United States Patent

Berkowitz et al.

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[45] **Feb. 22, 1972**

[54] TRASH-SEPARATING APPARATUS AND METHOD

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[21] Appl. No.: **846,320**

[52] **U.S. Cl.**.....**209/2**, 209/33, 209/12, 209/129, 209/135, 209/153, 209/37, 209/139 R, 209/315

[51] **Int. Cl.**.....**B07b 15/00**

[58] **Field of Search**.....209/129, 127 R, 127 A, 127 B, 209/127 C, 2, 12, 37, 139 R, 33, 153, 135, 142

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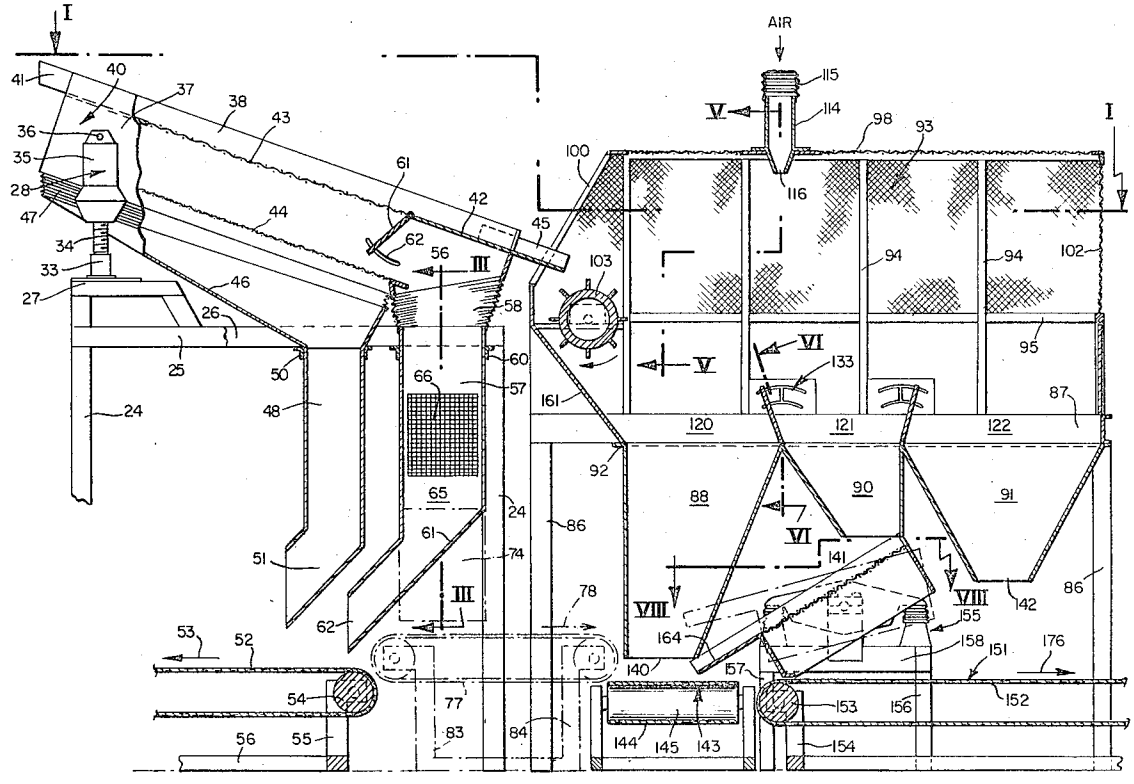
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[57] **ABSTRACT**

A system is provided for reclaiming usable paper other selected materials from a heterogeneous trash mixture that has previously been shredded to a predetermined size. The trash is deposited on a sloped vibrating screen which permits the passage therethrough of smaller sized trash particles. These particles then pass onto another sloped vibrating screen whereby minutely sized particles may pass therethrough, to be discarded. The smaller sized particles that pass through the first screen, but not the second then enter a chute which has a cross current in the form of an air stream, whereby paper, light sheet plastic and the like are forced from the smaller sized mixture and are delivered onto a conveyor. The larger sized particles that do not pass through the first vibrating screen are delivered onto a trash wheel, which is rotating, and which throws the larger sized particles in a given direction whereby the particles travel a given distance depending upon their weight, or upon their ability to be thrown, with at least the heavier of these larger particles passing through an air screen directed toward a series of bins. 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 nonpaper materials therein.

