United States Patent [19]

Berkowitz et al.

[11] **3,831,748**

[45] **Aug. 27, 1974**

[54] **TRASH SEPARATING APPARATUS**

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[22] Filed: **Feb. 14, 1972**

[21] Appl. No.: **225,852**

Related U.S. Application Data

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[52] **U.S. Cl.** **209/12,** 209/129

[51] **Int. Cl.** **B03b 7/00,** B03c 7/08

[58] **Field of Search** ..... 209/12, 129, 1, 2, 127 R, 209/127 A, 127 B, 127 C; 241/79

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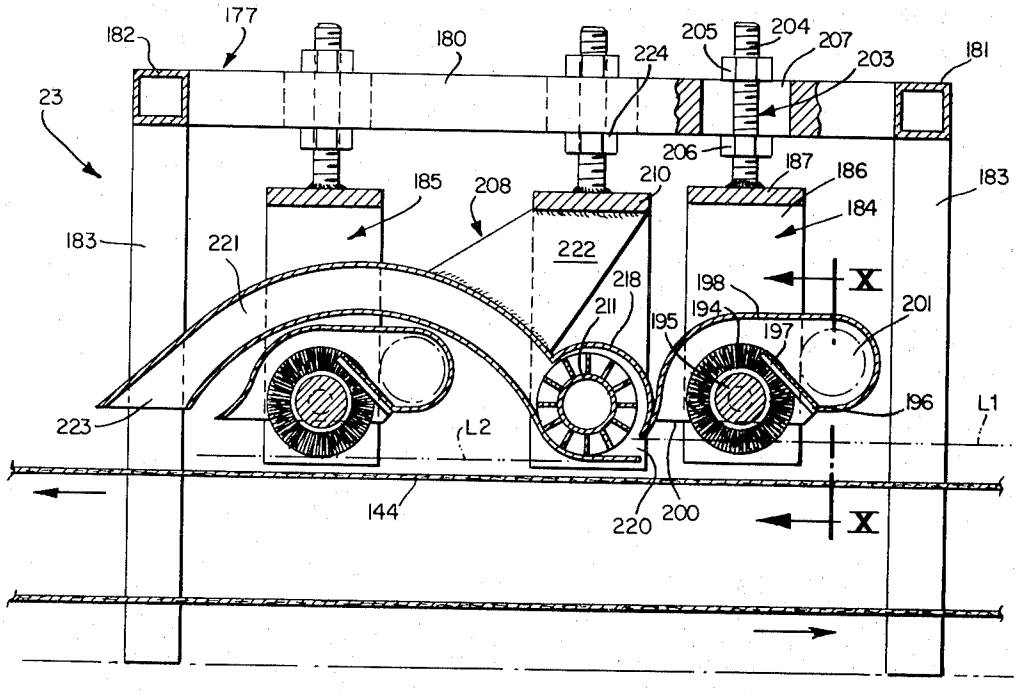
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Attorney, Agent, or Firm—Paul & Paul

[57] **ABSTRACT**

A conveyor transports a mixture of shredded paper materials and film along a predetermined path. Spaced electrostatically charged rotary brushes extracts the film from the mixture. A comb removes the film from the brushes and an exhaust duct carries off the thus removed film. An impeller intermediate the brushes removes the paper material and deposits it again on the conveyor downstream of the second brush.

3 Claims, 13 Drawing Figures



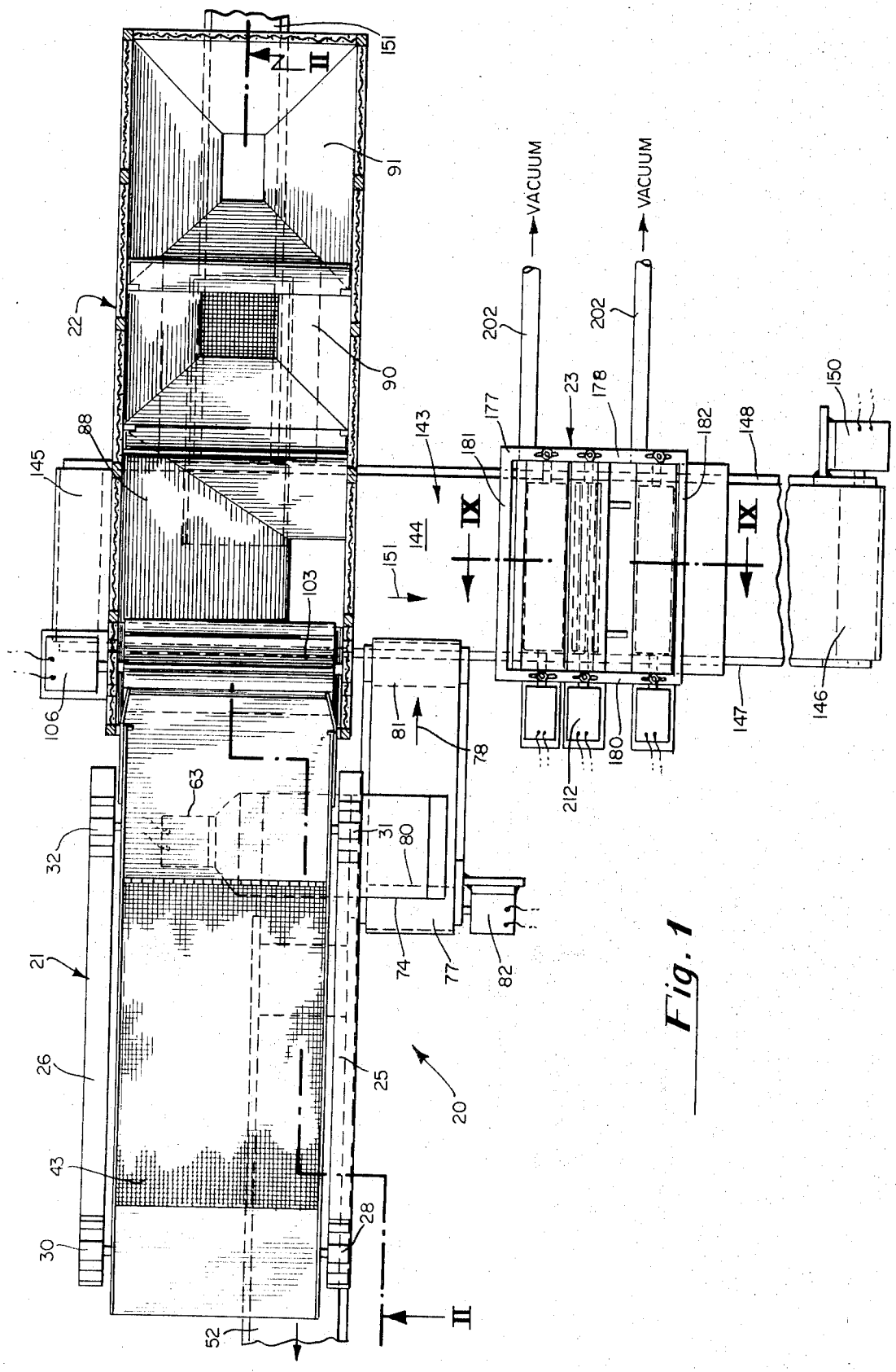
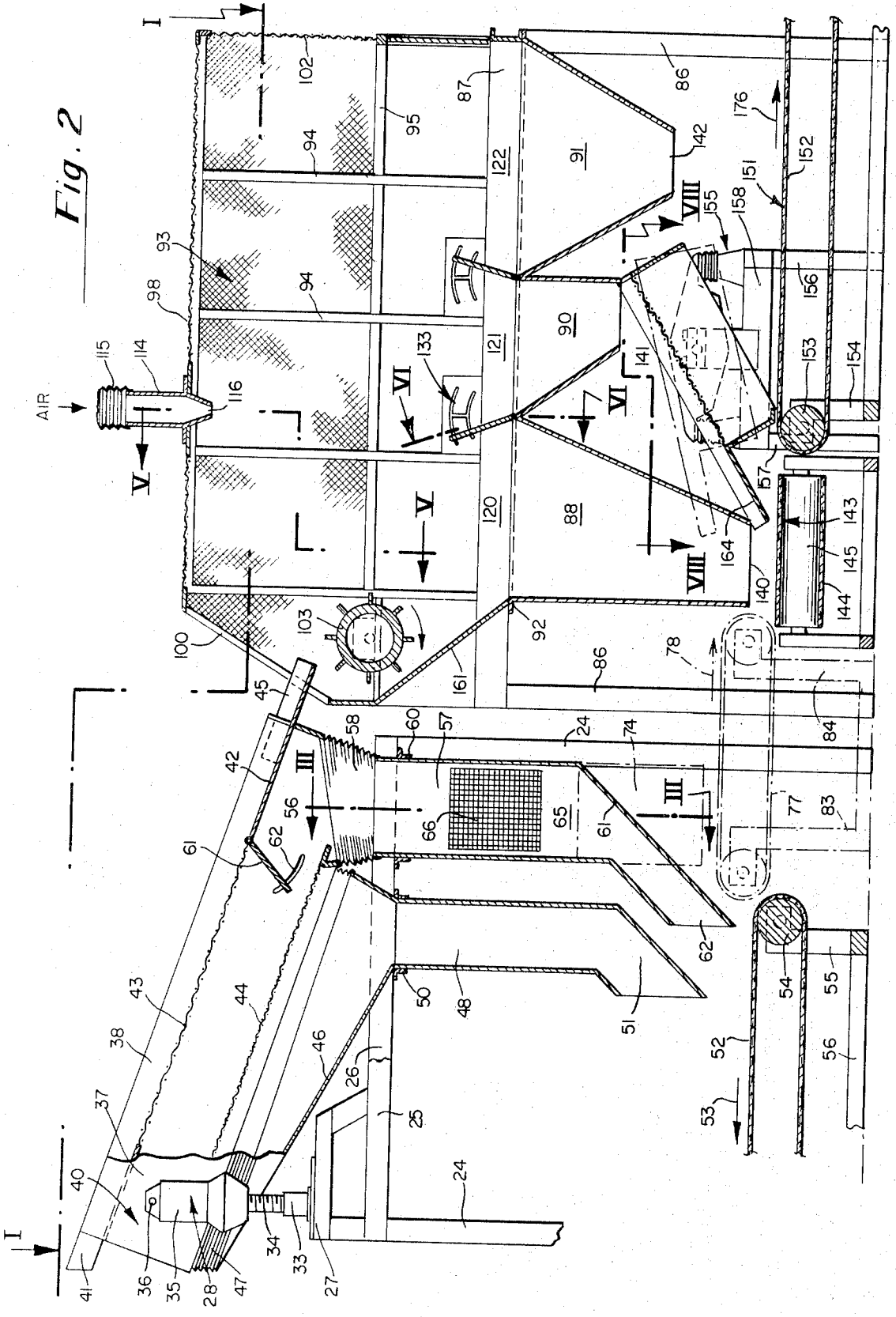

