United States Patent

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[54] **METHOD AND APPARATUS FOR REDUCING THE VOLUME OF WASTE MATERIALS**
7 Claims, 10 Drawing Figs.

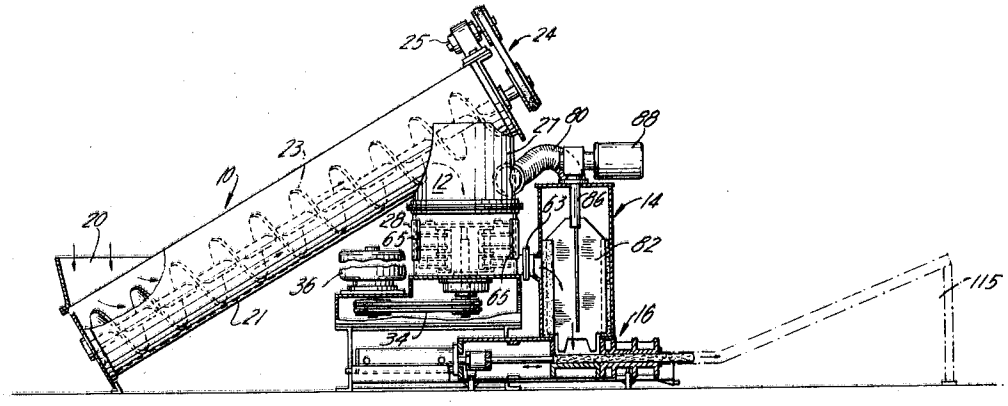
[52] **U.S. Cl.** **100/39,** 100/42, 100/97, 100/126, 100/139, 100/185, 100/189; 241/56, 241/154, 241/285; 18/12
[51] **Int. Cl.** **B30b 13/00,** B30b 15/08
[50] **Field of Search** 241/154, 56, 285; 100/39, 42, 97, 126, 232, 269, 96, 237, 215, 185, 189, 137, 138, 139, 90, 91, 98; 18/12

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ABSTRACT: Apparatus and method of reducing in volume waste material comprising comminuting the waste material in a pulverizer and delivering to an extruder-compacter through a precompaction feed chute in which a positive delivery air flow delivers the comminuted material to the extruder-compacter. The air flow is likewise used to recycle air to the pulverizer to assist in positively delivering waste material to the pulverizer. Fluff in the precompaction feed chute is scraped and compacted by a tamper for delivery to the extruder-compacter without impeding the air flow and collection of waste material in the feed chute is eliminated.



