United States Patent [19]

Benson

[11] **3,873,035**

[45] **Mar. 25, 1975**

[54] **APPARATUS FOR TREATING WASTE MATERIAL**

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[52] **U.S. Cl.** **241/100,** 241/190, 241/241

[51] **Int. Cl.** **B02c 13/09**

[58] **Field of Search** ..... 241/189 R, 190, 226, 241, 241/99, 100

[56] **References Cited**

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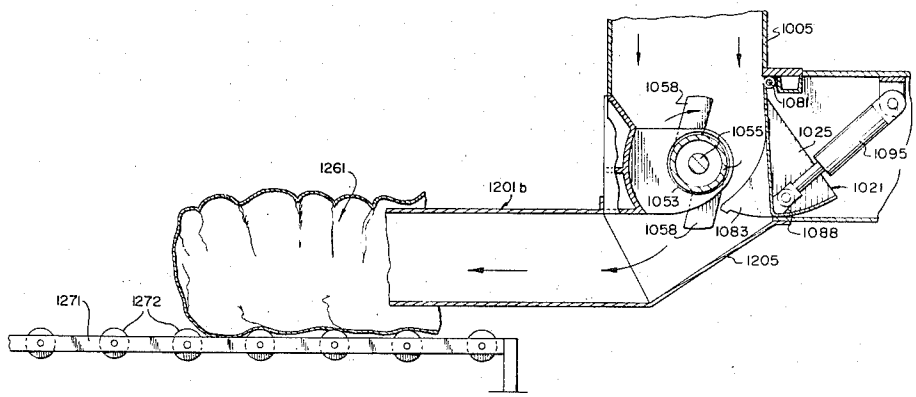
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Primary Examiner—Roy Lake
Assistant Examiner—E. F. Desmond
Attorney, Agent, or Firm—Watson, Cole, Grindle & Watson

[57] **ABSTRACT**

An apparatus is provided for treating garbage and trash so that it may be reduced to compact form in bags, blocks or otherwise. A breaking drum has check plates and several rows of teeth which mesh with tooth-like elements of an anvil. An electrical overload device and a movable anvil mounting are provided for overload protection. The apparatus directs treated material in a generally sideways direction to compact it in a receptacle.

3 Claims, 22 Drawing Figures



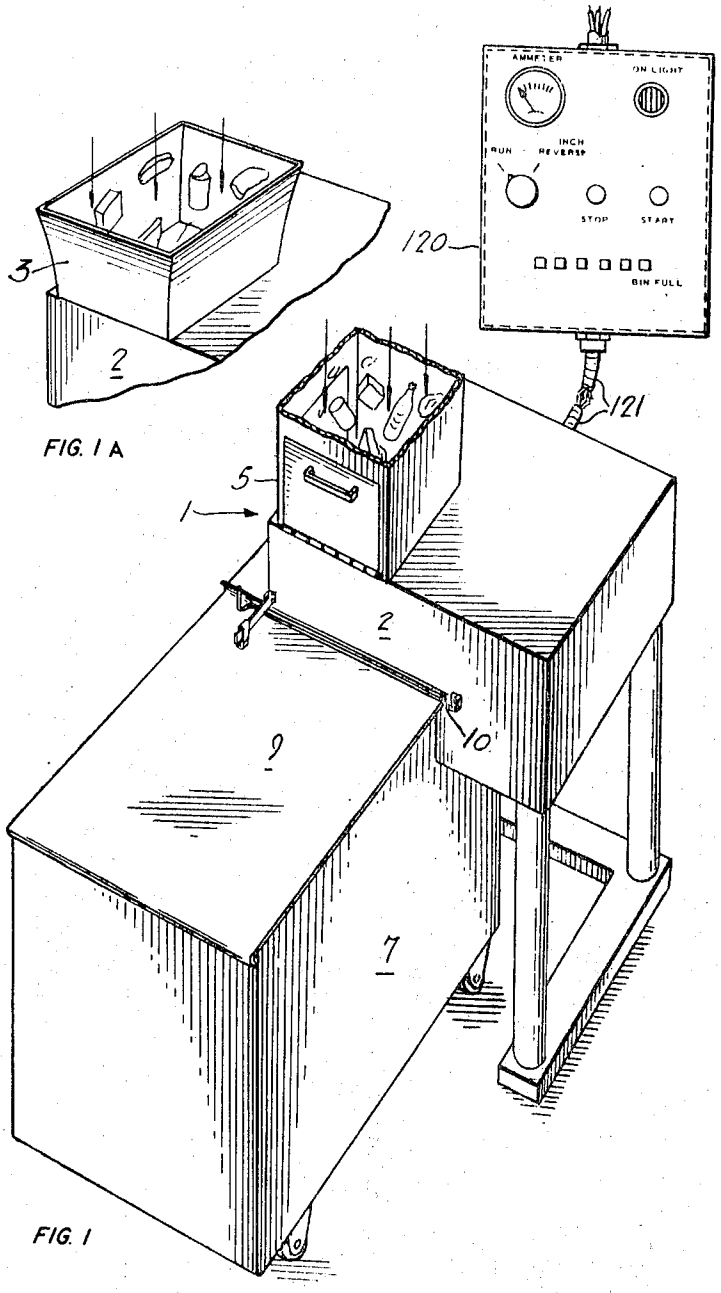

AMMETER
ON LIGHT
RUN
INCH
REVERSE
STOP
START
BIN FULL
120
121
3
2
5
1
2
9
10
7

FIG. 1 A

FIG. 1

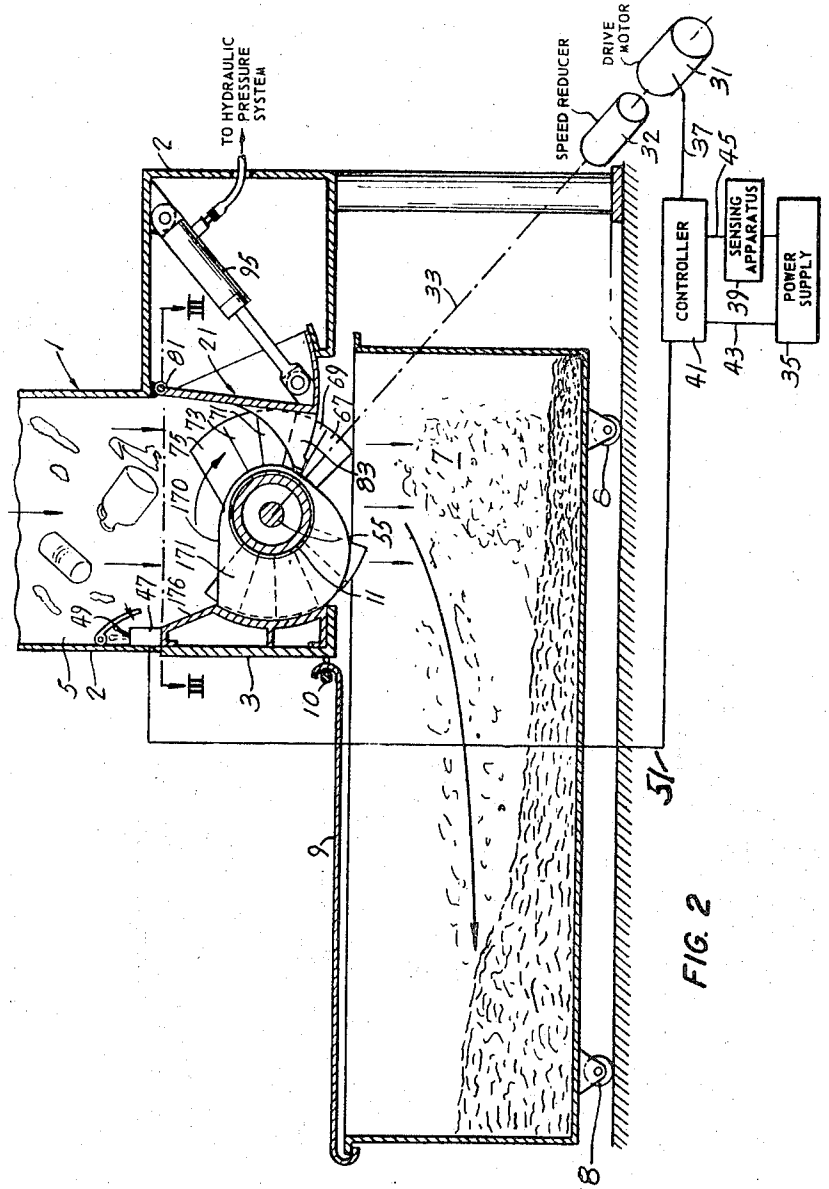

TO HYDRAULIC PRESSURE SYSTEM
SPEED REDUCER
DRIVE MOTOR
CONTROLLER
SENSING APPARATUS
POWER SUPPLY
1
2
3
5
6
8
9
10
11
21
31
32
33
35
37
39
41
43
45
47
49
51
55
61
67
69
73
75
83
95
116
170
171
III
III