22 Claims, 13 Drawing Figures



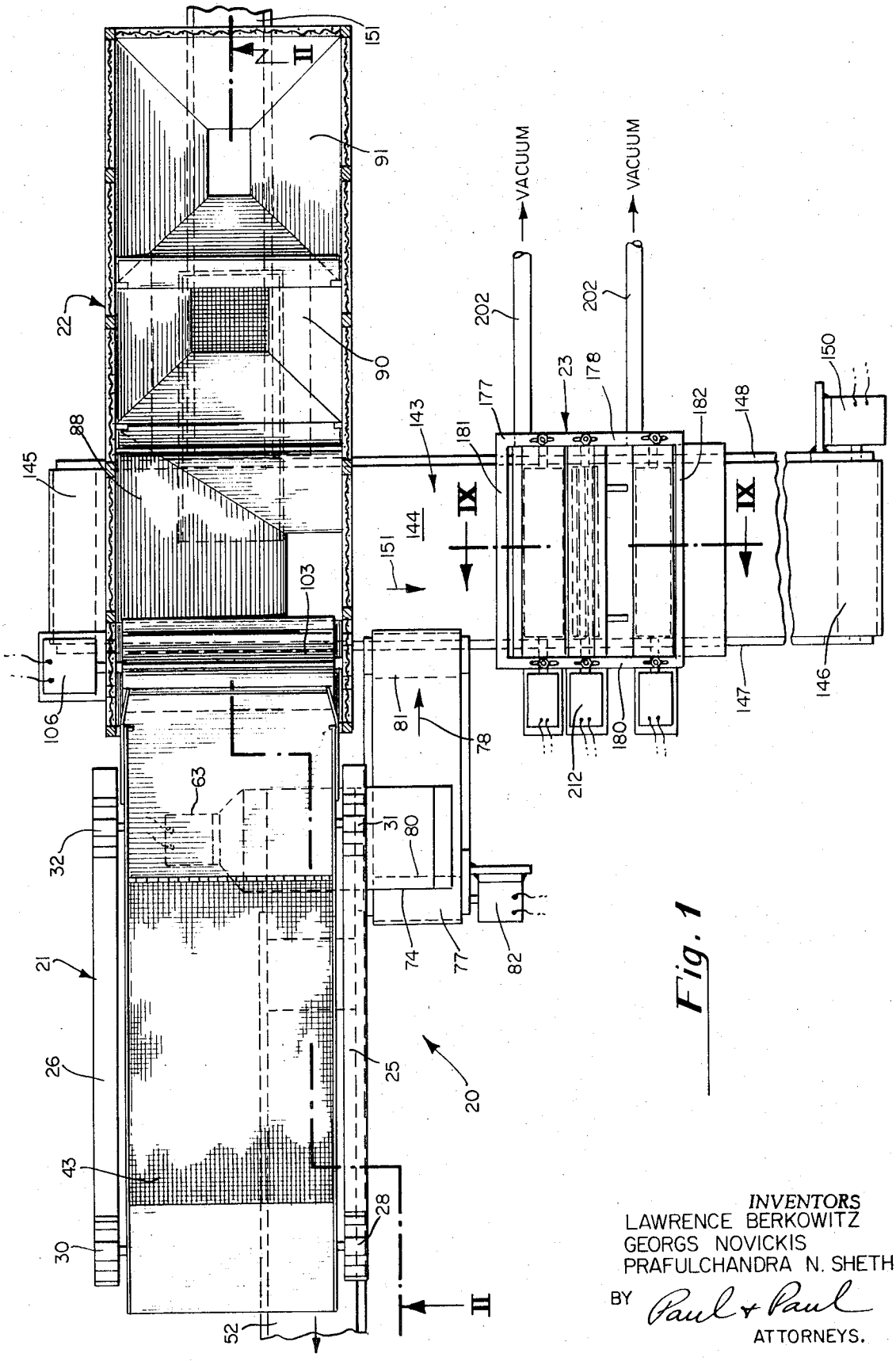
