United States Patent [19]

Schwarz

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[45] **Nov. 5, 1974**

[54] **APPARATUS FOR COMMINUTING TRASH**

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[21] Appl. No.: **402,590**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 180,687, Sept. 15, 1971, abandoned.

[30] **Foreign Application Priority Data**

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Apr. 10, 1971 Germany 2117519

[52] **U.S. Cl.** **241/36,** 241/191, 241/224, 241/230, 241/236, 241/290, 241/292.1

[51] **Int. Cl.** **B02 18/06**

[58] **Field of Search** ..... 241/36, 191, 195, 222, 241/224, 227, 230, 231, 235, 236, 242, 243, 290, 293; 83/501, 664; 74/665 G

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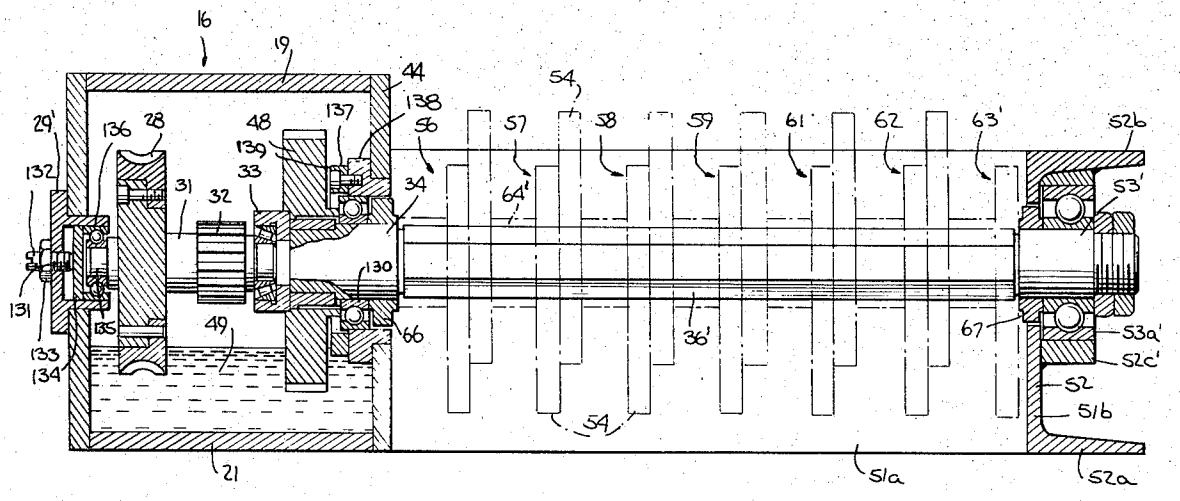
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Primary Examiner—Granville Y. Custer, Jr.
Assistant Examiner—Craig R. Feinberg

[57] **ABSTRACT**

In apparatus for comminuting trash in which two parallel disposed shafts, one having a degree of axial play and the other substantially no axial play, a motor, reduction gearing disposed between the motor and shafts through which the motor drives the shafts, a reversing device for driving the motor in different directions and a plurality of groups of disc-shaped blades disposed at regular intervals on each shaft and arranged such that the groups on one shaft engage in the interstices between the groups on the other shaft are provided. The inner distance between two adjacent groups on the shaft having substantially no axial play is equal to the degree of play plus the width of the group on the shaft having a degree of play. Each blade has at least one step region including a tongue with the surfaces which define the tongue forming an opening angle of the order of magnitude of 30°. The step regions of the blades on each shaft are angularly offset with respect to one another.