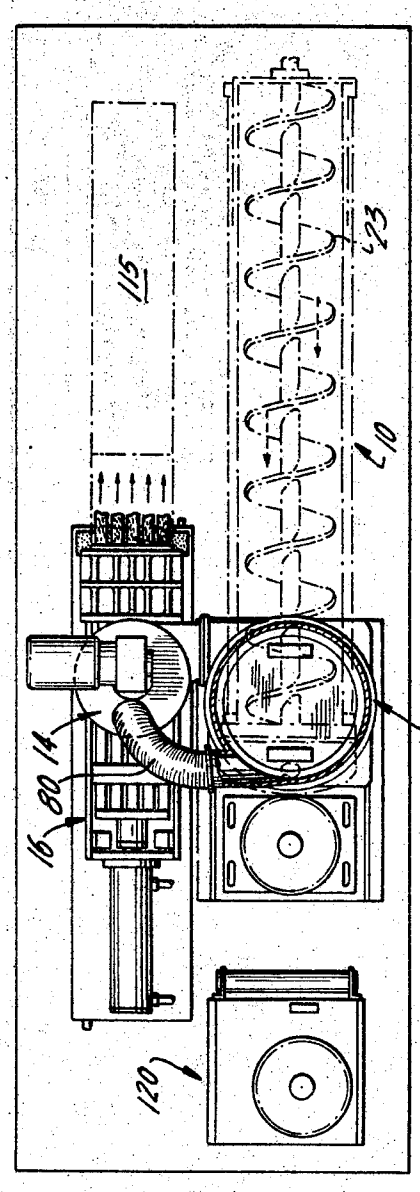


FIG. 1

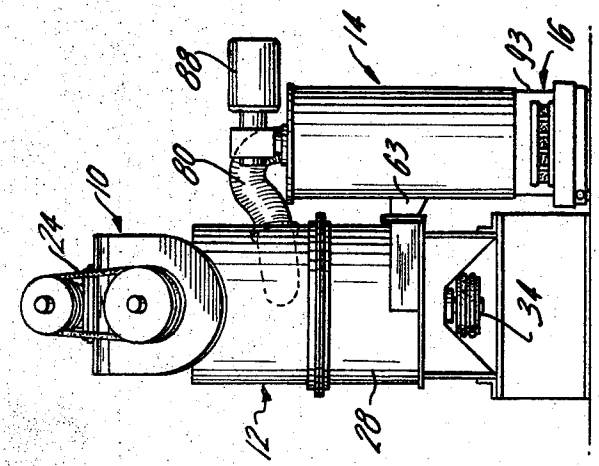


FIG. 2

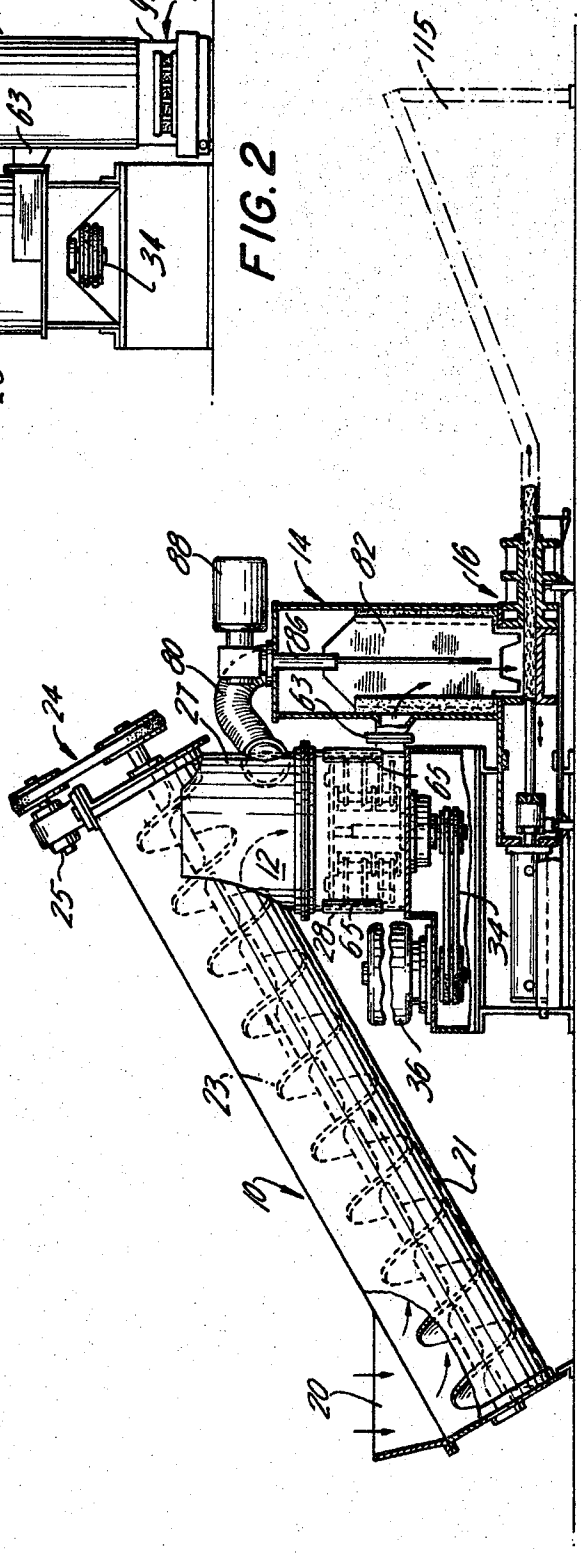


FIG. 3

