

[54] **APPARATUS HAVING AN AUGER-COMPACTER FOR REDUCING THE VOLUME OF WASTE MATERIALS**

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[22] Filed: **April 14, 1970**

[21] Appl. No.: **28,445**

[52] U.S. Cl. **100/145**, 100/DIG. 3, 100/39,
100/97, 100/147, 100/149

[51] Int. Cl. **B30b 3/00**

[58] Field of Search 100/DIG. 3, 145, 147, 39, 97,
100/149

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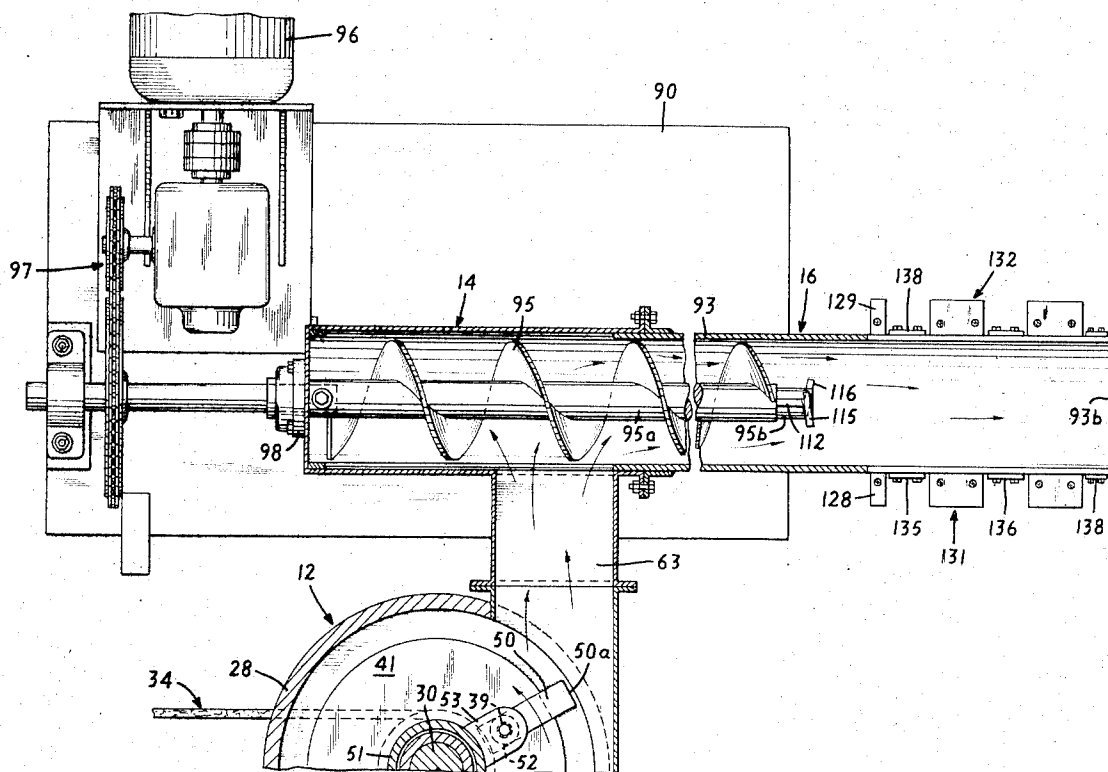
Primary Examiner—Billy J. Wilhite

