

[54] TOWER EXTRACTOR FOR MUNICIPAL WASTES

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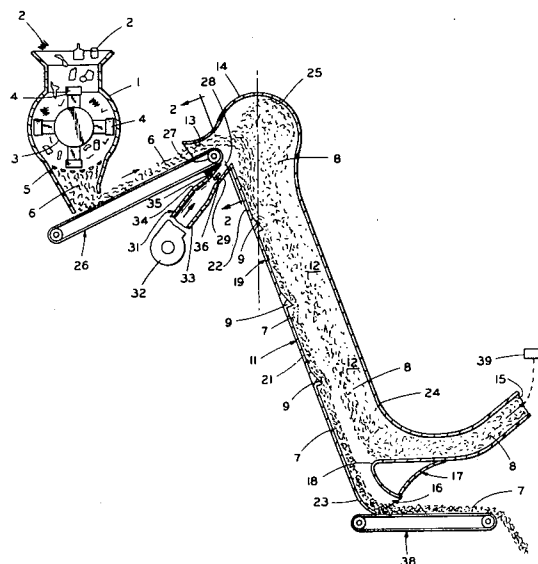
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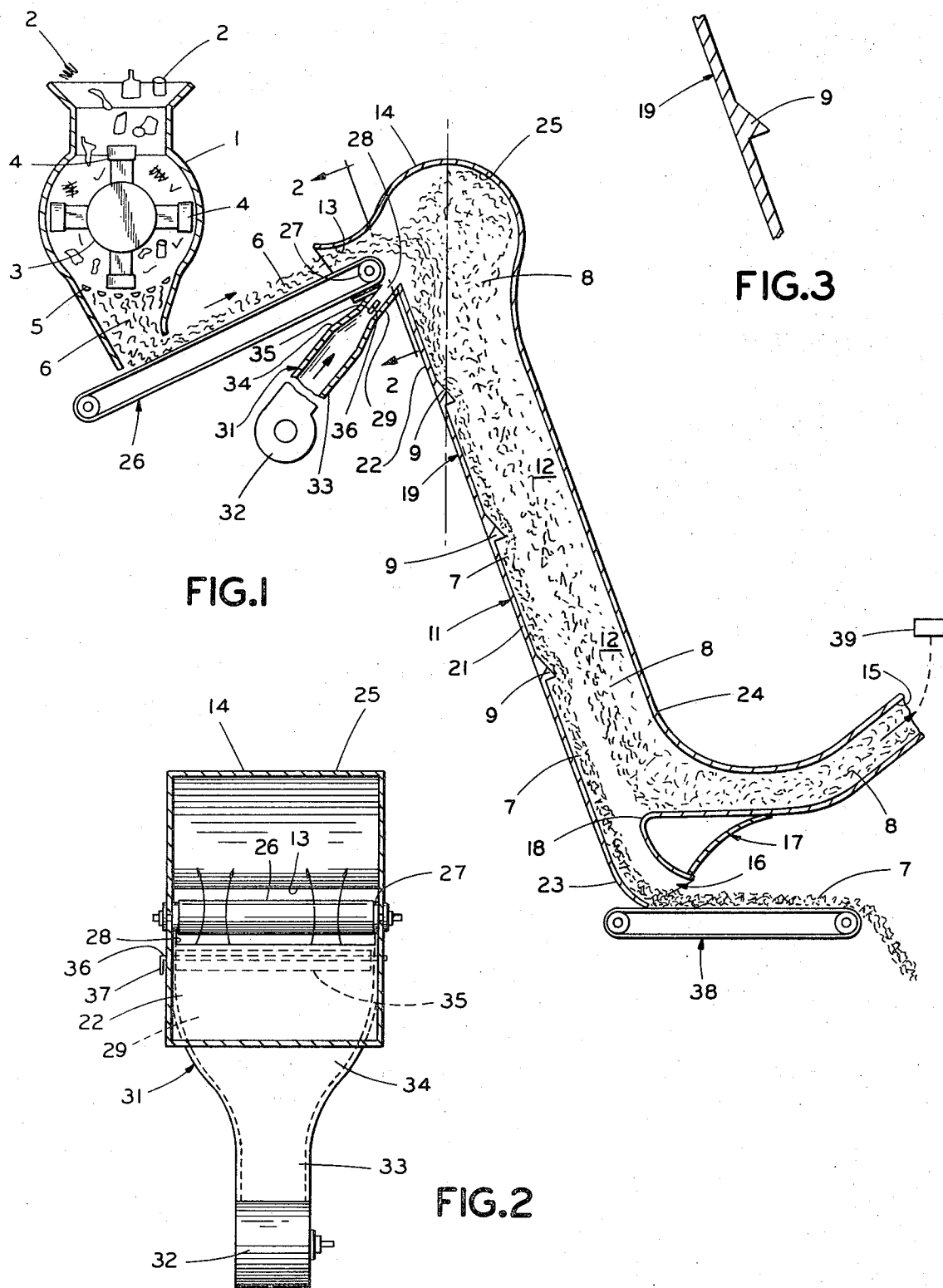
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[57] ABSTRACT