22 Claims, 16 Drawing Figures



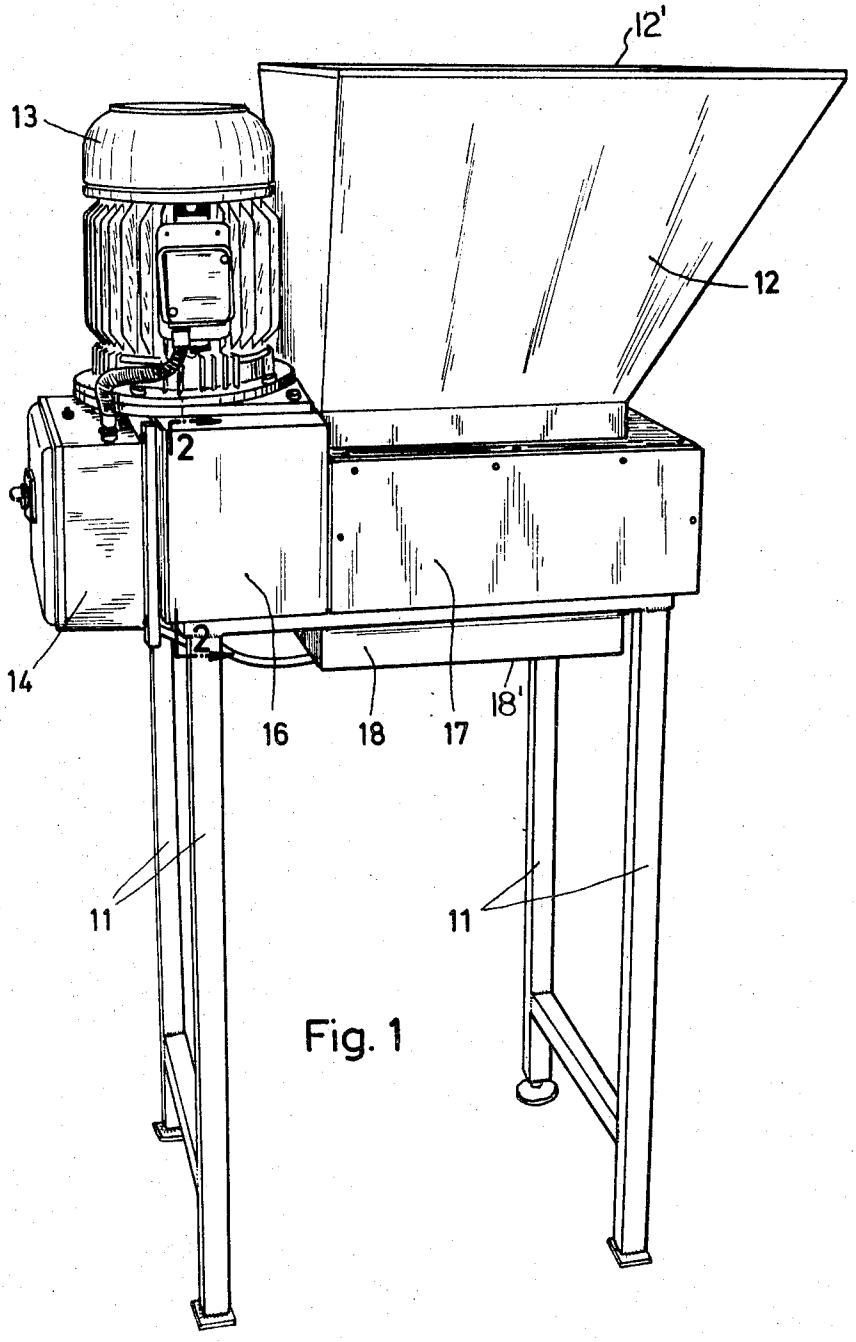


Fig. 1

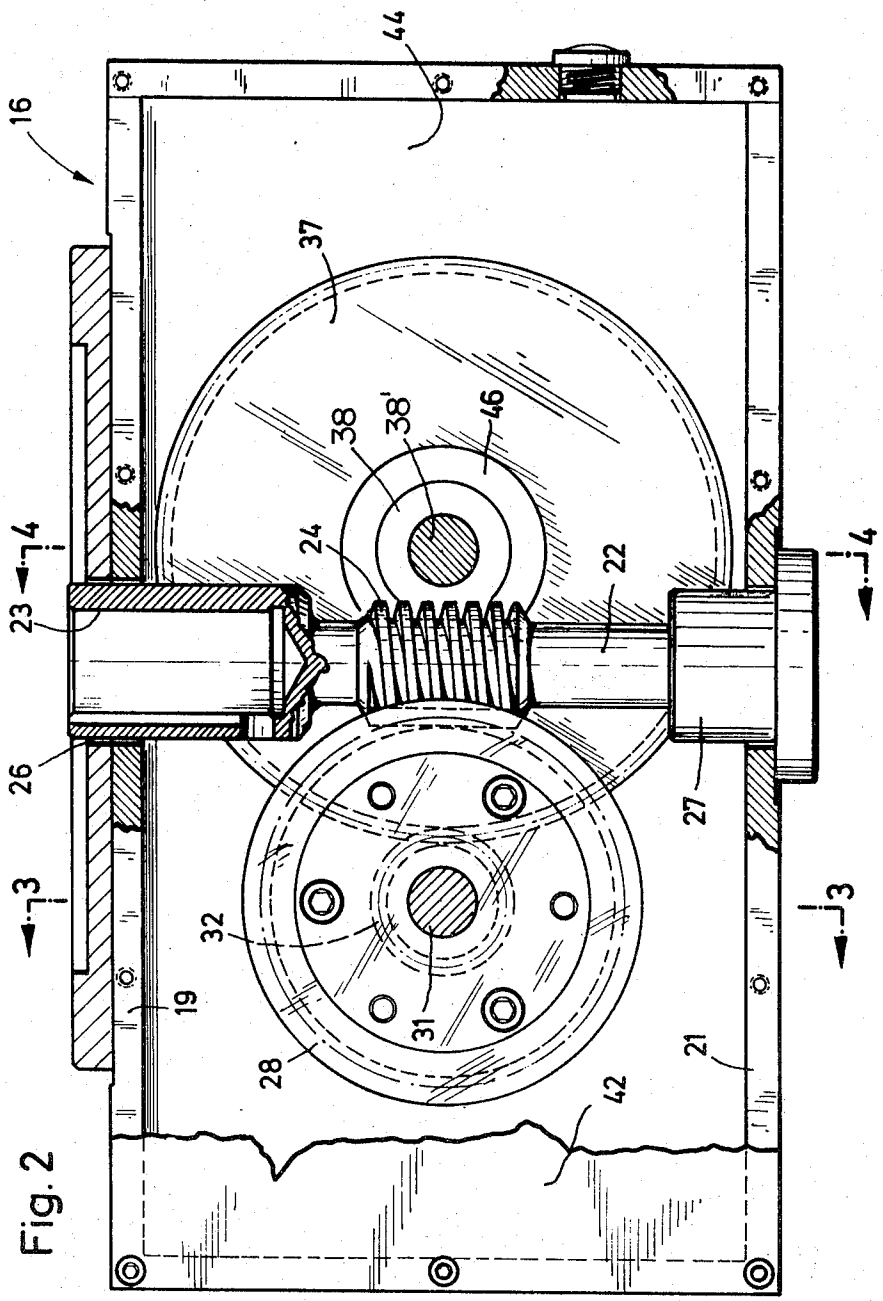


Fig. 2

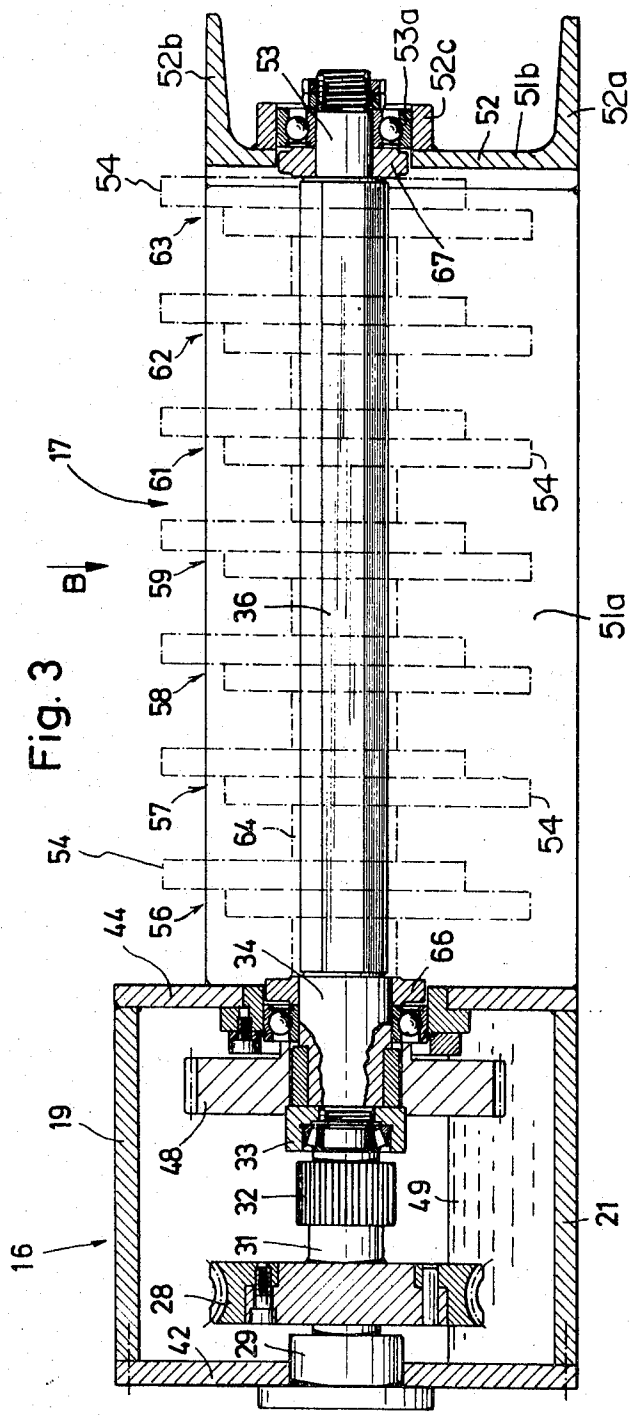
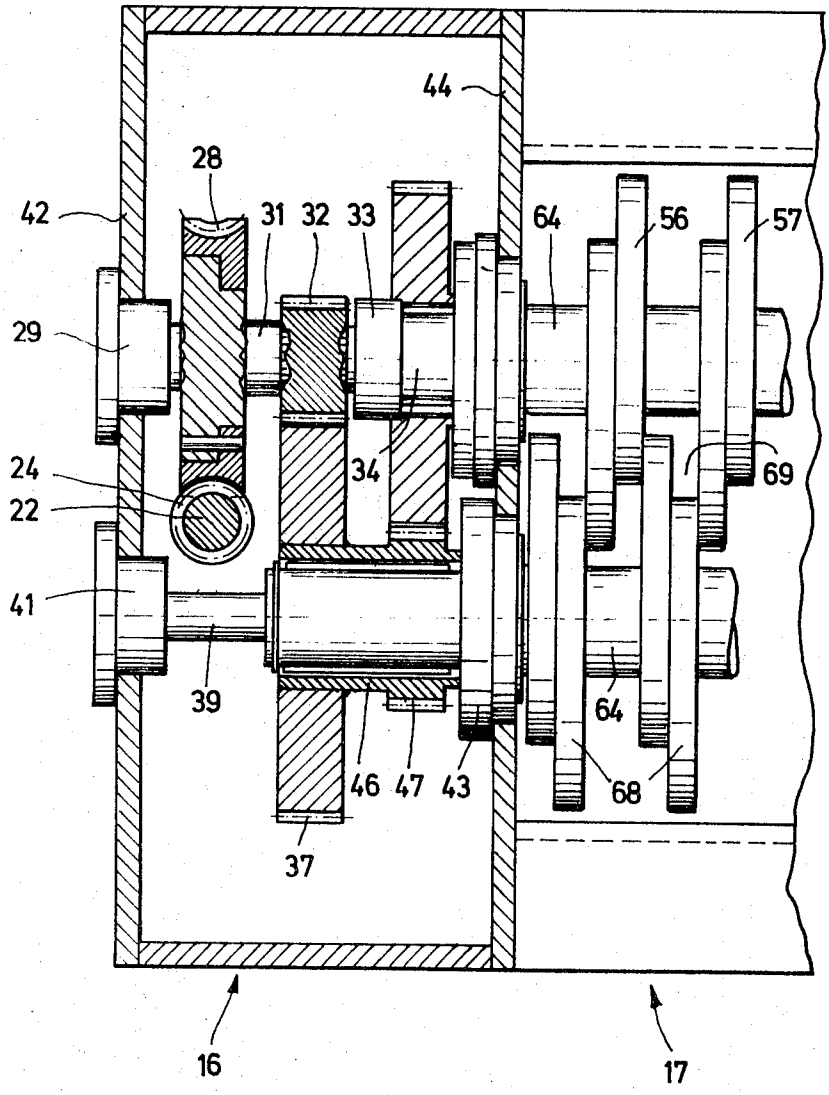

52b
53
53a
52c
52
51b
52a
54
63
67
62
17
61
54
59
B
36
51a
58
57
64
54
54
56
44
34
66
19
48
33
32
49
21
16
31
28
42
29