VACUUM
VACUUM
II
II
IX
IX
151
91
90
22
88
145
143
144
103
106
63
32
21
26
43
30
28
52
25
20
81
78
74
77
82
31
80
212
180
147
146
148
182
178
177
181
23
202
202
150

Fig. 1

Fig. 2


I
II
III
V
VI
VIII
AIR
102
87
86
95
94
122
91
142
176
152
151
155
158
93
98
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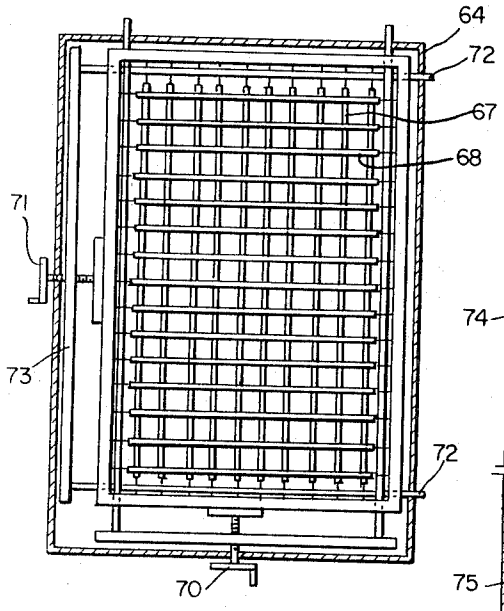


Fig. 4

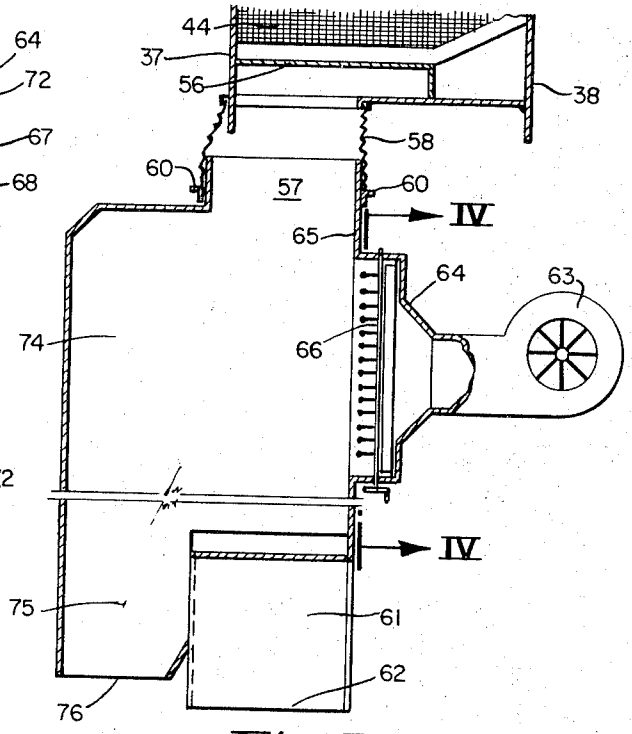


Fig. 3

Fig. 6

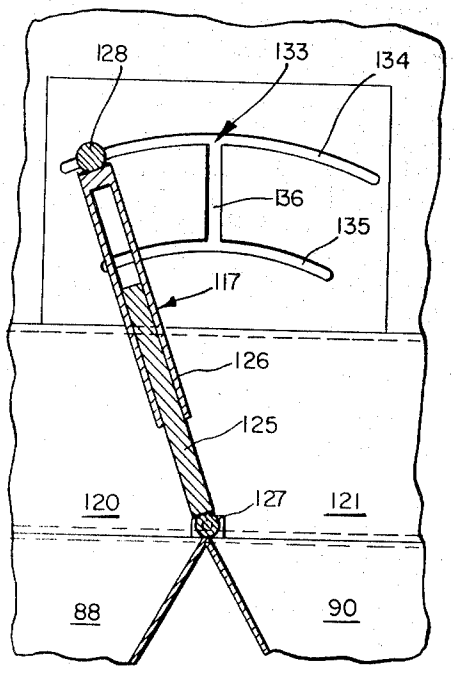
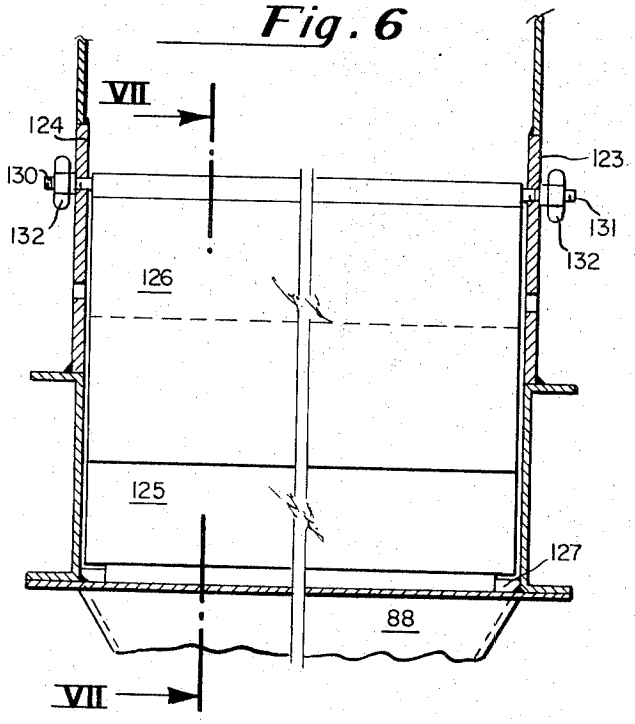