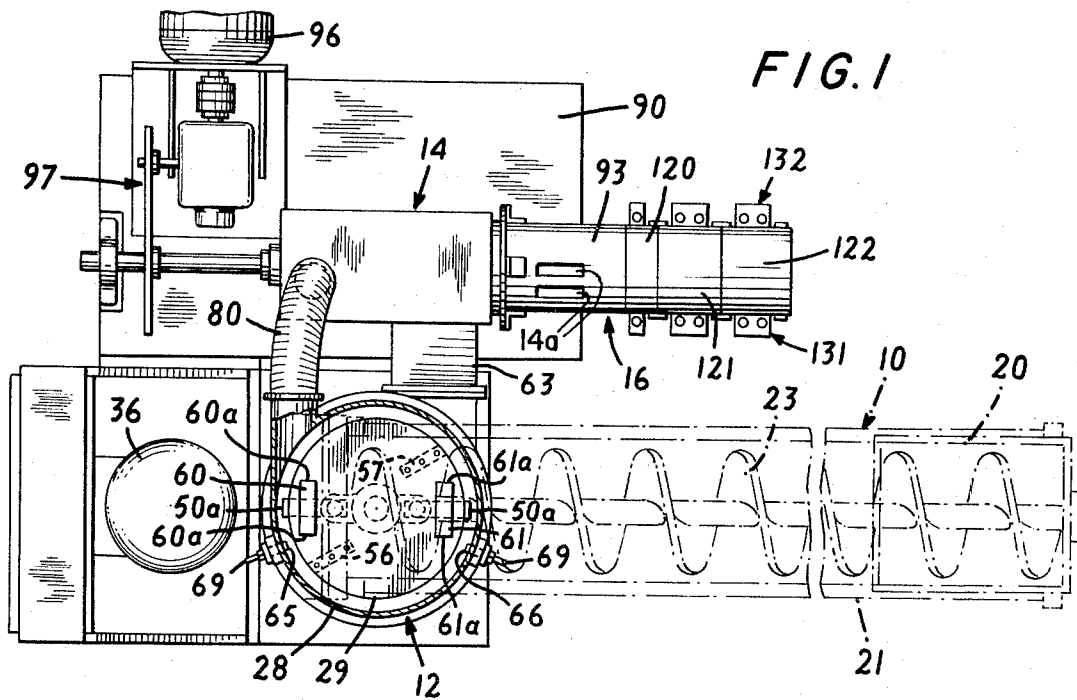
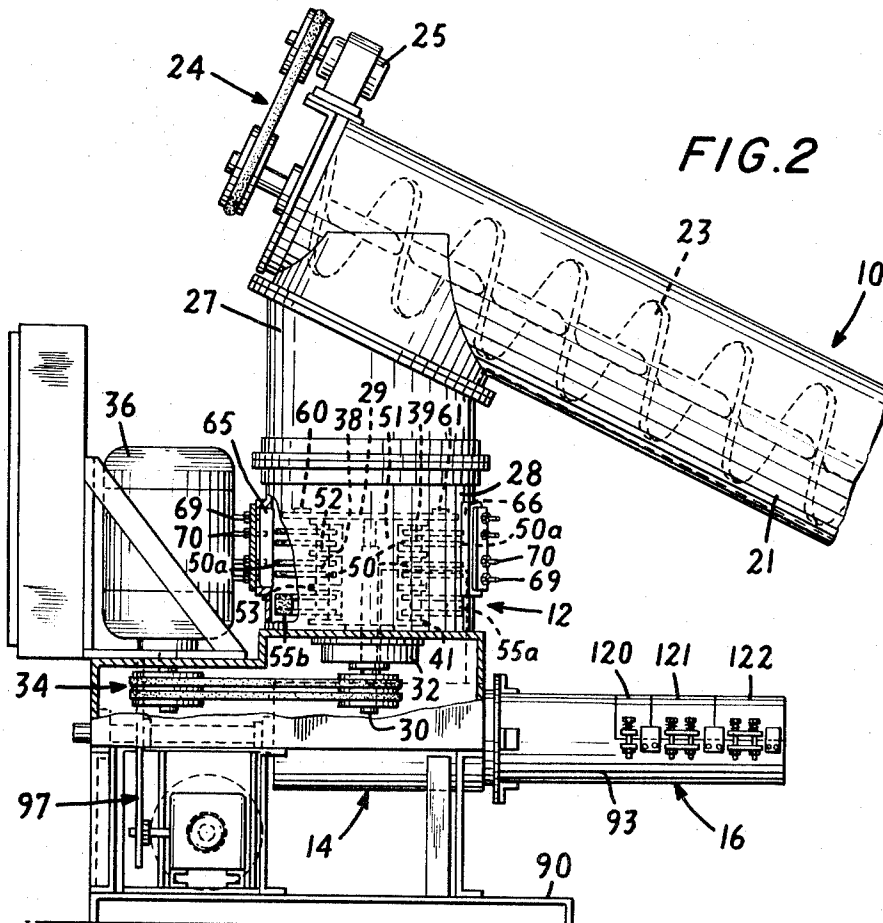
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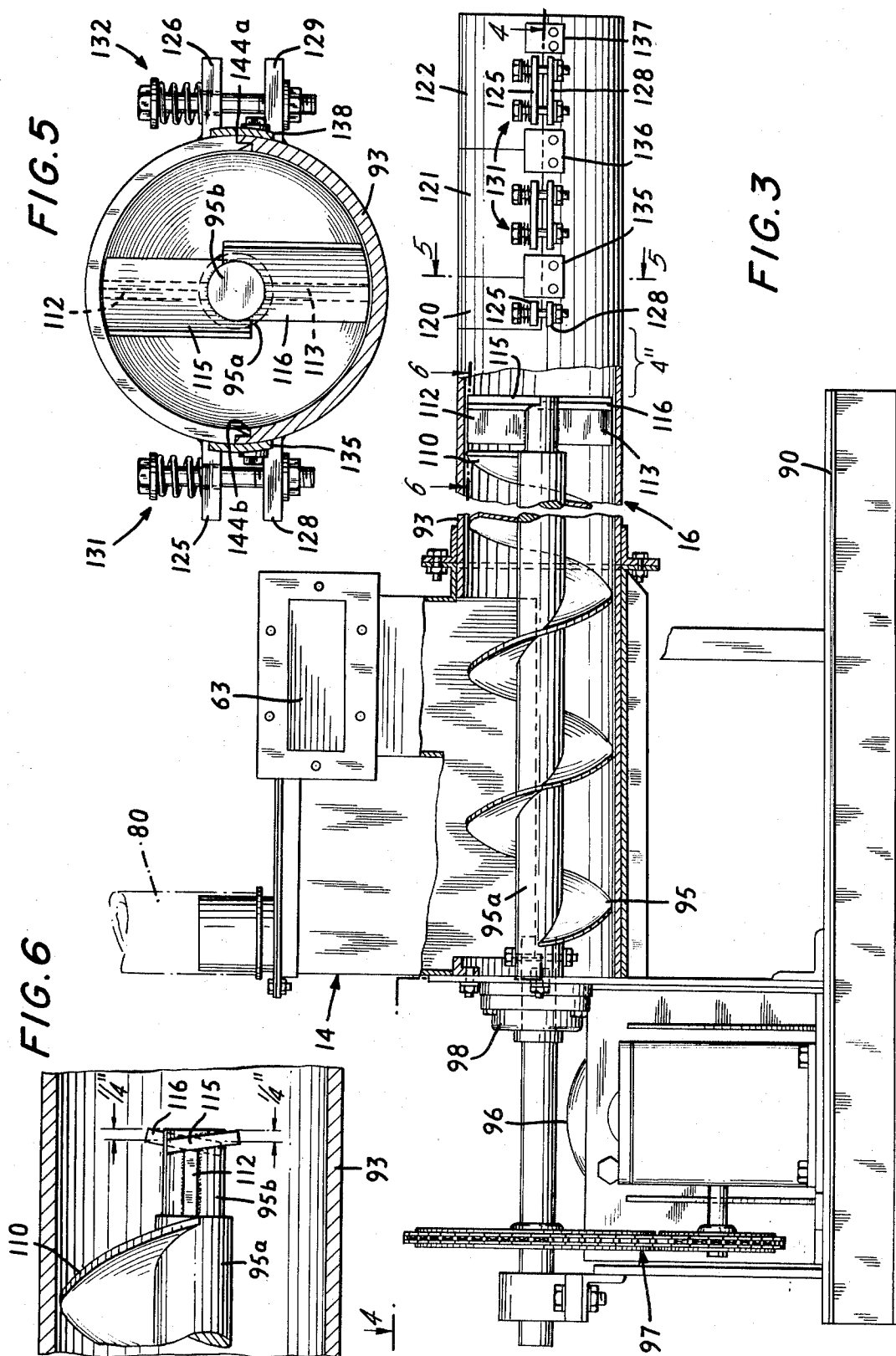
[57] **ABSTRACT**