FIG. 2

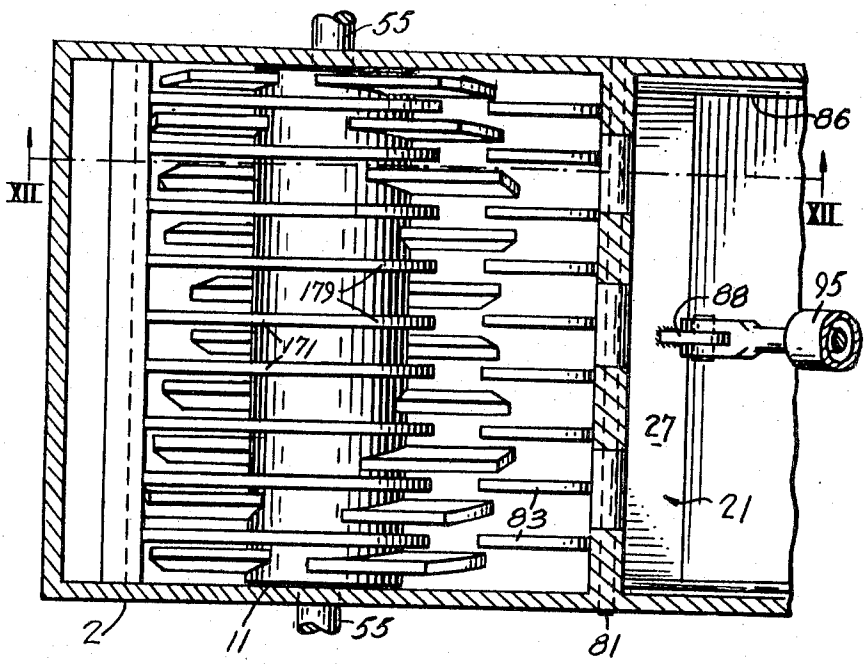

55
86
XII
XII
179
171
88
95
27
21
83
2
11
55
81

FIG. 3

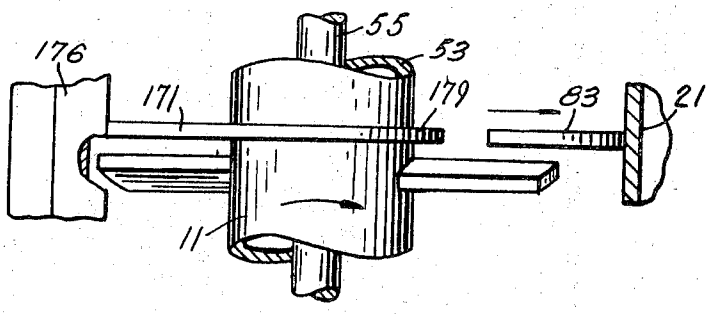

176
55
53
171
179
83
21
11

FIG. 4

FIG. 5

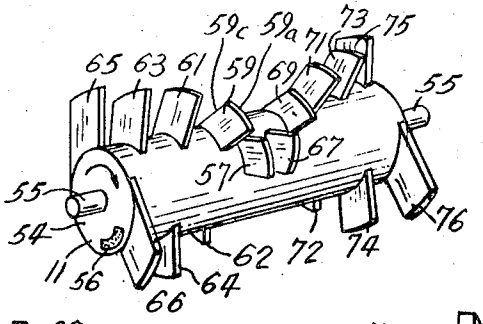


FIG. 6

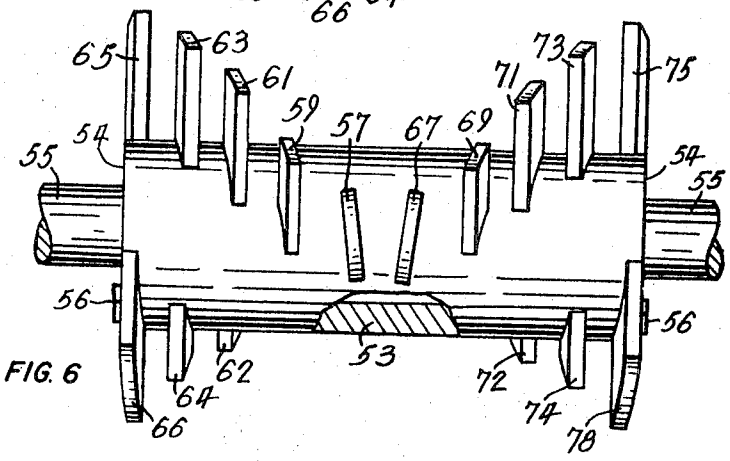
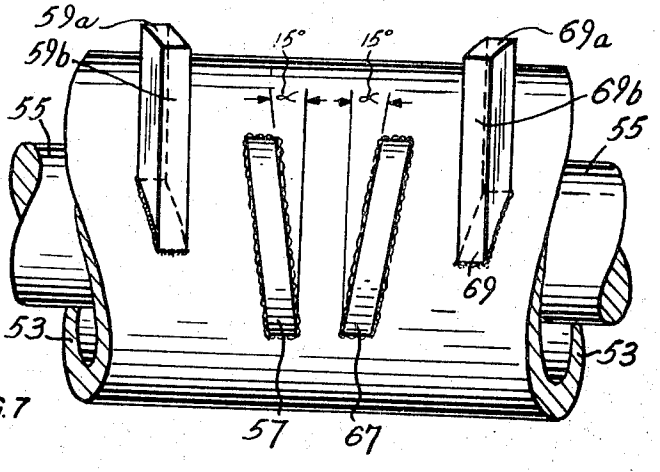


FIG. 7



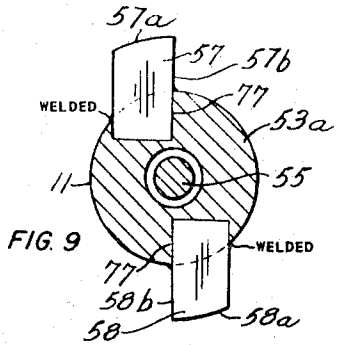


FIG. 9

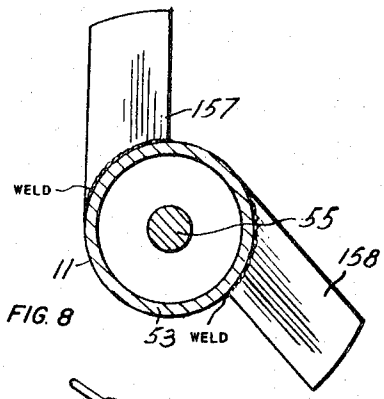


FIG. 8

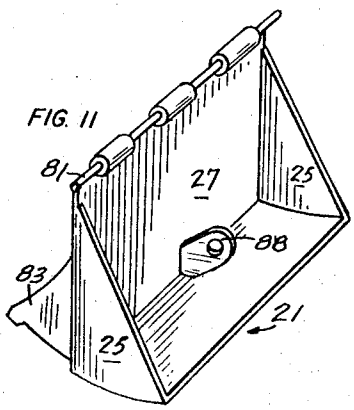


FIG. 11

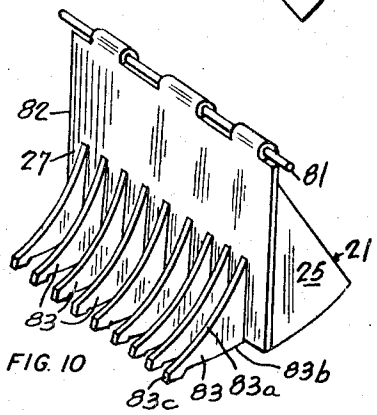


FIG. 10

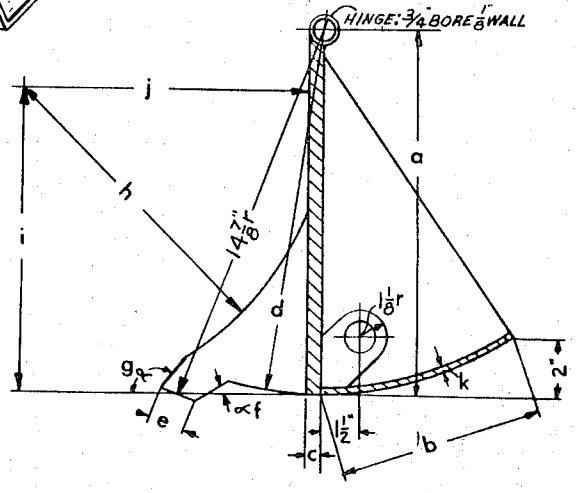


FIG. 11A

FIG. 12

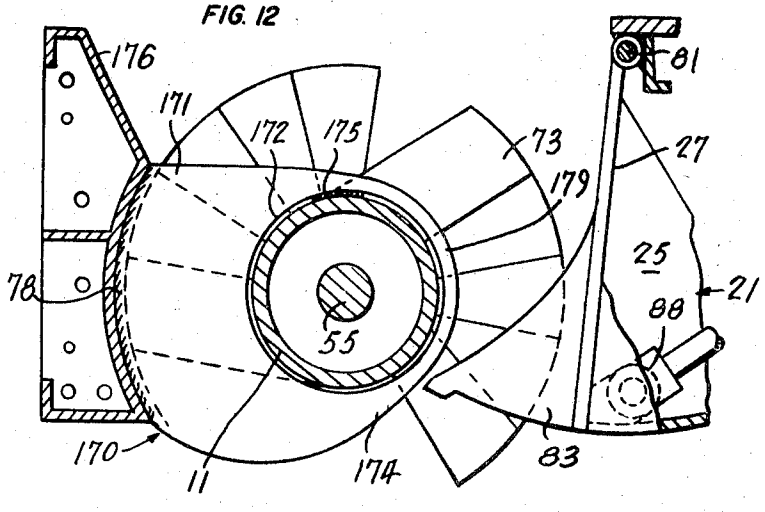
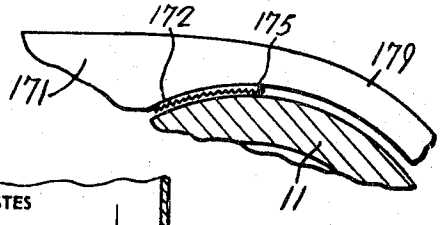