Fig. 7



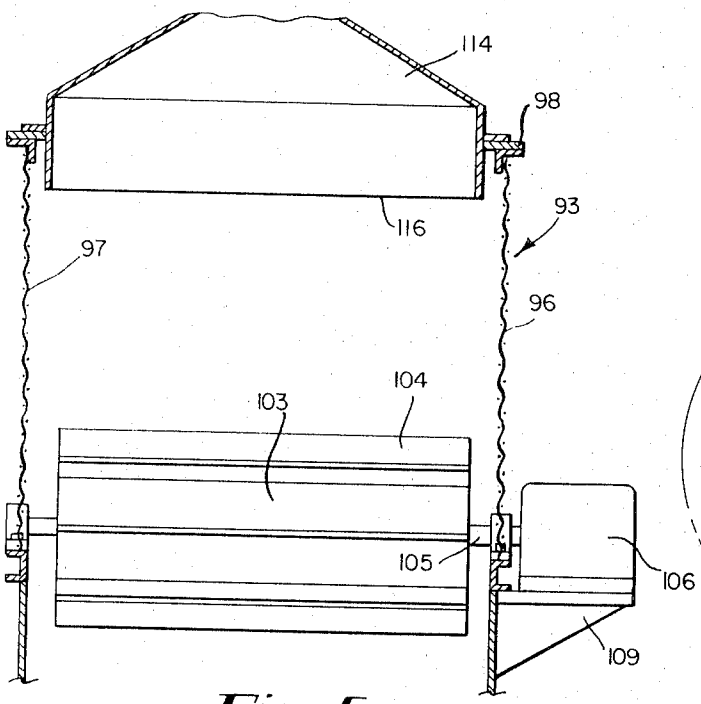


Fig. 5

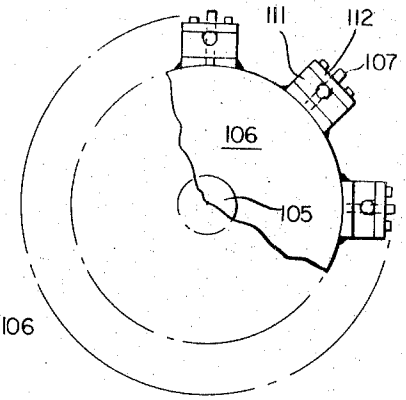


Fig. 12

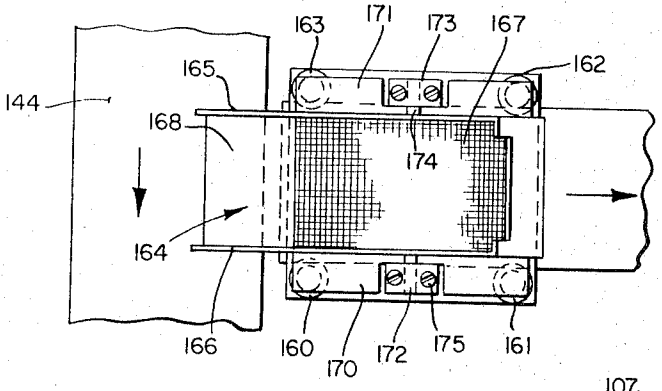


Fig. 8

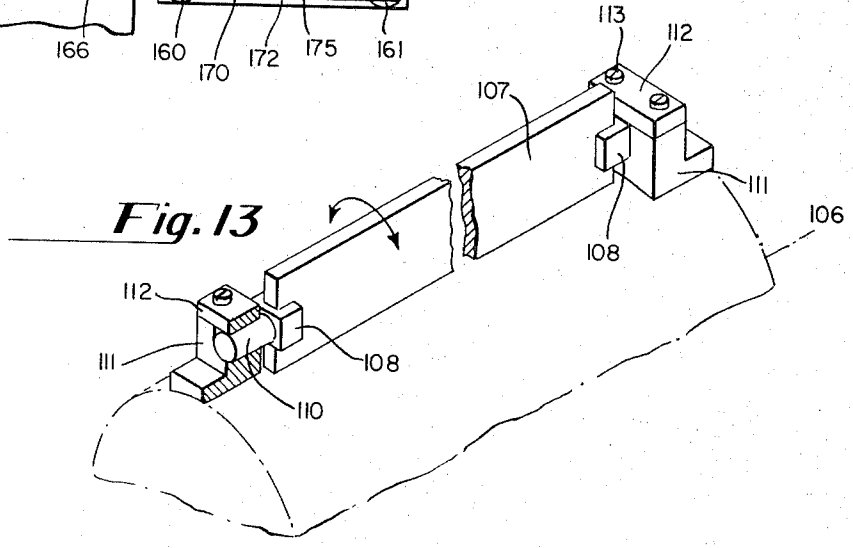


Fig. 13

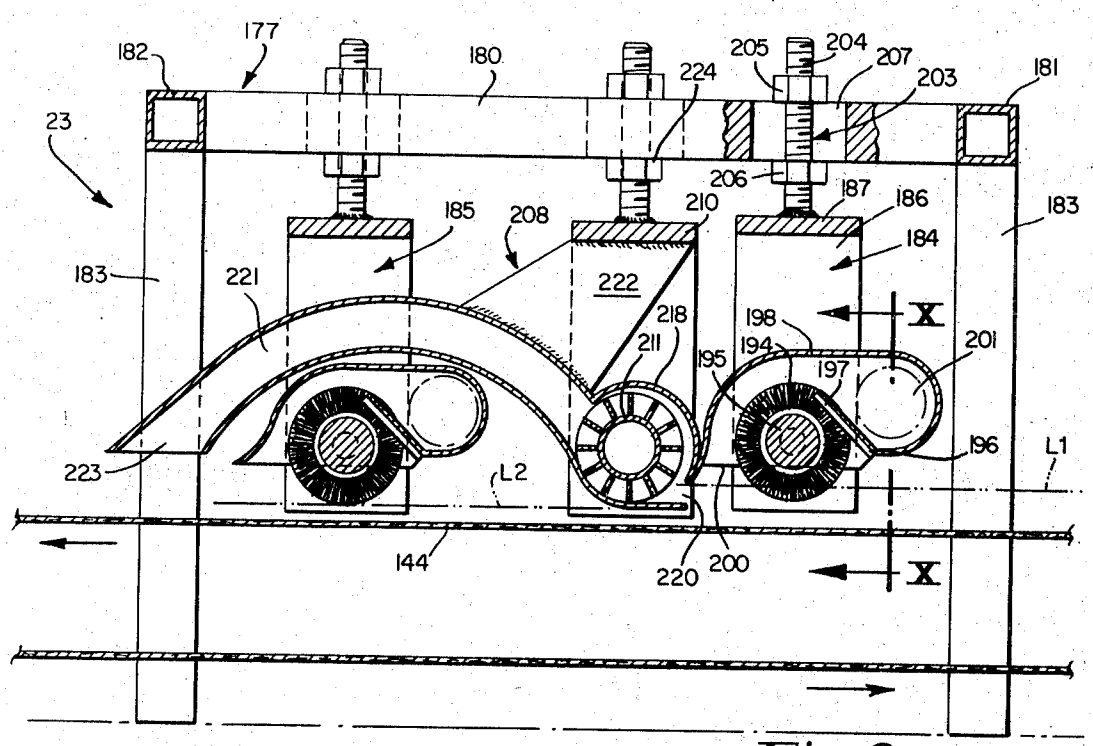


Fig. 9

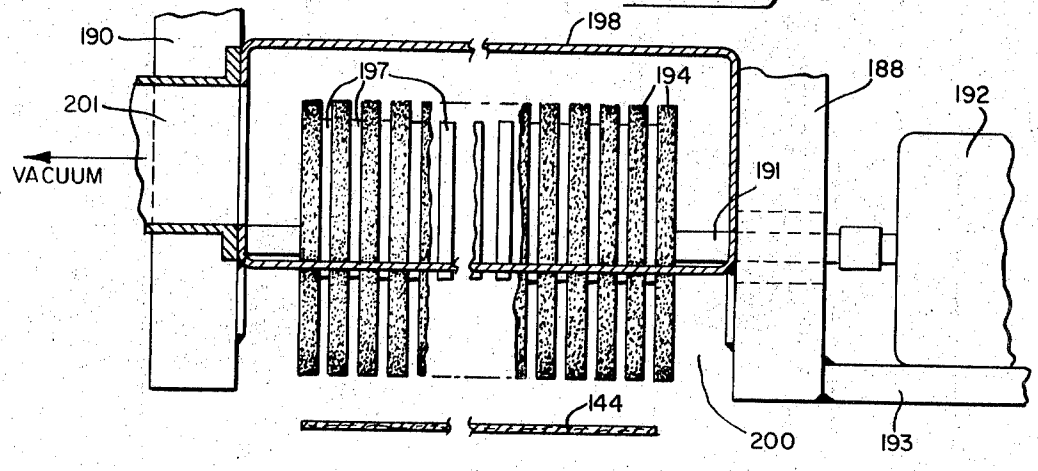


Fig. 10

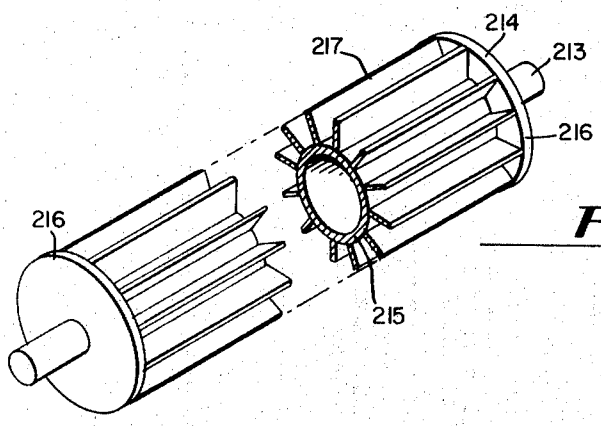


Fig. 11

TRASH SEPARATING APPARATUS

This is a division of Application Ser. No. 846,320, now U.S. Pat. No. 3,643,797 filed July 31, 1969.

The lighter of these larger particles are collected in a bin which is located most closely to the trash wheel, which bin deposits these lighter particles onto the conveyor. Trash which is thrown into an intermediate bin is deposited onto another sloped vibrating screen, whereby larger paper materials are separated from smaller but heavier trash components such as heavier plastics, with the thus separated paper materials also passing onto the conveyor. The conveyor then passes beneath an extractor which removes sheet plastic films and the like therefrom, preferably by means of electrostatic attraction of the plastic films from the paper materials, resulting in paper reclamation having an acceptable minimum percentage (if any) of non-paper materials therein.

BACKGROUND OF THE INVENTION

With increased technology in general, there is an ever-increasing demand for paper products. In contrast to this, there is an ever-decreasing supply of raw materials from which paper may be made, notably, forestry preserves. Consequently, there has been a constantly increasing demand for salvaging waste paper products for reclamation and reuse by the paper making industry. Furthermore, due to increased population, as well as due to increased use of new paper products, there has been a large increase in solid waste generation which, itself, presents an additional problem of growing concern-namely, how to dispose of solid wastes. A estimate of the percentage of paper trash included in solid wastes is 50 percent. Thus, it is recognized that a practical means of reclaiming paper from a heterogeneous mixture of solid waste would be highly desirable in that such would approach a solution to the double problem of providing the paper making industry with usable materials and of eliminating by a factor of approximately 50 percent the problem of disposal of solid waste.

With respect to solid waste disposal, various approaches have been made in the recent past, some of which have been directed toward pulverizing and pulping solid wastes for delivery into sewage systems. However, such approaches have generally not been concerned with the desirability of reclaiming paper materials from such wastes, but have, in fact, generally made more difficult any such reclamation, in that they attempted to reduce all waste into a homogeneous mass, for later introduction into sewage systems which would in turn tend to contaminate the water supply, or for later burning, which itself may be undesirable in view of the tendency of the same to contaminate the atmosphere. Other systems of trash disposal contemplate burying the trash, or using the same as landfill, which is undesirable, at least from the standpoint that usable paper components are thereby lost.

The separation of paper from trash is too large and difficult an operation to lend itself toward separation by hand, in that such manual separation techniques are undesirable from an economic standpoint. Other separation and classification techniques, nonanalogous to the waste separation problem are not desirable, in that they do not lend themsleves toward the particular problems of separating paper from a highly heterogeneous mixture, containing many substances which are similar in various respects to paper but yet are sufficiently different therefrom to be considered contaminants with respect to reclaimed paper that is usable in the paper making industry.