Apparatus for reducing in volume waste material or garbage comprising a pulverizer or hammermill receiving wet and dry organic and inorganic material, comminuting this waste material and delivering it in particle form to an auger-compacter. An air flow is likewise developed by the pulverizer and the apparatus recycles air to the pulverizer to assist in positively delivering waste material to the pulverizer. The auger-compacter has a helical screw that compacts the comminuted waste material or garbage in a compaction zone and delivers the compacted garbage reduced in volume as an output of the apparatus.

6 Claims, 18 Drawing Figures







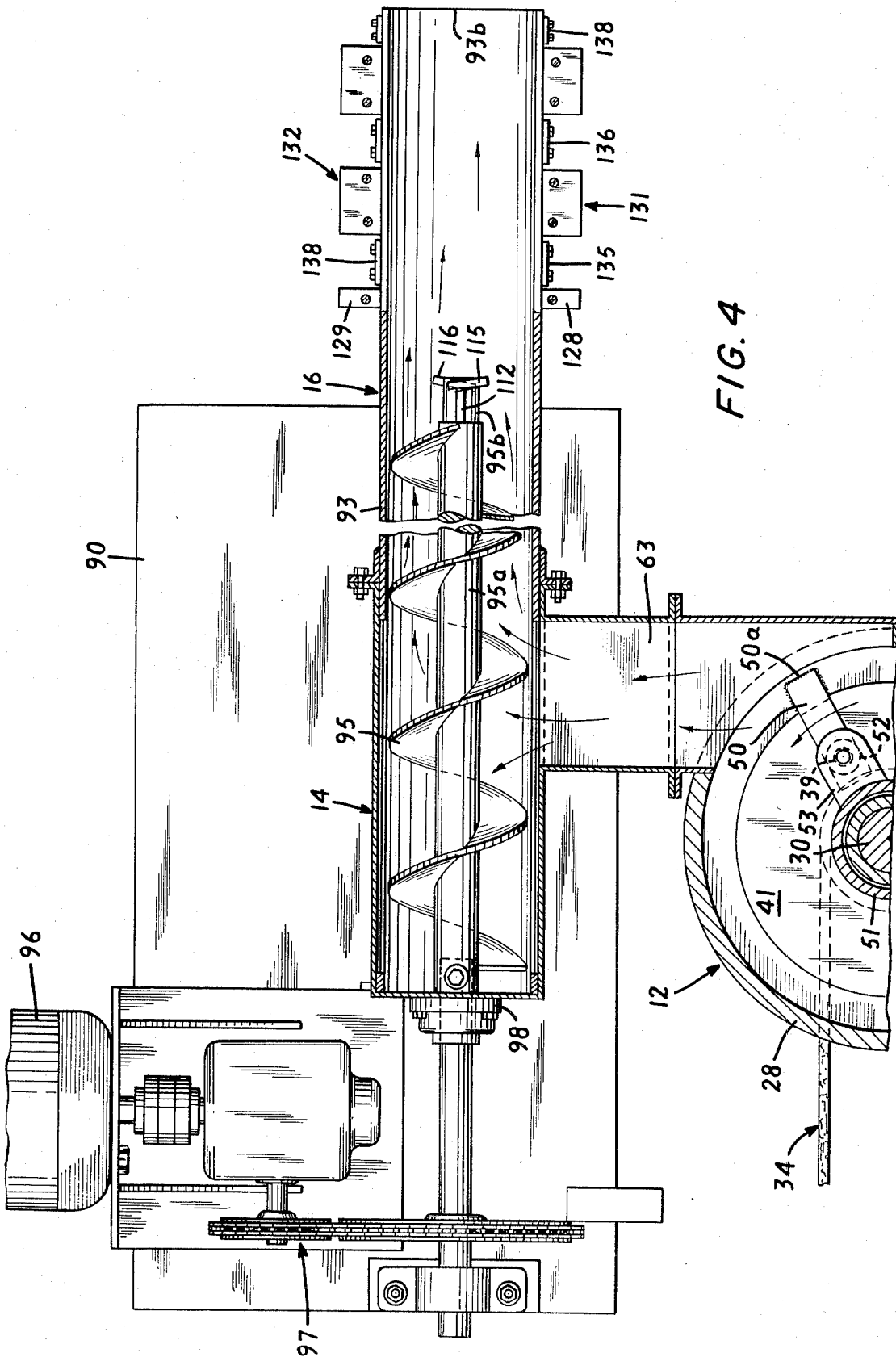


FIG. 7

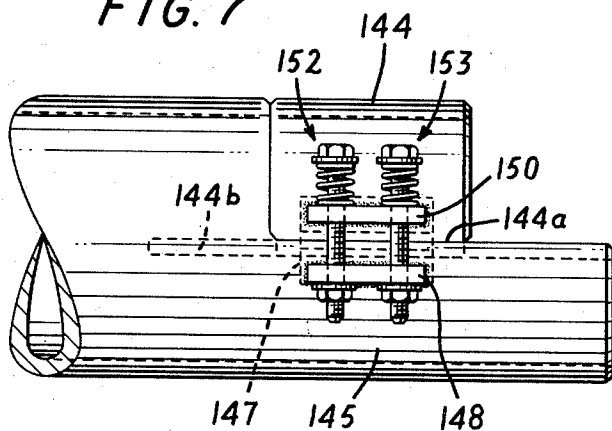


FIG. 8

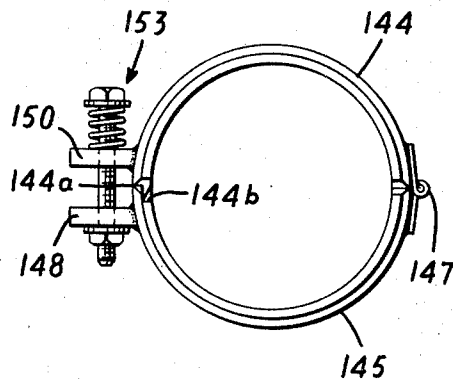


FIG. 9

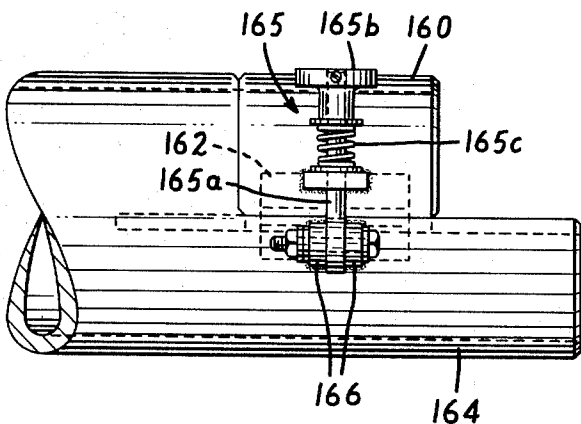


FIG. 10

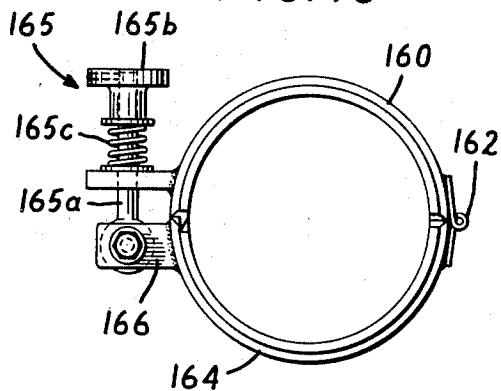


FIG. 11

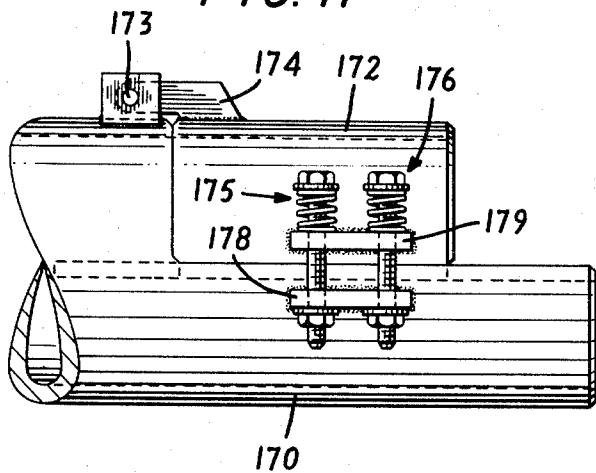
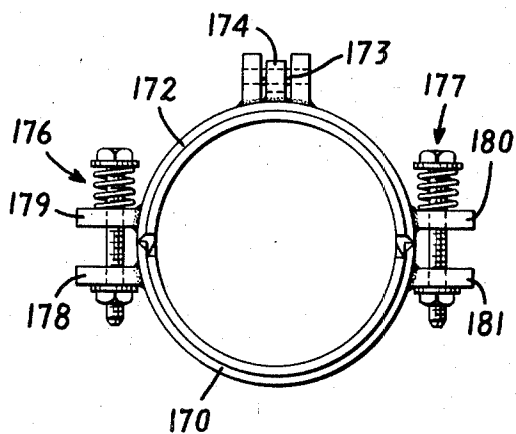