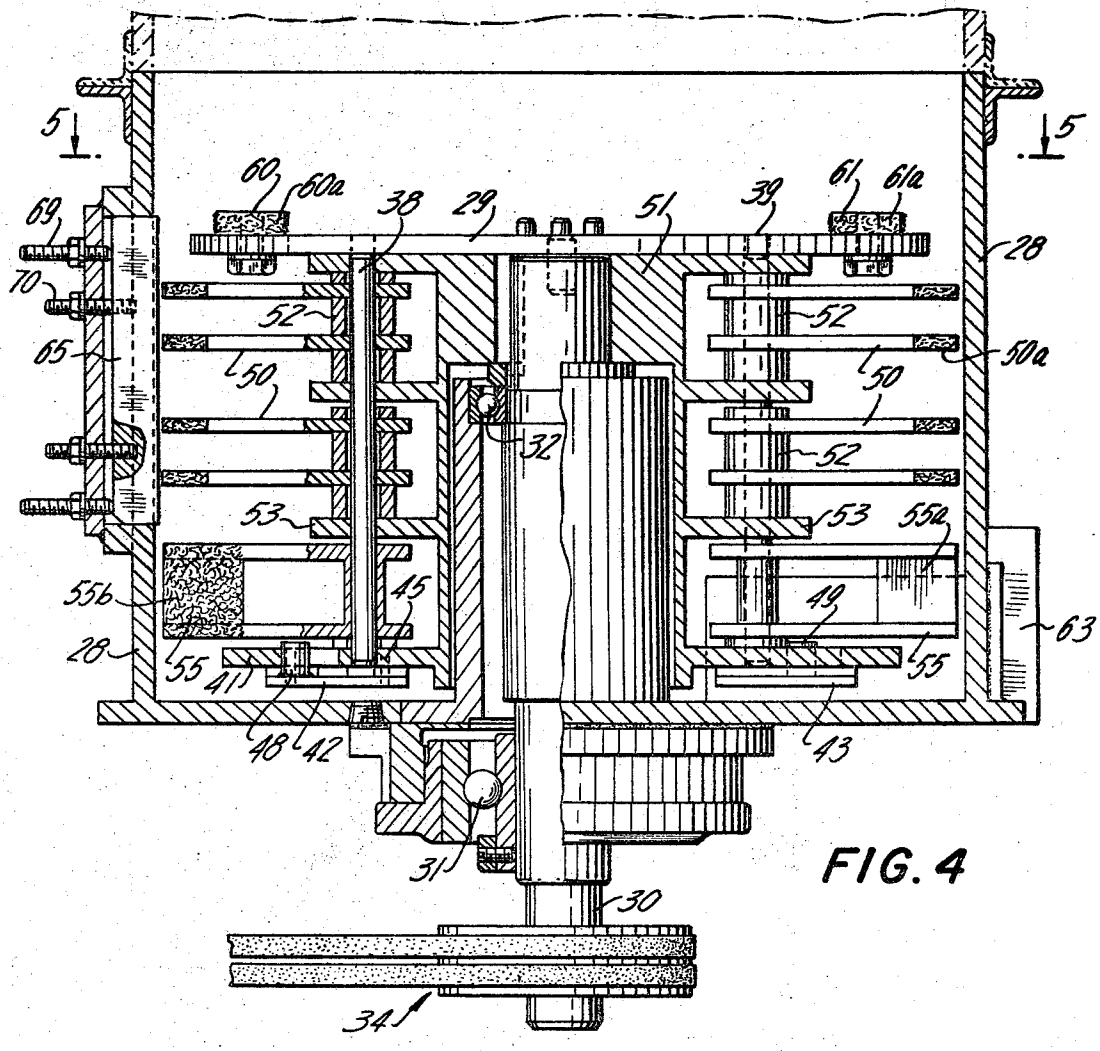

5
5
60
60a
38
29
51
39
61
61a
69
28
70
52
52
65
50
50a
50
32
52
53
53
55a
55b
45
49
63
28
55
41
55
48
42
43
31
30
34

