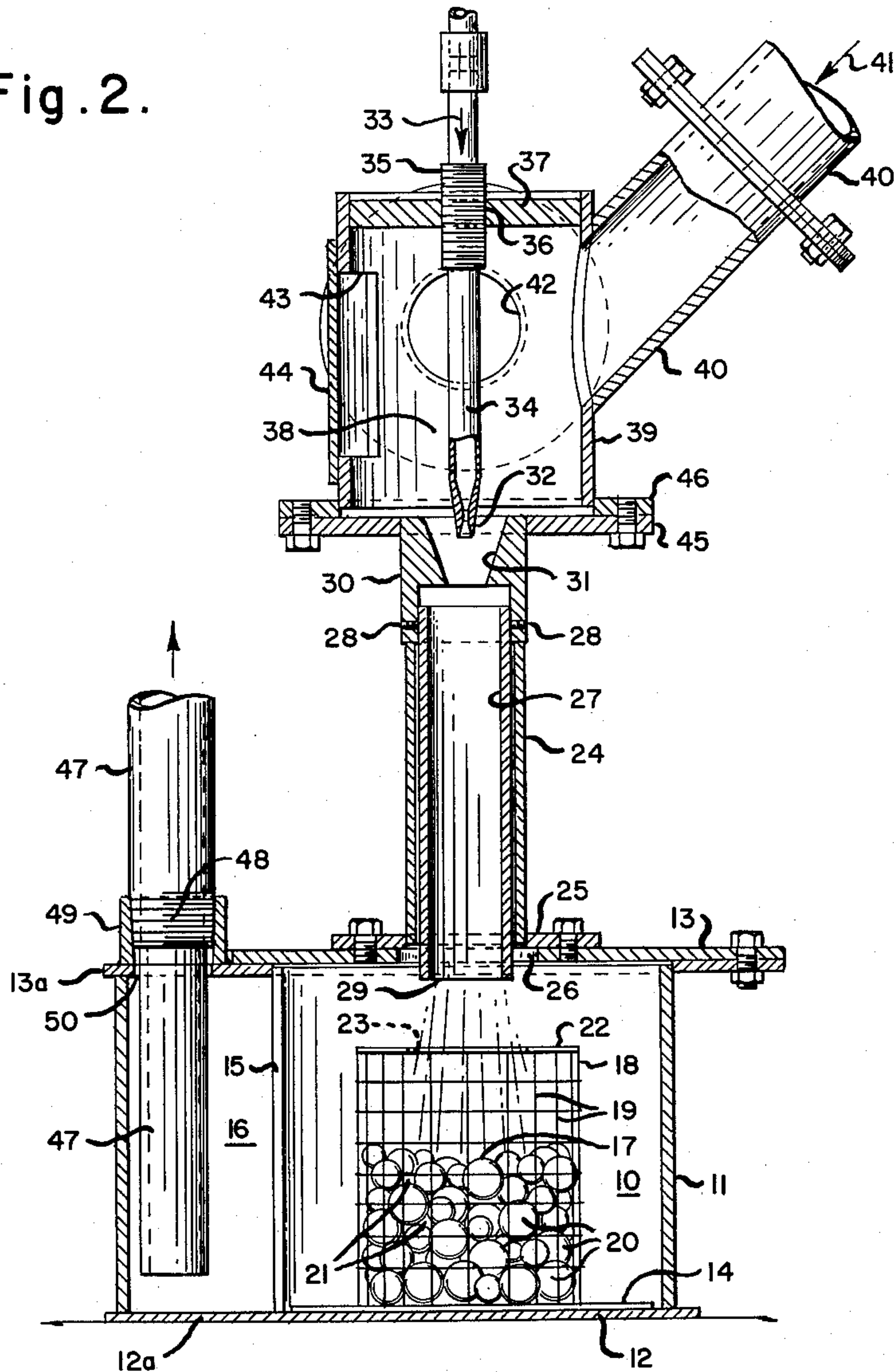