There have been developed, in conjunction with other techniques for reduction of trash volume and the like for ease of handling, various devices and processes for shredding all trash into desirably sized components, without regard to the nature of the trash materials. Such shredding devices are generally capable of handling all consumer trash, including automobiles, refrigerators, large wooden items, in addition to conventional domestic trash. Thus, such shredding devices generally produce a heterogeneous mixture of trash within a limited size range, such mixture however containing a wide spectrum of material components, as well as various sizes of shredded material within a given range. Generally, a preliminary extraction process is followed prior to such shredding techniques, for the removal of substantially all ferrous metals from the shredded trash, by conventional magnetic attraction techniques. Thus, large portions of metalic components are readily removed from the shredded trash. This yields a shredded trash mixture that is substantially free of ferrous metallic components, that contains glass, hard plastics, soft plastic films, non-ferrous metallic components, a small percentage of ferrous metallic components not removed by magnetic attraction, rubber and like material components, as well as paper trash components. Other material components may also be present. Thus resultant trash is sized within a given range by the preliminary shredding process.

The problem to which the present invention is addressed is the reclamation of paper materials from this pre-shredded trash which already has the bulk of ferrous metalic components removed therefrom.

SUMMARY OF THE INVENTION

The present invention is directed toward solving the above-mentioned problems of efficiently reclaiming paper from mixed shredded trash, as well as toward reducing the problem of trash disposal by providing a means for removing a high percentage of the trash (the paper materials) therefrom.

A system is provided for taking the mixed preshredded trash and for screening the same for size classification. Smaller sized components are then weight-classified whereby paper and other light components are removed therefrom. The larger size-classified components are then weight-classified, as for example by being thrown into one of a group of bins by a trash wheel or the like, with the lighter ones of the trash components being collected in one or more suitable bins from which they are deposited onto a conveying device, in conjunction with the lighter ones of the smaller sized-classified components, followed by an extraction of plastic film and like particles, to yield substantially only paper trash.

Accordingly, it is a primary object of this invention to provide an apparatus for performing the above-mentioned size-classifying and weight-classifying techniques, in conjunction with the extraction technique.

It is a further object of this invention to provide a novel method for accomplishing the above- mentioned size-classifying, weight-classifying, and extraction techniques.

It is a further object of this invention to provide a novel classification apparatus utilizing a sloped vibrat-

ing screen type size classification, along with an air stream type of weight classification technique.

It is another object of this invention to utilize a weight-classification technique wherein a heterogeneous trash mixture is thrown into various bins, depending upon the ability of the individual trash particles to be thrown, such particles depositing in bins located at various distances from the point from which the trash mixture is thrown, preferably also involving the passage of at least some of the trash particles through a forced air screen, whereby paper and like light particles may be reclaimed.