Fig. 3

Fig 3a



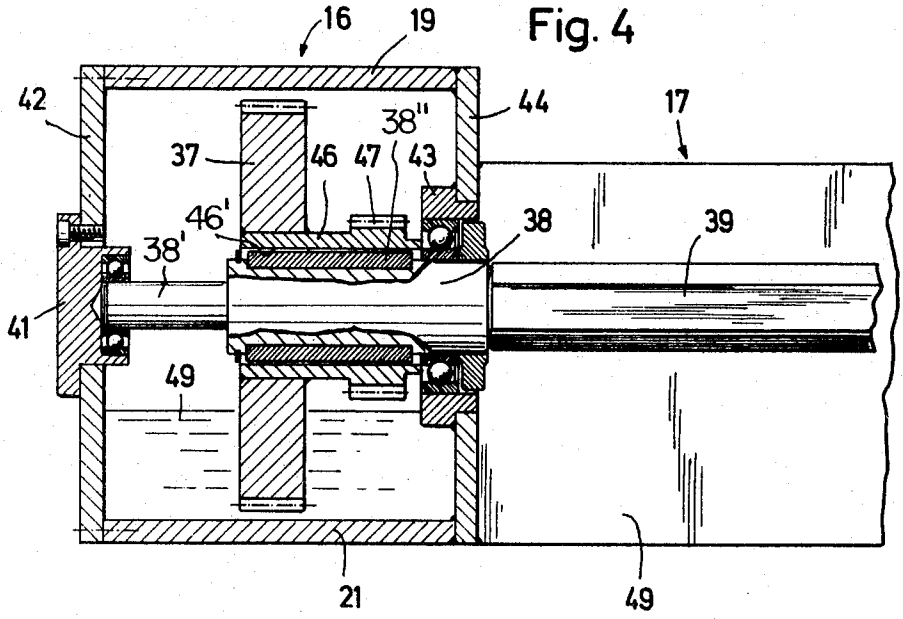


Fig. 4

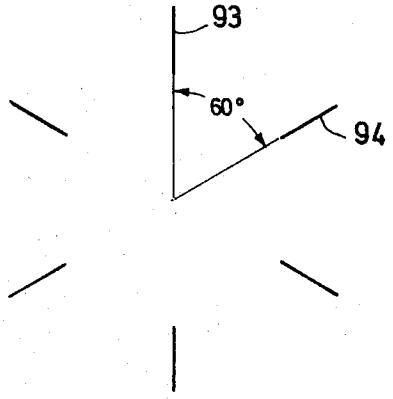


Fig. 11

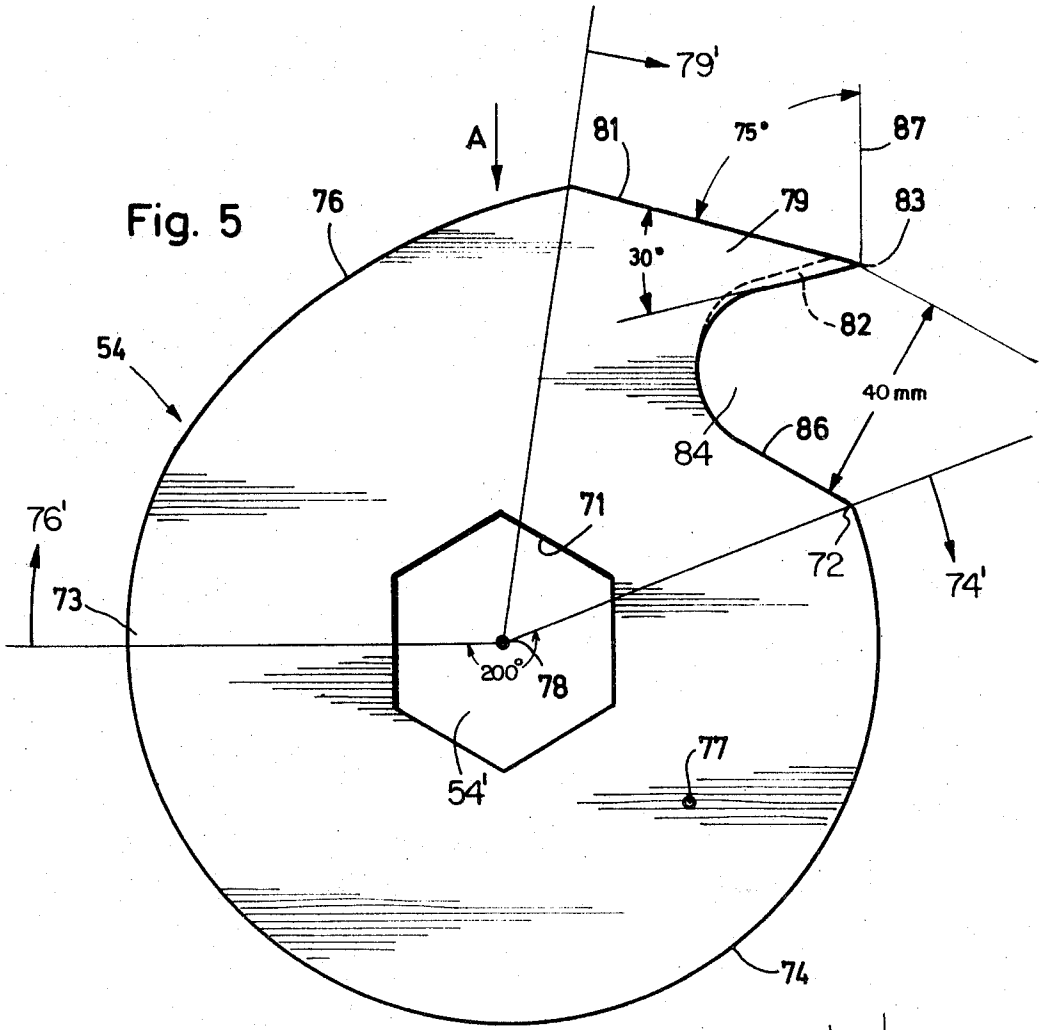

79'
A
81
75°
87
76
79
83
30°
82
54
40 mm
84
86
71
76'
72
74'
73
200°
78
77
54'
74

Fig. 5

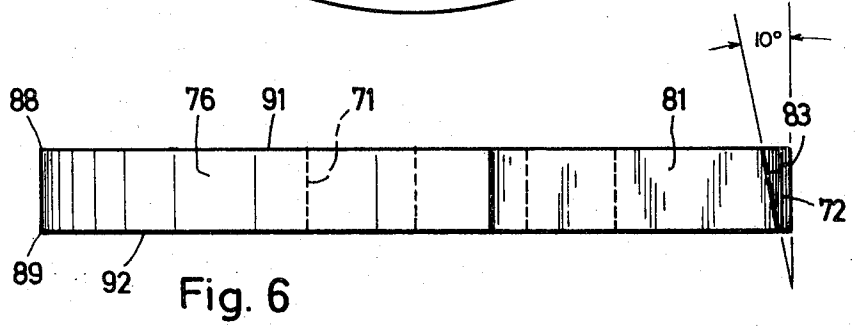

10°
88
76
91
71
81
83
72
89
92

Fig. 6

Fig. 7

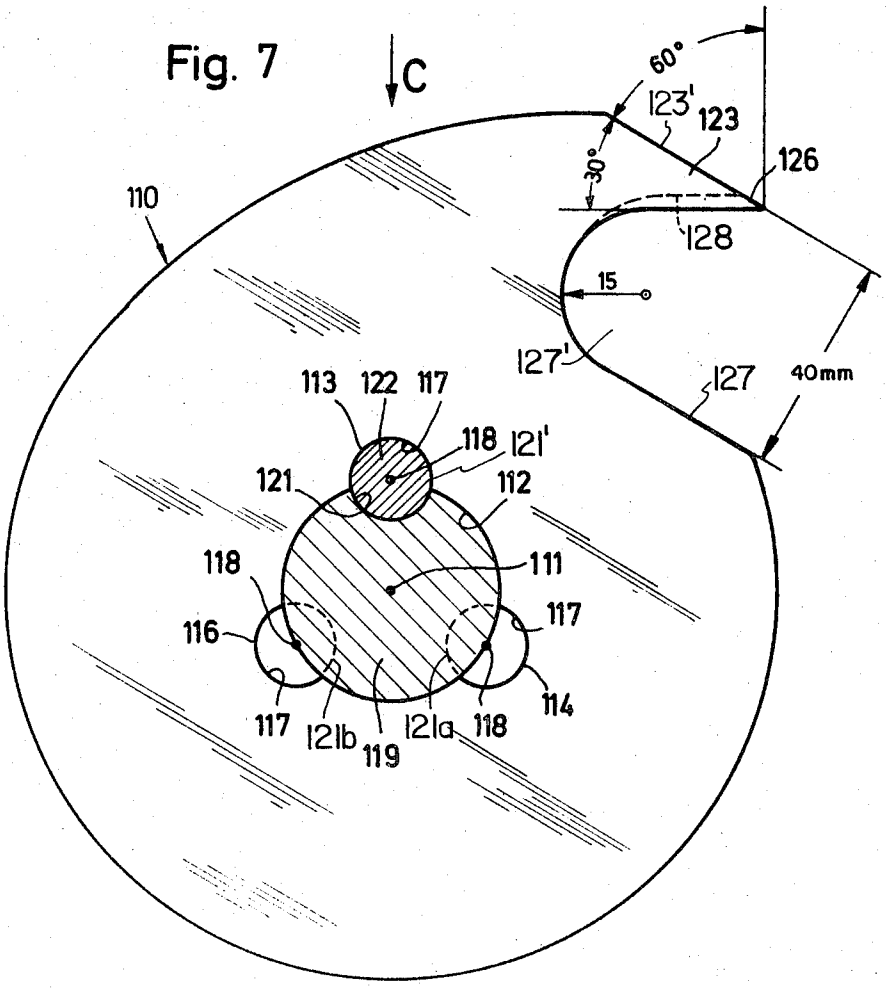

C
60°
123'
123
126
30°
128
110
15
127'
127
40mm
113
122
117
118
121'
121
112
111
118
116
117
114
117
121b
119
121a
118