A tower extractor and method to continuously and coarsely or roughly separate paper, film plastic products and like, lighter materials from the heavier materials in a relatively large volume conglomerate of mixed solid municipal wastes or refuse. The separation occurs as the result of an airstream being directed into the conglomerate of mixed solid wastes as the mixed solid wastes begin to slide down a chute at least 30 feet long disposed at an angle of about 60° to 80° from vertical in a separation chamber. The volume and pressure of the airstream are selected so as to cause an initial separation and suspension of at least a portion of the lighter materials from the heavier materials as the waste descends down the chute. While a portion of the lighter materials is air suspended, the heavy materials and the remaining portions of the waste mixture flow down the chute and the mixture is further separated into a light fraction and a heavy fraction. The separation occurs because the components in the light fraction move at a slower rate than the components in the heavy fraction. As a result, the light components stratify above the heavy component and are drawn out of the separation chamber as a light fraction, preferably by suction. The heavier materials remain in contact with the chute and are separately discharged out of the separation chamber.

17 Claims, 3 Drawing Figures





TOWER EXTRACTOR FOR MUNICIPAL WASTES

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of my co-pending application Ser. No. 125,516 filed Mar. 18, 1971 now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to a novel and improved tower extractor, and more particularly, to a novel and improved tower extractor for continuously, coarsely or roughly separating paper, film plastic products and like, lighter materials from the heavier materials in a relatively large volume of conglomerate of mixed solid municipal wastes or refuse.

The improved tower extractor of the present invention is utilized as a part of a new, overall system for the treatment of mixed solid wastes or refuse, such as the mixed solid wastes which originate from municipal, commercial and industrial sources. This new system is designed to be an alternative to the common practice of simply disposing of refuse or solid wastes in land fills or in refuse dumps.

In this new system, the refuse is separated into its component parts so that each part may be separately processed, and to a large extent, be reclaimed or converted into usable materials or energy. In a time when the public is becoming increasingly aware of problems relating to ecology and energy conservation, such new systems of effectively handling municipal wastes are of significant importance.

For example, the paper and fiber portion of municipal waste can represent up to 60 percent of the total waste. This material, when separated from the total waste, has a BTU value of at least 6,000 BTU/lb. Typically the paper and fiber portion has a BTU value of about 8,000 BTU/lb. Because of this high heat value, the paper, etc., could be a valuable fuel source.

In order for a system for the separation of municipal waste to be commercially attractive, it is of critical importance that the component parts of the refuse or solid wastes be inexpensively and quickly separated. The tower extractor of the present invention satisfies these requirements in a novel and unique manner and provides an economical and facile means for coarsely or roughly separating paper, film plastic products and like, lighter materials from the heavier materials in a mixed conglomerate of refuse or municipal solid wastes at or near the beginning of the separation process in the system. My improved tower extractor is relatively inexpensive to manufacture and maintain and is capable of handling a high volume of solid wastes or refuse while obtaining a relatively good quality, rough separation at minimal cost.