FIG. 4

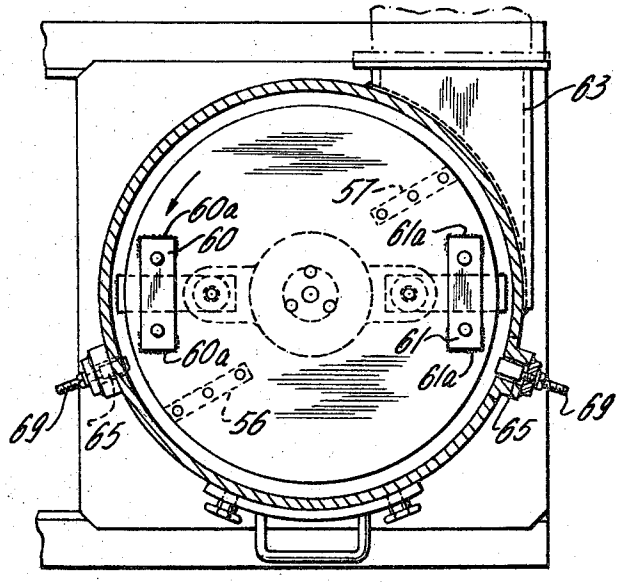

63
57
60a
60
61a
61
60a
61a
69
65
56
65
69

FIG. 5

FIG. 6

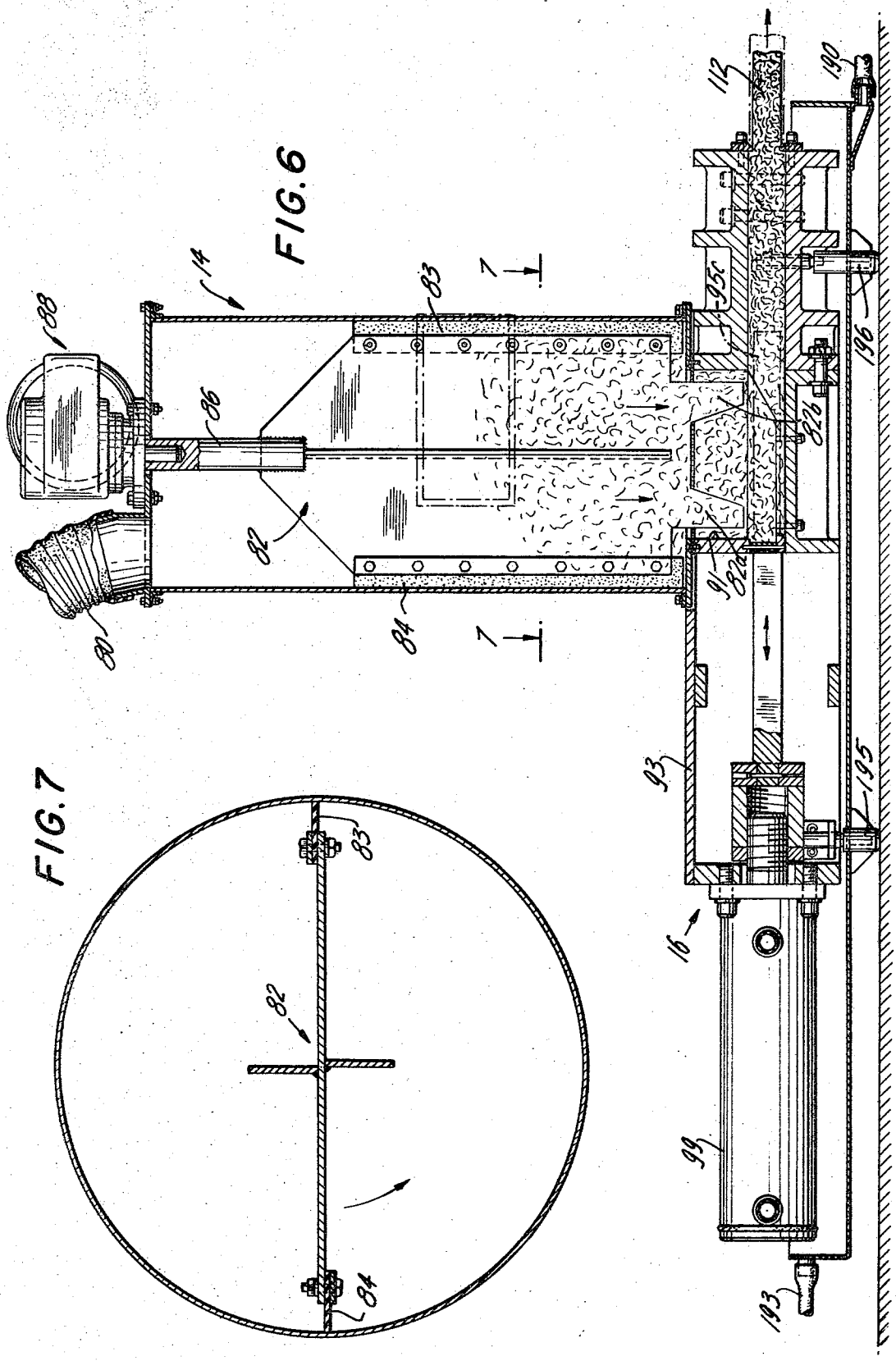

14
88
86
82
80
84
83
7
7
112
190
95r
196
82b
82a
91
93
195
16
99
193

FIG. 7

83
82
84

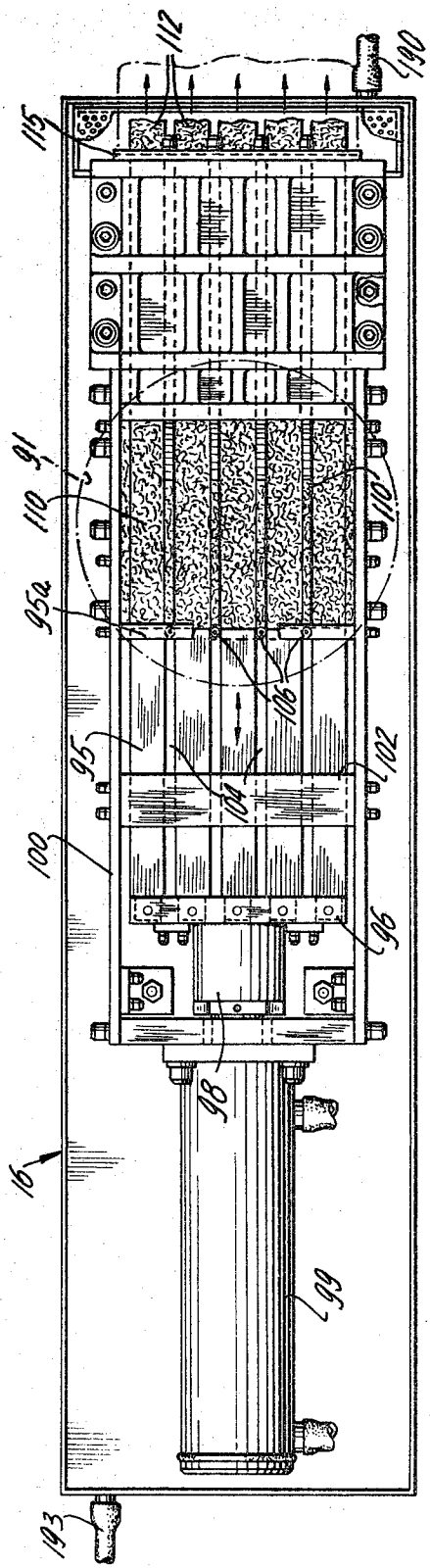


FIG. 8

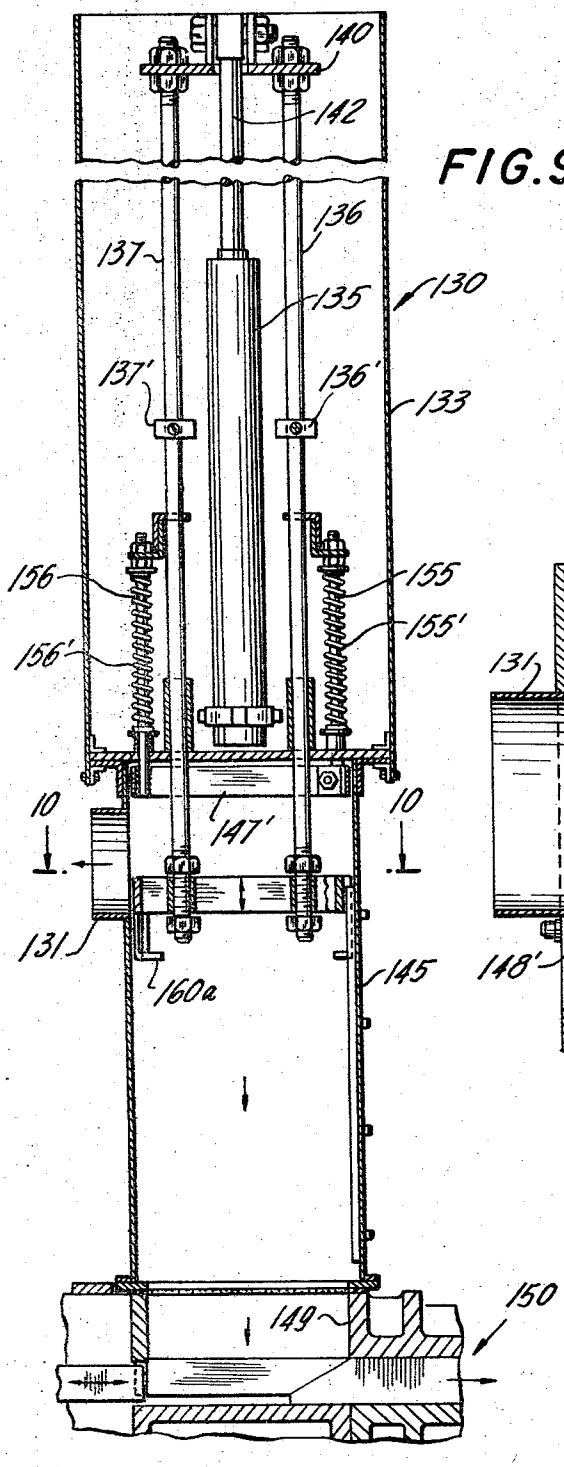
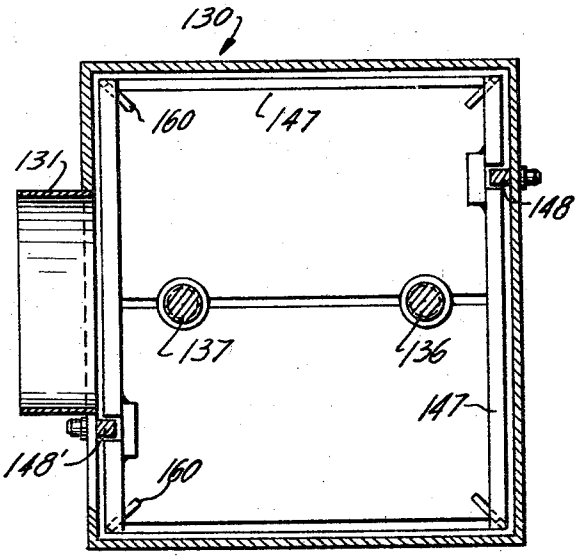

140
142
136
137
135
130
137'
136'
133
156
155
155'
156'
10
10
147'
131
160a
145
149
150

FIG. 9

FIG. 10


130
160
147
131
148
137
136
147
148'
160

METHOD AND APPARATUS FOR REDUCING THE VOLUME OF WASTE MATERIALS

This invention relates generally to processing of waste materials such as garbage and trash and more particularly to a new and improved method and apparatus for processing waste material.

Apparatus and methods of processing garbage and trash are known in which the waste material is comminuted and is then compacted to reduce the volume thereof. Such a method and apparatus is disclosed in U.S. Pat. No. 3,426,673.

The present invention is an improved method and apparatus for processing waste material improving the method and apparatus of the above-mentioned patent. Apparatus of the type disclosed in the patent have heretofore used a feed chute or settling chamber communicating between a reduction mill or pulverizer and a compacter which tends to have material gather within the chute if the comminuted waste is an in any way wet or damp. The known apparatus also have the interior of the feed chute material generally covered by adhering comminuted material which adheres to the interior of the chute because of charges carried by the particles and provision must be made for delivering the adhered material eventually to a compacter-extruder.