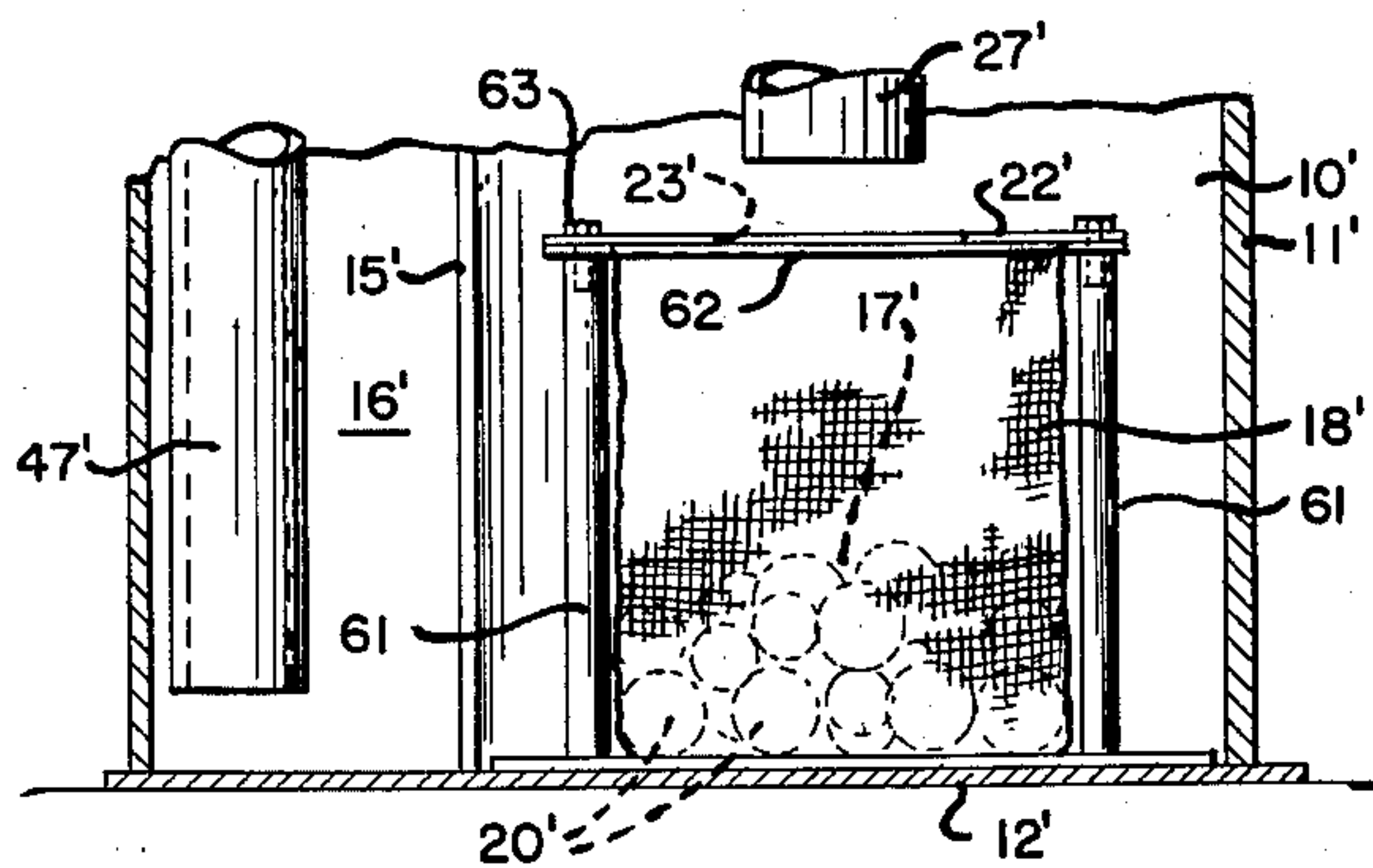