SUMMARY OF THE INVENTION

More specifically, my novel and improved tower extractor includes a separation chamber having a relatively steep chute disposed therein. This chute must be inclined at an angle of about 60° to about 80° and be of sufficient length to permit the light and heavy components in municipal waste to reach their terminal velocity as they descend down the chute. For a small capacity system, this length must be not less than 30 feet. The length should be proportionately longer for longer

capacity systems. A first conveyer is utilized to elevate the conglomerate of solid wastes or refuse to be separated to the upper end of the chute in the separation chamber. Preferably, the conglomerate of mixed solid wastes is shredded prior to its introduction into the separation chamber to facilitate the separation of the waste components in the chamber. As the solid wastes are dropped off at the discharge end of the first conveyer and onto the upper end of the chute, a relatively high volume, high pressure stream of air is directed into the wastes. This airstream causes at least a portion, if not all of the materials in the wastes to become momentarily suspended or airborne. However, the heavier materials in admixture with some light material soon fall back onto the chute and continue to slide down to the lower end of the chute. As this mixture slides down the chute, the mixture separates into a heavy fraction in direct contact with the chute and a light fraction stratified above the heavy fraction with the heavy fraction moving at a faster velocity than the light fraction. This stratification is due to the fact that the components in the heavier fraction have a smaller surface area and are more dense than the paper, etc., components in the light fraction. As a consequence, the components in the heavy fraction move at a higher velocity than the less dense, higher surface area lighter components. As the mixture flows, the lighter materials migrate toward the top of the heavy layer and stratification occurs. This stratification would occur if the mixture merely flowed down the steeply inclined chute without the need for the airstream. However for efficient separations to occur, a prohibitively long chute is necessary. The utilization of the airstream substantially lowers the length of the chute required. A second conveyer is positioned adjacent to the lower end of the chute and is utilized to transport the heavier materials out of the separation chamber.

The lighter materials, such as paper, film plastic products and the like, initially are in suspension or remain airborne in the separation chamber due to the volume and pressure of the airstream and due to the domed shape of the upper portion of the separation chamber. This allows the heavier materials to make first contact with the chute. The lighter materials are ultimately drawn out of the separation chamber, while stratified above the heavier materials by suction. Thus, through the utilization of the novel and improved tower extractor of my invention, an extremely satisfactory, rough separation of conglomerate municipal solid wastes or refuse can be achieved.

Accordingly, it is a primary object of my present invention to provide a novel tower extractor for coarsely and roughly separating paper, film plastic products and like, light materials from heavier materials in a conglomerate of mixed municipal solid wastes or refuse.

Another object of the present invention is to provide a novel tower extractor wherein the materials to be separated are conveyed to the upper end of a steeply inclined chute in a separation chamber; wherein as the materials begin to fall down the chute, a relatively high volume, high pressure stream of air is directed into the materials. Preferably, the stream causes at least a portion of the materials, particularly the light materials, to at least temporarily become suspended or airborne; wherein the heavier materials thereafter drop or fall back onto the chute and slide down the chute; and wherein due to the slope and length of the chute, the

materials stratify into a light fraction and a heavy fraction.

Still another object of the present invention is to provide a novel tower extractor wherein a first conveyor is utilized to convey the materials to be separated to the upper end of the chute in the separation chamber; wherein a second conveyor is utilized to convey the separated, heavier materials from the separation chamber; and wherein the stratified lighter materials are withdrawn from the separation chamber by suction.

A related object of the present invention is to provide a novel and improved tower extractor of the type described wherein the angle of the airstream may be adjusted with respect to the material to be separated.

These and other objects and advantages of my invention will be apparent from the following description of the preferred embodiment of my invention.

DESCRIPTION OF THE DRAWINGS

Referring to the drawings wherein like reference numerals indicate like parts throughout the figures:

FIG. 1 is a partial vertical cross-sectional view of a shredder, supply conveyor, and tower extractor embodying the principles of my invention.

FIG. 2 is a cross-sectional view taken along section line 2-2 in FIG. 1, and

FIG. 3 is a detailed plan view of the riffles positioned within the tower extractor.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the tower extractor of my invention is shown generally at 11 and is utilized to coarsely separate the lighter materials and the heavier materials in mixed solid wastes or refuse such as the type which originate from municipal, commercial and industrial sources. The extractor 11 is particularly suitable for use in the initial portion of the new overall systems for treatment of mixed solid waste or refuse materials which are being developed as an alternative to the common practice of simply disposing of refuse or solid wastes in land fills or in refuse dumps.