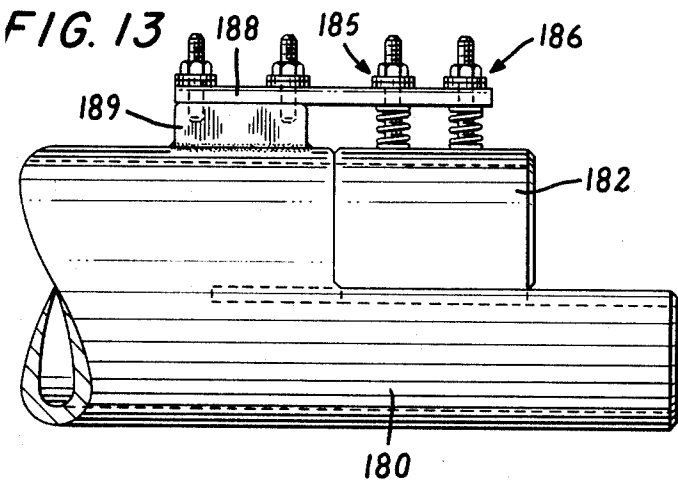
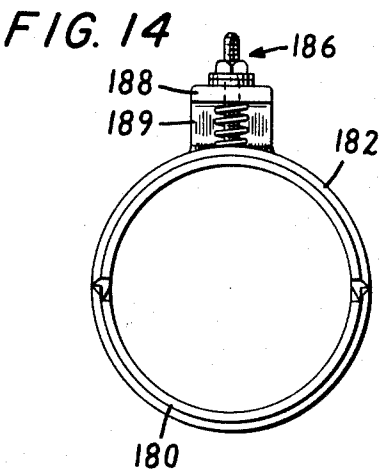
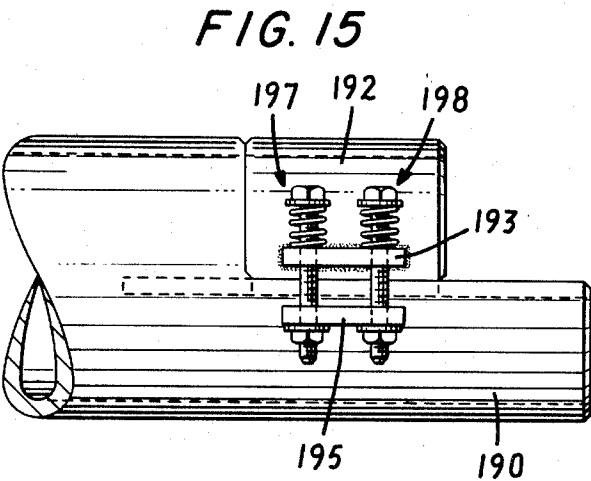
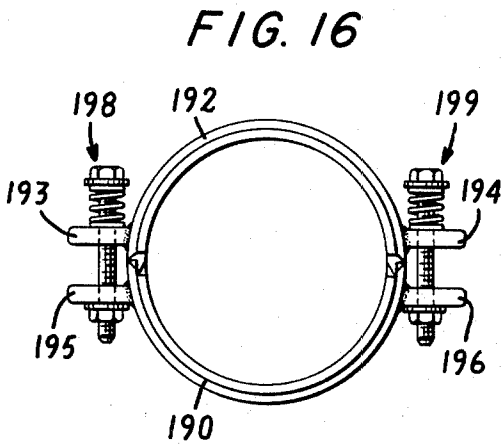
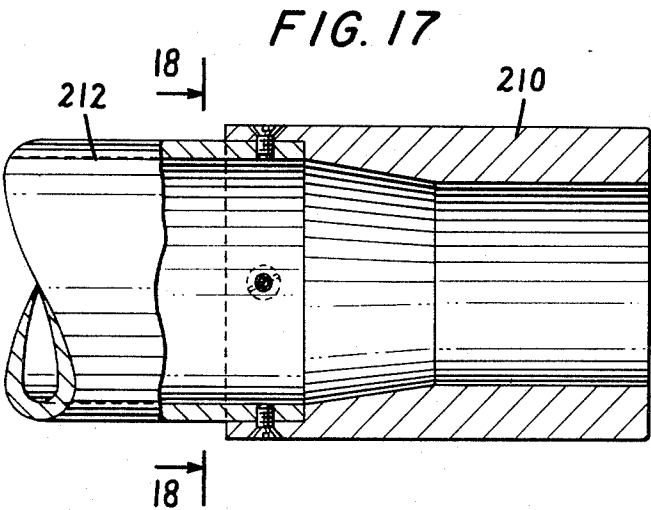
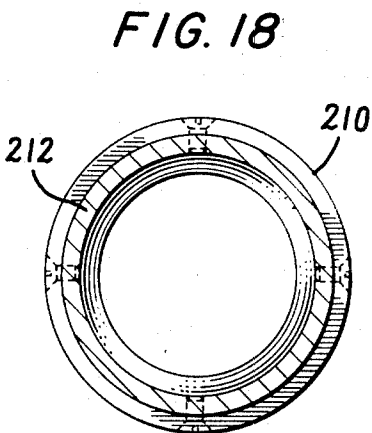


FIG. 12





APPARATUS HAVING AN AUGER-COMPACTER FOR REDUCING THE VOLUME OF WASTE MATERIALS

This invention relates generally to processing of organic and inorganic waste materials and more particularly to a new apparatus for processing waste material or garbage.

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 apparatus for processing waste material improving the 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 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 to the particles and provision must be made for delivering the adhered material eventually to a compacter-extruder.

Known apparatus also use an improved chute in which 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 an extruder-compacter. These known systems are generally hydraulically operated.

It is a principal object of the invention to provide an apparatus for processing garbage to reduce its volume by a mechanical system free of any hydraulically operated devices.

Another object is to provide an auger transport and compacter for reducing the volume of a mixture of organic and inorganic particles randomly mixed.

According to the invention, a hammermill or pulverizer receives waste material to be comminuted and on which are mounted means that break up the material before it passes downwardly to a second stage where cutting hammers 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 hammermill or pulverizer to controllably set the clearance between these plates and the cutting hammers in the second stage of the mill. The comminuted material is discharged centrifugally by a positive air flow developed by the mill. The discharge of pulverized waste material is further facilitated by sweep hammers positioned below the cutting hammers.