FIG. 12A



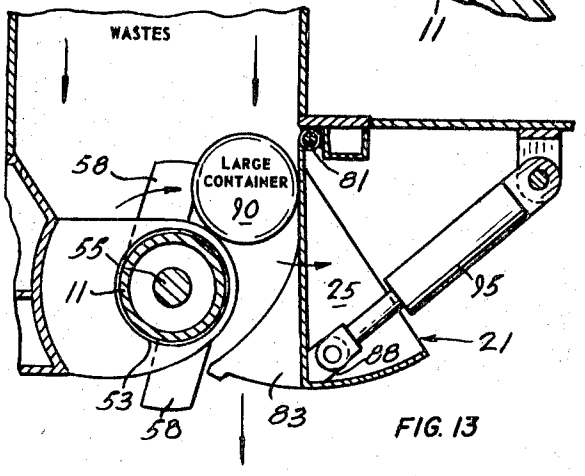


FIG. 13

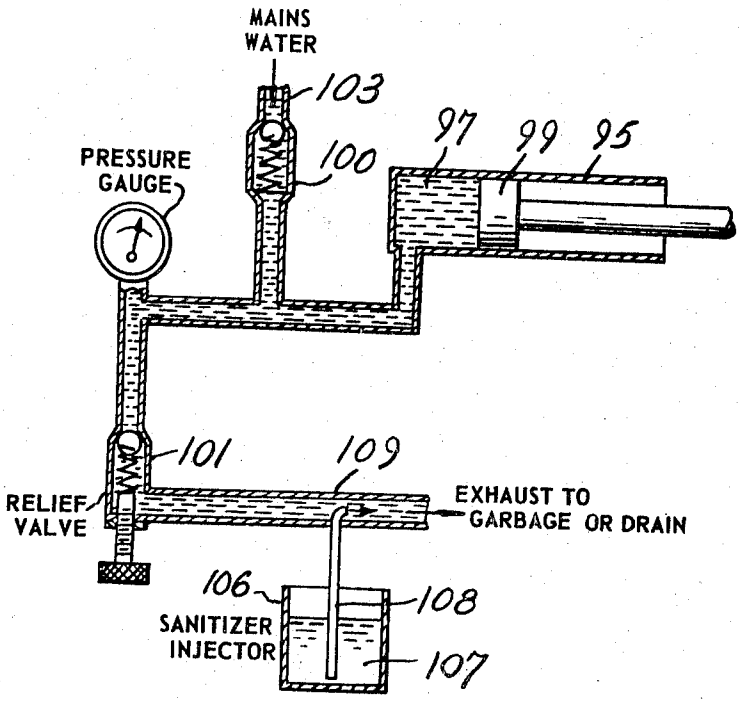

MAINS
WATER
103
100
97
99
95
PRESSURE
GAUGE
101
109
RELIEF
VALVE
EXHAUST TO
GARBAGE OR DRAIN
106
108
SANITIZER
INJECTOR
107

FIG. 14

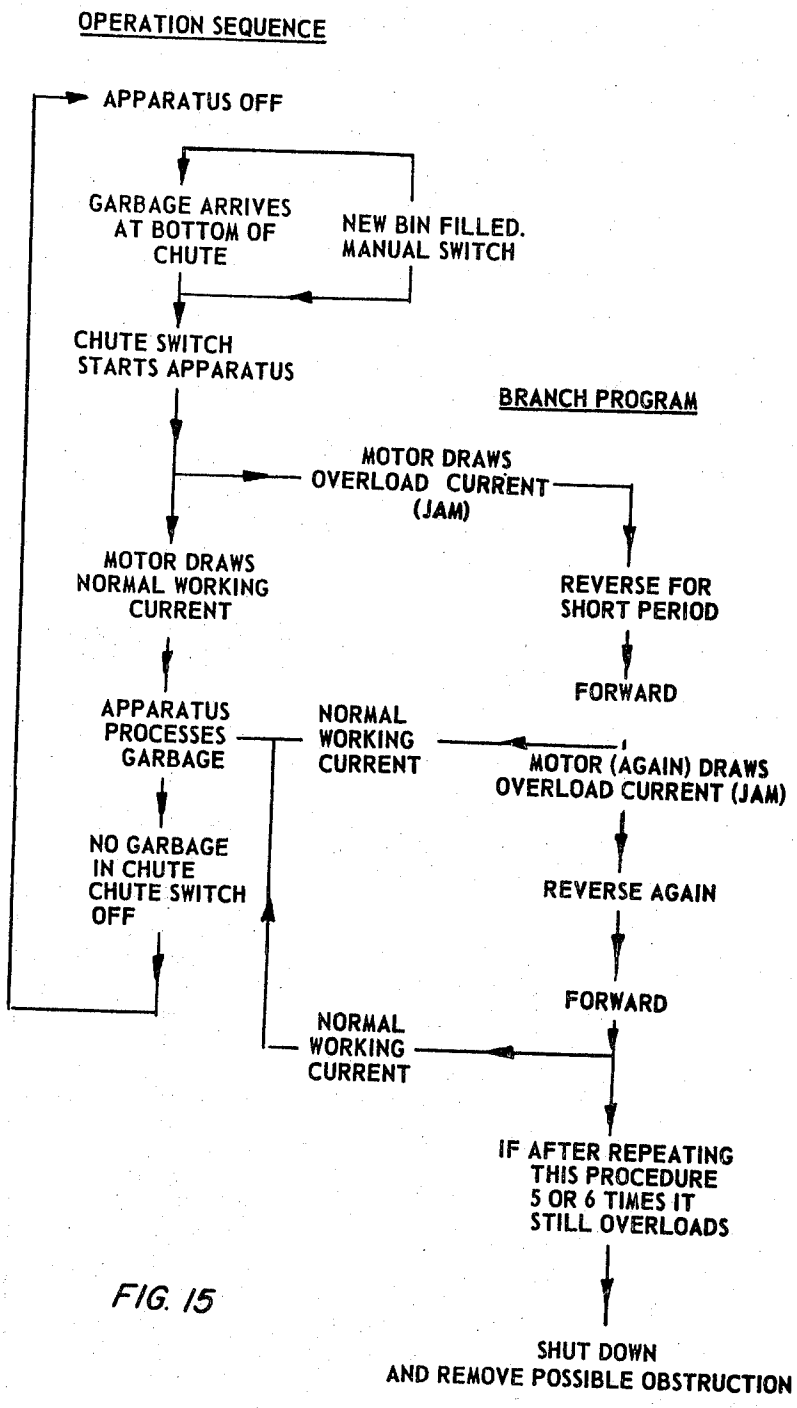

OPERATION SEQUENCE
APPARATUS OFF
GARBAGE ARRIVES AT BOTTOM OF CHUTE
NEW BIN FILLED. MANUAL SWITCH
CHUTE SWITCH STARTS APPARATUS
BRANCH PROGRAM
MOTOR DRAWS OVERLOAD CURRENT (JAM)
MOTOR DRAWS NORMAL WORKING CURRENT
REVERSE FOR SHORT PERIOD
FORWARD
APPARATUS PROCESSES GARBAGE
NORMAL WORKING CURRENT
MOTOR (AGAIN) DRAWS OVERLOAD CURRENT (JAM)
NO GARBAGE IN CHUTE CHUTE SWITCH OFF
REVERSE AGAIN
FORWARD
NORMAL WORKING CURRENT
IF AFTER REPEATING THIS PROCEDURE 5 OR 6 TIMES IT STILL OVERLOADS
SHUT DOWN AND REMOVE POSSIBLE OBSTRUCTION

FIG. 15

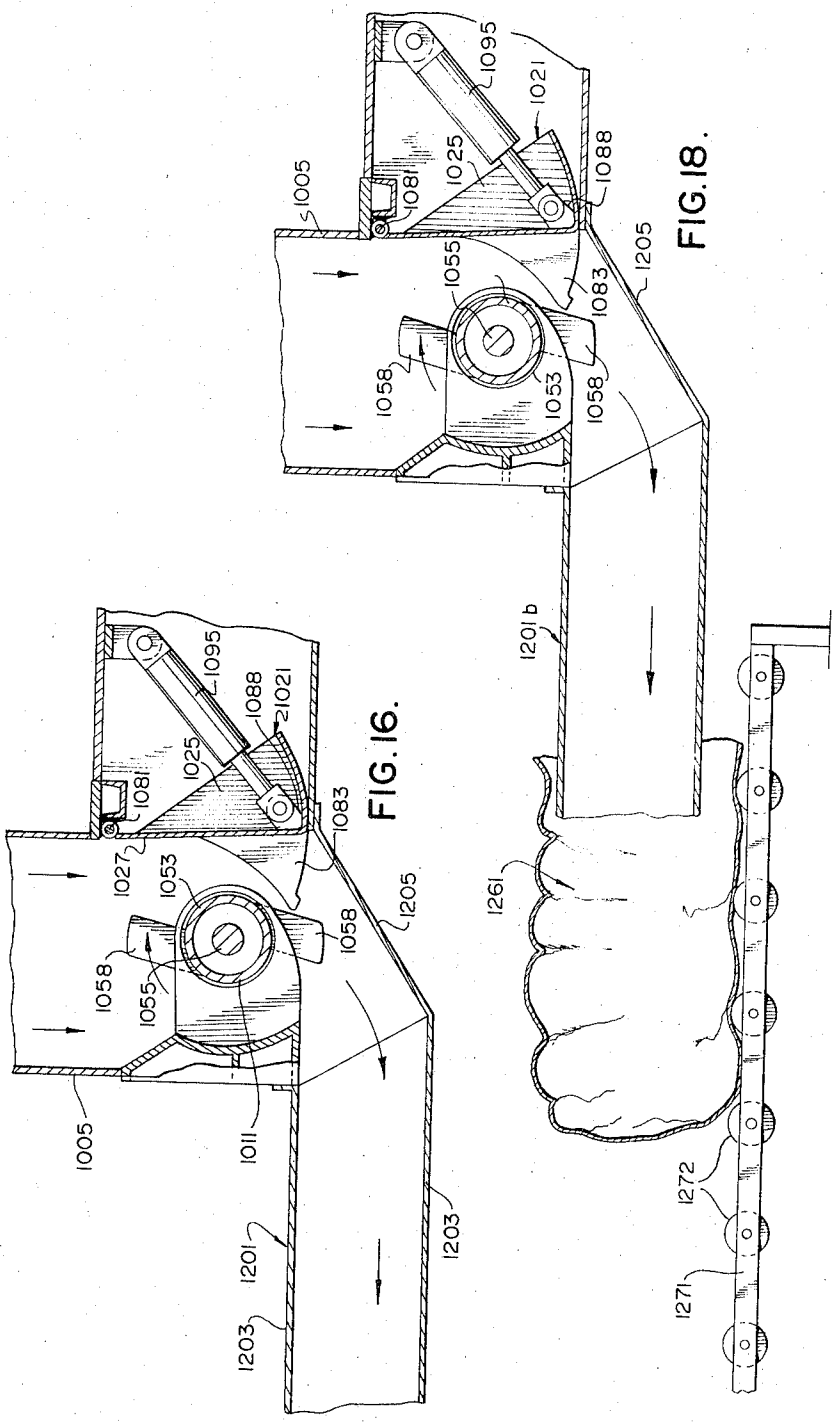

1095
1021
1088
1025
1081
1005
1055
1083
1205
1058
1053
1058
1201b
1261
1272
1271
1095
1021
1088
1025
1081
1083
1027
1053
1205
1058
1058
1055
1005
1011
1201
1203
1203

FIG. 18.