Fig.8

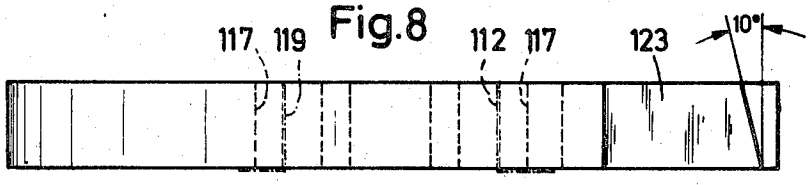

117
119
112
117
123
10°

Fig. 9

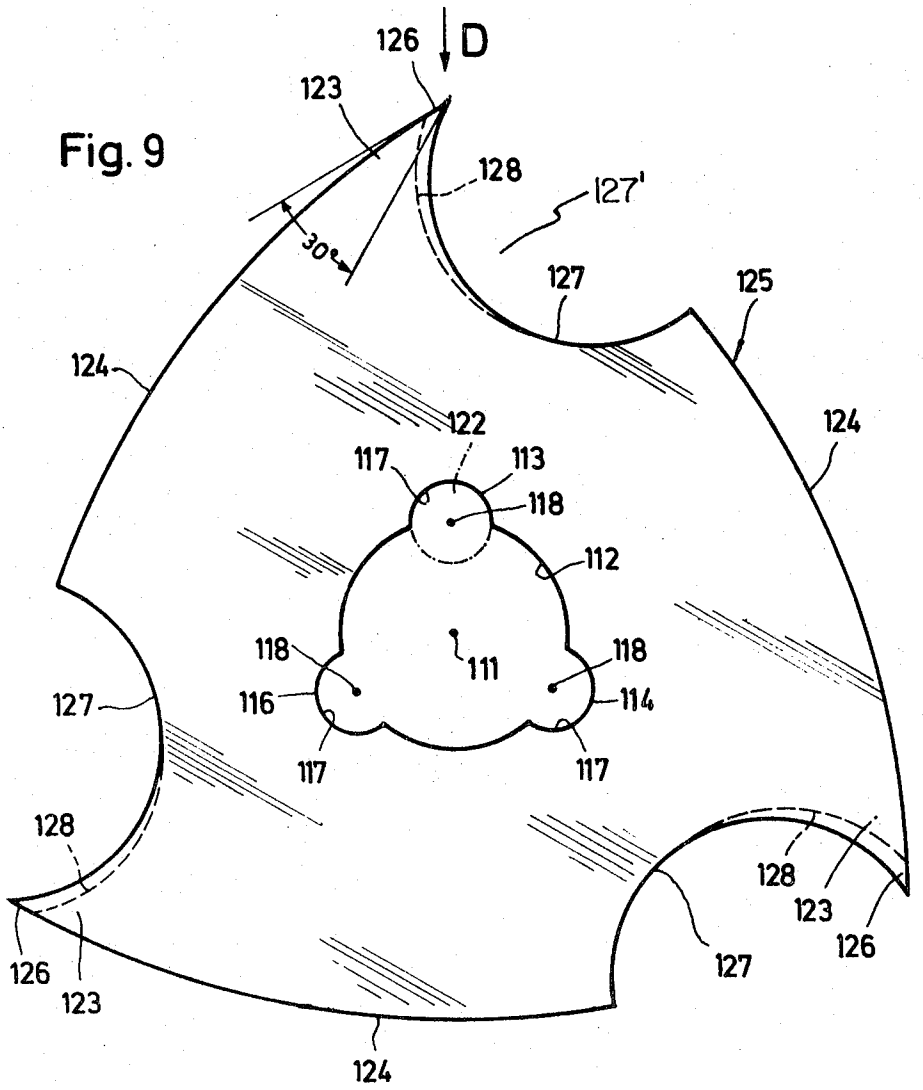

126
D
123
128
127'
30°
127
125
124
122
117
113
118
112
111
118
118
116
114
117
117
127
128
126
123
124
128
123
126
127

Fig. 10

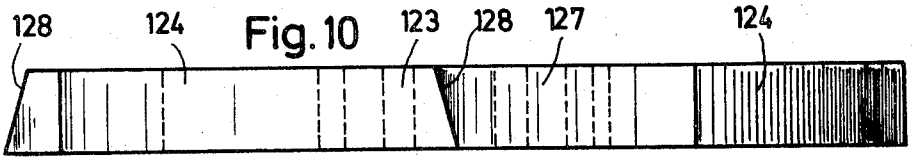
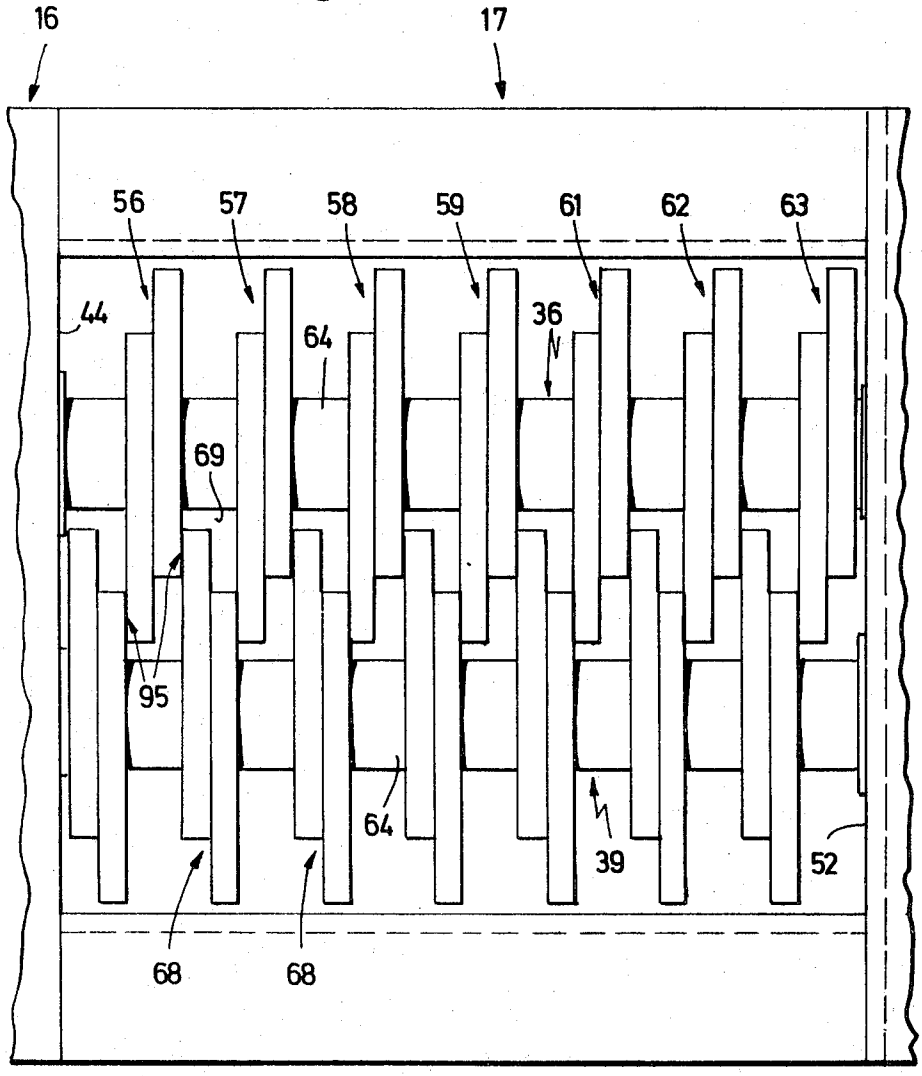