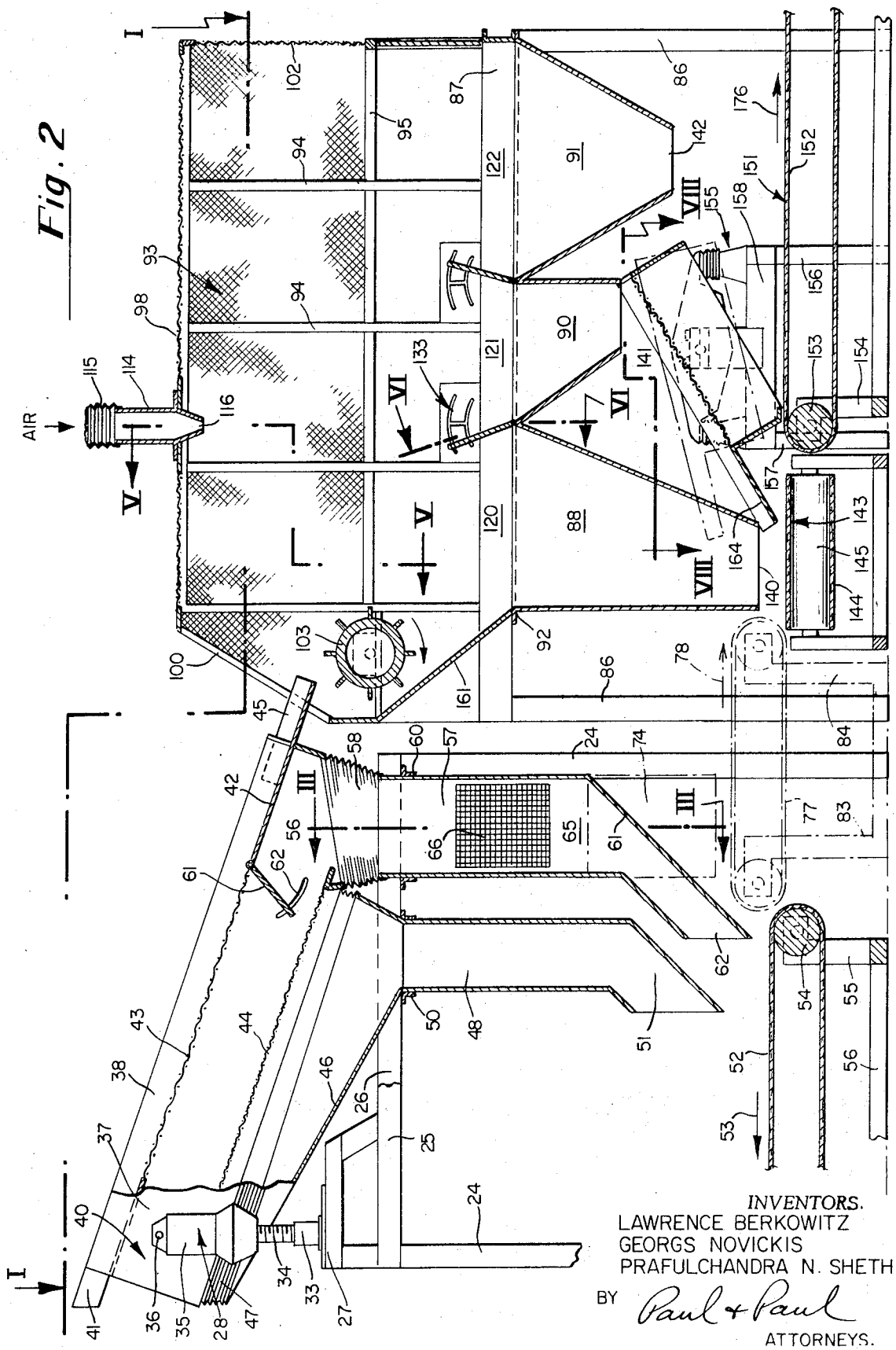