Fig. 3.



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1

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## IMPACT PULVERIZER

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9 Claims. (Cl. 241-40)

This invention relates to impact pulverizer constructions in which material is ground by projecting it against a target mass. More particularly, this invention pertains to grinding and pulverizing of fluid accompanied materials by jetting them against an interstitial mass utilized as an anvil.

Grinding has heretofore been done by projecting material against an impervious strike member, but such prior practices were generally displaced by other types of grinding and pulverizing because of a variety of shortcomings, including, lack of control of the grinding operation and of the ground product, wear on the strike member, contamination of the product in some cases and inefficiency. As a consequence, grinding and pulverizing largely turned to the use of loop mills, opposed jet impact pulverizers and other equipment.

By means of this invention, the deficiencies of prior grinding practices utilizing a strike member have been overcome. Thus, pursuant to this invention, a material to be ground can be jetted at high velocity with an elastic fluid like air against a target mass having interstices with foreseeable, successful results in terms of size and uniformity of the pulverized product and control and efficiency of the operation, without troublesome wear, undue expense, or contamination of the product. Preferably, the target mass comprises generally smooth surfaced discrete members, which may be of the same, or different or random sizes, held by a basket or checkerwork type container having openings through which the material and fluid pass after striking and passing through and around the target. A wide range of materials may be ground, pulverized and exfoliated, as desired, in an efficient, controllable size-reducing operation, yielding high quality ground product.

Other objects, features and advantages of this invention will be apparent from the following description and the accompanying drawings, which are illustrative only, in which—

FIGURE 1 is a plan view of one pulverizer embodiment of this invention with connecting pipes thereto broken away;

FIGURE 2 is a cross section thereof taken along line II—II of FIGURE 1;

FIGURE 3 is a view similar to the lower portion of FIGURE 2 of another means for holding a target mass in some cases, and

FIGURE 4 is a view in elevation and section showing still another construction embodying the teaching of this invention.

Referring to the drawings, the embodiment shown in FIGURES 1 and 2 comprises a grinding chamber 10 having side walls 11, a bottom 12 and a top or cover plate 13 fastened together. A wear plate 14 may be provided and tack welded to bottom plate 12. Wall 11 is provided with an opening 15 at one side thereof to communicate with an extension space 16 of the chamber 10. Side walls 11a enclose space 16 and are a continuation of the side walls 11, while the top and bottom of space 16 are enclosed by bottom extension 12a and a top 13a.

A target mass 17 is provided in chamber 10 within a container 18 the sides of which are open in the manner of a basket or net such as would be formed by a circular cylinder of hardware cloth 19, which may or may not have its own bottom depending upon the pressure exerted by the mass 17. As shown, the target 17 comprises a

2

plurality of discrete objects 20 of spherical shape and random size in tangential engagement with each other at respective contact points leaving a continuous maze or lacunae therethrough and thereamong by virtue of the interstices or voids 21 between the balls 20. The topmost layer of balls 20 presents an upwardly facing, highly irregular surface a selected distance below an annular top 22 fastened to basket 18 having a central opening 23 therein exposing such surface of mass 17. Such objects 20 may be balls as shown, or spheroids, or ovoids, or of other shape, preferably ones in which the entire surface of each object is smooth and continuous. And, depending upon the work to be done, and material to be pulverized, such objects 20 may be made of metal such as iron or steel, or of ceramic such as alumina or other hardened clay, or of other substance.

A jetting gun barrel 24 is provided in the illustrated embodiment having a lower flange 25 bolted to cover 13 with the axis of the barrel 24 coaxial with the vertical axis of container 18 and opening 23. The interior of barrel 24 is in communication with chamber 10 through an opening 26 in cover 13 and is provided with an axially adjustable wear-resistant liner 27 fastened in position by set screws 28 making the discharge end 29 of liner 27 in effect the discharge end of the gun barrel 24. The relative distance between the edge of end 29 and the upper surface of the target mass 17 may be varied, as desired, either by axial movement of the liner 27 or by changing the level of the objects 20 in basket 18, for regulation of the grinding effect to achieve the desired reduction in the end product for the selected starting material.

The upper end of barrel 24 is welded or otherwise fastened to a throat piece 30 coaxial therewith having a hollow conical portion 31 tapering toward the discharge end of the gun and cooperating with a jetting nozzle 32 preferably for an energy fluid such as compressed air which enters in the direction shown by arrow 33. Nozzle 32 is provided with a shank 34 having a threaded portion 35 in engagement with a correspondingly threaded opening 36 in a plate 37 forming the top of a feed chamber 38. Hence, by rotation, in the desired direction, of shank 34, the distance between the lower end of nozzle 32 and the discharge end of cone 31 may be adjusted for optimum operation.

A feed chamber 38 is provided with a surrounding side wall 39 having a feed pipe 40 connected thereto and communicating with the interior thereof to supply chamber 38 with particles of material to be ground, and/or reground, as the case might be, such particles moving in the direction of arrow 41. Wall 39 may be provided with a further opening communicating with a pipe 42 to supply strip air to chamber 38, such strip air normally being of a lower velocity than the jetting air fed through nozzle 32. Additionally, an access opening 43 is provided in wall 39 and normally closed by a cover 44 bolted to the wall. A flange 45 is fixed around the top of member 30 and serves as a base for chamber 38, the walls 39 of which are provided with a cooperating flange 46, suitable gaskets or other sealing provision being made at this and other respective joints in the apparatus.