Prior to passage to the extractor 11, the raw solid wastes 2 (FIG. 2) collected from the general public is first crushed and shredded in shredder 1. It has been discovered that shredding enhances the efficiency of the extractors. Preferably, the raw solid wastes 2 are shredded so that the paper portion of the waste is between 1 and 12 inches in cross section. Shredder 1 comprises a rotor 3 having positioned on the arms of the rotor grinding members 4. Grinding members 4 shred the waste by a shearing action between the members 4 and the interior of shredder 1. The waste is further shredded by the forcing of the waste by members 4 through the narrow gaps in grate 5. The raw shredded waste 6 is then discharged onto the conveyor 26 and passed to extractor 11 for separation.

The extractor 11 includes an air separation chamber 12 which is generally disposed so that its longitudinal axis is disposed at an angle with respect to the vertical. The chamber 12 has inlet opening 13 adjacent to its upper end 14, and has a light material discharge opening 15 and a heavy material opening 16 adjacent to its lower end 17.

As shown in FIG. 1, the discharge openings 15 and 16 are spaced from each other, with the opening 15 being spaced above the opening 16 and being separated

from the opening 17 by an inwardly curved, generally triangular wall section 18. The light material discharge opening 15 is generally tubular in form, with the initial part of the tubular opening being defined by the wall section 18 which also defines the initial portion of the heavy material discharge opening 16.

The lowermost or bottom wall 19 of the chamber 12 defines and functions as a chute 21. The upper end 22 of the chute 21 is positioned adjacent to the inlet opening 13 and the lower end 23 of the chute is positioned adjacent to and forms a part of the heavy materials discharge opening 16. The uppermost or top wall 24 of the chamber 12 is generally parallel to the wall 19 except adjacent to the upper end 14 of the chamber wherein a dome-like section 25 is formed for the reasons hereinafter explained.

It is necessary that the chute be inclined at an angle of 60°-80° and be of sufficient length to allow the light and heavy components in its waste to reach their terminal velocity so that stratification of the components occurs. This stratification is further enhanced by adding riffles 9 to the surface of chute 21 which extends laterally across the entire width of the chute. As illustrated in greater detail in FIG. 3, riffles 9 are generally triangular in shape with the base of the triangle facing downstream. The base of the triangle generally is about 1 - 1.5 inches high and the hypotenuse is positioned at an angle of about 30° - 45° to the surface of chute 21. Riffles 9 are spaced about 8 - 12 feet apart along the length of chute 21. Typically three to six riffles are used in a given extractor, the exact number being a function of the size and capacity of the unit.

A conventional, endless, conveyor 26 is positioned adjacent to the upper end 14 of the chamber 12. The conveyor 26 extends into the chamber 12 through the inlet opening 13 so that its head pulley 27 is positioned within the interior of the chamber 12 and so that the path along which materials are conveyed thereon is generally perpendicular to the plane of the chute 21. The conveyor 26 is disposed at an angle with respect to the vertical (and with respect to the longitudinal axis of chamber 12) so that it elevates and conveys the conglomerate of mixed solid wastes or refuse materials to be separated into the interior of the separation chamber 12. Preferably, the mixed solid waste and refuse materials are shredded prior to their being conveyed by the conveyor 26 since such shredding tends to improve the degree of separation obtained in the tower extractor 11. When the materials being conveyed reach the upper end of the conveyor 26, i.e., the head pulley 27, the conveyor 26 is arranged so that the waste and refuse materials are dropped onto the upper end 22 of the chute 21.

An air stream inlet 28 is defined by a portion 29 of a duct 31 and is located adjacent to but immediately below the head pulley 27 and immediately above the upper end 22 of the bottom wall 19. The duct 31 is connected to the outlet of a conventional, adjustable air blower 32 so that a continuous, high volume, high pressure stream of air may be introduced into the interior of the separation chamber 12 through the inlet 28. The stream of air introduced through the inlet 28 may be varied as to velocity and pressure, by adjusting the operation of the blower 32, so as to provide the optimum separation, considering the local conditions of the mixture, i.e., the amount of moisture, composition, etc.