The pulverized waste material or garbage is delivered to an auger-compacter that comprises a helical screw mounted rotationally within a tube. The helical screw is constructed so that the angle of friction is such that the screw effects compaction and reduction of volume of the comminuted garbage and discharges the compacted garbage greatly reduced in volume.

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

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

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

FIG. 3 is a side elevation view, on an enlarged scale and partly in section, of an auger-compacter of the apparatus illustrated in FIGS. 1 and 2;

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

FIG. 5 is a cross-section view taken along section line 5—5 of FIG. 3;

FIG. 6 is a fragmentary section view, on an enlarged scale, taken on line 6—6 on the apparatus shown in FIG. 3;

FIG. 7 is a fragmentary side view of another embodiment of a part of an auger-compacter of the type shown in FIG. 3;

FIG. 8 is an end view of an auger-compacter device illustrated in FIG. 7;

FIG. 9 is a fragmentary side view of a third embodiment of an auger-compacter device of the apparatus shown in FIG. 3;

FIG. 10 is an end view of the device shown in FIG. 9;

FIG. 11 is a fragmentary side view of a fourth embodiment of a part of an auger-compacter according to the invention;

FIG. 12 is an end view of the device shown in FIG. 11;

FIG. 13 is a fragmentary side view of a fifth embodiment of a part of an auger-compacter according to the invention;

FIG. 14 is an end view of the device illustrated in FIG. 13;

FIG. 15 is a fragmentary side view of a sixth embodiment of a part of an auger-compacter according to the invention;

FIG. 16 is an end view of the device illustrated in FIG. 15;

FIG. 17 is a fragmentary side view, partly in section, of a nozzle for use on an auger-compacter according to the invention; and

FIG. 18 is a cross-section view taken along section line 18—18 in FIG. 17.

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 organic and inorganic waste. The apparatus compresses the pulverized product to as little as a very small fraction of its original volume extracting excess moisture as hereinafter described and the end product or output is a compressed, relatively dry waste. While the apparatus will be described for processing garbage and waste of the above-described type, it will be understood by those skilled in the art that other waste materials may be similarly processed by the apparatus of the invention.

Apparatus according to the invention comprises a motorized inclined conveyor 10 (FIG. 2) for receiving garbage or 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 auger-compacter 16 that greatly reduces the volume of the comminuted material and discharges it as a dry output. 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 transport 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 is in communication therewith a chute or hopper 27 defining an upper connector to the reduction mill or pulverizer 12.

Apparatus according to the invention comprises a hammermill consisting of a tub 28 within which is mounted a flow control plate 29 connected to a rotor spindle 30 mounted on lower bearings 32 and upper bearings, not shown, 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. 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 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 50a coated with tungsten carbide or similar hard-faced material to reduce wear. The sweeper hammers 55 are provided with a plate 55a coated with hardening material 55b 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 61a, 60a 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. A second stage of the hammermill or pulverizer is the space where the cutting hammers driven by centrifugal force, as the flow control plate rotates, reduce the material to comminuted material and the rotationally driven sweep hammers centrifugally discharge the comminuted waste material through centrifugal force outwardly through a discharge conduit 63 tangentially disposed relative to the path of the sweep 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 of the particles may be controlled and any wear of the hammers compensated so that the set clearance is maintained for maintaining the proper particle size to which the waste is reduced or comminuted.

The driven cutting hammers and sweep hammers develop an air flow through the outlet connection 63 through which the comminuted material is discharged. The reduced or comminuted material is discharged into the feed chute and moves downwardly to the auger-compacter 16 as illustrated by the directional arrows in FIG. 4. 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 pro-

vided 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 a dry output as later described.

The auger-compacter 16 comprises a base 90 on which is mounted the feed chute 14 which is in communication with a compacter, a tube 93 in which is enclosed a helical screw 95 to which the comminuted particles are delivered through the feed chute. The helical screw is driven from a motor 96 through a chain-reduction drive 97. The auger-compacter is provided with a thrust bearing 98 receiving the axial thrust of the helical screw 93. The comminuted particles enter the feed chute 14 which is in communication with the tube upstream of an outlet 93b and are advanced axially through the tube where compaction takes place, as later described, greatly reducing in volume the mixture of particles of organic and inorganic materials.

As the particles of garbage are advanced axially through the tube 93, the particles pass through a transition zone in the tube in which each particle is pushed at an effective angle of friction, for example 55.3°, because of the angle of the screw and the friction. It is necessary for the particles to slide against the screw in order to be compacted. It has been found that a coefficient of friction of the particles of at least 1.73 and/or angle of friction of 55.3° is required to compact the matter in a garbage mixture which is composed both of organic and inorganic material. If the angle is less, as it is for example in the center of the screw, and perhaps because various materials are involved, slippage occurs and as soon as there is slippage within the compaction zone the "plug" of compacted material will overheat rapidly, which may cause jamming. A groove or two grooves 14a may be made on the upper side of the compaction tube to keep the "plug" from rotating. However, the principal compaction takes place at the downstream end of the screw closest to the outlet of the compaction tube or auger-compacter. In order to improve the compaction, it has been found that if the flight of the screw nearest the outlet end of the tube is constructed as illustrated in FIGS. 5-7, as a "cut flight", the apparatus will operate better, as later described.

The compacter screw 95 has a flight 110 "cut" or terminating as illustrated in FIGS. 3 and 6 and has two radial plates or blades 112, 113, of about two inches in width or axial extent, that are disposed substantially parallel to the longitudinal axis of the shaft 95a of the compacter helical screw 95 and have a radial extent corresponding substantially to the diameter of the individual flights of the compacter screw 95. The two radial blades are disposed coaxially and are both in a common plane passing through a diameter of the screw and substantially constitute an axial extension of the "cut flight" 110.