Fig. 1

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Fig. 2



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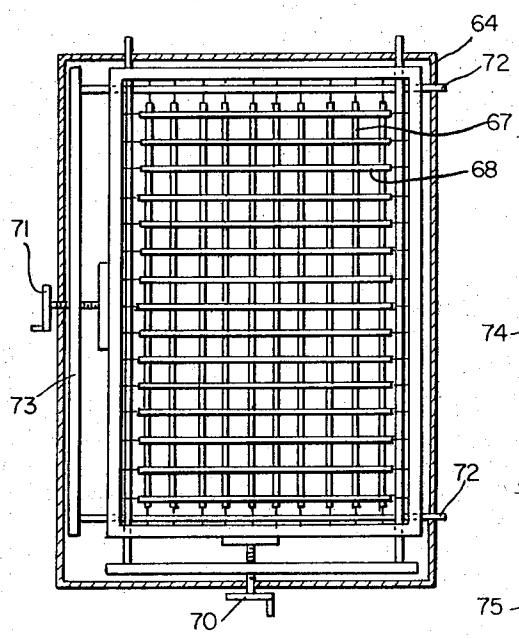


Fig. 4

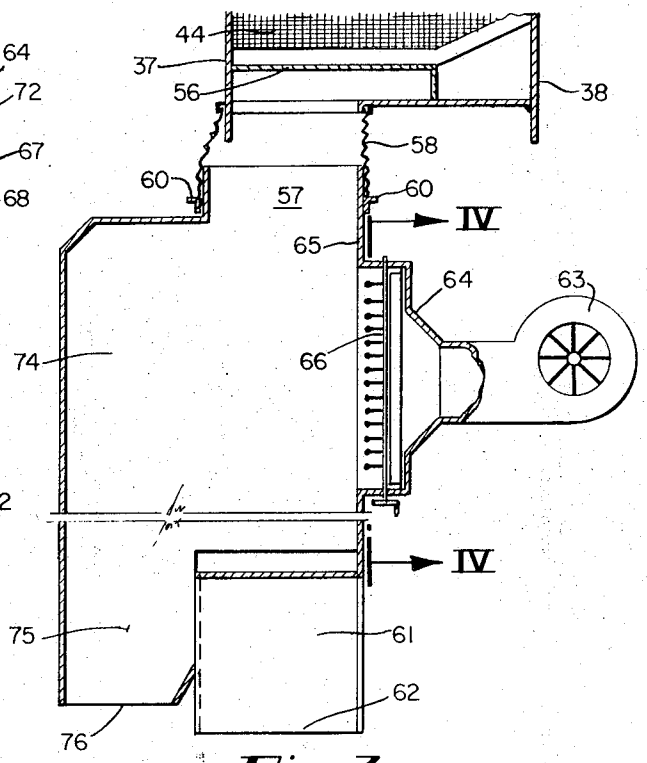


Fig. 3

Fig. 6

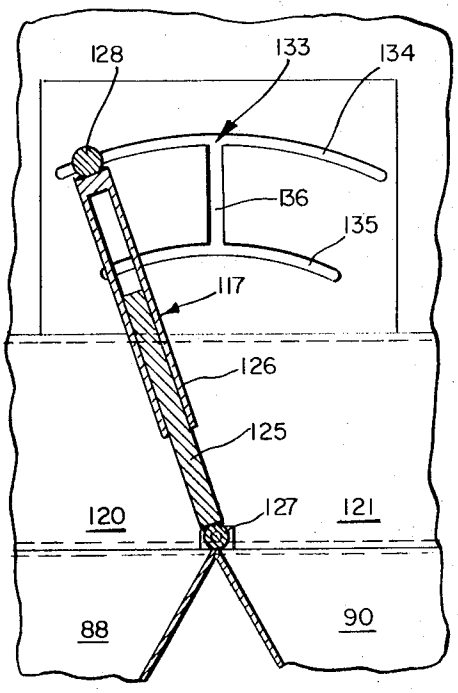
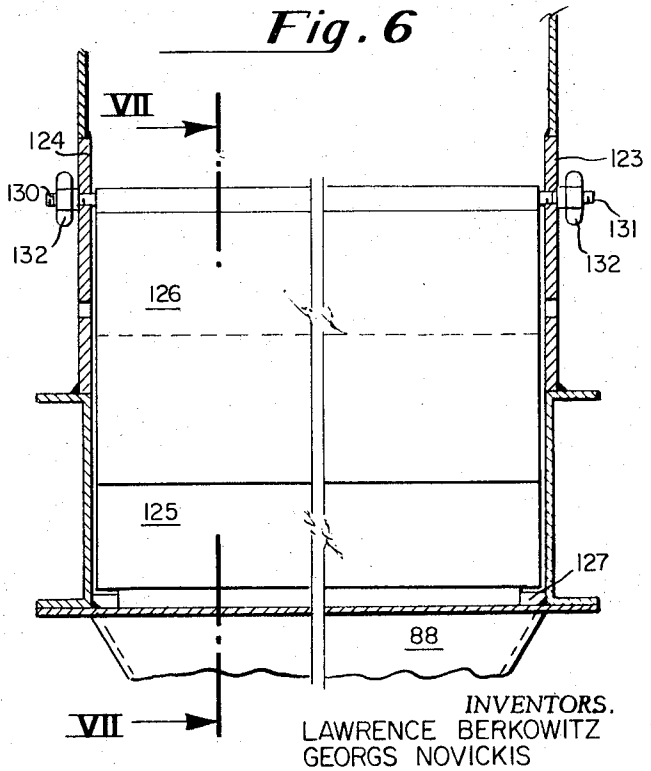