FIG. 16.

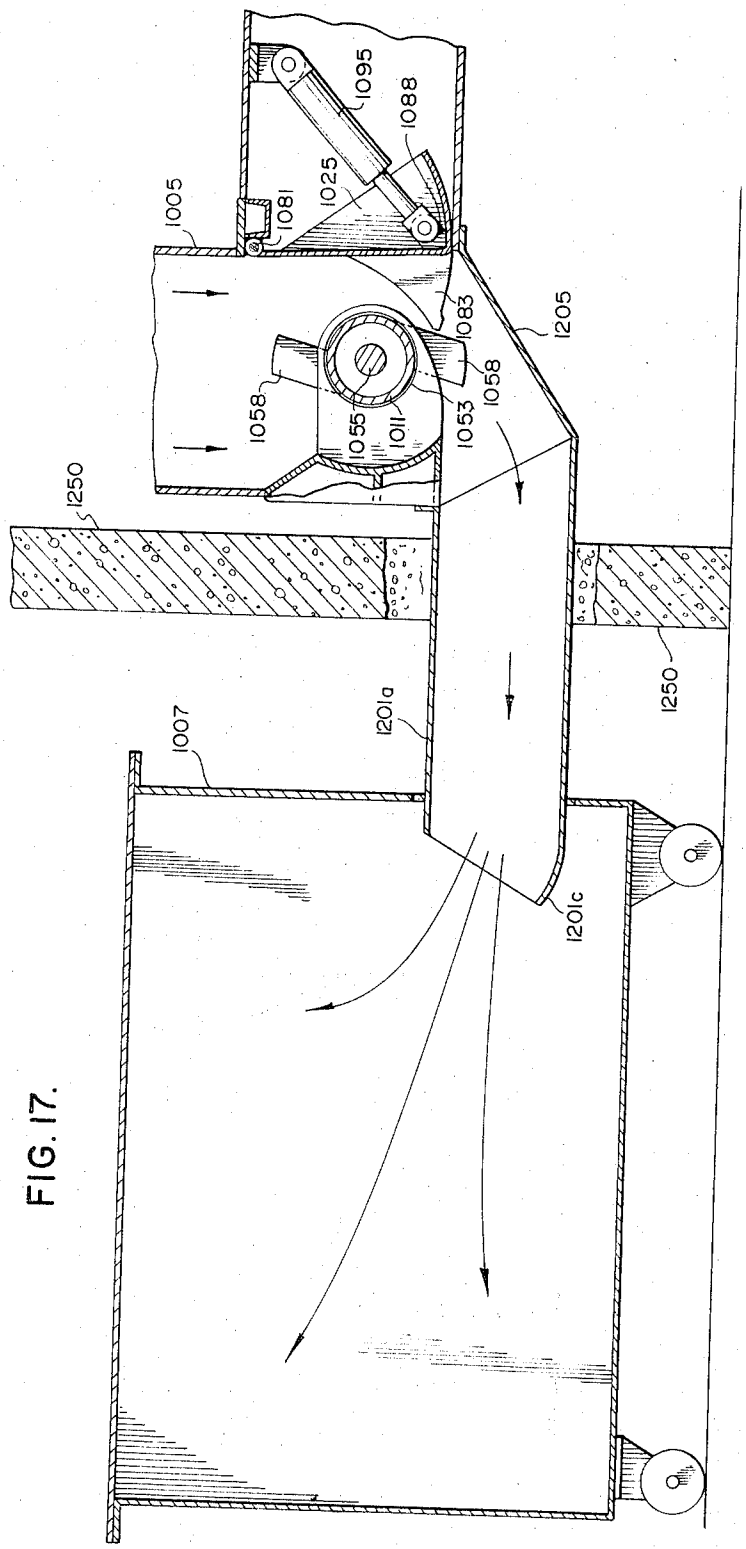

1095
1088
1025
1081
1005
1083
1205
1058
1053
1011
1055
1058
1250
1250
1007
1201a
1201c

FIG. 17.

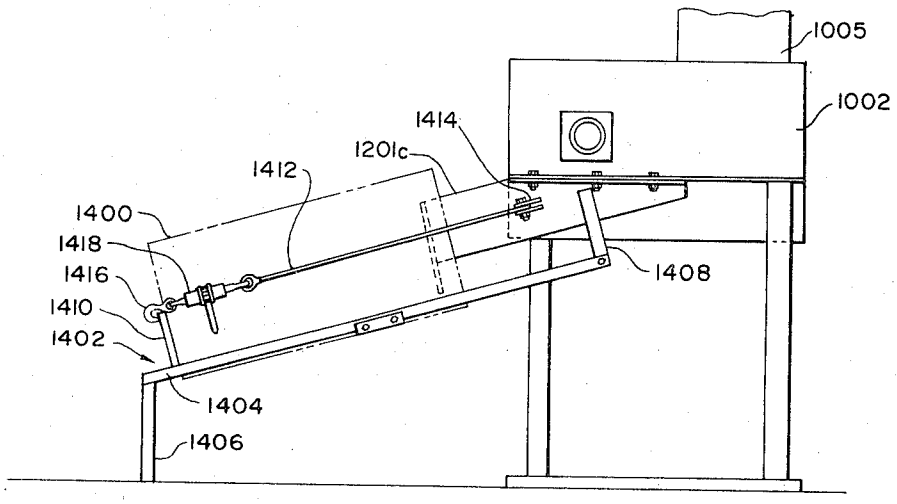

1005
1002
1414
1201c
1412
1400
1418
1416
1410
1402
1408
1404
1406

FIG. 19

APPARATUS FOR TREATING WASTE MATERIAL

This invention relates to apparatus for treating waste material, particularly garbage and trash of the kind normally collected and disposed of by the city and garbage disposal authorities or processed for re-cycling or reclaimation.

One of the very considerable problems relating to garbage disposal is the volume occupied by waste material of this kind. The large volume of course results from the fact that much trash of this nature consists of empty containers such as bottles and cans which occupy much space unless properly broken up. Much other garbage material also has considerable volume and this means that the disposal operation has to contend with very considerable bulk of material.

It is a principal object of this invention to effectively compact waste material such that in its compacted form it may be more economically disposed of whether this be in conventional land fill, incineration or as the main ingredient in building block production.

A further object is to provide means for effectively compacting waste material with a minimum of attention and handling by adaptation of automatic devices suitable for this purpose.

The aforesaid object of achieving the desired result with a minimum of attention is accomplished by providing features which largely prevent serious jams from occurring.

Other objects and advantages will be apparent from the present specification and drawings and from the appended claims.

The preferred embodiment of the invention disclosed herein may be described as a garbage treating apparatus comprising: a rotatable low speed high-torque power driven breaking drum, cooperating anvil, cooperating check means and cooperating substantially horizontally-acting discharge means, the rotatable breaking drum being provided with a series of teeth mounted on the drum and spaced along the drum. The anvil is of general crescent shape and downwardly depending so as to extend partly under the breaking drum and is moveably mounted so as to be able to move away from the breaking drum temporarily in order to pass large incompressible objects through the apparatus and then return to the initial anvil position. The check means consist of a number of parallel check plates mounted on the frame of the apparatus and placed in close proximity to the breaking drum between the teeth spaced along the drum. Motive power means is provided for driving the breaking drum and means is connected through the motive power means for detecting a serious overload and to thereupon cause the apparatus to execute a predetermined series of steps such as: stop, reverse, restart, and if a serious overload still remains a repeat of the said stop, reverse and restart cycle; repeat the aforesaid several times; and if the said overload still exists shutting down the machine.

The invention will now be described with reference to the accompanying drawings, wherein,

FIG. 1 shows an oblique three-quarters view illustrating a practical form of a preferred embodiment of the present invention;

FIG. 1A shows a fragmentary representation of an alternative form of the top portion of the apparatus shown in FIG. 1 to indicate the difference of construction where hopper feeding rather than chute feeding of the apparatus is used;

FIG. 2 shows a partly cross-sectioned and partly schematic side elevation view of the embodiment of the invention shown in FIG. 1 as seen looking from the right-hand side of center in FIG. 1;

FIG. 3 shows a fragmentary partly cross-sectional view as seen at III—III in FIG. 2 to illustrate the relative position of the breaking drum, anvil and check means to be described in greater detail below;

FIG. 4 shows an enlarged fragmentary view of the central region of FIG. 3 in order to more clearly illustrate the structure shown therein;

FIGS. 5, 6 and 7 show the breaking drum which is an important feature of the present invention, FIG. 5 being a three-quarters oblique view of the breaking drum, FIG. 6 a side elevation view as seen from the right-hand side in FIG. 5, and FIG. 7 a fragmentary enlarged partly cross-sectioned view of the central region of FIG. 6 in order to more clearly illustrate the structure;

FIG. 8 shows a "slice" cross-sectional view of a preferred form of the breaking drum particularly illustrated in FIGS. 5, 6 and 7;

FIG. 9 shows a "slice" cross-sectional view of an alternative form of the breaking drum 11;

FIG. 10 and 11 show oblique three-quarters views of the anvil which is an important feature of the present invention, FIG. 10, showing the working face of the anvil which is positioned adjacent the breaking drum, and FIG. 11 is a similar view, but turned clockwise from the position of FIG. 10 to show the rear face of the anvil;

FIG. 11a is a vertical medial cross-sectional view of the anvil shown in FIGS. 10 and 11 to disclose the design characteristics thereof;

FIG. 12 shows a fragmentary partly cross-sectioned elevation view as seen at XII—XII in FIG. 3, to effectively illustrate the check means which is an important feature of the present invention;

FIG. 12A shows a fragmentary enlarged view of a part of the apparatus illustrated in FIG. 12 to better illustrate its construction;

FIG. 13 shows a fragmentary partly cross-sectional view of certain of the important components shown in the preceeding figures to better illustrate the function of the apparatus when handling objects of large size such as large bottles;

FIG. 14 shows in typical form the components whereby the proper position of the breaking drum and anvil shown in the foregoing figures may be maintained, and indicates the manner of operation in connection therewith;

FIG. 15 shows a function chart indicating the manner in which the previously-referred to apparatus typically operates;

FIG. 16 illustrates an alternative construction of the apparatus already described to provide for discharge of the processed material in a substantially sideways direction; and

FIGS. 17, 18 and 19 illustrate specific uses of the alternative construction referred to in FIG. 16.