According to the invention a reduction mill or pulverizer having a flow control plate receives waste material to be comminuted and on which are mounted cutter bars that break up the material before it passes downwardly to a second stage where hammer blades or flails reduce the waste material to smaller particles. The size of the particles may be substantially controlled by breaker plates adjustable inwardly and outwardly relative to the interior of the reduction mill or pulverizer to controllably set the clearance between these plates and the hammer blades in the second stage of the mill. The comminuted material is discharged centrifugally by a positive air flow developed by the mill into a feed chute which delivers the material to an extruder-compacter reducing the material in size or volume and discharges as extrusions dry waste briquettes. The feed chute is provided with an air return conduit that allows recycling of air flow from the mill into the feed chute and back into the interior of the pulverizer to improve delivery of the waste.

Within the feed chute is mounted a scraper or sweeper that removes comminuted material adhering to the interior surfaces of the feed chute and positively delivers this waste material to the extruder-compacter. The sweeper or scraper is provided as a new and novel construction as a tamper in which the air flow between the pulverizer and feed chute is not in any way impeded.

Other features and advantages of the apparatus and method in accordance with the present invention will be better understood as described in the following sped specification and appended claims, in conjunction with the following drawings in which:

FIG. 1, is a plan view of apparatus embodying the invention;

FIG. 2, is a side elevation view of the apparatus shown in FIG. 1;

FIG. 3, is a developed side elevation view, partly in section, of the apparatus illustrated in FIGS. 1 and 2;

FIG. 4 is a fragmentary sectional view, on an enlarged scale, of a pulverizer of the apparatus shown in FIG. 1;

FIG. 5, is a cross section view take taken along section line 5–5 of FIG. 4;

FIG. 6, is a fragmentary elevation section view, on an enlarged scale, of a part of the apparatus shown in FIG. 3;

FIG. 7, is a cross section view taken along section line 7–7 of FIG. 6;

FIG. 8, is a plan view, partly in section, of an extruder-compacter of the apparatus illustrated in FIG. 3;

FIG. 9, is a vertical section view of a second embodiment of a feed chute of the apparatus shown in FIG. 3; and

FIG. 10, is a cross section view taken along section line 10–10 of FIG. 9.

The apparatus hereinafter described reduces solid waste by greatly reducing its volume and may be used to process, by pulverization and reduction in volume, paper, glass, plastic, metal cans and other wet and dry solid waste. The apparatus compresses the pulverized product to as little as one-fifteenth its original volume extracting excess moisture as hereinafter described and the end product is a compressed, relatively dry waste formed, for example, as dry briquettes. While the apparatus will be described for processing products of the above described type it will be understood by those skilled in the art that other waste materials may be similarly processed.

Apparatus according to the invention comprises a motorized inclined conveyor **10** for receiving waste material delivering it to a pulverizer or reduction mill **12** which discharges into a feed chute **14** comminuted material which is fed by the feed chute to an extruder-compacter **16** that greatly reduces the volume of the comminuted material and extrudes it as dry briquettes. The motorized conveyor is provided with a hopper **20** in communication with a lower end of a tube or housing **21** within which is housed a conveyor screw **23** driven by a belt drive **24** rotationally driven by an electric motor **25**. The motorized conveyor has an opening at an upper end thereof to which is connected or in communication therewith a chute or hopper **27** defining an upper connector to the reduction mill or pulverizer **12**.

The upper connector **27** receives the waste material from the conveyor **10** and delivers it into a lower part of the reduction mill constituting a tub **28** within which is mounted a flow control plate **29** connected to a rotor spindle **30** mounted on bearings **31, 32** and rotationally driven by a belt drive **34** powered by an electric motor **36**. Within the mill and intermediate the rotor and the tub **28** and below the flow control plate are mounted hammer pins **38, 39** each supported on a plate **41** by pin locks **42, 43** pivotally mounted on pins **45**, and rotationally movable relative to the plate **41** for insertion of the hammer pins **38** into position and then rotated back into position into a recess within the plate in which a locking pin **48, 49** is received thereby locking the hammer pins in place. The hammer pins pivotally mount thereon eight hammer blades or flails **50** symmetrically disposed and spaced from one another by spacer washers **52** disposed circumferentially of the individual hammer pins as illustrated.

The support plate **41** is integral with a support structure **51** provided with outwardly extending flanges **53** supporting the spacers **52**. Beneath the lowermost flange **53** are mounted two sweeper hammers **55** and sweeper bars **56, 57** are mounted on and below the plate **41** to sweep the waste out of the pulverizer. Each of the hammer blades or flails has a tip portion **50*a*** coated with "Certanium 250" a certanium carbide hardening material to reduce wear. The sweeper hammers **55** are provided with a plate **55*a*** coated with hardening material **55*b*** of the same composition as the hardening material on the hammer blades.