Fig. 7



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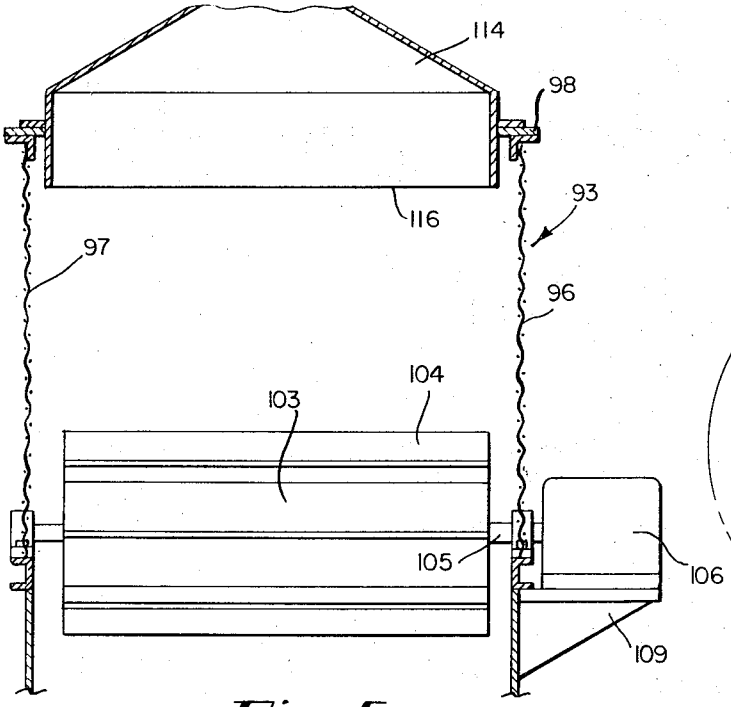