The apparatus shown in the foregoing figures in which the same reference numerals denote like parts will now be described in further detail. The foregoing figures are by way of example only, and for the precise

scope of the invention reference should be made to the appended claims.

With particular reference at the outset to FIG. 1, the waste compacting apparatus of the present invention is shown generally at 1. Waste compacting apparatus 1 has an apparatus frame denoted by 2. Garbage may be fed automatically by chute denoted by 5 connected to waste compacting apparatus 1.

The use of a chute 5 will be useful where the waste compacting apparatus is installed in a multi-story building such as an apartment house where the garbage originates on different floors or levels and must be brought down to street level. Where there is a building of one or two floors, such as a supermarket, where the garbage originates on the same general level, a chute is not usually appropriate and a hopper seen at 3 in FIG. 1A into which the garbage may be dumped will generally be preferable.

It is contemplated that the trash will be fed to apparatus 1 and will there by appropriately broken up and will drop into a bin denoted by 7. Bin 7 indicates only a bin of simple form but in practice various kinds of bins could be used. Bin 7 typically extends from under apparatus 1 as shown in FIG. 2. Bin 7 may be provided with casters, shown at 8, and a lid shown at 9, held in place by a locking bar denoted by 10. By means of the construction shown, bin 7 is held rigidly in place but may be easily removed if desired. As will be described below various other forms of ultimate disposal are contemplated by the present invention.

A control box denoted by 120 is provided whereby an operator can control the operation of compacting apparatus 1, and control box 120 is connected to apparatus 1 by a multiple electric cable denoted by 121.

Referring now to FIG. 2, three of the most important features of the present invention are the rotatable breaking drum denoted by 11, the anvil denoted by 21 and the check means denoted by 170.

Breaking drum 11 is rotated by a drive motor denoted by 31 through conventional speed reducers shown diagrammatically at 32, the drive being through appropriate shaft means shown diagrammatically at 33. Breaking drum 11 has a series of projecting teeth denoted as 57 through 76 and the anvil 21 has a series of anvil elements denoted by 83. It is contemplated that trash will be crushed and broken between the teeth 57 through 76 of breaking drum 11 and the anvil elements 83 of anvil 21 as the breaking drum 11 rotates. Check means 170 helps keep the breaking drum 11 free of material likely to impede its operation and controls the direction of pressure applied to material treated in apparatus 1.

The breaking drum 11 is driven at low speed but with high available torque through the speed reducer 32. It has been found desirable that breaking drum 11 turn at such speed that the tips of the teeth 57 through 76 move at a speed of 40 to 50 feet per minute. For a machine of typical size with the tip speed mentioned the corresponding rotational speed of breaking drum 11 will be of the order of 10rpm.

Drive motor 31 is supplied with electrical energy by a power supply denoted by 35 through a line shown at 37. It is important in the operation of the present device to ascertain when the drove motor 31 is being overloaded as by a trash article in the apparatus which does not break properly and accordingly there is an appropriate electrical overload sensing device denoted by 39 attached to drive motor 31 through a controller denoted by 41 through lines shown at 43 and 45.

The power supply 35, overload sensing device 39 and controller 41 are all perfectly conventional and need not be further described. However, so far as the present inventor is aware it is new to make use of the elements just referred to in the combination illustrated and described herein and to carry out the method disclosed.

The overload sensing device 39 and the controller 41 would normally be housed in the control box 120 along with other apparatus to be referred to below and line 37 would normally be carried in cable 121.

Anvil 21 is pivotally mounted on a pivot shaft denoted as 81 so as to be capable of rotation from the position shown, away from breaking drum 11 through an angle of approximately 45°. Anvil 21 is normally in the position shown in FIG. 2, but under certain operating conditions where an incompressible object is received in apparatus 1 to be described below, anvil 21 swings about pivot shaft 81 in a counter-clockwise direction as viewed in FIGS. 2 and FIG. 13.

Other kinds of motion of anvil 21 are contemplated as an alternative such as linear translation motion rather than the pivotal motion referred to, but the pivotal motion will be particularly referred to.

In a typical installation, solid waste is introduced to the apparatus 1 from the bottom of the garbage chute 5 in, say, an apartment building.

It is contemplated that garbage entering the apparatus 1 will automatically start the rotation of a drum 11. This automatic starting of the drum 11 may be accomplished by any suitable detecting method such as the interruption of a light beam directed at a photo-electric cell, or by provision of a pressure-operated switch. By way of example in the embodiment described the starting of drum 11 is accomplished by means of a pressure operated switch denoted as 47 attached near the entrance to apparatus 1. A suitable flap or lever denoted by 49 is moved inwardly when it is contacted by trash fed into the machine and this causes the switch 47 to be operated which turns on drive motor 31 through controller 41 by a line denoted as 51 for this purpose. Line 51 would normally be carried in cable 121.

The drum 11 rotates in cooperation with anvil 21 so that garbage fed into the machine is broken up and drops into bin 7. This breaking up is accomplished by the action of the teeth 57 through 76 of breaking drum 11, which rotate between the anvil elements 83 of anvil 21 and forcefully reduce to small fragments material received between the teeth 57 through 76 and the anvil elements 83.

As bin 7 fills up, the rotating drum 11 acts so as to force the broken-up garbage downwardly into bin 7, and to move the broken up garbage horizontally in the bin. The broken up garbage in the bin 7 initially moves in the direction of motion of teeth 57 through 76 on the lower side of breaking drum 11, that is in a left-hand direction as seen in FIG. 2 but as the bin 7 fills up the broken-up garbage flows to all sides of the bin 7 in the manner of granular material. In this way the pressure on the garbage in bin 7 is such as to compact it firmly in the bin 7. The action of drum 11 in compacting the garbage in bin 7 is thus in the nature of a pump in forcing a liquid into a confined space.

As will be seen particularly in FIGS. 2 and 13 the frum 11 is positioned in relation to anvil 21 that a 'nip' is formed between the drum 11 and the anvil 21. The

teeth 57 through 76 of drum 11 are so designed as to allow glass and metal containers and other material to be drawn into and trapped in the 'nip' resulting in the glass breaking and the metal containers being torn or heavily deformed.

It is of particular importance to understand how the apparatus 1 handles incompressible and undeformable articles such as lumps of concrete, large telephone directories, discarded pieces of machinery and the like which cannot be reduced to any smaller volume. Such articles are automatically passed through apparatus 1 without any attempt to break them up. When incompressible and undeformable articles are received in apparatus 1 and caught in the nip, the anvil 21 is caused to move back from breaking drum 11 for a short interval of time so as to permit such incompressible and undeformable articles to pass immediately to bin 7.

When incompressible and undeformable articles are caught in the nip, the anvil 21 is caused to rotate away from drum 11 if the crushing force exceeds a predetermined value. This means that under normal operating conditions the garbage passes through the region of drum 11 and anvil 21 and the garbage is crushed, broken up and reduced in particle size without anvil 21 being rotated appreciably, but when some unusual object which would be likely to seriously damage the machine if the machine attempted to crush it, such as a chunk of concrete, is received in the region of drum 11 and anvil 21 the predetermined pressure on anvil 21 would be exceeded, and anvil 21 caused to rotate about its pivot shaft 81 allowing the object in question to drop through into bin 7.

It may be mentioned that the fact that an unusual object such as a chunk of concrete is passed through the machine without further breaking up does not mean that the machine is not functioning in a desirable manner in respect of such an object. Rather, the machine is functioning in the best possible manner under these circumstances. An object such as a chunk of concrete not easily further broken up is already compacted to the greatest possible degree and if it were to be further broken up it would actually occupy a larger volume. Thus the passing of a not easily broken object of relatively large size by the partial rotation of anvil 21 about pivot shaft 81 is a normal and expected part of the operation of the apparatus described herein.

The rotation of anvil 21 under the circumstances just referred to may be carried on by holding the anvil 21 in its initial position by means of a hydraulic ram in its extended position and providing for retraction of the hydraulic ram and corresponding rotation of anvil 21 when more than a predetermined pressure is applied to anvil 21. The motion of anvil 21 just referred to will be discussed more fully below.

The breaking drum 11, the anvil 21 and the check means 170 will now be described in a little further detail. As particularly shown in FIGS. 3 through 7, the drum 11 consists of a heavy steel cylinder shown at 53 mounted on a shaft denoted as 55 appropriately held in suitable bearings, such as ball bearings (not shown and which form no part of the present invention). At each end of steel cylinder 53 is a circular end plate denoted by 54, to which shaft 55 is rigidly attached. At each end of breaking drum 11, on end plates 54 are short abrasive strips denoted by 56 the function of which will be discussed below.

As already stated breaking drum 11 has a number of teeth denoted as 57 through 76.

Two manners of tooth positioning will be referred to.

The teeth 57 through 76 may be arranged in pairs at diametrically opposite sides of drum 11, or else they may be arranged at an angle other than diametrically opposite as shown in FIG. 8, where non-diametrically arranged teeth are shown at 157 and 158. Whether the teeth are arranged diametrically opposite or otherwise is a matter of convenience: if arranged as shown in FIG. 8, it will be possible to more easily position drum 11 so as to provide a clearance to remove and replace bin 7, but the operation is equally good in either case.