The flow control plate **29** is mounted with a larger clearance between it and the mill tub interior surfaces as illustrated and is provided with cutter bars **60, 61** having end portions **61*a***, **60*a*** coated with hardening material of the type on the flails or hammers. These cutter bars constitute a first reduction stage and reduce the size of the waste. The clearance between the flow plate and the tub allows the material to move downwardly into the second stage of the reduction mill or pulverizer where the flails driven by centrifugal force as the flow control plate rotates reduce the material to comminuted material and the rotationally driven sweeper hammers centrifugally discharge the comminuted waste material through centrifugal force outwardly through a discharge conduit **63** tangentially disposed relative to the path of the sweeper hammers and the hammer tub. The pulverizer is provided with breaker plates **65, 66** that are mounted on the mill hammer tub and may be adjusted in their radial position relative to the tips of the hammers by adjust screws **69, 70** so that the size particles may be controlled and any wear of the hammers compensated so that the set clearance is maintained for main-

taining the proper particle size to which the waste is reduced or comminuted.

The driven flails and scraper hammers develop an air flow into the feed chute or precompacter **14** through the outlet connection **63** providing communication between the reduction mill or pulverizer **12** and the feed chute **14**. The reduced or comminuted material is discharged into the feed chute and moves downwardly to the extruder-compacter **16** as illustrated by the directional arrows in FIG. **3**. The downward movement of the material is positively assisted by the air flow between the pulverizer and the feed chute **14**. An air return **80** is provided at the top of the feed chute **14** for returning air to the connector **27** immediately above the pulverizer feed control plate in order to allow an improved recirculation of the air to better deliver the waste to the hammers and to deliver particles carried by the air flow back into the system for reworking and eventual delivery outwardly from the apparatus as dry briquettes as later described.

Within the feed chute is mounted a scraper paddle **82**, illustrated in detail in FIGS. **6** and **7**. The paddle is provided with rubber strips **83, 84** bearing against the inner surfaces of the feed chute **14**, which is circular in cross section. The paddle is driven rotationally by a suspension shaft **86** driven by a motor drive **88**. The paddle is constructed to allow the downward air flow from the reduction mill positively delivering the comminuted material to the extruder-compacter **16**. The paddle is driven rotationally in a counterclockwise direction and scrapes off any comminuted material which may have adhered to the inner walls of the feed chute due to, for example, its moisture content or because of the electric charges of the particles. Thus, any buildup of waste material is precluded from taking place within the chute and the entire waste discharge from the pulverizer is delivered to the extruder-compacter **16**. The paddle is provided with downwardly extending projections **82***a*, **82***b* which project into an opening **91** providing communication between the feed chute and the extruder-compacter **16** provided in a base **93**. These projections breakup the waste particles at the opening of the extruder-compacter that may bridge it due to the attraction of the particles for each other that tends to cause bridging.

The extruder-compacter comprises a fork-shaped ram arrangement having, for example, five bars **95** mounted on a support plate **96** connected to a piston **98** reciprocally driven by hydraulic cylinder **99** mounted on a frame **100** having brace bars **102**. The extruder-compacter bars are spaced from each other and extend generally in the same direction parallel to each other. Within spaces **104** between the ram bars **95** are mounted rollers **106** for guiding axial movement of the compacter bars during reciprocable travel thereof.

The extruder-compacter is provided with guide members **110** aligned with the spaces **104** and disposed immediately below the opening **91** of the precompaction feed chute. The bars of the compacter have free ends **95***a* disposed as illustrated in FIG. **8** when the compacter forklike element is in a retracted position below the opening **91** and as the material is received between the guides or spaces **110** and the compacter ram moves forwardly the bars moved to a position shown in broken lines and designated **95***c* in FIG. **6**, to form continuous briquettes **112** of compacted waste comminuted material which are extruded through an extrusion plate **113** and delivered on to an output chute **115** and then removed from the vicinity of the apparatus. The hydraulic cylinder **99** is supplied with hydraulic fluid from a hydraulic system **120** for continuously reciprocating the forklike ram element so that the discharge of dry briquettes is continuous from the extruder-compacter.

The precompacter **14** may be constructed in a different and improved manner as illustrated in FIGS. **9** and **10** in which a feed chute or precompacter **130** is illustrated constructed rectangular in cross section. This compacter receives the particles of waste material from the pulverizer through an opening, not shown, in a manner as before described. The feed chute comprises an air return **131**, as before described but in this embodiment a housing **133** houses a hydraulic cylinder **135** provided with hydraulic fluid for reciprocally driving a pair of drive rods **136, 137** connected to a plate **140** operably driven through a piston rod **142** of the hydraulic cylinder **135**. The rods extend out of the casing into the lower part of the feed chute and at the lower ends thereof a frame scraper **147** is connected for reciprocable travel with the operating rods **136, 137** guided by guides **148, 148'**. This scraper functions as a scraper to remove the light weight materials or fluff from the inner walls of the feed chute portion **145** and as a tamper to compact the comminuted scraped material at the lower end of the stroke thereof and positively deliver the particles into an opening **149** of an extruder-compacter **150** of the type heretofore described with respect to the first embodiment of the apparatus.