As shown in FIG. 2, the portion 29 of the duct 31 is rectangular in cross-section and is arranged so that it extends completely across the full width of the conveyor 26 and so that the steady forceful air blast flowing through the inlet 28 bears on the mixed refuse or solid waste falling off the head pulley. The rectangular configuration of the portion 29 of the duct 31, which defines the inlet 28, is utilized to insure that the airstream bears on all the falling particles of refuse or solid waste. The portion 33 of the duct 31, upstream from the inlet 28, may have a more conventional cross-section, such as a round or square configuration. The portions 29 and 33 of the duct 31 are interconnected by a transition portion 34.

An adjustable baffle plate 35 is located within the portion 29 of the duct 31, just upstream from the inlet 28, and this plate 35 extends across the portion 29. The plate 35 is secured to a rod 36 whose ends are journaled in the sides of the portion 32, adjacent the sides of the conveyor 26. A handle 37 is connected to an extended end of the rod 36 and is utilized to adjustably rotate the rod 36 about its longitudinal central axis. Rotation of the rod 36 results in pivotal movement of the plate 35 within the portion 29 of the duct 31. Locking means, not shown, may be used to hold the plate 35 in any pre-selected position within the duct 31. The purpose of permitting adjustment of the angular disposition of the plate 35 is to enable the user of the tower extractor to adjust the direction of airstream introduced into the interior of the chamber 12 through the inlet 28, so as to obtain optimum separation for the solid wastes or refuse being processed.

A second conventional endless conveyor 38 is positioned adjacent to the heavy material discharge opening 16. The conveyor 38 is generally horizontally disposed and is adapted to receive the separated heavy materials 7 from the lower end 23 of the chute 21. The conveyor 38 is utilized to convey these heavy materials 7 to the next step in the overall process.

The light material discharge opening 15 is connected to a source of suction, shown generally at 39, which causes the light materials 8 stratified over heavy materials 7 in the interior of the chamber 21 near the end of lower end 23 of chute 21 to be withdrawn from the chamber 12. Upon the light materials 8 being withdrawn from the chamber 12, they too are conveyed by conventional means, not shown, to the next processing step in the overall treatment process.

OPERATION

The operation of the improved tower extractor is as follows: A relatively large volume of mixed solid waste or refuse materials 2 to be roughly or coarsely separated is continuously conveyed into the inlet of crusher 1 wherein the waste is ground into a waste stream 6 of small size. The ground waste is then continuously conveyed into the upper end 14 of the chamber 12 by the conveyor 26. The shredding or crushing of materials 2 improves even more the efficiency of the separation operation. The waste or refuse materials are conveyed by the conveyor 26 along a first path, disposed at an angle with respect to the vertical, into the interior of chamber 12 through the opening 13. As the waste or refuse materials reach the upper end or the head pulley 27 of the conveyor 26, they fall, by gravity, off the conveyor and onto the upper end 22 of the chute 21. At this point, i.e., as the waste or refuse materials fall away

from the conveyor 26, a high volume, high pressure stream of air from blower 32 is directed into the falling materials. As noted previously, the direction and intensity of the airstream is regulated by the position of the adjustable plate 35.

The airstream causes at least a portion of the materials to be momentarily suspended in the air or to become temporarily airborne. However, the heavier materials in the conglomerate of mixed materials and at least a portion of the light materials in admixture with the heavy materials tend to fall, by gravity, back onto the chute 22 and again, by gravity, slide down the chute 22 to its lower end 23.

In contrast to the heavy materials, at least a portion of the lighter materials, such as paper, film plastic products, and the like, are at least momentarily held in air suspension by the airstream in the upper dome-like section 25 and along the upper wall 24 of the chamber 12. The amount of materials in air suspension results from selection of the volume, velocity and pressure of the airstream introduced into the interior of the chamber 12.

Those materials not in air suspension slide down chute 22. As they descend down the chute, the components reach their terminal velocity with the light materials 8 stratifying over heavy materials 7 whereby this stratification allows the materials to be separated at the end of the chute by the cooperation of curved wall 18 which is adapted to extend to the interface between the two separately moving strata and the suction, induced in the inlet 15 by the suction means 39. This causes these stratified lighter materials to be drawn from the section 25 along the upper wall 24 and into and out of the discharge opening 15.