Whether diametrically opposed teeth are used or not, the teeth 57 through 76 should be spaced along the length of the drum 11 so as to cooperate with the structure of anvil 21. Reference is made to FIGS. 5 and 6 where there are shown ten pairs of teeth as follows: tooth 57 and its opposite pair 58 (not visible in FIG. 6), tooth 59 and its opposite pair 60 (not visible in FIG. 6). Pair of teeth 59 and 60 are spaced along drum 11 from teeth 57 and 58 and staggered away from the direction of rotation of drum 11 angularly with relation to pair of teeth 57 and 58 an angle of approximately 22½°. The direction of rotation is clockwise as seen in FIG. 5 and appropriately marked on the drawings.

The ten pairs of teeth shown are merely a typical number. There could be more or less than ten pairs depending on the material being handled. In general with coarser material, fewer teeth would be desirable, and vice versa.

Pair of teeth 61 and 62 are similarly spaced along the drum from pair of teeth 59 and 60, and similarly staggered angularly backward in relation to the rotation of drum 11.

Pairs of teeth 63 and 64 and 65 and 66 are similarly spaced along the drum 11 and angularly staggered backwardly progressively in the same manner as described in connection with pairs of teeth 57, 58, 59, 60 and 61, 62.

Because of the progressive angular staggering of the pairs of teeth with an angle of approximately 22½° between each pair, pair of teeth 65, 66 is displaced 90° in relation to pair of teeth 57, 58.

The remainder of the pairs of teeth 67, 68 (tooth 68 is not visible in FIG. 6) 68, 69 (tooth 69 is not visible in FIG. 6) 73, 74 and 75, 76 are arranged in a similar way to the arrangement of teeth 57 through 66 except that they are progressively staggered backwardly from tooth 67, such that teeth 67 through 76 are a "mirror image" of teeth 57 through 66.

The teeth 57 through 76 thus present a sort of "prow" configuration whereby teeth 57 and 67 are at the leading edges and the remaining teeth are arranged along rearwardly-inclined side lines.

As particularly seen in FIG. 7, the teeth 57 through 76 are inclined at a small angle to the direction of rotation of the breaking drum 11. The teeth of each half of the drum are inclined toward the nearest side of drum 11. The effect of the inclination of the teeth is to exert an outward thrust toward the ends of breaking drum 11 and also aid to prevent jamming when the teeth 57 through 76 pass between the anvil elements 23 of anvil 21 with garbage material adhering to the teeth. The angle of inclination of the teeth 57 through 76 denoted by α in the drawings, is preferably of the order of about 15°.

An arrangement of the "pairing" of opposite teeth **57** through **76** in a non-diametrically arranged fashion has already been referred to with reference to FIG. **8** where only teeth **157** and **158** are shown for simplicity. Teeth **157** and **158** are similar to any of teeth **57** through **76,** apart from their angular positioning. It is contemplated that there will be a series of pairs of teeth like teeth **157** and **158,** arranged in a staggered row in relation to teeth **157** arranged in a staggered row in relation to tooth **158** similar to the arrangement shown in FIGS. **5,** 6 and **7.** In other words tooth **157** may be one of a series of teeth such as teeth **57, 59, 61, 63, 65, 67, 69, 71,** 73, and **75** in FIGS. **5** and **6** and tooth **158** one of a series of teeth such as teeth **58, 60, 62, 64, 66, 68, 70, 72,** 74, and **76** in FIGS. **5** and **6.** The arrangement of FIG. **8** may be found advantageous where it is desirable to position drum **11** so as to be able to leave a clear space below drum **11** as for the removal of bin **7.** A guide mark on the end of shaft **55** (not shown) will indicate the shaft position where the drum **11** is in position to leave a clear space as aforesaid.

The arrangements of teeth shown and described have been found satisfactory in practice, but these arrangements are only examples. The pairs of teeth **57** through **76** or **157** and **158** are intended to pass between the slots between anvil elements **23** of anvil **21,** to be described more fully below.

Reference will now be made to the construction of teeth **57** through **76.** With particular reference to FIG. **7,** each of teeth **57** through **76** is in the form of a generally rectangular plate.

The teeth **57** through **76** are typically blocks of steel welded to shell **53** of drum **11.** If a tooth should become broken it can ordinarily be repaired or replaced by welding. FIGS. **5, 6,** and **7** show the construction of the teeth **57** through **76** and the manner in which they are positioned. Typical dimensions of any one of teeth **57** through **76** may be length — 5 inches, width — 3 inches, thickness — ¾inch. All of the sides of teeth **57** through **76** may be linear except for the peripheral edges denoted for example in relation to tooth **59** as peripheral edge **59*a*** in FIGS. **5** and **7.** Tooth **59** is referred to by way of example, but all the teeth will have similar characteristics.

It will be noted that each leading edge as viewed in relation to the direction of motion of drum **11** of each of teeth **57** through **76,** a leading edge denoted by **59*b*** being given as an example is along a radius of drum **11** whereas each of the trailing edges is parallel to its companion leading edge, and is thus not along a radius of drum **11.** An example of a trailing edge is shown at **59*c***, which is desirably tangential to drum **11.**

The peripheral edge **59*a*** of tooth **59** by way of example, has the same curve as a circle with its center at the center of drum **11.**

It is contemplated that both leading edges such as **59*a*** and trailing edges such as **59*c*** will be straight and flat. There might in some circumstances be a slight advantage in providing leading edge **59*b*** with a triangular or sharpened cross-section, or a rounded cross-section, but the present inventor considers that the danger of tooth breakage is increased if the leading edges such as edge **59*b*** are other than flat. The description of the shape and construction of tooth **59** applies to all of teeth **57** through **76.**

As particularly indicated in FIG. **8,** teeth **57** through **76** may be attached to the steel cylinder **53** of breaking drum **11** by simply welding the teeth **57** through **76** to the surface of cylinder **53.** If desired, steel cylinder **53** may be thick as seen in FIG. **9** at **53*a*** and the teeth **57** through **76** attached in the manner exemplified by teeth **57** and **58** shown in FIG. **9** by way of example, with the tooth faces **57*a***, **58*a***, and **57*b***, **58*b***, being similar to those of tooth **59** already referred to. In the alternative construction of FIG. **9,** teeth **57** and **58** are set in rectangular sockets denoted by **77** and welded in place as shown. In spite of the apparently rugged alternative construction of FIG. **9,** the construction as shown in FIG. **8** provides adequate strength.

It is also contemplated by the present invention that the breaking drum **11** with its teeth **57** through **76** may be made by casting as an integral whole. It is also contemplated that the breaking drum **11** and teeth **57** through **76** could be of laminar construction such as by assembling a stack of laminae corresponding to teeth and spaces therebetween on a central shaft.

Teeth **57** through **76** and anvil **21** (to be described in greater detail below) obviously are subjected to considerable stress, shocks and abrasion, and it has been found desirable to use a steel for these members which provides high strength, easy weldability, good wear resistance and a good work-hardness characteristic such that the impact of hard objects give the surface a specially hard exterior. Such a steel is that sold under the trade name "WEL-TEN 80 C" a low-carbon steel alloy with magnesium, copper and molybdenum. However, the material of teeth **57** through **76** and anvil **21** is not critical so long as reasonably good steel is used, in view of the fact that the overload features of the apparatus are such that it passes incompressible objects without necessarily breaking such objects further and has the stop-reversal cycle of operation as an overload protection feature.

Referring now to the anvil **21,** as particularly shown in FIGS. **10, 11** and **13** the anvil **21** in its elevation view has a crescent-shaped appearance resembling a portion of a scoop associated with certain kinds of earth moving machinery. Anvil **21** is pivotally mounted on shaft **81** so that it can swing toward and away from breaking drum **11.** It is also contemplated by the present invention that anvil **21** could move horizontally in a motion of translation instead of moving pivotally.

As already described, anvil **21** is capable of rotating about shaft **81** so as to temporarily provide a large clearance between anvil **21** and the drum **11** when a relatively large solid object is received in the apparatus **1.** The rotated position of anvil **21** may be referred to as the retracted anvil position.

It is believed that the shape of anvil **21** contributes materially to the operation of machine **1,** as discussed elsewhere in the present application, and certain typical dimensions can be seen in FIG. **11A.**

Typical dimensions of anvil element **21** can be appreciated with reference to FIG. **11a** as follows:

a. (length of anvil **21**) — 13 7/8 inches
b. (length of backing plate **27**) — 8 inches
c. (thickness of backing plate **27**) — ½ inch
d. (radius of lower main length of anvil element) — 13 7/8 inches
e. (width of toe **26**) — 1¼ inches
f. (under angle of toe) — 30°
g. (upper angle of toe) — 125°
h. (radius of curvature of part of anvil element **83**) — 12 inches

i. (ordinate of centre of radius *h*) — 11½ inches
j. (abscissa of centre of radius *h*) — 11⅛ inches

The anvil **21** is pivotally mounted so as to depend downwardly and is normally held firmly in place close to drum **11** as seen in FIG. **2.**

As already noted anvil **21** has a number of parallel anvil elements or anvil teeth denoted by **83.** Anvil elements **83** are of generally triangular shape made up of an upper curved portion denoted by **83***a*, and a lower curved portion denoted by **83***b* connected by a toe portion denoted as **83***c*.

The anvil elements **83** may be of substantially the same thickness as the teeth **57** through **76,** and the anvil elements **83** are adapted to lie between the spaces left between the rows of teeth **57** through **76.**

Anvil **21** has anvil elements **83** mounted on and preferably integrally connected to a backing plate denoted by **27.** Backing plate has two side members denoted as **25** which act as guides and also act as reinforcing ribs.

As already indicated there are two limiting positions of the pivotal motion of anvil **21.** As seen in FIG. **2** the usual operative position of drum **11** and anvil **21** is such that a small clearance is left therebetween so that garbage material broken up by the teeth **57** through **76** and anvil **21** can pass through the region of the rotating teeth **57** through **76** and into bin **7.** With a machine having an anvil with the dimensions of FIG. **11A,** in the position shown in FIG. **2,** there will normally be only a small gap between toe **83c** and the check means **171,** of the order of three-sixteenths inch. The position of anvil **21** shown in FIG. **2** may be referred to as the forward anvil position.