The illustrated embodiment is also provided with an outlet in the form of an off-take pipe 47, for ground material and its accompanying fluid which exit through opening 15 and chamber 16 where they enter the bottom of the outlet which is adjacent to the bottom 12 and 12a to help provide a "scouring" action in keeping deposits of material from building up on the floor of chamber 10 including its extension 16. Off-take 47 comprises a somewhat smaller diameter section in extension 16 and a larger pipe thereabove, the larger pipe having a threaded portion 48 which is fastened to the threads in a fitting 49



secured to top 13a around the edge of an opening 50 therethrough.

In operation, particles of material enter pipe 40 by gravity and in the course of flowing therethrough, sufficiently light particles in that material may be stripped out by strip air entering pipe 42 and exiting through pipe 40 countercurrent to the direction of the material to be ground, if and when strip air is used. The remainder of the material is substantially aspirated by the jetting characteristics of nozzle 32 and cone 31. The material enters the cone around nozzle 32 and it is tremendously boosted in kinetic energy and propelled with relatively great force against the target mass 17 through the gun barrel and opening 23. That target mass 17 of discrete objects 20 provides enormous surface in, around and under the various objects wherever they are not in contact for the pulverization to the selected extent of the starting material. The motive air, if such is the fluid used, very readily passes through the interstices of the mass 17 without relatively cushioning or impeding the collision of the material and target objects and, with the ground product, exits from the interstitial maze of the target mass, passes through the openings in the container 18 and goes out through off-take 47, the upper end of which may, for example, be connected to a classifier. In the classifier, the rejects may be returned to pipe 40, or go elsewhere. The force utilized in the operation does not "lift" the discrete objects 20 in the target mass 17 to any significant extent but may be great enough to cause some of those objects to rotate or move somewhat in the target mass, a feature of value in keeping target mass objects relatively clean when pulverizing substances which tend to become too sticky or slimy when the grinding thereof is tried in conventional mills. In general, I have discovered that a highly satisfactory operation is obtainable when the height of the target mass is about three-quarters of the height of the grinding chamber and the floor area of the grinding chamber around the target mass is about twice the floor area occupied by the target mass, although it will be recognized that various other proportions and dimensional relations will also be effective.

In mills of this invention, such diverse substances as grains, rubber, plastics, mica, oxides and other chemical compounds, feathers, waxes, clays and many other materials may be ground, pulverized or exfoliated with economy and without difficulty. Moreover, while the operation of the illustrated embodiment was described in connection with the use of compressed air as a motive fluid, other fluids may be utilized as a medium for conveying and kinetically jetting solid state particles to be ground. With more abrasive materials, a basket such as basket 18 in FIGURE 2 may be used with the strands forming the sides made of rubber-coated wire.

In the embodiment of FIGURE 3, parts thereof corresponding generally in construction and functioning to the construction of FIGURE 2 are provided with the same reference numerals with the addition of a prime accent thereto. The embodiment of FIGURE 3 illustrates the relative lack of wear of the container which is present in the pulverizing of most substances by a practice of this invention. Thus, the container 18' is shown as a net bag containing objects forming a target mass 17' with the openings in the bag sufficient for the passage therethrough of the ground material and accompanying fluid. Such container 18' may have the upper open mouth thereof suspended from four posts 61 with the upper edge of the bag clamped between a lower annular ring 62 and the outer edge of the upper annular ring 22', bolts 63 maintaining them in clamped position.

In the case of the grinding of very abrasive materials, or of ones such as the grinding of enamel frit, in which no trace of iron is acceptable, or of certain pyrophoric substances, a ceramic target mass and container may be utilized, one such embodiment being shown in FIGURE 4. Therein, a grinding chamber 71 is provided with a

cover 72 having a central opening 73 through which a jetting gun 74 propels material to be ground through the open top of a circular container 75. Container 75 as shown by the portion broken away contains a target mass 76 of ceramic balls, the container itself being made of bricks 77 laid up in checkerwork fashion with openings in staggered arrangement in successive courses. As shown, the basket 75 is supported on a plate 78 held by radial gussets 79 fixed to a lower tapering wall 80 of the chamber 71 which leads to a bottom outlet 81 where, in the case of pyrophoric material, for instance, there may be fast separation of the ground material from the accompanying kinetic energy fluid, if that fluid be air or other combustion-supporting fluid.