Fig. 5

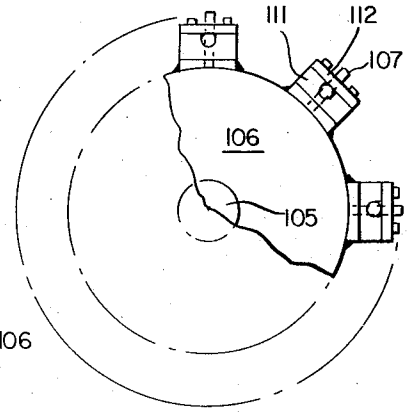


Fig. 12

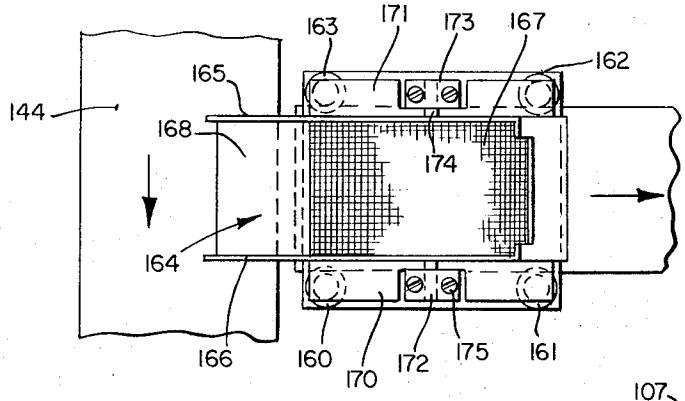


Fig. 8

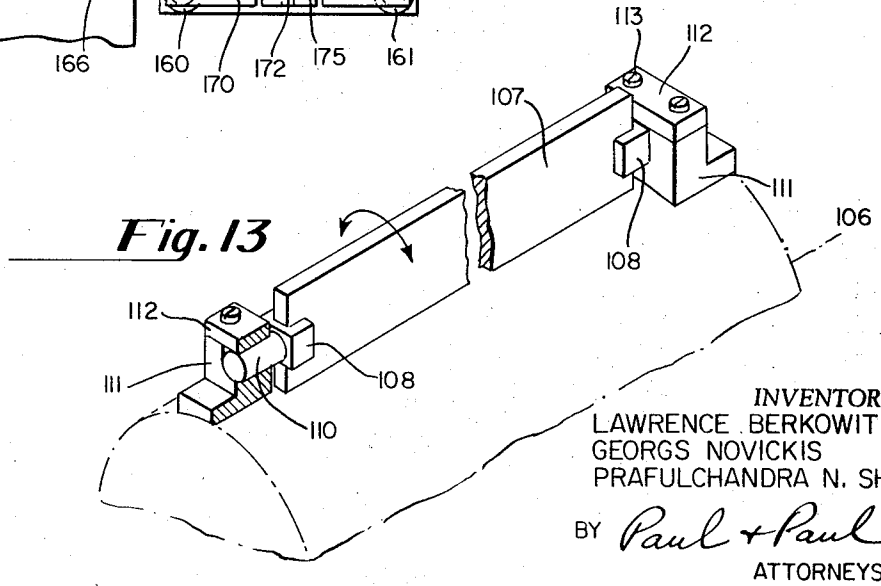


Fig. 13

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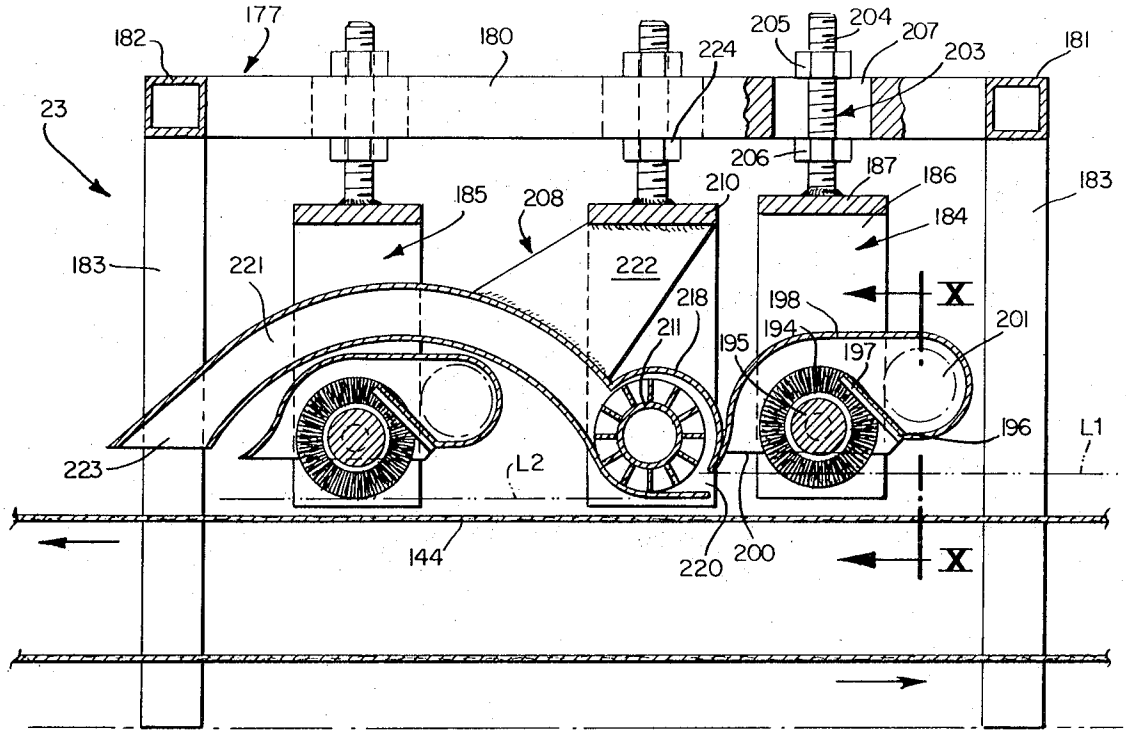