128
124
123
128
127
124

Fig. 12



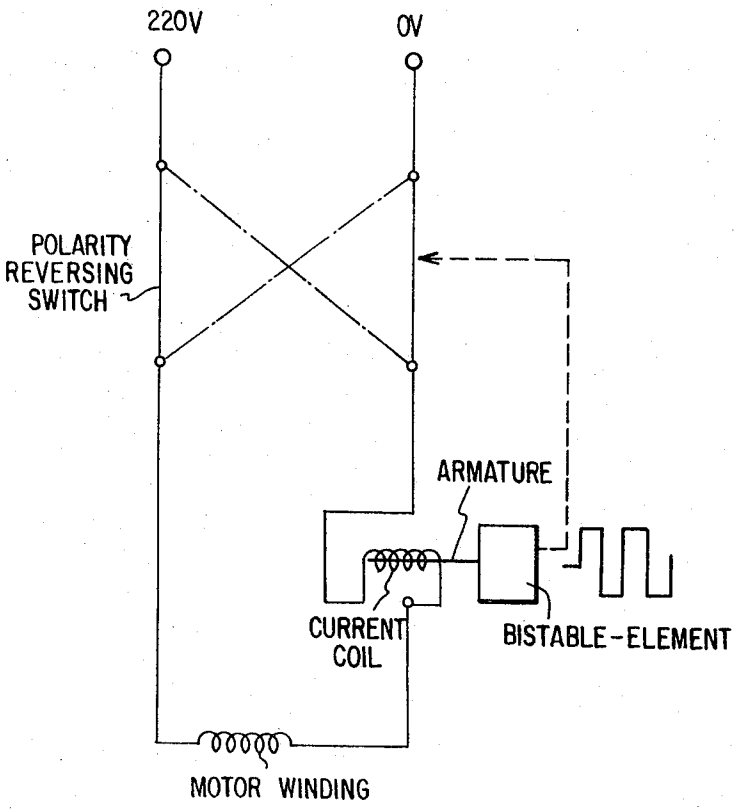

220V
0V
POLARITY
REVERSING
SWITCH
ARMATURE
CURRENT
COIL
BISTABLE-ELEMENT
MOTOR WINDING

Fig. 13

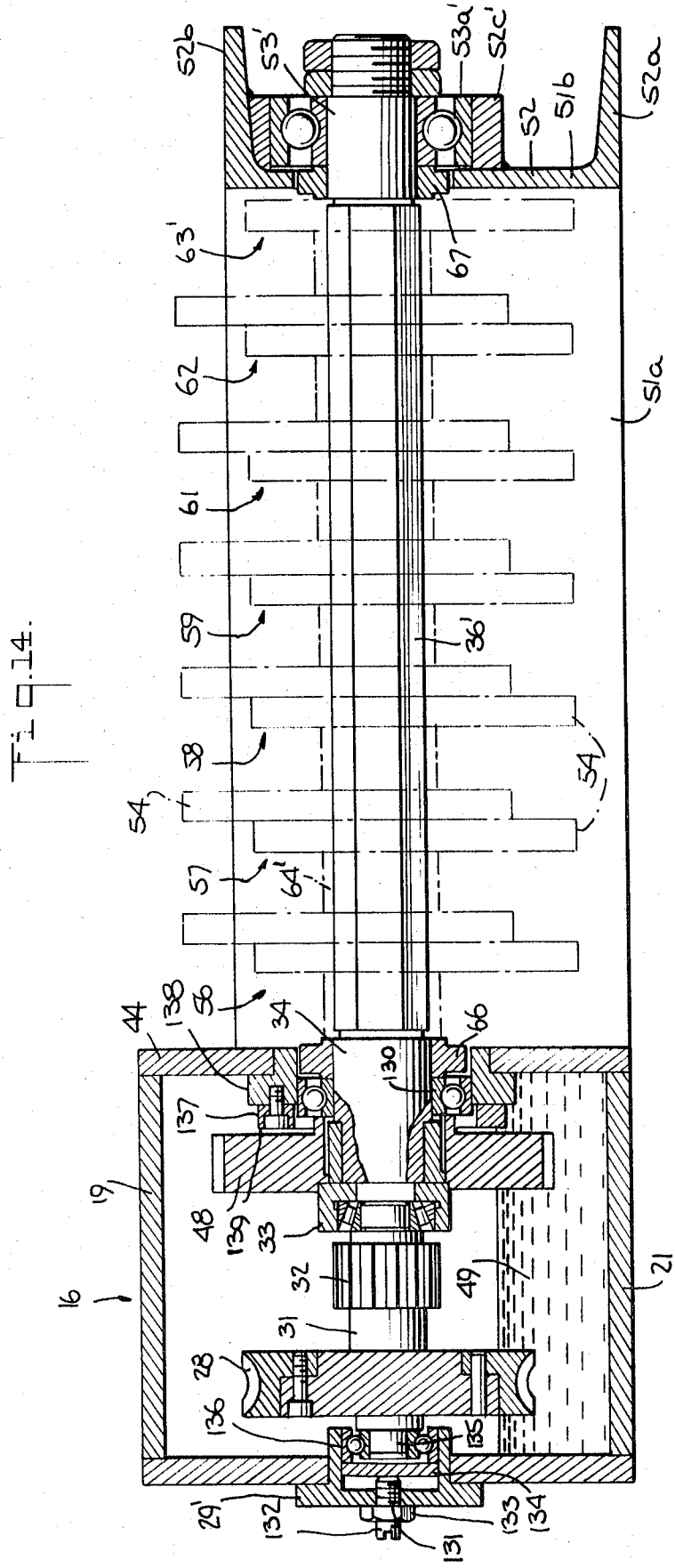

52b
53'
53a'
52c'
52
51b
52a
63'
67
62
51a
61
59
36'
58
54
54
57
64'
44
138
56
34
66
130
137
19
48
139
33
32
49
21
16
31
28
136
135
29'
132
133
134
131

FIG. 14.

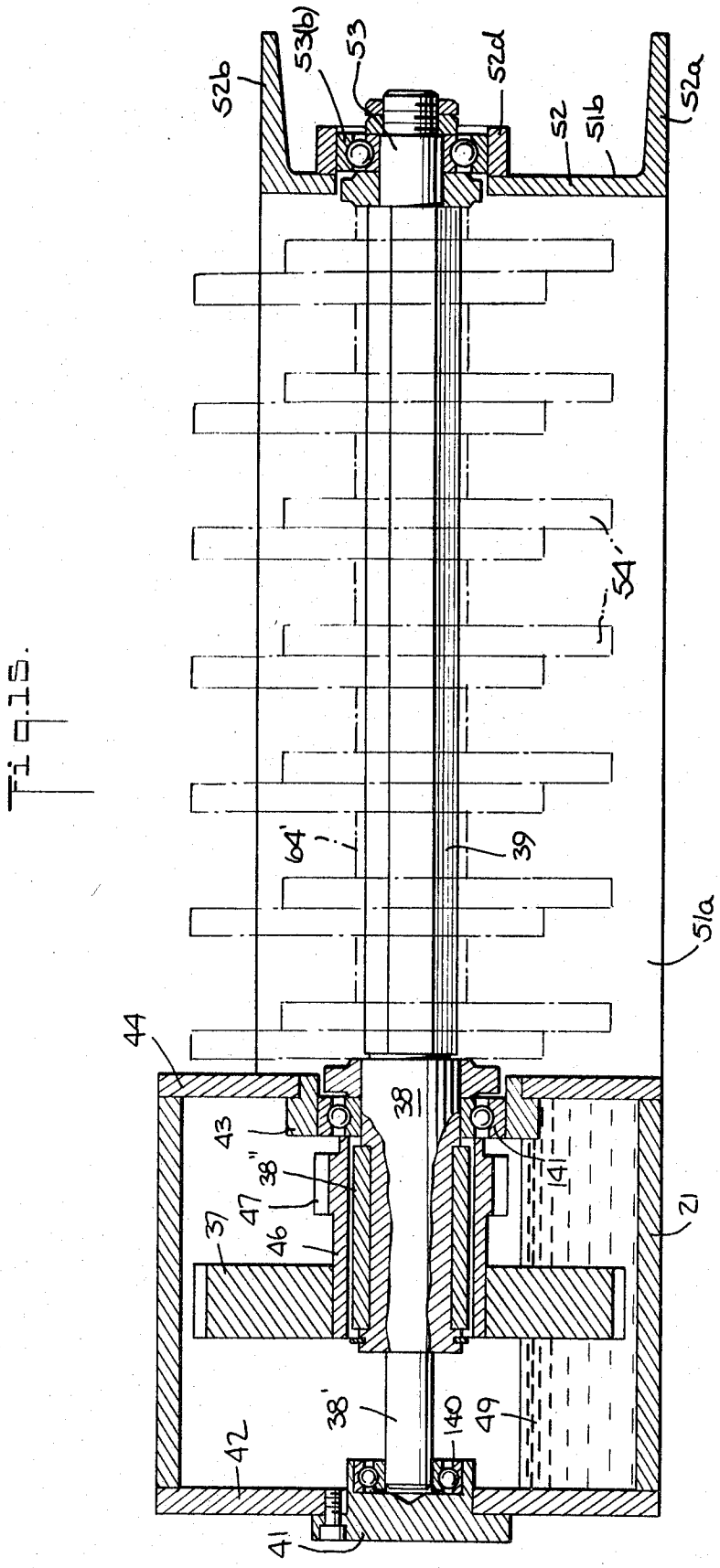

52b
53(b)
53
52d
52
51b
52a
54'
64'
39
51a
44
43
38"
47
46
37
38
141
21
38'
140
49
42
41

Fig. 15.

APPARATUS FOR COMMINUTING TRASH

This is a continuation-in-part of application Ser. No. 180,687, filed Sept. 15, 1971 now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus for comminuting trash such as bottles, borings, crates or the like. More particularly, the present invention relates to an apparatus for comminuting trash including a motor, reduction gearing connected with the motor, at least one shaft driven by the reduction gearing, blades fastened to the shaft, an inlet opening disposed above the blades and an outlet opening disposed below the blades for ingress of the trash and egress of the comminutant respectively.

A larger number of devices for comminuting trash are known. These, however, are specialized and do not possess the desired versatility since they do not process everything that accumulates in industrial operations such as the boring and grinding industry, in warehouses and retail businesses, etc. There are also a variety of automobile batteries, plastic containers, oil barrels, wooden crates, catalogs, television tubes, bottles, steel shavings resulting from boring and grinding, etc. which they cannot process and comminute. Moreover, known devices of this type require more operating experience from the operating personnel and more care than might be expected. Fruit crates, for example, must first be broken up before being inserted for comminution.

Such a device must be able to handle the problems of glass dust resulting from smashing bottles and the comminution of metal objects which wrap themselves around the shaft and jam the device instead of being comminuted by the blades.

SUMMARY OF THE INVENTION

It is, therefore, a general object of the present invention to provide an apparatus for comminuting trash such as bottles, borings, crates or the like.

It is a more particular object of the present invention to provide a comminuting apparatus which can be operated with practically no operational knowledge.

It is another particular object of the present invention to provide a comminuting apparatus which is compact in size and yet is sufficiently versatile to accomplish the comminution of a variety of items such as automobile batteries, plastic containers, oil barrels, trash accumulations in industrial operations such as the boring and grinding industry, etc.

It is yet another particular object of the present invention to provide a comminuting apparatus including a plurality of groups of disc-shaped blades mounted on a pair of driven shafts disposed parallel to each other with one shaft having a degree of axial play and the other shaft having substantially no axial play and with the inner distance between two adjacent groups on the shaft having substantially no axial play being equal to the degree of play plus the width of the group on the shaft having a degree of play.

It is still another particular object of the present invention to provide a comminuting apparatus including a reversing device which can be either time or torque dependent.

It is yet another particular object of the present invention to provide a comminuting apparatus including an improved blade design.

These and other objects are accomplished according to the present invention by the provision of an apparatus for comminuting trash including two parallel shafts with one of the shafts having a degree of axial play associated therewith and the other shaft having substantially no axial play associated therewith; a plurality of groups of discshaped blades disposed at regular intervals on each shaft, so that the blade groups of the one shaft mesh in the interstices between the blade groups of the other shaft, and so that the inner space between two adjacent groups on the shaft having substantially no axial play associated therewith is equal to the degree of play plus the width of the intermeshing blade group on the shaft having a degree of play associated therewith, and further so that the shafts move during operation in opposite rotational directions and at a slightly different speed; a motor; reduction gearing disposed between the motor and shafts through which the motor drives the shafts; a reversing device for driving the motor in different directions; and inlet opening disposed above the blade groups through which trash is supplied to the blade groups; and an outlet opening disposed below the blade groups through which the comminutant is removed.

As used herein, the terms "play" and "axial play" are used in their ordinary dictionary senses, namely, the degree of freedom and uncontrolled motion of a shaft journaled in its housing, i.e., in the case of axial play, to move or function freely within prescribed limits in either direction parallel to the axis of the shaft. This is to be distinguished from the controlled movement of one shaft relative to another.

The forward direction of rotation of the shafts is such that when viewing the blade groups through the inlet opening, the blades move toward one another. That is, if one were to view a point on a blade on each of the shafts, these points would appear to approach each other as the two shafts are caused to rotate in the opposite directions.

The blades have one or a plurality of step regions where they deviate from a larger diameter to a smaller diameter. The step regions include surfaces which define a tongue and generally sickle-shaped recesses. The tongues extend in one direction of rotation of the blade. The surfaces defining the tongue form an opening angle of the order of magnitude of 30°. A retreating area of the step region disposed below the tongue and toward the smaller diameter can accommodate items of the dimensions of ordinary wine, beer, liquor bottles or bottle necks thereof. The blades are mounted on each shaft so that the step regions thereof are angularly offset against one another.