It is yet another object of this invention to provide a novel method and apparatus for extracting plastic films and like soft substances from a mixture containing paper and such substances.

It is a further object of this invention to provide a novel size-classification apparatus utilizing a sloped vibrating screen.

Other objects and advantages of the present invention will be readily apparent to those skilled in the art from a reading of the following brief descriptions of the drawing figures, detailed descriptions of the preferred embodiments, and the appended claims.

IN THE DRAWINGS

FIG. **1** is a top plan view of the apparatus of this invention, with portions broken away for clarity of illustration.

FIG. **2** is a longitudinal sectional view taken through the apparatus of FIG. **1**, generally along the line II—II of FIG. **1**, wherein various apparatus are illustrated, some in vertical section, some in vertical elevation, and others in phantom.

FIG. **3** is an enlarged transverse, vertical sectional view taken generally along the line III—III of FIG. **2**, and wherein a weight-classification apparatus is clearly illustrated.

FIG. **4** is an enlarged vertical sectional view through a portion of the apparatus illustrated in FIG. **3**, taken generally along the line IV—IV of FIG. **3**, wherein a grid used in providing a weight-classification, along with adjustments therefore are clearly illustrated.

FIG. **5** is an enlarged vertical transverse sectional view, through a portion of the apparatus illustrated in FIG. **2**, taken generally along the line V—V of FIG. **2**, and wherein the trash wheel and means for providing a forced air screen are clearly illustrated.

FIG. **6** is an enlarged substantially vertical sectional view taken generally along the line VI—VI of FIG. **2**, and wherein one of the bin inlets, and inlet adjustment means therefore is clearly illustrated.

FIG. **7** is a fragmentary vertical sectional view through the apparatus illustrated in FIG. **6**, taken generally the line VII—VII of FIG. **6**.

FIG. **8** is a plan view of a portion of the apparatus illustrated in FIG. **2**, taken generally along the line VIII—VIII of FIG. **2**, and wherein a sloped vibrating screen device in accordance with this invention is illustrated.

FIG. **9** is an enlarged vertical transverse sectional view, taken generally along the line IX—IX of FIG. **1**, and wherein the extraction device of this invention is most clearly illustrated.

FIG. **10** is an enlarged vertical sectional view taken generally along the line X—X of FIG. **9**, wherein a portion of the extraction device is fragmentally illustrated, with detailed illustration of the brush devices which form parts thereof.

FIG. **11** is a perspective view of an impeller wheel illustrated in FIG. **9**, which is used to pick-up paper materials from which sheet plastic and the like has been extracted, and to by-pass a secondary extraction device for deposit of such paper materials onto a downstream portion of the conveyor illustrated in FIG. **9**.

FIG. **12** is an enlarged fragmentary end view of the trash wheel of this invention which is illustrated in FIGS. **2** and **13**, with portions illustrated in phantom, and wherein the adjustable nature of the blades of the trash wheel is clearly illustrated.

FIG. **13** is an enlarged fragmentary perspective view of the means for attachment and adjustment of the blades of the trash wheel of FIGS. **2** and **12**.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings in detail, reference is first made to FIG. **1**, wherein the paper reclamation system is generally designated by the numeral **20**. The system **20** includes a first stage **21**, a second stage **22**, and a third stage **23**.

The first stage **21** is directed toward a combination size-classification and weight-classification. The first stage **21** includes four vertical frame members **24**, arranged in pairs, on opposite sides of the stage **21**, each pair of vertical members **24** supporting a horizontal frame member **25** or **26**. At the left-most end of the horizontal frame member **25** and **26**, as viewed in FIG. **2**, a pedestal **27** of frame members is provided. Four vibratory supports **28**, **30**, **31** and **32** are provided, mounted respectively on either the pedestal **27**, (for rearward support mounting), or on the right-most end of either of the horizontal frame members **25** or **26** (for forward-most supports). Each of the supports **28** includes a base **33** having a threaded member **34** disposed therein, which is received in an upper member **35**, such upper member **35** being secured by a suitable pin **36** or the like to an adjacent portion of a side wall **37**, or **38** of a trough **40**, as shown. Each vibratory support **28**, **30**, **31**, and **32** is adapted to provide a trough **40** with a controlled vibratory motion, such motion preferably being synchronized with the motion provided by each of the other vibratory supports. The means (not shown) for actuating the vibratory supports **28**, **30**, **31** and **32** may either be contained within those supports, or may be provided from a remote location, such as pneumatically, electrically, or the like. If desired, a cam device can be provided, disposed within each of the vibratory supports, for oscillatory motion of the upper end **35** of each of the supports upon rotation of the cam.

The trough **40** is provide with an inlet ramp **41**, and an outlet ramp **42**, connected by a grid or screen **43** of predetermined size; i.e., having voids or holes therein for passing particles therethrough of preselected size.

The trough **40** is provided with a lower sloped surface, or ramp, **44**, also being of grid or screen effect, but wherein the screen is finer, or having smaller holes or voids therein, than the screen **43**. A slope chute **45** is provided at the lower end of the ramp **42**, for delivering particles from the ramp **42** into the second stage **22** of the system of this invention.

Beneath the grid ramp **42** there is provided a hopper **46**, connected to the walls of the trough **40** by means of a flexible connection **47**. The hopper **46** communicates with a vertically disposed chute **48**, both of which are connected to frame members **25** and **26** by suitable welded flange connections **50**, or the like. The chute **48** has a rearwardly sloped lower end **51**, for passing material traveling therethrough onto a conveyor **52** disposed therebeneath, and traveling in the direction indicated by the arrow **53** in FIG. **2**. The conveyor **52** is of the belt type, and is carried by suitable shaft-supported rolls **54**, which, in turn, are carried by suitable frame members **55** and **56**.

The lower end of the ramp **44** in provided with an inlet **56**, also of the ramp type, for material inlet into the upper end of a vertically disposed chute **57**. The chute **57** is also connected to the trough **40**, at the right lower end thereof by a suitable flexible connection **58**. The chute **57** is carried by the frame members **25** and **26**, by means of suitable welded flange supports **60** or the like.

A baffle **61** is provided, extending across the trough **40**, between the upper and lower ramp grid **43** and **44**, respectively, such baffle **61** being provided with a slotted hole type position adjustment **62**, as shown in FIG. **2**.

The bottom of the chute **57** has a rearwardly bent portion **61**, as is illustrated in FIGS. **2** and **3**, for disposition of the outlet **62** of the chute over the conveyor **52**.

At the right-most side of the chute **57**, as viewed in FIG. **3**, there is provided a blower motor **63**, with a suitable airtight delivery connection **64**, to a wall **65** of the chute **67**. A grid **66** is provided in the wall **65**, the grid **66** comprising vertically and horizontally disposed louvers **67** and **68** respectively. The louvers **67** are adjustable from side to side, as viewed in FIG. **4**, and the louvers **68** are adjustable upwardly and downwardly, as viewed in FIG. **4**, such adjustments being respectively provided by suitable hand crank type adjusting means **70** and **71**, respectively. Rotation of the crank **70** will cause horizontal movement of the bars **72**, which in turn, will cause pivoting of the louvers **67** about their centers. Similarly, rotation of the crank **71** will cause vertical movement of the bar **73**, which in turn would cause pivoting of the horizontal louvers **68** about their centers. Thus, by controlling the cranks **70** and **71**, any suitable desired deflection control can be maintained across the chute **57** for forced air emanating from the blower **63**.

At the left-most side of the chute **57**, as viewed in FIG. **3**, there is provided a side chute **74**, connected to the chute **57** and communicating therewith, over an area slightly greater than the area of the grid **66**, with the chute **74** having a lower end **75** thereof extending downwardly in straight disposition to have an outlet **76** thereof disposed above a conveyor belt **77**, which has a rightward direction of movement as viewed by the arrows **78** in FIGS. **1** and **2**. The conveyor belt **77** is carried on suitable end rolls **80** and **81**, with the roll **80** being driven by a suitable electric motor **82**. The rolls **80** and **81** are carried on suitable frames **83** and **84**, respectively.