As will be discussed below, the position of anvil **21** is controlled by hydraulic means, and, typically, a hydraulic ram denoted by **95** is attached to anvil **21** by means of a lug denoted by **88.**

The manner in which the anvil **21** is moved in response to the pressure applied to anvil **21** can best be seen with reference to FIGS. **2** and **14.** Anvil **21** is held in its initial or forward position by means of a hydraulic ram denoted by **95** connected to anvil **21** by means of lug **88** on anvil **21** and it is contemplated that when a pressure in excess of a predetermined pressure is applied to anvil **21,** hydraulic ram **95** will retract, and the details thereof will now be discussed.

The normal operating position of the anvil **21** as seen in FIG. **2** will preferably correspond to the fully-extended position of hydraulic ram **95.** Such fully-extended position may be called the "bottomed" position, and indicates that the piston (not shown) inside ram **95** has moved as far outward as possible.

The retracted position of anvil **21** may but need not correspond to the completely non-extended piston position of ram **95.**

In FIG. **14** the cylinder **95** is the same cylinder **95** shown in FIG. **2,** although it will be seen that cylinder **95** in FIG. **14** is shown in the opposite direction with respect to FIG. **2** and **13.** It is contemplated that there will be fluid such as water provided for cylinder **95** in the space denoted by **97.** If predetermined pressure is applied to anvil **21** the piston denoted as **99** in cylinder **95** attempts to move in a left-hand direction as seen in FIG. **14,** (it will be realized that "left" and "right" are only in relation to the direction of view in FIG. **14**) thereby exerting increased pressure on the liquid in space **97** which, in turn, forces liquid out through the relief valve denoted by **101** and permits the piston **99** to move to the left as seen in FIG. **14.** This decreases the volume of water in space **97** and permits anvil **21** to move to the right as seen in FIG. **2.** When the object creating the pressure on anvil **21** has been cleared from the machine, liquid under pressure from a supply through a pipe denoted by **103** flows back into the space **97** through a check valve denoted as **100** thus restoring pressure in the space **97** and causing the anvil **21** to rotate back to its initial position.

Water from ordinary supply mains is generally available as the liquid in the space **97** and in hydraulic cylinder **95.** In such a case, the restoring or water mains pressure, generally from 70 to 110 psi, will normally be less than the pressure necessary to actuate relief valve **101.** This is not a problem because the overload conditions when relief valve **101** is released usually correspond to a much higher pressure in the system than when the overload has passed and the anvil **21** is being restored to its initial position.

Although making use of water from regular supply mains is desirable, the invention is not restricted to the use of water. For example, air or a gas other than air could be used. Also some simplification of the apparatus is possible with some sacrifice of efficiency, by providing a simple gas-filled cylinder and piston acting as an alternative to hydraulic ram **95.**

As stated above, when there is high pressure on anvil **21,** the effect may be to discharge liquid through relief valve **101.** If the liquid is water, the water discharge through relief valve **101** may be applied to the interior of chute **5** to dampen the garbage being treated, or otherwise applied to the intake side of the machine to dampen the trash as a fire preventative and to make the trash easier to treat. Separate, alternative or additional spraying apparatus may be provided in chute **5** if desired.

It may also be desirable to periodically apply sanitizing or deordorizing chemicals to the garbage being treated, and such substances may be mixed with water spray or applied separately.

Referring further to FIG. **14,** it has been found advantageous to provide an injector, denoted by **106** as part of the hydraulic system associated with valve **101** and pipe **103.** Injector **106** may be charged with any desired sanitizing or deodorizing chemical, denoted by **107** and an escape tube denoted by **108** with an escape nozzle denoted by **109** of known construction may be provided. Each time the pressure on anvil **21** causes water to escape through relief valve **101,** a small quantity of chemical substance **107** is withdrawn from injector **106** and applied to the incoming garbage in chute **5.**

The present invention has been described with particular reference to the anvil **21** rotating away from breaking drum **11** when a predetermined force exists between anvil **21** and drum **11.** It is possible and within the scope of the present invention to have the anvil **21** rigidly mounted and provide for the drum **11** to move away from anvil **21** when the predetermined force exists. In such a case the shaft **55** carrying drum **11** would be mounted in bearings in turn mounted on a moveable structure capable of moving drum **11** away from anvil **21** and restoring drum **11** to its initial position in a similar manner to that discussed above in relation to anvil **21.**

Another important feature of the apparatus of the present invention is the check means denoted by **170**

now to be described, particularly illustrated in FIGS. 3, 4, 12 and 12A. The check means 170 are important because they remove material if it does adhere to the breaking drum 11 and the teeth 57 through 76 and they determine the direction of flow of material within the apparatus. That is, the check means 170, in addition to keeping breaking drum 11 free of entangling material further act so as to block the return of treated garbage on the side of breaking drum 11 where the teeth are going upwardly while at the same time garbage is subjected to pressure below from the teeth going downwardly, causing the apparatus of the present invention to function as a sort of pump or compressor which not only breaks up the garbage but compresses it, guides it in the apparatus and compacts it tightly in a bin or other suitable means.

Referring further to the check means, it may be pointed out that some items which are disposed of as garbage do not require any particular breaking up but they must be treated along with other material which does require such breaking up, and there are certain materials which tend to collect on and adhere to the moving parts of apparatus 1. Lengths of cord, discarded garments and the like tend to become impaled on the teeth 57 through 64 and to bind upon the drum 11. Such discarded garments as nylon stockings and nylon pantyhose having quite tough and resilient fibres tend to become impaled on various parts of the apparatus and are rather difficult to dislodge.

As will be seen the check means 170 consists of a series of parallel check plates each denoted as 171. Each check plate 171 is perforated by a circular opening denoted by 172 just large enough to receive breaking drum 11. The circular opening 172 is so close to the edge of plate 171 that check plate 171 has the appearance of a ring held in a concave cut in a plate. As a matter of fact, for ease of assembly it has been found desirable to make check plates 171 in two parts consisting of a flat plate with a semi-circular cut out portion, and welding the aforesaid components together to provide the shape of check plate 171 as seen in FIG. 12. Whichever construction of check plate 171 is used, the size of the circular opening is such that a clearance of approximately three-sixteenths inch may be left all around the breaking drum 11.

Check plate 171 is securely attached to the frame of apparatus 1 as by welding to a bracket denoted by 176 rigidly attached to the apparatus 1, the weld is shown 78.

As particularly seen in FIG. 12A check plate 171 is provided with an abrasive strip denoted by 175. Abrasive strip 175 is provided on the inside of the circular opening 172 of check plate 171, of length of 2 or 3 inches. The purpose of abrasive strip 175 is to grind off tightly adhering tough fibres which may have become wound on the breaking drum 11, such as strips of discarded nylon garments. Abrasive strip 175 is preferably made by welding in to the inside of the circular opening 172 a short strip of abrasive material made up, for example, of particles of tungsten-carbide nickel steel. Such material is available under the trade name "GRITALLOY — 1100."

The effect of abrasive strip 172 is to wear down and disintegrate material stubbornly adhering to breaking drum 11 and cause it to be loosened and be dropped from the drum.

Similar abrasive strips 56 already referred to are provided on the end plates 54 of breaking drum 11 and the purpose is similar to the abrasive strip 175 just discussed.

Further reference to abrasive strips 56 has been delayed until they have been described in relation to the check means 170. Abrasive strips 56 in breaking drum 11 similarly applied to those in check plates 171 wear down and disintegrate material stubbornly adhering to the end plates 54 of breaking drum 11 and likely to cause the breaking drum 11 to bind against the frame of apparatus 1.

The structure and operation of the described embodiment of the invention in relation to the handling of large relatively incompressible objects has been described above. In the event of a blockage or jam which is too serious to be handled by the motion of the anvil 21 described above, the controller 41 may be actuated through overload device 39.

The controller 41 may be programmed merely to stop the apparatus 1 in the event of a serious overload. It is generally more useful if the controller 41 is programmed to attempt to first clear the jam by going through the cycle of: stopping the apparatus 1, reversing the drum 11 for a half revolution and restarting the drum 11 in its original direction and carrying out this cycle several times. If the jam persists, controller 41 should be programmed so as to then shut down the machine and to signal an alarm such as by a visible and audible signal simultaneously.

It would be convenient at this point to refer again to the speed of rotation of drum 11. As already stated, the drum preferably rotates at relatively slow speed, so that the tip speed of teeth 57 – 64 is of the order of 40 – 50 fpm. The ideal speed is that speed which smoothly opens anvil 21 or required when a relatively incompressible mass is applied between drum 11 and anvil 21. The anvil 21 and its associated components is quite massive and has considerable inertia and running the drum 11 at a high speed would impose serious strains on the components. The speed at which the anvil opens depends primarily on the speed of drum 11 as modified by the shape of the anvil and the material being treated and keeping the drum speed to a low level causes the anvil to be pushed open rather than being subjected to a sharp blow slamming it open with consequent stresses.

The apparatus of the present invention in its operation can be more fully understood with reference to FIG. 15 which is adequately labelled and self-explanatory.

The function of the apparatus in the present invention is to carry out the following specific steps, that is to say to smash glass containers, collapse and flatten metal containers, burst and rip plastic containers, squeeze and flatten other weak containers such as milk cartons, allow incompressible objects of a common size to pass through the apparatus without performing shredding or pulverizing operations.

The function of the opposed-pair positioning of the teeth 57 – 76 on breaking drum 11 already referred to will now be discussed in greater detail.

As can best be seen with reference to FIGS. 8, 9 and 13, each row of teeth 57 – 76 are arranged non-continuously in each row, and in the present embodiment the pairs of teeth are oppositely arranged so as to provide gaps in order to ensure that large glass bottles

and other containers will be drawn into the nip formed by such gaps. Large containers shown at **90** in FIG. **13** which would otherwise fail to gain purchase on the teeth for geometric reasons, will fall to the drum diameter, when the space left between teeth comes round. Having made this downward movement into the nip, the following tooth such as **57** is able to trap and deform the container. In this way, very large bottles such as up to **10** inch diameter as shown at **90** can be smashed.

By having each row of teeth progressively staggered in an angular sense as seen in FIGS. **5, 6** and **7,** the nip referred to is created over a sufficient length of the length of drum **11** to trap some part of a large container like bottle **90,** and even if it is not totally shattered at once it will be reduced to small pieces in a short time. Random arrangement of teeth on drum **11** do not appear to be effective in breaking large containers and appear to act rather as a large brush.