Because of the axial play, room is provided between the sides of the blades for the glass dust mentioned above. However, the axial play is still small enough so that no metal pieces can get stuck in the resulting gap which then, instead of being comminuted, would only be pulled through the apparatus whole. Because of the different number of revolutions (speeds) of the two shafts, the items to be comminuted are caused to rotate if required and as a result are chewed by the blades from different sides. The different speeds prevent sudden stresses and jamming of the apparatus. The reversing device also serves to prevent the apparatus from becoming jammed.

In one embodiment of the present invention the blades are provided with a hexagonal bore. These

blades are then mounted on a shaft which has a hexagonal circumferential configuration. In this embodiment, a substantially improved torsion connection between the blades and shaft results. However, this blade configuration is expensive to fabricate because the bore can only be produced by means of removal of material and must be carefully and slowly machined. Hexagonal shafts are more easily fabricated and commercially available in a relatively large number of different dimensions. However, they are substantially more expensive than circular shafts which can be turned much more easily, for example.

In order to obtain a substantially improved torsion connection between shaft and blade which is much less expensive, which requires no removal operations, which permits precision work where necessary to be done at relatively low cost, and which finally permits the arrangement of the blades in such a manner that their cutting tongues are offset by any desirable angular relationship, such as, for example, angles of 180°, 120°, 90° etc., other embodiments of the blades and shafts are possible. For example, the blades are provided with a cylindrical bore, with recesses provided parallel to the bore at regular angular spacings. The inner surfaces of the recesses follow a circular arc. The shaft has a cylindrical circumference and fits into the blade bore. The shaft has at least one longitudinal groove parallel to its longitudinal axis whose inner surface complements the inner surface of one of the recesses in the blade, so that together they define a cylindrical bore. A cylindrical rod is fitted into the cylindrical bore defined by the shaft groove and blade recess.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the apparatus of the present invention to scale.

FIG. 2 is a sectional view taken along 2—2 of FIG. 1, to scale, but without motor, reversing device, fill funnel and feet.

FIG. 3 is a sectional view taken along line 3—3 of FIG. 2, showing the blade groups on one of the shafts as well as part of the gearing.

FIG. 3*a* is a vertical sectional view of the gear box showing the two shafts and the meshing gearing to drive each shaft.

FIG. 4 is a sectional view, to scale taken along the line 4—4 of FIG. 2, showing the other shaft as well as part of the gearing associated therewith.

FIG. 5 is a full scale side view of a blade according to one embodiment of the invention showing the stepped region thereof.

FIG. 6 is a view of FIG. 5 as seen in the direction indicated by arrow A.

FIG. 7 is a side view of a mounted blade according to another embodiment of the invention showing the stepped region thereof.

FIG. 8 is a view of FIG. 7 as seen in the direction indicated by the arrow C.

FIG. 9 is a side view of a blade according to a further embodiment of the invention showing three stepped regions.

FIG. 10 is a view of FIG. 9 as seen in the direction indicated by arrow D.

FIG. 11 is a schematic representation of the angular offset of the stepped regions of two successively mounted blade groups.

FIG. 12 is a schematic partial view as seen in the direction indicated by the arrow B of FIG. 3.

FIG. 13 is a schematic circuit diagram of one embodiment showing the reversing capability for the drive motor.

FIG. 14 is a sectional view comparable to the sectional view according to FIG. 3, showing the blade groups on one of the shafts and part of the gearing according to another embodiment of the invention.

FIG. 15 is a sectional view for the embodiment of FIG. 14 which is the same as the sectional view according to FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The apparatus according to the present invention is supported on four legs **11**, as shown in FIG. **1**. The legs **11** support a hopper or basket **12** or the like, into which the trash to be comminuted is placed through an inlet opening **12'**; a 7.5 HP electric motor **13**, whose shaft is perpendicularly disposed with respect to inlet opening **12'**; a box **14**, in which fuses, on and off switches as well as the known reversing device are provided; a gear box **16**; a blade box **17**; and an outlet duct **18** including an outlet opening **18'**.

The gear box **16** (FIG. **2**) has an upper wall **19** and a lower wall **21** which serve as the bearing supports for a perpendicularly disposed worm gear shaft **22**. The worm gear shaft **22** has at its upper end an internal multi-edge opening or socket **23** into which the shaft of electric motor **13** fits. In the center region of the gear shaft **22** a worm **24** is provided which is seated secured against rotation in any conventional manner. A bearing **26** in the upper wall **19** and a bearing **27** in the lower wall **21** mount the worm shaft **22** to the bearing supports. Bearing **27** includes a double tapered roller bearing and can support an axial thrust load whose direction depends on the rotational direction of motor **13**.

A worm tooth gear **28** meshes with worm **24**. The worm gear **28** is mounted on a shaft **31** and secured against rotation thereon in any conventional manner. As can be seen from FIGS. **3** and **3***a*, shaft **31** also supports a smaller toothed wheel **32** to the right of gear **28**. The right-hand end of shaft **31** is mounted to be freely suspended and rotatable in a bearing **33**. The bearing **33** is screwed to the left-hand end of the cylindrical portion **34** of a hexagonal shaft **36**. Bearing **33** and shaft **31** can thus rotate independently of one another, but are coaxial.

A larger toothed wheel **37** meshes with gear **32**. The toothed wheel **37**, (FIG. **4**), is securely fastened as, for example by welding, to a hub **46**. The hub **46** is wedged on the left-hand cylindrical portion **38** of a second hexagonal shaft **39**. The cylindrical portion **38** includes a plurality of spline-type keys **38''** each of which engages a key way **46'** formed in the hub **46**. The keys **38''** are preferably press-fitted into the key ways **46'** resulting in the wedging action. For purposes of clarity, FIG. **4** does not show the worm **24** or the worm shaft **22**. The cylindrical portion **38** is stepped toward the left and terminates in a reduced diameter extension **38'** which is supported in a bearing **41** of sidewall **42** of the gear box **16**. At its other end, the cylindrical portion **38** passes through the right sidewall **44** of the gear box **16** and is there supported in a bearing **43**. The hub **46** includes a smaller gear **47** which is integrally formed

thereon. The gear **47** thus rotates at the same speed as gear **37.** The gear **47** meshes with a larger gear **48** which, however, has a somewhat smaller diameter than gear **37.** The gear **48** is wedged on the cylindrical portion **34,** (FIG. 3), in a manner similar to that of hub **46** on cylindrical portion **38.** It is thus possible to substantially reduce the number of revolutions of motor **13** and to drive the two hexagonal shafts **36** and **39** in opposite directions and at a different speed. Also, it is possible to have a ratio of shaft revolutions of approximately 40:70, for example. Of course, it should be understood that other ratios may be achieved as desired.

The gear box **16** can, for example, have a width of 19 cm, an inner height of 22.5 cm and an inner length of 59.5 cm. The gear box **16** is designed to be oil tight so that the gearing can be splash lubricated from the sump level **49.** This gear box construction has been found to successfully withstand the high axial and radial forces which develop during the comminuting operation.

The blade box **17** has a stable frame structure which is open at the top to receive the trash from the hopper **12,** and opened at the bottom to discharge the comminuted trash to the outlet duct **18.** The frame structure includes the sidewall **44** which forms a party wall with the gear box **16.** The three remaining walls **51***a*, **51***b* and a third, not shown, are generally U-shaped or channel beams which are preferably welded together. FIG. 3 shows in cross-section the channel **51***b* which is exemplary. The channel **51***b* includes, typically, a web portion **52** and flanges **52***a* and **52***b*. The upper flanges of all three walls are joined in a conventional manner such as through the use of bolt joints with a corresponding three-sided flange portion (not shown) of the hopper **12.** The U-shaped beam **51***b* is provided in its web portion **52** with two bearing supports **52***c* and **52***d* (the latter shown in FIG. **15**) for the end pins **53** of the two hexagonal shafts **36** and **39** and their associated bearings **53***a* and **53** *b* (the latter shown in FIG. **15**). Each hexagonal shaft **36** and **39** bears fourteen blades **54** which are preferably similarly configured and which are each combined into groups of two **56, 57, 58, 59, 61, 62, 63.** For reasons for simplicity, FIG. **3** shows only the blade groups of the hexagonal shaft **36.** These blade groups are spaced apart by spacer sleeves **64,** which are all of the same dimension, but which are wider than the width of a blade group which are preferably 15 mm in width, by the degree of axial play of one of the shafts **36.**

It should be noted at this time that the degree of axial play is not shown in FIG. **12** because it is of such a small magnitude in comparison to the size of the elements shown. Pressure rings **66** and **67** axially pretension the entire arrangement of the blade groups and the spacer sleeves **64** when assembled as shown in FIG. **3,** so that any axial displacement on the hexagonal shaft **36** is substantially eliminated.

Referring to FIG. **12** it can be seen that an qual number of blade groups **68** on the hexagonal shaft **39** are provided. These blade groups fit into each interstice between adjacent blade groups on shaft **36** so that a gap opening **69** remains through which the comminuted material can fall downwardly and through outlet opening **18'**.

In one embodiment of the present invention, the blades **54** have the shape illustrated in FIGS. **5** and **6.** In this embodiment the blades **54** have a hexagonal opening or bore **54'** which is adapted to fit in a conforming manner on the hexagonal shafts **36** or **39.** The hexagonal shafts are intentionally hardened so that their toughness index will be enhanced. The shafts **36** and **39** are made from an unhardened chromium steel, preferably 12 percent chromium steel. In contradistinction, however, the blades **54** are hardened to a Rockwell hardness of **60-62.** The blades **54** are made from a material identified by the number 2090 according to DIN (Deutsche Industrie Normen, German Industrial Standards), which is a 12 percent chromium steel.