The second stage **22** comprises a suitable frame construction having vertical frame members **86** and horizontal frame members **87**. Three bins **88**, **90**, and **91** are carried by the horizontal frame members **87**, by means of suitable welded flange connections **92**, or the like. A screened enclosure **93** is provided, covering the bins **88**, **90** and **91**, with suitable horizontal and vertical frame supports **95** and **94**, respectively. The enclosure **93** has opposite side walls **96** and **97**, an upper wall **98**, and an inlet end having an upper opening **100** and a sloped inlet portion **101** disposed beneath the upper opening **100**, and downwardly sloped toward an inlet of the adjacent bin **88**. A screened rear wall **102** is provided for the enclosure **93**, thereby constituting a substantially completely enclosed but substantially large zone above the bins **88**, **90** and **91**.

With reference to FIG. **5**, in particular, a trash wheel **103** or throwing device is provided, extending substantially between the screen walls **96** and **97**, and having a rounded peripheral configuration with a plurality of blades **104** emanating outwardly therefrom. The wheel **103** is shaft-mounted at **105** and has an electric motor type drive means **106** therefore, disposed on a shelf **107** carried by a suitable frame member **108** outside the enclosure **93**, as viewed in FIG. **5**. The trash wheel **103** may be of fixed blade construction, as illustrated in FIG. **5**, wherein the blades **104** are radially disposed relative to the wheel **103**, or if desired, the blades **104** may be adjustably mounted as illustrated in FIGS. **12** and **13**.

Referring to FIGS. **12** and **13**, there is illustrated a wheel or drum **106** constituting an alternative embodiment for the trash wheel, wherein blades **107** are retained at their ends by U-shaped clamps **108** which have suitable trunnions **110** integrally connected therewith, which trunnions are suitably journaled in journal blocks **111**, each of which has a removable cap **112** thereon, connected thereto by removable screws **113** or the like. The caps **112**, when tightly connected to the blocks **111**, positively engage the trunnions **110**, and maintain the blades **107** in fixed position. By loosening screws **113**, the trunnions **110** may be slidably repositioned for any desired position of the blade **107**.

The motor **106** may also be of the variable speed type, in order that any desired speed of rotation for the wheel **103** of **106** may be obtained.

An air screen providing means **114** is carried by the top wall **98** of the enclosure **93**, approximately just above the division between the bins **88** and **90**, for the purpose of establishing an air screen, later to be described herein. The device **114** includes an inlet **115** for receiving a source of pressurized air, which expands to substantially the distance between the enclosure side walls **96** and **97**, and which narrows at its outlet **116** to provide a thin concentrated air screen, entirely across the width of the enclosure **93**.

The bins **88** and **90**, as well as the bins **90** and **91**, are connected by suitable baffles **117** and **118**, which are adjustably positionable for varying the sizes of the inlets **120**, **121**, and **122** to the respective bins **88**, **90** and **91**. The baffles **117** and **118** are identical, except for their relative positions, which may be as desired. With particular reference to FIGS. **6** and **7**, the baffle **117** is clearly illustrated, as comprising a movable plate-member extending between opposite walls **123** and **124** of the second stage **22** at a location beneath the screened enclosure **93**.

Each plate **117** includes an inner plate portion **125**, and an outer plate portion **126**, telescopically disposed thereover, for relative vertical adjustment between the two, as desired. The inner plate **125**, is pivotally

mounted at **127**, at precisely the juncture of the inlets **121** and **120** of the bins **90** and **88**, respectively. A bar **128** is welded or otherwise secured to the upper end of the outer telescopic member **126**, with the bar having threaded protruding ends **130** and **131**, having wing nuts **132** or the like threadedly secured thereto, for clamping the bar **28** in a desired position. The threaded ends **130** and **131** of the bar **128** may be adjusted for positioning in any of the infinite number of positions defined by the slotted hole configuration generally designated by the numeral **133** in FIG. **7**. The slotted hole configuration **133** includes two concentric circular slotted holes **134** and **135**, connected by a slotted hole **136**, whereby pivotal adjustment for the plate **117**, as well as vertical adjustment may also be effected.

With particular reference to FIG. **2**, it will be seen that the bins **88**, **90** and **91** are provided with bottom outlets **140**, **141** and **142** respectively.

The bin outlet **140** is disposed above a conveyor device **143**. The conveyor device **143** comprises a conveyor belt **144**, mounted on rotatable rolls **145** and **146** at opposite ends thereof, with the rolls being carried by suitable frame members **147** and **148**. A drive **150** of the electric motor type is provided for the roll **146**, for driving the upper run of the conveyor in the direction indicated by the arrow **151**, as viewed in FIG. **1**. It will be noted that the conveyor device **143** extends transversly of the conveyors **52** and **77**, and is located beneath the outlet **140** of the bin **188**, in addition to being located in position for receiving material conveyed from the conveyor **77**. Material conveyed along the upper run of the conveyor **77** will be deposited onto the conveyor belt **144** by dropping downwardly thereto, over the conveyor roll **81**, as may be clearly seen in accordance with the relative dispositions of such conveyors in FIGS. **1** and **2**. The outlet **141** for the bin **90** is disposed above another conveying device **151**, which device **151** also runs beneath the outlet **142** of the bin **91**. The conveying device **151** comprises a belt **152** and end rolls **153**, along with drive means therefore (not shown), and is carried by suitable frame members such as that **154**.

A weight separation device generally designated by the numeral **155** is disposed in vertical alignment between the outlet **141** of the bin **90** and the left-most end of the conveying device **151**, as viewed in FIG. **2**.

The device **155** comprises frame supports **156**, **157** and **158** which, in turn carry four vibratory drive supports **160**, **161**, **162** and **163**, which are substantially similar in construction and operation to the supports **28**, **30**, **31** and **32** discussed above. Suitable drive means are also provided for such vibratory supports. An inclined trough **164** is carried by the supports **160**, **161**, **162** and **163**, the trough **164** having side walls **165** and **166**, a sloped screen grid **167** of a selected size for passage of desirably sized particles therethrough, and a lower chute portion **168**. The trough **164** is carried by upper blocks **170** and **171** which in turn receive their vibratory motion from the supports **160** through **163**. The blocks **170** and **171** carry journal boxes **172** and **173** for fixedly mounting a shaft **174** and carrying the same therebetween. The trough **164** is fixedly carried on the shaft **174**, but the shaft **174** may be adjustably pivoted within its journal boxes **172** and **173**, whereby the trough **164** may be pivoted between the phantom and full line positions illustrated in FIG. **2**. Upon obtaining the desired angular disposition for the trough **164**, the journal boxes **172** and **173** may be tightened down to fixedly clamp the shaft **174** in the selected position by tightening screws **175**. The grid size of the screen **167** on the trough **164** is selected to have passage openings therethrough sufficient to pass particles of a given size therethrough, whereby the remaining particles will be shaken down the slope of the grid **167**, onto the chute **168** for depositing the same onto the upper run of the conveyor belt **144**.

The outlet **142** for the chute **91** is so disposed above the belt **152** of the conveyor device **151** for depositing particles collected in the bin **91** onto the upper run of the conveying device **151**, to be carried off to discard in the direction indicated by the arrow **176** in FIGS. **2** and **8**.

With particular reference to FIGS. **1**, **9**, **10** and **11**, the plastic film extraction device **23** of this invention will now be described.

The device **23** is disposed above the conveyor belt **144**, as viewed in FIG. **1**, carried on a rectangular frame member **177** having bars **178** and **180** extending parallel to the conveyor belt **144** and bars **181** and **182** interconnecting the bars **178** and **180**. The frame **177** is supported on four legs **183**, disposed on opposite sides of the conveyor device **143**, for straddling the conveyor belt **144**.