Fig. 9

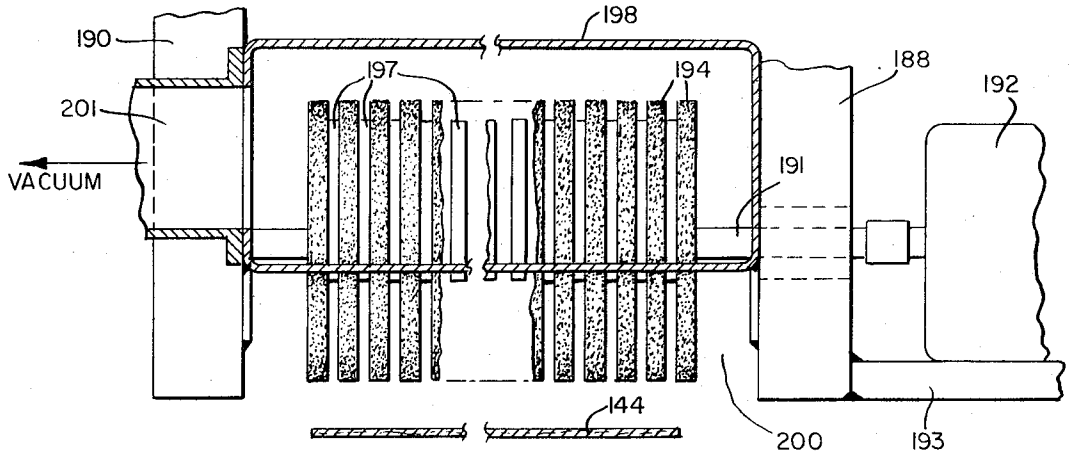


Fig. 10

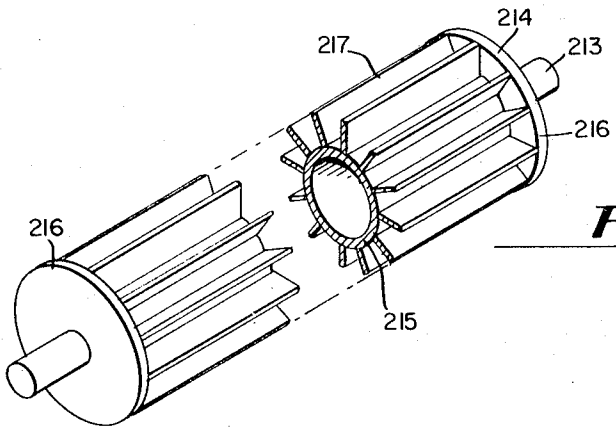


Fig. 11

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TRASH-SEPARATING APPARATUS AND METHOD

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 papermaking 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 themselves 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, nonferrous 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 preshredded 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 vibrating-screen-type size classification, along with an airstream 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 are clearly illustrated.

FIG. 7 is a fragmentary vertical sectional view through the apparatus illustrated in FIG. 6, taken generally along 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 bypass 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 leftmost 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 rightmost end of either of the horizontal frame members 25 or 26 (for forwardmost 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 sidewall 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 provided 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 sloped 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 is 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 FIG. 2 and 3, for disposition of the outlet 62 of the chute over the conveyor 52.

At the rightmost 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 handcrank-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 leftmost 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 sidewalls 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 109 carried by a suitable frame member 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 or 106 may be obtained.

An air stream 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 stream, 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 stream, 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 134. 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 transversely 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 size separation device generally designated by the numeral 155 is disposed in vertical alignment between the outlet 141 of the bin 90 and the leftmost 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 sidewalls 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 in 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 bypass 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 one-half 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 slid 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 FIG. 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 conveyor 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 L1.

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 L1 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 pickup of sheet plastic components and the like will be effected by purely mechanical pickup, 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 pickup 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 impeller **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 pickup 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 leftmost 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 nonpaper components which has been predetermined as being acceptable, and for which the system **20** of this invention has been preset by the selection of proper grid sizes, airflow 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. Apparatus for reclaiming selected materials from mixed shredded trash comprising first means for receiving mixed shredded trash and classifying the trash by size into differently sized components, second means for concurrently and separately classifying by weight trash of each selected size received from said first means, and third means for extracting sheet plastics and the like from lighter trash components delivered from said second means.

2. The apparatus of claim 1, wherein said first means includes at least a first grid of preselected size with means for vibrating said grid for passage of selectively sized materials therethrough.

3. The apparatus of claim 2, wherein a secondary grid of smaller size than said first grid is provided, with vibrating means therefor, for passage of minute undesirably sized components therethrough.

4. The apparatus of claim 2, including ramp means for delivering size-classified trash components to said second classifying means.

5. The apparatus of claim 1, wherein said second classifying means includes means for directing a stream of air, and means for delivering size-classified trash components past the air stream.