The process of mass flow through the described apparatus is further utilized to obtain compacting pressure as a garbage "pump" (in a manner roughly analogous to the paddle wheel of an old stern wheeler river boat) when the solid wastes are fed out of the drum area and into a closed volume bin at **7.** This downstream pumping pressure serves to compact the already high density waste coming from the drum. When the bin **7** is full and under compacting pressure, the apparatus is automatically stopped and the high density waste material is removed to the next stage of processing.

In practical operation of the device high density solid wastes coming from the drum **11** are driven downward by the drum action to collect in a bin **7** securely attached to the base of the apparatus. After loosely filling the bin, the apparatus is allowed to continue working so that the drum action will further compress the garbage up to a predetermined compaction pressure. At this point, the above mentioned switch operates, and the bin may then be removed.

The present inventor would like to supply further details of practical embodiment of the invention. Referring to the drive motor **31** and the drive shaft shown diagrammatically at **33** it may be stated that transmission from the drive motor **31** which may be a 3 H.P. 3 ph. a.c. motor is by a 4:1 (approx.) Vee belt reduction to a 60:1, 6 inch centres, worm gear reducer with torque-limiter, which is directly coupled to the shaft of brake drum **11.** The Vee belt reduction can be varied to adjust the drum speed around the 10 r.p.m. mark, to give the desired tip speed of 40–50 fpm.

Referring to the chute switch **47,** switch **47** is actuated from off to working conditions when garbage entering from the bottom of the chute operates the chute switch **47.** The mechanism utilizes side pressure from the garbage to flatten a hinged plate **49** against the heavier armour plate of the upper wall of the apparatus. This hinged plate is spring-loaded against the switch **47** which is typically a micro-switch.

In order to achieve the maximum practical value from the present invention, the present inventor desires to discuss in a little further detail the ultimate disposal of the waste material treated by the apparatus just referred to.

Referring now to FIG. **16** there is shown a variant of the apparatus described above having the capability of providing for discharge of the processed material in a substantially sideways direction.

It has been found that while the apparatus already described operates extremely well and treats garbage material in a manner which represents a considerable advance over previous equipment, there are circumstances where having the discharge of the apparatus downwardly into a bin is not the most convenient method of discharge.

It has been found that substantially sideways discharge of the processed material has, in some circumstances, considerable advantages. For example, it will sometimes be found more convenient to have the entire apparatus lower in relation to the floor level, and it will often be found convenient to load bins through an opening in the side thereof instead of through the top. A particular advantage of horizontal discharge of the apparatus is found when it is desirable to fill bags of treated garbage directly from the apparatus.

It is only necessary to show a fragmentary portion of the apparatus in order to illustrate the variant now about to be described. Referring again to FIG. **16,** only a portion of the garbage treating apparatus is shown, being that portion which corresponds closely to FIG. **13** of the drawings.

In FIG. **16** the garbage chute is now shown at **1005.** (In relation to FIGS. **16, 17, 18** and **19,** similar reference numerals will be used to those used in connection with the preceding figures as exemplified by the chute **1005** which is similar to the chute **5** previously referred to).

Once again, the waste material descends vertically through the chute **1005** where it is treated in exactly the same way as heretofore described, that is by means of rotating breaking drum denoted by **1011** mounted on shaft **1055** having teeth thereon denoted by **1058.** The steel cylinder constituting the surface of the drum is in FIG. **16** denoted by **1053.**

The co-operating anvil is denoted by **1021** consisting of the same elements as before denoted by reference numerals similar to those already used added to "**1000**". In the present embodiment the anvil **1021** is mounted on a pivot shaft denoted by **1081.** Once again hydraulic ram means, or the like denoted by **1095** is connected to the anvil **1021** at lug **1088.**

It may again be pointed out that the precise form of the ram **1095** is a matter of choice depending on the particular use of the device and while a liquid-containing cylinder and associated parts as previously described may be used, a considerably simpler equivalent device such as a gas-filled cylinder may also be used with some sacrifice of efficiency.

In the apparatus shown in FIG. **16,** the discharge of the apparatus is now through a sideways tube denoted by **1201.** Tube **1201** has side walls denoted by **1203** and a transitional portion denoted as **1205.**

As labelled on the drawing the direction of flow is in a left-hand direction as seen in FIG. **16.** As already indicated, the apparatus already described has a considerable pumping action and the treated garbage moves in the direction of the teeth **1058** at the lower part of drum **1011,** that is in a left-hand direction as seen in FIG. **16** and thus the treated garbage flows under pressure in a left-hand direction through the tube **1201,** as seen in FIG. **16.**

The exact cross-sectional shape of the tube **1201** is of no great importance. From a constructional standpoint the shape of tube **1201** may be round, square or

rectangular in cross-section, and regardless of the form there is no problem about the design thereof.

In FIGS. **17, 18** and **19** are shown typical applications of the device just described in connection with FIG. **16.** In FIGS. **17** and **18,** the parts of the apparatus that break up the garbage are exactly as in FIG. **16** and in the preceding figures. It may be emphasized that what is shown in connection with FIGS. **17, 18** and **19** are applications of the device and not detailed construction of the apparatus.

In FIG. **17,** the apparatus as already described is shown with its discharge tube **1201***a*, adapted to be used to feed into a bin denoted by **1007.** A suitable opening in the bin is provided as shown and the treated material passes horizontally in a left-hand direction as seen in FIG. **17** into bin **1007.** An upwardly turned lip is shown at the left-hand end of tube **1201***a* in order to give to the treated garbage an upward thrust to assist in spreading it evenly in bin **1007.**

In order to illustrate the fact that the equipment shown in FIG. **17** may be in a remote location from bin **1007,** a wall denoted by **1250** is indicated.

The apparatus of FIG. **18** is extremely similar to that already described except the apparatus in FIG. **18** is used for filling bags of treated material. The similar discharge tube is shown at **1201***b* and the latter is adapted to fill bags such as is shown at **1261.** The manner of filling the bags at **1261** is obviously clear and need not be further described.

For convenience it may be desirable to have a conventional roller conveyor denoted as **1271** as shown. The conveyor has rollers shown at **1271** and all of the conveyor components are perfectly conventional.

Referring now to FIG. **19** it is desired to illustrate an embodiment of the invention similar to that shown in FIGS. **16, 17** and **18** but particularly adapted to fill hollow containers with treated garbage. For example, used oil drums if even slightly rusted are not easy to reclaim and may be solidly filled with treated garbage and disposed of as land fill or the like.

In FIG. **19** is shown the same basic apparatus as illustrated in the foregoing figures. The garbage treating apparatus is now denoted by **1002** and the chute by which the garbage enters apparatus **1002** is shown at **1005.** The sideways discharge tube is now denoted by **1201***c*. Instead of being horizontal as shown in FIG. **16,** for example, the tube **1201***c* is now inclined downwardly at an angle of about 20°. No special transition portion like transition portion **1205** in FIG. **16** is now required as the tube **1201***e* connects to apparatus **1002** at substantially the same angle as the transition portion **1205** in FIG. **16.**

A hollow container such as an oil drum open at its end toward apparatus **1002** is shown at **1400.** Hollow container **1400** is permitted to rest upon a stand denoted as **1402,** the stand **1402** consisting of a framework of which the main parts are longitudinal bars denoted by **1404,** base members denoted by **1406** and support members denoted by **1408.** Support members **1408** anchor the stand **1402** securely to apparatus **1002.**

As the apparatus **1002** treats garbage, the treated garbage will be caused to flow through tube **1201***c* like container **1400.** This causes pressure to be applied to container **1400** tending to cause it to move away from apparatus **1002.** To keep the container securely in place, a foot member denoted by **1410** is provided, adapted to be held in place against container **1400** by means of a cable denoted by **1412,** securely anchored to apparatus **1002** by means of an anchor bracket denoted by **1414.** Cable **1412** is attached to foot member by means of a hook denoted by **1416** and a load-binder denoted by **1418.** It will be understood that another cable like cable **1412,** and attachments (not shown) will be provided on the opposite side of container **1400.**

In operation, the empty container **1400** is placed on stand **1402,** the foot member **1410** put in place, and the loadbinder **1418** tightened up. The container **1400** can then be permitted to fill, and when full the load binder **1418** released, after which the filled container **1400** may be sent to whatever disposal site that is desired.

As will be seen the present invention has very great adaptability to various circumstances and provides a greatly improved apparatus for compacting garbage.

What is claimed is:

1. Garbage treating apparatus comprising a hopper having a discharge opening through its bottom, a breaking drum means rotatably mounted within said openning and comprising a central cylindrical member with a plurality of teeth fixed thereto and extending outwardly therefrom, the opposite ends of said drum means being disposed closely adjacent the opposite ends of said opening; anvil means disposed at and defining one side of said opening, said anvil means including a plurality of anvil elements extending between adjacent teeth of said breaking drum means, check means rigidly supported from the side of said opening opposite said first-mentioned side and including check plates disposed between the respective teeth of said breaking drum means and encircling said cylindrical member, power means for rotating said breaking drum means at a low peripheral speed in a direction such that its said teeth rotate downwardly between said anvil elements to force the treated garbage downwardly through said opening, while said check plates occupying the spaces between adjoining teeth prevent the upward return of garbage into the said hopper; a horizontally disposed tube means below said breaking drum means and communicating through said opening with the hopper; a receptacle having a horizontally directed opening telescopically receiving and movable lengthwise on said tube means, and means supporting the receptacle for lengthwise movement on the said tube means in response to the pressure of treated garbage as caused by rotation of said breaking drum means, said breaking drum means projecting downwardly through said opening into said tube means to produce said pressure on the treated garbage and movement of the treated garbage through the tube means.

2. Garbage treating apparatus as defined in claim **1** in which said receptacle comprises a wheel supported bin.

3. Garbage treating apparatus as defined in claim **1** in which said receptacle comprises a generally tubular bag having an open end slidably receiving said tube means, said means supporting the receptacle comprising a roller conveyor.

* * * * *