The tamper **147** is advanced in a downwardly direction by the cylinder **135** by fluid received from the hydraulic unit **120** and it is retracted by hydraulic pressure reciprocably driving the piston rod. The downward stroke of the scraper-tamper **147** starts from the position in which it is illustrated. In order to keep the air outlet **131** clear a second scraper **147'** is provided. This second scraper has a stroke from its retracted position to a lowered position in which it clears fluff from the precompacter **130** upper wall surfaces and the air-return **131**.

The second scraper **147'** is driven by rods **155** and **156** extending axially of two compression springs **155', 156'**. Four of these rods and springs are employed but only two of each are shown. These rods have their lower ends connected to the second scraper and their upper ends are connected to Z-shaped elements movable axially of the main rods **136, 137** driving the scraper-tamper **147**. When the main actuating rods **136, 137** move downwardly they carry with them respective collars **136', 137'** which engage the Z-shaped elements and drive the rods **155, 156** connected thereto downwardly to effect the downward stroke of the second scraper **147'**. When the first scraper **147** is moved upwardly hydraulically the compression springs extend and retract the second scraper to its starting position illustrated.

The scraper-tamper **147** does not impede the air flow from the pulverizer so that the same positive delivery of material is accomplished by the air flow as above described. The scraper **147** is provided with four fingers **160** at the corners thereof extending downwardly and each has an inwardly extending projection **160***a*. These fingers extend downwardly sufficiently at the bottom dead center position of the travel of the scraper to loosen material subjected to compaction or tamping which takes place at the lowermost travel of the tamper **147**. These fingers and projections sufficiently breakup the compacted or tamped material removed from the inner walls so that it does not bridge on itself and is positively delivered to the extruder-compacter **150**.

Provision is made for draining out the extruder-compacter **16** through a drain **190** and it may be flushed out by supplying water through an inlet connection **193**. The extruder-compacter is provided with leveling feet **195, 196**.

We claim:

1. Apparatus for reducing the volume of waste material comprising, comminuting means having means to comminute waste waste material, precompaction means in communication with said comminuting means to receive the comminuted material from said comminuting means, an extruder-compacter receiving the comminuted waste from said precompaction means to compact the comminuted waste material to reduce it in volume and extrude it as a dry output of said apparatus, said means to comminute waste material comprising means developing a positive air flow through said precompaction means to positively deliver the comminuted waste discharge from said comminuting means to said extruder-compacter and air return means to recycle air back to said comminuting means immediately upstream of said means to comminute waste material.

2. Apparatus according to claim **1**, in which said means to comminute comprises rotationally driven hammer blades,

means pivotally mounting said hammer blades, said means developing said air flow including scraper hammers rotationally driven, and means in said precompaction means to positively deliver comminuted waste material to said extruder-compacter in conjunction with said air flow comprising means operative to effect positive delivery of comminuted waste without impeding said air flow.

3. Apparatus according to claim 2, in which said precompaction means comprises means defining a feed chute receiving comminuted waste material from said comminuting means, and in which said means in said precompaction means to positively deliver comminuted waste material to said extruder-compacter comprises a reciprocably driven frame to remove waste material from inner surfaces of said feed chute and effective to precompact said comminuted waste material before compaction by said extruder-compacter.

4. Apparatus for reducing the volume of waste material comprising, a pulverizer to comminute waste material received therein, driven hammer blades and scraper hammers in said pulverizer to comminute the waste material and to deliver it outwardly of said pulverizer, a feed chute in communicating with said pulverizer receiving comminuted waste from said pulverizer, an extruder-compacter in communication with said feed chute for receiving comminuted waste from said feed chute to compact and reduce its volume and having means to extrude the compacted waste material as dry outputs of said apparatus, said scraper hammers comprising means to develop an air flow positively feeding comminuted waste material into said feed chute and delivering comminuted waste material through said feed chute into said extruder-compacter, and an air return delivering air from said air flow in said feed chute back to said pulverizer immediately upstream of a zone in which said hammer blades are disposed thereby to assist in positively delivering waste material to said zone including comminuted waste material in said air flow.

5. Apparatus according to claim 4, including a scraper driven in said feed chute to remove comminuted waste from inner surfaces of said feed chute and deliver the waste material removed positively to said extruder-compacter without impeding delivery of comminuted waste to said extruder-compacter by said air flow during operation of said apparatus.

6. A method of reducing the volume of waste material comprising, comminuting a volume of waste material, compacting the waste comminuted waste material to reduce its volume, extruding the compacted waste material, and while comminuting the waste material developing an air flow to positively deliver the comminuted waste material to a zone in which the compacting is effected and returning a part of said air flow immediately upstream of another zone in which said comminuting is effected thereby to improve the delivery of comminuted waste material to the first-mentioned zone.

7. A method according to claim 6, including mechanically positively delivering comminuted waste material from said another zone in conjunction with said air flow without impeding the air flow and delivery of comminuted waste material to the first-mentioned zone by said air flow.