Two other plates or blades 115, 116 are fixed on a reduced diameter 95b of the shaft 95a. The latter plates have a radial dimension such that their radial extent is equal to that of the other two radial blades and the diameter of the flights. These two blades are disposed

transversely of the longitudinal axis and are offset about $\frac{1}{4}$ inch to a common plane transverse and normal to the longitudinal axis of the helical screw so that they are disposed offset to each other on opposite radii of the screw. These plates are disposed next to the downstream end of the first-mentioned plates 112, 113 which are parallel to the axis of the helical screw. The transverse plates 115, 116 are of about the same width, about three inches wide transversely of the screw axis, and are each disposed transverse and next to a downstream end of a respective one of the parallel radial blades 112, 113. The transverse transverse end blades are each offset in opposite directions relative to the plane in which the parallel plates 112, 113 are disposed so that the tube is not closed off, as can be seen in FIG. 5.

In order to effect compaction, the length of the tube downstream of the compacting screw must be sufficiently long to provide enough of a "restriction" to the "plug" of material developed downstream of the helical screw in order to obtain good compaction ratios. If it is desired to obtain the same compaction with a shorter tube, it has been found that the screw must either be constructed of hardened steel so that it does not wear excessively or a restriction may be provided as later described. Moreover, if the tube is provided as a solid tube, the length of the compacter tube, if too great, will cause jamming downstream of the screw because of excessive swelling of the "plug" of material developed downstream of the screw.

The principle relied on in the invention is that compressibility and the coefficient of friction of the materials involved, as well as the angular friction, permit the compaction required. However, the compressibility and coefficient of friction of these materials can vary considerably, for example moisture can influence the friction factor greatly, and in order to compensate for these variables, a "nozzle" of variable cross-section area is provided in the invention. This nozzle automatically changes its area of cross-section to compensate for changes in physical properties of the "plug" and avoids jamming of the tube in the event that the compacted material swells.

The variable cross-section changes and construction of the nozzle are illustrated as various embodiments in the drawings. A first embodiment is illustrated in FIG. 3 in which the nozzle is constructed as a "latch" made of a plurality of lids or sections 120, 121, 122 movable radially outwardly relative to the longitudinal axis of the tube. Each lid section of the tube is provided with outwardly extending flanges 125, 126 on opposite sides thereof. The lower part of the tube is provided with outwardly extending lugs 128, 129 spaced axially and aligned with the respective flanges of the lids for mounting variably adjustable means, for example spring-loaded bolt assemblies 131, 132. Each of the spring-loaded bolt assemblies will allow the respective lids or sections to move upwardly and substantially radially of the corresponding lower section of the tube. Guides 135, 136, 137, 138 are provided axially spaced and paired on opposite sides of the lower part of the tube to guide the radial movement upwardly allowing the individual sections or lids to compensate for any expansion or swelling of the compacted material. It can thus be seen that the lids can be variably adjusted to in

effect provide a device for precluding jamming of the material downstream of the screw and in effect provide a variable packer lid arrangement or automatically variable nozzle or latch having a minimum cross-section area changing in an increasing direction depending upon the adjustments set on the spring-loaded assemblies of the individual lids. This device will relieve the tensions in the compacted material.

A packer lid variation is illustrated in FIGS. 7 and 8 in which a single lid 144 is constructed as a latch arrangement. A tube 145 has the upper hemispherical part thereof removed, as illustrated, and the single, hemispherical lid section 144 is secured to the lower hemispherical section of the tube and pivotally mounted thereto by a hinge 147. The lower part of the tube is provided with a lug 148 which is in registry with an outwardly extending lug or flange 150 on the movable lid section. Two variably adjustable spring-loaded bolt assemblies 152, 153 are provided so that the single lid section 144 will be allowed to "swing" so that in the event of excessive internal pressure on the lid 144 it will move outwardly sufficiently to preclude jamming of the screw and tube due to the "plug" of compacted material being "frozen" in the tube 145. The increase in cross-section of the tube allowed by the pivotally mounted lid or section 144 is sufficient to compensate for swelling that may take place in the "plug" of compacted material without any compacted material being allowed to escape between the lid and tube. The tube and lid section are constructed as shown in FIG. 8 along the length of their cooperating surfaces to that a longitudinal seam 144a is formed and compacted material cannot escape as the lid 144 moves pivotally relative to the tube. Moreover, an axial groove 144b formed along the length of the nozzle will maintain the "plug" of compacted material from rotating so that it only moves axially, thus reducing heating of the "plug" and its consequent expansion. The other embodiments of this variable nozzle are similarly constructed.

Another embodiment of a variable nozzle or lid construction is illustrated in FIGS. 9 and 10 in which a single lid 160 is pivotally mounted by a hinge 162 on a compacter tube 164. A spring-loaded bolt assembly 165 is pivotally mounted on a lug 166 on the tube and an upper lug 167 on the lid 160. The upper lug is constructed with a slot so that the bolt 165a can swing through the slot into position, clamping the lid in a closed position so that it completes the discharge end of the tube. A hand knob 165b is provided for manually adjusting the pressure applied to a spring 165c for controllably setting the pressure at which the lid will tend to open in response to any expansion of the "plug" of material within the outlet end of the tube.