From point **72** to point **73,** i.e., over an angle of 200°, the peripheral surface **74** defines a circular region **74'** of the blade with a radius of 140 mm. The peripheral surface **76** which follows point **73** in a clockwise direction also follows a circular path whose center **77** is offset downwardly by 29 mm and to the right by 34.5 mm with respect to center **78.**

A region **76'** defined by the peripheral surface **76,** when viewed from the center **78,** has a continuously increasing radius. A step region **79'** follows the region **76'** and includes a tongue **79.** The tongue **79** has a planar upper surface **81** which is perpendicular to the plane of the drawing and a lower surface **82** which is also planar but is inclined downwardly at an angle of 10° perpendicularly to the plane of the drawing. The surface **82** is preferably ground. From the tip **83** of the tongue **79** to the beginning of region **74'** at point **72,** a recess **84** is formed in the approximate shape of a sicle. This recess **84** forms the receding portion of the step region **79'**. More precisely, the ground surface **82** transitions into a curved surface having a radius of 15 mm and extending through an arc of approximately 120°, and this curved surface blends into the surface **86,** which is perpendicular to the plane of the drawing and which in turn extends to point **72** of region **74'**.

The vertically measured distance between surface **86** and the tip **83** of tongue **79** is 40 mm, while the surface **81** forms an angle of 75° with respect to the vertical (FIG. **5**). Except for the surface **82** and a portion of the adjacent curved surface having the radius of **15** mm nothing is ground along the circumference of blade **54.**

Edges **88** and **89** are rounded so that they are not very sharp. The side surfaces **91** and **92,** however, are ground to be plane and parallel, the thickness of the blades being preferably 15 + 0.01 mm. The opening angle of the tongue **79** defined by the surfaces **81** and **82** is preferably 30° as shown in FIG. **5.** It has been found that variations of this angle up to ± 20 percent are acceptable.

The approximately 30° angle is important particularly when comminuting metal. On the one hand, it prevents the forces produced by the entrance of the metal from increasing too rapidly, which would be the case with larger angles, such as e.g., 50°; while on the other hand, the angle is sufficiently large to effectively produce a large hole in the metal sheet and also large enough so that it can be pulled out of the metal sheet during each reversing process. A tongue with too small an angle would more easily penetrate into the metal, but would have difficulty in being withdrawn from the hole during reversal.

In the other embodiment of the present invention which is illustrated in FIGS. **7** and **8,** blade **110** has the shape of blade **54** shown in FIGS. **5** and **6,** but blade **110** has a cylindrical bore **112** which is concentric with center **111.** Blade **110** also has parallel surfaces **127**

and **123'**, which like blade **54** and 40 mm apart. Recesses **113, 114,** and **116** are provided at an angular offset with respect to each other according to the relationship $360°/n$, where $n = 2, 3, 4$ etc., and is preferably **3.** The inner surfaces **117** of the recesses follow a circular arc of approximately 200°. The distance of the center **118** of all recesses **113, 114, 116,** from center **111** is the same. In the embodiment illustrated, the center **118** is disposed on the extension of the inner surface of the bore **112.**

A cylindrical shaft **119** is provided which corresponds to the hexagonal shafts **36** and **39** and which has a diameter such that it can be inserted through the bore **112,** so that all blades **110** can be disposed thereon. The shaft **119** has a longitudinal groove **121** which extends over the entire length of the shaft over which the blades **110** are to be mounted. As is shown in FIG. **7,** the groove **121** supplements with its inner surface the inner surface **117** of recess **113** to form a circular bore **121'**. Thus, when recesses **113** and longitudinal groove **121** are congruent to form the bore **121'**, a cylindrical rod **122** can be placed therethrough so that shaft **119** will carry the blade in both directions of rotation of the shaft. For the next blade **110,** the recess **116** supplements longitudinal groove **121**; for the blade **110** after that, recess **114** supplements longitudinal groove **121,** etc., so that tongues **123** of blades **110,** which are designed in the same manner as tongues **79** of blades **54** and which here have an opening angle of 30° ± the variation stated above, are offset with respect to one another by a preferred angle of 120°. Preferably, the bore **121'** is formed such that more than one-half of the bore is within the blade body.

Alternatively, additional longitudinal grooves **121***a* and **121***b* could also be provided at the periphery of shaft **119** parallel to the longitudinal groove **121** and offset by 120° so that additional bores may be formed with recess **114** and recess **116.** It must be noted here, however, that any practical number of additional grooves and resulting bores are possible, but that too many longitudinal grooves would not be desirable since they would tend to weaken the shaft **119.** This would also have the drawback that the longitudinal grooves would have to be manufactured on a machine with graduated circle devices since the angular offset of 120° or the like must be precise. If, however, only a single longitudinal groove **121** is provided these angular relationships need not be of concern.

During the manufacturing process, holes are first drilled to correspond to the recesses **113, 114** and **116.** Then bore **112** is drilled and worked with a reamer, if required. The only tool required is thus a drill.

With respect to the rod **122,** the shaft **119** and the blades **110** or **125,** it has been found that a rod diameter of 15 mm ± 4.5 mm, a shaft diameter of 40 mm ± 12 mm and a blade width of 280 mm ± 42 mm is preferable.

The blade **125** which was fabricated according to a further embodiment of the present invention as illustrated in FIGS. **9** and **10** is carried along in a form-fitting manner by shaft **119.** However, it has three tongues **123,** each offset by 120°. The blade **125** has, therefore, the general outline of a triangle with regions each having a surface **124** which lies on a circular arc and having the same length partly defining the sides of the triangle. From the three tips **126** which later from the tip of the nose and which are designed to be cutting edges, areas **127** recede.

The surfaces **127** and **128** define a recess **127'** which is generally sickle-shaped and which is large enough so that it can hold bottle necks and the like. The back of the tongue **123** is a smooth continuation of the surface **124.** Tongue **123** of blade **125** like blades **54** and **110** opens at an angle of 30° ± the variation stated above. Tongue **123** may be undercut in the same manner as tongue **79** of blade **54** to an angle of 10° to form the surface **128.**

Each one of the blade groups has the individual blades **54, 110** or **125,** respectively, arranged next to one another without spacings therebetween so that the tips **83** or **126** of the step regions **84** or **127'** of the tongues **79** or **123** are offset by 180°. This explains why in FIG. **3** the right-hand blades extend higher than the left-hand blades, while the left-hand blades protrude lower than the right-hand blades. Each blade group is offset by 60° with respect to the next blade group.

Let us now consider the tips **83** or **126** of the tongues of the right-hand blades **54** or **110** of each blade group **56-63.** For example, the tip of the tongue of one blade for the blade group **56** is on a radius **93,** (FIG. **11**), and the tip of the tongue of a corresponding blade for the blade group **57** is on a radius **94** etc. The angular deviation is preferably 60°. The preferably 60° deviation continues with succeeding blade groups until the tip of the tongue of a corresponding blade for the blade group **63** lies on radius **93.** This then results in the schematic arrangement shown in FIG. **11.**

The spacing between the hexagonal shafts **36** and **39** or of the cylindrical shafts **119** is such that with a given blade configuration, the blades always overlap and define an overlap portion **95,** as shown in FIG. **12.**

This has the result that the blades on one shaft can be guided laterally, i.e., parallel to the shaft axis, by the blades on the other shaft and that no common gap opening along the hexagonal shafts **36** and **39** or along the cylindrical shafts **119** appears, except the limited gap openings **69,** as shown in FIG. **12.**

The shafts **36, 39** or **119** preferably have a center spacing of approximately 130 mm. The distance between the parallel sides of the hexagonally configured shafts **36** and **39** is preferably 41 mm.

The peripheral surface **76** makes it possible for a blade to remain in engagement as long as possible with an adjacent blade on the other shaft. Metal cans or the like are then not only crushed but also cut apart. It is insignificant which shaft receives the axial play.

However, both shafts must not have the axial play.

Blades **125** are also arranged in blade groups and are arranged to be offset with respect to one another by 60° within the blade groups in a corresponding manner to blades **54** and **110.**

A motor of 7.5 HP was selected for the embodiments. The motor permits the use of sufficiently long hexagonal shafts **36** and **39** or cylindrical shafts **119** for the gears employed so that fruit crates can be thrown whole into the hopper **12** and need not be broken up first. The motor **13** is also able to produce a torque which produces, with respect to the moment arms between the recesses **84** or **127'** and the geometrical longitudinal axis of the shaft, moments sufficient to effect the desired comminution, Standard motors with 4 or 10 HP cannot be used because the 4 HP motor would not be powerful enough and the 10 HP motor would be too

powerful. An apparatus which would be provided with a 10 HP motor would be too cumbersome for the intended purposes. A 7.5 HP motor is fed with 15 amperes. This is a value which can be handled by normal electrical lines.

The point at which motor reversal takes place can be made time or torque dependent. With respect to time dependent reversals, one would only require a clock, which would switch the motor, for example, every five minutes into a reversal of rotation. Also, a revolution counter could also be used so that the motor could be reversed, for example, every 10 revolutions.

With respect to torque dependent reversals, one could measure by how many angular degrees the ends of shaft **31**, for example, are twisted with respect to one another and the reversal could be effected when a certain torsion has been reached. Also, it has been found that with a strong load, the 7.5 HP motor requires **12** amperes of current and that from this point on the motor rotation should be reversed. Since the current through the motor is proportional to the torque, the current can also be used as a criterion under the torque dependent category. In this regard consider, for example, the circuit diagram of FIG. **13**. A current coil whose armature is attracted whenever the current through the motor winding has reached a certain level, for example **12** amperes, is connected in the lead to the motor winding. The armature controls a bistable member which produces the pulses shown at its output. With these pulses the polarity reversing switch is controlled from the solid line position to the dashed line position.