6. The apparatus of claim 5, wherein a substantially vertical chute is provided as said delivering means, including ramp means for directing the size-classified trash components to said chute, with said means for directing a stream of air being mounted for passing air substantially horizontally across the chute, including secondary chute means for receiving from the vertical chute lighter trash components directed thereto by the stream of air.

7. The apparatus of claim 1, wherein said second classifying means includes a plurality of bins and means for throwing size-classified trash components into said bins, said bins being disposed at various distances from said throwing means, whereby size-classified trash is substantially classified by weight depending upon the distance such trash is thrown by said throwing means.

8. The apparatus of claim 7, wherein said throwing means comprises a wheellike member having radial portions extending outwardly therefrom, and including means for rotating said wheellike member at a predetermined speed.

9. The apparatus of claim 7, including means for directing a stream of air substantially transversely to the path of travel of trash thrown from said throwing means.

10. Apparatus for reclaiming selected materials from mixed shredded trash comprising first means for receiving mixed shredded trash and classifying the trash by size into differently sized components, second means for classifying by weight trash of a selected size received from said first means and third means for extracting sheet plastics and the like from lighter trash components delivered from said second means, wherein said second classifying means includes a plurality of bins and means for throwing size-classified trash components into said bins, said bins being disposed at various distances from said throwing means, whereby size-classified trash is substantially classified by weight depending upon the distance such trash is thrown by said throwing means, including means for size-classifying weight-classified trash from one of said bins.

11. The apparatus of claim 10, including single conveyor means for delivering all lighter weight-classified trash to said extracting means.

12. Apparatus for reclaiming selected materials from mixed shredded trash comprising a first stage for receiving the mixed shredded trash and including a ramp having a grid surface thereon, with means for vibrating the ramp with larger particles being delivered down the ramp to a second stage and with smaller particles passing through the grid and being delivered to a substantially vertical duct, a duct for receiving smaller particles thus delivered, means for directing a stream of air across said duct and directing lighter particles in the duct into a separate zone for delivery onto a conveyor, a second stage comprising at least three serially disposed bins and rotatable throwing device for receiving the larger particles from said first stage and throwing the particles into one of the bins, and means for directing a stream of air across the path of travel of at least some of the particles thrown by said throwing device, means delivering particles from the bin located nearest said throwing device to said conveyor, and means for extracting sheet plastics and the like from particles carried on said conveyor.

13. The apparatus of claim 12, wherein means are provided for adjusting the particle inlets to said bins.

14. The apparatus of claim 12, including vibrating ramp means having a selected grid surface thereon for receiving particles from one said bin, classifying these particles by size and delivering selectively sized ones of these particles onto said conveyor.

15. The apparatus of claim 12, including in said first stage a second ramp having a second grid thereon, and means for vibrating said second grid and separating minute particles from smaller particles which pass through said other grid.

16. The apparatus of claim 12, wherein said extracting means includes means for brushing through a combination of paper and soft plastic materials carried on said conveyor, comb means disposed for removing from said brushing means plastic materials extracted from the conveyor by said brushing means, and exhaust means for carrying away plastic materials thus removed.

17. The apparatus of claim 12, wherein at least two said extracting means are serially disposed on said conveyor, and including means disposed between said extracting means for receiving paper materials that a first one of said brushing means has brushed through, and directing these paper materials to a downstream location on said conveyor relative to the second or downstreammost one of said extracting means, in bypass relation relative to said second extracting means.

18. A method of reclaiming paper materials from mixed shredded trash comprising the steps of classifying the trash by size into larger and smaller sized particles, classifying the smaller sized particles by weight to remove lighter paperlike and plastic film particles therefrom, classifying the larger sized particles by weight to remove the lighter paperlike and plastic film particles therefrom, directing both groups of lighter particles through an extraction device, and extracting plastic film and the like from the lighter particles to yield lighter paper materials.

19. The process of claim 18, wherein the size classification step includes the step of screening the trash while vibrating the same.

20. The process of claim 18, wherein the step of weight classifying the smaller size-classified particles includes the step of directing the smaller size-classified particles past an airstream which directs the lighter of the particles into a predetermined zone.

21. The process of claim 18, wherein the step of weight classifying the larger sized size-classified particles includes the step of throwing these particles in a predetermined direction across inlets to variously located bins, while directing pressurized air across paths of at least some of the thrown particles to separate the particles into bins according to the ability of the particles to be thrown predetermined distances defined by bin locations.

22. The process of claim 18, wherein the extracting step includes the step of electrostatically attracting plastic film from the lighter particles.

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