A fourth embodiment of a packer lid or automatically variable nozzle arrangement for a compacter tube is illustrated in FIGS. 11 and 12. This embodiment, like the two embodiments last described and two later herein described, has a compacter tube notched at the discharge or outlet end so that a lower part thereof functions as a "tray" on which is mounted an automatically compensating packer lid. In this embodiment, a compacter tube 170 is provided with a single lid 172 pivotally mounted on a pivot 173 on the tube by an arm 174, as illustrated. The lid will move upwardly in response to internal pressure of the compacted materi-

al. The pivot 173 is disposed on a focal point such that as the latch opens in response to internal pressure the internal diameter is not reduced and the upstream end of the lid or section 172 does not offer an obstruction in the path of the compacted material as the latch or nozzle "opens".

In order to determine the extent of upward movement of the lid 172 and the internal pressure at which this movement is permitted, provision is made for variably setting these parameters with two pairs of spring-loaded bolt assemblies 175, 176, 177 on opposite sides of the compacter tube. These bolt assemblies are mounted on lugs or flanges 178-181, as illustrated.

The compacter packer lid can be constructed with a cantilevered support and adjust spring-loaded bolts as shown in FIGS. 13 and 14. In this embodiment, a compacter tube 180 is provided with a section 182 which is movable upwardly and downwardly under control of two spring-loaded bolt assemblies 185, 186 secured to the lid. The spring-loaded bolts are axially guided by a bracket or lever 188 bolted or otherwise secured on a lug 189 on the compacter tube 180.

A construction of a packer lid using spring-loaded bolt assemblies, as in the embodiment in FIG. 11, is illustrated in FIGS. 15, 16. In this construction, a compacter tube 190 has a movable section or lid 192 downstream of a helical screw, not shown, in the manner of the apparatus first described and all the others. The lid 192 is provided with lugs 193, 194 on opposite sides aligned with other lugs 195, 196 on the compacter screw. Spring-loaded bolts 197-199 paired on opposite sides allow the upper lugs 193, 194 to move relative thereto so that the springs of the bolt assemblies adjustably control the internal pressure, and the extent of movement, at which the lid 192 will move upwardly in response to internal pressure developed by the compacted waste material within this portion of the compacter tube.

The variable nozzles or latches described above relieve the internal tension of the compacted material and still maintain a good compaction ratio. This provision avoids jamming; however, provision may be made for electrically protecting the apparatus in the event the compacter screw freezes or becomes jammed because of its inability to advance the "plug" of compacted material.

The apparatus above described requires resistance to the particles of material for compacting. Compaction takes place in the screw and the desired compaction can be accomplished solely by the screw without the two sets of blades 112-116 described above. In order to provide resistance to the material, the tube should extend at least about four inches downstream of the compacter screw blades. The portion of compacter tube between the downstream end of the compacter screw and upstream of the automatically variable nozzle is about four inches. However, the use of the two sets of compacting blades improves the compaction ratio. The transverse blades 115, 116 develop only axial forces that greatly compact the material in the four inch length of tube downstream of the compacter screw and upstream of the nozzle or latch arrangement. This is in contrast to compacting solely with the screw where radial forces are developed that are lost energy to the principal compaction function.

A "starting nozzle" 210 as above described is connected to a compacter tube 212. The starting nozzle has a length whose inner diameter reduces the inner diameter of the compacter tube 212 by about twenty percent. For example, if the inner diameter of the compacter tube 212 is 10 inches, the diameter of the outlet of the fixed nozzle is 8 inches. The resistance offered to the waste material is sufficient to cause the apparatus to function without temporarily blanking off the outlet as described above. This fixed nozzle can be used in conjunction with the variable nozzle arrangement or without such an arrangement.

The construction described above provides an apparatus free of hydraulic systems and their attendant problems. This construction requires considerably less power in effecting compaction than the known systems. For example, a 7.5 H.P. electric motor rotating at 87 1/2 R.P.M. geared down in a 9.66 : 1 gear reduction to 84 1/2 R.P.M. drives a 24 : 48 sprocket ratio drive so that a compacter screw having 9 inch diameter flights develops 1820 lbs. of thrust and will have a cubic foot displacement of 24.9³ F.M. with a desirable compaction ratio.

What we claim and desire to secure by letters patent is:

1. An auger-compacter for compacting organic and inorganic waste particles randomly mixed, comprising, a tubular member, a driven auger-compacter screw disposed axially in said tubular member, having helices and a downstream end flight having a sector removed therefrom for compacting said waste particles in said tubular member, a pair of diametrically disposed blades disposed parallel to the longitudinal axis of said compacter screw extending radially of said compacter screw axis and next adjacent axially to said downstream end flight, and a pair of transverse blades transverse to the longitudinal axis of said compacter screw adjacent said parallel blades and disposed offset relative to a common plane transverse and normal to said axis, said transverse blades being disposed axially spaced from said end flight with said parallel blades intermediate said end flight and said transverse blades.

2. An auger-compacter for compacting organic and inorganic waste particles randomly mixed according to claim 1, comprising, means to receive particles of comminuted waste organic and inorganic materials for delivery to said screw, said screw having a length thereof disposed in the last-mentioned means.

3. An auger-compacter for compacting organic and inorganic waste particles randomly mixed according to claim 1, in which each of said blades has a radial extent corresponding to the radii of flight of said screw.

4. An auger-compacter for compacting organic and inorganic waste particles randomly mixed according to claim 1, in which said helices have a similar pitch.

5. An auger-compacter for compacting organic and inorganic waste particles randomly mixed according to claim 1, including a length of said tubular member cooperative with said compacter screw having axial grooves to reduce any tendency of a plug of compacted waste material to move rotationally while advancing axially in said tubular member.

6. An auger-compacter for compacting organic and inorganic waste particles randomly mixed according to claim 1, in which said axial grooves are spaced in a circumferential direction and are downstream of said compacter screw.

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