Further, if desired, a filler tube 82 having a normally closed gate 83 therein may be provided and extend through the top 72 of chamber 71 for the filling, or addition, of balls or other target mass objects 76 to the interior of basket 75 as and when a new operation is to be started or there is settling or attrition of the target mass, the level of which may be kept under observation through a sight glass 84 in cover 72, or tube 82.

The ceramic basket and target mass of FIGURE 4 may be utilized in the embodiment of FIGURES 1 and 2; or the target mass may be of iron or steel or other substance in a ceramic basket, and vice versa. Moreover, although the foregoing embodiments show a container for the discrete objects of the target mass, it will be realized that such discrete objects may be piled in such fashion, as in a corner with a face slope less than the angle of repose, so that no container as such may be needed to take advantage of the new impact pulverizing teaching of this invention.

Various changes may be made in illustrated aspects of the embodiments shown, and other embodiments provided, without departing from the spirit of this invention or the scope of the appended claims.

I claim:

1. In an impact pulverizer, apparatus comprising, in combination, a grinding chamber, a target mass in said chamber spaced from the walls thereof, said target mass comprising a plurality of generally smooth surfaced objects generally forming voids therebetween when in engagement, a container for said objects having an opening in the upper portion thereof to expose said target mass therethrough and sides having openings therein, said objects in said container presenting an upwardly facing irregular surface, a gaseous fluid-operated gun positioned adjacent said chamber so as to point at said surface through said first-named opening, said gun being adapted to jet material to be ground against said surface and target mass, and an outlet from said chamber for jetted material and gaseous fluid.

2. An impact pulverizer as set forth in claim 1 in which said objects are balls of random size and in which said outlet has an entrance end adjacent but spaced from the bottom of said chamber to the side of said container.

3. An impact pulverizer as set forth in claim 1 having means for supplying said objects to said container from the exterior of said chamber.

4. An impact pulverizer as set forth in claim 1 in which said target mass is relatively stationary, said gun is operatively connected to said chamber and in which there are means for adjusting the distance between said surface and the discharge end of said gun.

5. In an impact pulverizer, apparatus comprising, in combination, a grinding chamber, a target mass in said chamber, said target mass comprising a plurality of discrete objects forming voids therebetween when in contact engagement, means for supporting said objects in said contact engagement arrangement, a fluid-operated gun positioned adjacent said chamber so as to discharge against said mass, said gun being adapted to jet material to be ground against said target mass, said voids being sufficient to pass substantial quantities of said fluid there-



5

through, and an outlet from said chamber for jetted material and fluid.

6. In an impact pulverizer, apparatus comprising, in combination, a grinding chamber generally cylindrical in plan, a target mass positioned centrally in said grinding chamber, said target mass comprising a pile of relatively smooth generally globoid objects on top of one another, a container for said objects having a wall with relatively large proportions of openings through said wall, said mass presenting a generally upwardly facing irregular surface, a feed chamber for material to be ground, a fluid-operated grinding gun substantially extending between said feed chamber and grinding chamber to jet said material at said surface, a jetting nozzle and a barrel in said gun to aspirate and accelerate said material, and an off-take for jetted material and fluid.

7. An impact pulverizer as set forth in claim 6 having a longitudinally adjustable wear-resistant liner for said barrel and said off-take positioned to one side of said grinding chamber with its bottom adjacent but spaced from the bottom of said grinding chamber.

8. An impact pulverizer as set forth in claim 6 having a gravity feed pipe connected to said feed chamber for said material and means to supply strip air to said feed chamber for passage at least in part up through said pipe.

6

9. In an impact pulverizer, apparatus comprising in combination, a target mass composed of discrete objects so shaped as to provide appreciable interstices therebetween when said objects are in engagement and a jetting gun to project material to be ground against said target mass accompanied by a kinetic energy supplying fluid a substantial quantity of which passes through said interstices, the respective masses of said objects being sufficiently greater than that of the particles of material to be ground so as to retain said objects substantially in position in said target mass during operation of said pulverizer.

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