Another embodiment of the invention is shown in FIGS. **14, 15,** in which portions which are the same as corresponding portions in FIGS. **3** and **4,** are designated by the same reference numerals. It has been found that for certain comminuting applications, such as comminuting tires, axial play in one shaft of up to approximately 0.2 mm produces advantageous results. Additional axial play is achieved over the embodiment described with reference to FIG. **3** by supporting the shaft **36'** by bearing **53***a'* which is larger than bearing **53***a* in the embodiment of FIG. **3.** The bearing **53***a'* supports end pin **53'** and is in turn supported within bearing support **52***c'*, each of which is correspondingly larger to accommodate the larger bearing **53***a'*. As is well known, the larger the radial ball bearing, the greater the degree of axial play of the bearing and the axial play of the shaft supported by the bearing. The bearing **53***a* supporting the shaft **36** in the embodiment of FIG. **3** is large enough to permit the shaft **36** to move through the distance allowed by the spacing between the blades on the other shaft **39,** and the larger bearing **53***a'* will permit the shaft **36'** to move through the greater distance of 0.2 mm allowed by the spacing between the blades on the shaft **39** in this embodiment.

In this embodiment the additional axial play is accommodated in a machine of similar size to the machine described with reference to FIG. **3** by providing a single blade **54** at the end blade position **63'**. The blade groups are spaced apart by spacer sleeves **64'** which are of the same axial dimension, but which are 0.2 mm wider than the width of the blade group. The difference, in the order of approximately 0.2 mm, corresponds to the limits of axial play allowed on one of the shafts **36'** relative to the other shaft **39.** The blade groups on one shaft **36'** fit into each interstice between adjacent blade groups on shaft **39.** The spacing between the hexagonal shafts **36'** and **39** is such that with the given blade configuration the blades **54** always overlap and define an overlap portion. Thus, as described in connection with the embodiment of FIG. **3,** the blades on the one shaft **36',** having axial play, can be guided laterally, i.e., parallel to the shaft axis, by the blades on the other shaft **39** with relatively no axial play.

The degree of axial play of shaft **36'** is limited, as in the embodiment of FIG. **3,** by the blades on the fixed shaft **39** and the axial play on the shaft **39** is limited to substantially no axial play in relation to shaft **36'** as in the embodiment of FIG. **4,** by the size and arrangement of the bearings supporting the shaft **39** because the embodiment shown in FIG. **15** is exactly the same as in FIG. **4.**

Shaft **39** is a solid shaft end to end. It is supported at three places by bearings **140, 141** and **53***b*, each of which is a different size, the end bearing **140** is bearing support **41** being substantially smaller than the other bearings **141** and **53***b* as well as the bearings supporting shaft **36.** The inherently small axial play of the small end bearing **140** is further limited by the bearing support **41** and substantially all of the axial play is eliminated from the shaft **39** by the spaced arrangement of the bearings **140, 141** and **53***b* along the shaft **39,** which produces forces and bending moments on the bearings **140, 141** and **53***b* in response to the comminuting forces on the blades **54.** In particular, substantially all of the axial play on the shaft **39** is eliminated by the small bearing **140,** which is remote from the blades **54** and in which the inner ring of the bearing is moved radially by the comminuting forces on the blades **54** acting about the bearing **141.**

It should be understood that the axial play can be substantially eliminated by other means in addition to the means described above.

It is advantageous if the engagement force exerted by the blades **54** on one shaft **36'** against the adjacent blades on the other shaft **39** is limited so as not to exceed the force appropriate for smooth cutting engagement between the adjacent blades.

It is also advantageous that with the adjacent blades in engagement along one face, the maximum gap between adjacent blades along the opposite face is not so large that the material will be stuffed and chocked down between the faces, but is limited to a gap size appropriate to break up the material without choking down the machine.

To these ends, the bearing cap **29'** has a threaded axial hole **131** which receives a set screw **132** having a locking nut **133** thereon.

The end of the set screw abuts and presses against a spacer **134** which, in turn, presses against the outer ring of a bearing **136** supported in the bearing cap **29'**. The bearing **136** supports the end pin **135** of gear shaft **31.** The shaft **36'** is supported in gear box **16** by bearing **130** which is supported by a seal ring **138.** A spacer ring **137** is secured to the seal ring by screws **137** one of which is shown. The spacer ring surrounds the cylindrical portion **34** of the shaft and is spaced slightly from the gear **48.**

Tightening the set screw **132** against the spacer **134** reduces the play and movement of the bearing **136** to the left as shown in FIG. **14** and limits and controls the

play of the shaft **36'** to the left and hence the cutting force and space between the blades in that direction.

As in the embodiment of FIG. **4**, the play of the shaft **36'** to the right is limited by movement of the blades **54** on the shaft **36'** against the blade **54** on the shaft **39'** which limits and controls the cutting force and the space between the blades in that direction. Hence, the setting of the set screw **132** in relation to the blades **54** on the fixed shaft **39** controls the degree of axial play of the shaft **36'** to limit the force of engagement between the blades on one shaft **36'** and the adjacent blades on the other shaft **39** to a smooth cutting force and the space between adjacent blades along their opposite faces to a space advantageous for comminuting the material, in this embodiment about 0.2 mm.

The setting of the set screw **132** can also be used to adjust the degree of axial play on the shaft **36'** as may be necessary from time to time.

What is claimed is:

1. Apparatus for comminuting trash comprising:

a. a motor;

b. at least two parallel shafts driven at least indirectly by said motor;

c. a plurality of disc-shaped blades disposed on each of said shafts and secured thereto for rotation therewith, each of said blades having at least one tongue extending into the direction of rotation and at least some of the blades on each of said shafts being spaced from adjacent blades on the same shaft, with the blades on one shaft extending into the spaces between blades on the opposite shaft;

d. means for rotatably supporting one of said shafts so as to have at least a predetermined degree of axial play parallel to said shaft associated therewith;

e. means for rotatably supporting the other of said shafts so as to have substantially no axial play associated therewith relative to the one shaft, and

f. the blades on one shaft extending into said spaces on the other shaft with a clearance equal to said predetermined degree of axial play.

2. Apparatus for comminuting trash according to claim **1** in which said blades are disposed at regular intervals on each of said shafts in groups of at least two blades and arranged so that the blade groups on one shaft extend into the spaces between the blade groups of the other of said shafts and the tongues of the blades on each of said shafts being angularly offset with respect to each other.

3. Apparatus for comminuting trash according to claim **2** comprising

a. means for reversing the rotation of both of said shafts;

b. an inlet above said blades; and

c. an outlet below said blades.

4. Apparatus for comminuting trash according to claim **2** in which the inner distance between two adjacent blade groups on the shaft having relatively no axial play associated therewith is equal to the degree of axial play plus the width of the blade group on the shaft having a degree of axial play associated therewith.

5. Apparatus for comminuting trash according to claim **2**, in which the tongues of said blades on each of said shafts are helically offset with respect to each other along that shaft.

6. Apparatus according to claim **2** wherein the degree of axial play is approximately 0.2 mm and wherein a spacer sleeve is provided which is wider than any group of blades by the amount of said degree of play.

7. Apparatus for comminuting trash according to claim **1** in which the inner distance between adjacent spaced blades on the same shaft is equal to the degree of play plus the width of the blades on the other shaft extending into the space between said blades.

8. Apparatus according to claim **1** comprising means on the blades on the shaft having relatively no axial play associated therewith for guiding the blades on the other shaft parallel to the axis of said other shaft.

9. Apparatus according to claim **8** in which said blade means comprises flank portions on the blades on each shaft for engaging and defining an overlap portion with the adjacent blades on the other shaft.

10. Apparatus according to claim **1** comprising means on said blades for enabling the blades on one shaft to remain in cutting engagement with the blades on the other shaft beyond said tongue.

11. Apparatus according to claim **1** comprising means for limiting the force of engagement between the blades on the shaft having axial play associated therewith and adjacent blades on the shaft having relatively no axial play associated therewith, said engagement force limiting means comprising means for limiting the axial play on the shaft having axial play associated therewith.

12. Apparatus according to claim **11** comprising bearing means for supporting said shaft having axial play associated therewith and said limiting means comprises means for adjusting the position of said bearing means.

13. Apparatus according to claim **12** in which said means for adjusting said bearing means position comprises means axially disposed with respect to said shaft having axial play associated therewith for limiting the movement of said bearing means in one direction.

14. Apparatus as defined in claim **1**, wherein said shafts have a center spacing of approximately 130 mm.

15. Apparatus as defined in claim **1**, wherein said shafts have a hexagonal circumferential configuration, and have a width between parallel sides of 41 mm and consist of non-hardened chromium steel, preferably 12 percent chromium steel.

16. Apparatus as defined in claim **1** wherein each blade group comprises two blades which are arranged next to one another without spacings therebetween and whose step regions are offset with respect to one another, preferably by 180°.

17. Apparatus as defined in claim **1** wherein even groups of blades which are each substantially 15 mm wide are provided on each shaft.

18. Apparatus according to claim **1** wherein the degree of axial play is in the order of magnitude of 0.2 mm.

19. Apparatus according to claim **1** wherein the degree of axial play is up to 0.2 mm.

20. Apparatus as defined in claim **1**, wherein the numbers of shaft revolutions have a ratio of approximately 40:70.

21. Apparatus as defined in claim **3**, wherein the actuation of said reversing means is torque dependent.

22. Apparatus as defined in claim **1**, wherein said shafts have comminuting lengths of approximately 40 cm and the gearing includes a worm meshing with a

worm gear, the worm gear mounted on a shaft which has mounted thereon and secured against rotation relative thereto a smaller toothed wheel which meshes with a larger toothed wheel of the other shaft, and a second smaller toothed wheel being disposed on the other shaft and secured against rotation relative thereto which meshes with a second larger toothed wheel of said shaft, said worm being driven by a motor which is an approximately 7.5 HP motor.

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