A pair of extraction devices **184** and **185**, identical in construction are carried by the frame **177**, in disposition above the upper run of the conveyor belt **144** as viewed in FIG. **9**. Because the devices **184** and **185** are identical in construction, only device **184** will be described in detail. The device **184** comprises a downwardly opening U-shaped yoke **186** comprising an upper bar **187** and opposed side bars **188** and **190**. The bars **188** and **190** carry a shaft **191** therebetween, with the shaft **191** being provided with a suitable rotary drive **192**, preferably of the electric motor type. The motor drive **192** is carried by a suitable shelf **193** welded or otherwise secured to the frame bar portion **188**. A plurality of brush elements **194** are carried by the shaft **191**, in fixed securement thereto, by any suitable means, with the brushes **194** being spaced by spacers **195** between adjacent ones of the brushes **194**. The brushes **194** extend substantially across the entire width of the conveyor belt **144**, as viewed in FIG. **10**. The brushes **194** are generally of the wire brush type, having an outer diameter substantially as shown, relative to a lesser diametrical dimension for the spacers **195** disposed therebetween.

A comb **196** is provided, having a plurality of teeth **197** carried thereby, with the teeth **197** extending toward the brush elements **194**. The comb teeth **197** each extend between adjacent ones of the brush elements **194**, and are fixed relative to the brush elements **194**, such that particles which are picked up by the brush elements **194**, during rotation of the same, and which cling thereto or engage between such brush elements **194** may be combed from between the brush elements **194** by the teeth **197** of the comb **196**. Thus the reduced diameter dimensions for the spacers **195** facilitate the introduction of comb teeth **197** between the brush elements **194**.

A hood **198** is provided in upper-enclosing relation to the comb **197** and brush elements **194**, as indicated in FIGS. **8** and **9**, with the enclosure **198** being carried by the frame bars **188** and **190**, and having an open lower end **200**, disposed is spaced relation above the

upper run of the conveyor belt **144.** A duct **201** is provided, in communication with the interior of the enclosure **198,** which duct is connected to a vacuum withdrawal line **202,** as indicated in FIG. **1,** for removal of particles extracted from the brush elements **194** by the comb teeth **197,** to discard.

The yoke **187** is carried by the frame portions **178** and **180** of the frame **177,** with means generally designated by the numeral **203** for vertical adjustment of the device **184** relative to the upper run of the conveyor belt **144,** as well as for adjustment of the device **184** along the conveyor belt **144.** Such adjustment may be by any suitable means, such by means of a threaded member **203** welded or otherwise suitably carried by the upper bar **187** of the yoke **186,** with suitable nuts **205** and **206** being engaged with the threaded member **204** for locking the same in any vertical position relative to the frame bars **178** and **80,** as well as for locking the same in any selected position of the slotted holes **207** in the bars **178** and **180.**

A pick up device generally designated by the numeral **208** is provided, also carried by the bars **178** and **180** of the frame **177,** the pick up device **208** also being carried in disposition above but close to the upper run of the conveyor belt **144,** as indicated in FIG. **9.**

The pick up device **208** also utilizes a downwardly opening U-shaped yoke **210,** but has a rotary impeller **211** carried between vertical bars of the yoke **210,** with the impeller **211** being also substantially coextensive with the width of the upper run of the conveyor belt **144.** A suitable drive, such as an electric motor **212** is provided for the impeller **211,** as indicated in FIG. **1.** The impeller **211** is clearly indicated in FIG. **11,** as comprising a shaft **213** which carries a spool **214** comprising a cylinder **215** with end plates **216.** A plurality of flat blades **217** are fixedly carried between the end plates **216,** also being fixedly secured to the cylinder **215.** The blades **217** may assume any helical, or other desired configuration, other than the flat radial disposition illustrated in FIGS. **9** and **11,** as desired. The impeller **211** is provided with a housing **218** which substantially completely surrounds the impeller, except for an inlet **220** disposed at a lower upstream portion of the housing **218,** which opening **220** extends substantially completely across the width of the upper run of the conveyor belt **144,** in the form of a scoop or the like, for picking up papers from which plastic films and the like have been extracted, which papers are skimmed from the surface of paper particles being conveyed along the conveyor belt **144.** A duct **221** is provided, in communication with the housing **218,** which duct **221** is carried by means of a plate **222** being welded or otherwise secured thereto, and also being secured to the yoke **210.** The duct **221** is configured as illustrated in FIG. **9,** to by-pass the device **185,** and for delivering papers downstream thereof, onto the upper run of the conveyor **144,** being provided with a duct outlet **223** disposed above the upper run of the conveyor **144.** Suitable adjustment means **224** are also provided for the pickup device **208,** such adjustment means **224** being generally similar to the adjustment means **203** described above.

OPERATION

Shredded trash from which it is desired to collect paper will be dumped into the inlet **41** of the first stage **21,** as viewed in FIGS. **1** and **2,** with the trash being deposited onto the grid **43.** This trash would principally consist of paper and paper board of various sizes between ½ inch and 8 inches, shattered and pulverized glass with slivers on the order of **1** inch size or smaller, crushed metal, bottle caps, can lids, hard plastic objects, and sheet plastic films such as polyethylene and like soft plastics, The trash deposited on the grid **43** will be screened such that larger particles may continue to pass onto the ramp **43,** to be delivered to the trash wheel **103.** Smaller particles including smaller pieces of paper, glass, dust, bottle caps and the like will pass through the grid **43,** to be deposited onto the grid **44,** which is of a generally finer mesh, sufficient to permit dust, glass particles, and other very fine particles, such as hard metal particles and the like, to pass through into the hopper **46,** to be delivered to the chute **48,** which will in turn deposit such minute particles onto the conveyor belt **52,** to be delivered to discard. Particles which would not pass through to the grid or screen **44** would be delivered to slide down the screen **44,** due to the vibratory nature of the motion provided to the trough **40** by means of the supports **28, 30, 31** and **32,** whereby such intermediate or "smaller" particles would pass into the chute **57.** Such intermediate or "smaller" particles may include paper, bottle caps, large glass pieces, etc. Such particles are permitted to fall off the shelf edge **56,** and then to fall vertically downwardly through the chute **57,** whereby they would be subjected to a horizontal blast of air from the blower motor **43,** passing through the grid **66,** whereby the lighter particles such as paper, thin sheet plastics and the like would be separated from the harder particles, to be delivered into the zone **74,** through the chute outlet **76,** and onto the upper run of the conveyor belt **77.**

It will herein be noted that the force of the air blast provided by the blower **63** may be controlled as desired, as by adjusting the speed of rotation of the motor which drives the blower **63.** Also, the orientation or direction of the air blast through the grid **66** may be controlled by suitably adjusting the louvers **67** and **68,** by means of the adjustments **70** and **71** provided as illustrated in FIGS. **3** and **4.** After the light particles, such as paper, sheet plastic and the like are separated from the heavier particles by means of the air blast, as mentioned above, the heavier particles may fall vertically downwardly through the outlet **62** of the chute **61,** to be delivered also onto the upper run of the conveyor **52,** to discard. The lighter particles which have thus been weight-separated by the air blast are then delivered along the upper run of the conveyer belt **77,** to be deposited onto the upper run of the conveyor belt **144.** It will be noted that any desired vibratory motion may be provided for the trough **40,** which will control the distribution paper down the grid ramps **43** and **44,** at a desired flow. Also, the baffle **61** may be adjusted, as desired, in order to control the distribution of the smaller sized particles into the chute **57.** Still further, the vibratory screen feeder of the first stage permits a uniform layer of the larger size-separated mixed trash to be delivered to the trash wheel **103.** Such particles contact the blades **104,** or **107** of the trash wheel **103,** and are given a velocity which is a function of the speed of rotation of the impeller blades **104** or **107.** It will herein be noted that the rotational speed of the trash wheel **103** may be carefully controlled by suitably adjusting the motor **106** to yield the desired rotational

speed. An initial forward and upward velocity is imparted to the trash due to the direction of rotation of the trash wheel (clockwise as viewed in FIG. 2). The trajectory of such particles thrown by the trash wheel **103** will be, in addition to a function of the velocity of the blades **104** or **107**, a function of the resiliency of the particles, their ability to bounce, their size, their weight and shape. With particular reference to FIGS. **12** and **13**, it will be noted that adjustments in trajectory paths for trash thrown by the trash wheel **103** may be made by varying the angle of inclination of the blades **107**, to any desired setting.

It has been found that paper particles thrown by the trash wheel **103** will have the shortest trajectory, and would be deposited in the bin **88**. Metal and like hard heavy plastic particles in addition to some metalic particles will have the greatest trajectory, and will be deposited in the bin **91**. Some metal, as well as cardboard particles would be deposited in the bin **90**. The air screen provided through the nozzle **114** serves to assure that lightweight particles are not deposited in the bin **91**. Thus, any particles being thrown toward the bins **90** and **91** are passed through the screen of air provided through the nozzle **114**, as viewed in FIG. **2**, for directing the lighter of such particles into the bin **90**, with the remaining particles continuing in their trajectories or paths into the bin **91**. It will be noted that various adjustments, as desired, may be made by adjusting the plates **117** and **118** and securing the plates in any desired position, as may be found in practice which will yield the desired distribution of particles by weight, or otherwise by their ability to be thrown by the trash wheel **103**, into bins designed to receive such particles.

The paper particles deposited in the bin **88**, which contain a certain amount of sheet plastic film and the like are then deposited onto the upper run of the conveyor belt **144**, which has received similar paper and sheet plastic particles from the conveyor belts **77**.

A further refinement is provided by providing a device for extracting from the particles leaving bin **90**, the larger paper, cardboard, and like particles. The discharge from the bin **90** is deposited onto another vertically vibrating screen **167**, having a grid size which has been predetermined as being desirable to permit passage therethrough of particles which are desired to be discarded. The particles which are discharged from the bin **90** generally comprise lighter hard particles such as plastics and metal, and only the heavier paper products, which would necessarily require that such paper products that are present in the bin **90** be substantially larger than particles present in the bin **88**. Thus, all substantially large particles that are deposited into the bin **90** will be paper and like particles. Such may be filtered or screened out from the remaining material deposited in the bin **90**, to be vibrated down the ramp provided by the screen grid **167**, over the sloped chute **168**, and onto the upper run of the conveyor belt **144**. The remaining particles from the bin **90** would pass through the screen grid **167**, onto the upper run of the conveyor belt **152**, to discard, as will the particles discarded from the bin **142**.

It will be noted, that with respect to the above-mentioned screening operations, the term "size" has been used to refer to the passages through the grid. Also, particularly with respect to the first stage of the apparatus of this invention, the particles have been termed "larger," "smaller" and "minute," to distinguish between particles which would not pass through the grid **43**, particles which will pass through the grid **43** but not through the grid **44**, and particles which would pass through the grid **44**, respectively.

It will be noted that the particles which are delivered onto the upper run of the conveyor belt **144** are indicated as comprising paper, small cardboard particles, and sheet plastic film and the like. The expression "sheet plastic film and the like" is not intended to encompass paper, nor is the expression "paper and the like" intended to encompass sheet plastic film particularly with respect to the operation of the extraction stage **23**, described below.

It will first be noted that, if desired, a uniform distribution of particles from the bin **88** may be provided, by any suitable baffle or like means, to yield a uniform thickness layer of paper mixed with soft plastic and like components onto the upper run of the conveyor belt **144**, for delivery to the extraction stage **23**. Such level of paper products on the upper run of the conveyor belt **144** may be for example at the level L**1**.

The extraction device **184** is positioned above the upper run of the conveyor belt **144**, as illustrated in FIG. **9** such that the brush elements **194** are disposed lower than the level L**1** of material on the belt **144**, to engage within the material carried by the belt **144** to a predetermined depth. The brushes **194** are rotated by the motor **192** at a peripheral speed, generally greater than the linear speed of particles carried along the belt **144**, whereby an electrostatic charge is induced on the brushes **194**. Such electrostatic charge may also be induced by a rubbing of the brush elements **194** against the teeth **197** of the comb **196**, or by any other suitable means. Because sheet plastic films and the like, such as polyethylene sheets have a greater affinity for electrostatic attraction than do paper particles, such sheet plastic films and the like which are included in the material carried by the upper run of the belt **144** will be attracted to the brush elements **194**. Additionally, some physical pick-up of sheet plastic components and the like will be effected by purely mechanical pick-up, as for example by sheet plastic components and the like engaging between the brush elements **194**, in the recesses provided by the spacing of the brush elements **194**. The speed of rotation of the brush elements **194** may be adjusted, or varied, as desired, as may be necessary in order to provide the desired electrostatic charge on the brush elements **194**, and to obtain any desired relative speed between the peripheral speed of the brush elements **194** and the material carried along the belt **144**. The teeth **197** of the comb **196** are adapted to remove plastic particles picked up by the brush elements **194**, by scraping such particles therefrom. The partial vacuum created beneath the hood **198** will draw such particles scraped from the brush elements **194** into the duct **201** to be carried away to discharge. Thus, sheet plastic particles and the like will be removed from the layer of particles carried along the upper run of the belt **144**, to a predetermined depth.

The paper pick-up device **208** is disposed with its inlet **220** at a level above the upper run of the belt **144**, which level will correspond with the depth of particles carried along the belt **144** which has been "cleaned" of sheet plastic particles and the like, such that substantially only paper particles will enter the inlet **220** of the housing **218**, to be engaged by blades **217** of the impel-

ler **211.** The impeller **211** is driven at a desired speed to handle the flow of paper particles thus picked-up and to deliver the same through the duct **221,** to be redeposited onto the upper run of the belt **144,** at a location downstream of the secondary extraction device **185.** The extraction device **185** being disposed at a location downstream of each of the pick-up device **208** and the extraction device **184,** is positioned above the upper run of the conveyor belt **144,** by suitable adjustment, to extract sheet plastic particles and the like carried along the belt **144** between the level L2 and the belt **144,** or within a range not "cleaned" of sheet plastic particles and the like by the extraction device **184.** The device **185** operates in the same manner as does the device **184,** such that, at a location downstream of the device **185,** substantially only paper particles are delivered at the left-most end of the conveyor belt **144,** as viewed in FIG. **9.** Such paper particles constitute the reclaimed paper desired in accordance with the objects of this invention, and contain only a very minimum acceptable percentage of non-paper components which has been predetermined as being acceptable, and for which the system **20** of this invention has been pre-set by the selection of proper grid sizes, air flow rates, speeds of rotation for the trash wheel, impellers, rotary brushes, and the like. It will thus be apparent to those skilled in the art that the objects of this invention are readily obtained by the system described herein.

What is claimed is:

1. An apparatus for extracting sheet plastic films and the like from a mixture of shredded paper materials and film, comprising conveyor means for conveying the mixture along a predetermined path, a first extraction device disposed above said path, said extraction device comprising rotary brush means for brushing through the mixture conveyed therepast to a first predetermined depth, means for inducing an electrostatic charge on said brush means for attracting plastic films from the mixture and removing the films therefrom, comb means in engagement with said brush means for removing from said brush means plastic films extracted thereby, and exhaust means for carrying off films removed from said brush means by said comb means, including a second said extraction device disposed above said path at a location downstream of said first extraction device, said second extraction device being disposed for brushing through the mixture conveyed therepast to a second predetermined depth which is in closer to said conveyor means than said first extraction device, including paper pickup means disposed intermediate said first and second extraction devices for picking up paper materials from a depth substantially equal to the depth of extraction by said first extraction device and above, and for delivering the paper materials thus picked-up to said conveyor means downstream of said second extraction device, in by-passing relation relative to said second extraction device.

2. The apparatus of claim **1,** wherein said pickup means includes a rotary impeller and drive means therefor, said impeller having a plurality of blades disposed on the periphery thereof.

3. The apparatus of claim **1,** including means for adjusting the positions of said extraction devices and pickup means relative to said conveyor means.

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