As mentioned earlier, the stratification between light materials and heavy materials occurs because of the difference in density and the ratio of density to surface area in the waste mixture. As the mixture descends down chute 21 the lighter materials, because of their greater resistance to air tend to flow at a lower terminal velocity than the heavy materials. As a consequence, the flowing light materials rise to the top of the flowing heavy materials and form a slower moving light strata which can be readily removed from the separation chamber.

From the foregoing it will be apparent that my novel and improved tower extractor provides an expeditious and facile means for roughly or coarsely separating the lighter materials from the heavier materials from a conglomerate of mixed municipal solid wastes or refuse, and increases the efficiency and effects of the overall waste or refuse treatment process. Moreover, the novel and improved tower extractor of the present invention does not utilize many movable parts and the parts utilized, for the most, are standard, readily available parts, so that the tower extractor may be operated with a minimum of maintenance and operational expenses.

While in the foregoing, there has been provided a detailed description of the preferred embodiment of the present invention, it is to be understood that all modifications obvious to those having ordinary skill in the art are to be included within the scope of the invention as claimed.

I claim:

1. A tower extractor for continuously, coarsely separating paper, film plastic products and like, lighter ma-

terials from the heavier materials in a conglomerate of mixed municipal solid wastes, comprising:

- i. a separation chamber having an upper portion and an inlet opening, a light material discharge opening and a heavy material discharge opening spaced below said upper portion, with the inlet opening, the light material discharge opening, and the heavy material discharge opening being spaced from each other with the heavy material opening and light material discharge opening spaced below the inlet opening;
- ii. means for moving the conglomerate of mixed municipal solid wastes to be coarsely separated into the air separation chamber means, through the inlet opening thereof, along a first path;
- iii. means for providing an airstream;
- iv. means for passing said airstream into the separation chamber means so that the air stream axis intersects said first path adjacent to the inlet opening of the air separation chamber means, said airstream being of sufficient pressure and volume so that at least a portion of the paper, film plastic products and like, lighter materials become at least momentarily airborne, and are partially separated from the heavier materials in the conglomerate of mixed municipal solid wastes;
- v. a chute portion positioned within said separation chamber at least 30 feet long and which slopes relatively steeply downward at an angle of about 60° to about 80° and has its upper end adjacent to the inlet opening in the separation chamber, the chute portion being positioned below the first path and said axis of said airstream to initially receive the heavier materials that fall away from said first path and slide down said chute portion after passing the point of the intersection between said airstream and said first path, said chute further separating the components in said waste as they slide down the chute;
- vi. means for removing the heavier materials in the conglomerate of mixed municipal solid wastes from the separation chamber means through the heavy material discharge opening; and
- vii. means for removing the light paper, plastic film products and like, lighter materials from the separation chamber means through the light material discharge opening.

2. The tower extractor described in claim 1, wherein said first path is disposed at a first angle with respect to the vertical and said airstream is directed from below said first path whereby all materials become momentarily air suspended.

3. The tower extractor described in claim 1, wherein the means for removing the suspended paper, plastic film products and like, lighter materials includes suction means connected with the light materials discharge opening and which removes the paper, plastic film products and like, lighter materials from the air separation chamber means.

4. The tower extractor described in claim 1, wherein the means for moving the conglomerate of mixed municipal solid wastes into the separation chamber is a first conveyer which has its discharge end located within the air separation chamber means adjacent to the inlet opening thereof; and wherein said airstream intersects said first path adjacent to the discharge end of the first conveyer.

5. The tower extractor described in claim 1 wherein the longitudinal axis of the first conveyer is inclined with respect to the vertical; wherein the means for providing said airstream is positioned below the discharge end of the first conveyer; wherein the means for directing said airstream is arranged so that said airstream is inclined with respect to the vertical and with respect to the longitudinal axis of the first conveyer and so that said airstream intersects said first path at point downstream, but adjacent to, the discharge end of the conveyer.

6. The tower extractor described in claim 5 wherein the means for removing the heavier materials includes a second conveyer positioned adjacent to the lower end of the chute portion and extending out of the separation chamber through the heavy material discharge opening in the separation chamber.

7. The tower extractor described in claim 6 wherein the means for removing the suspended paper, plastic film products and like, lighter materials includes suction means which is connected with the light materials discharge opening in the separation chamber and which removes the paper, plastic film products and like, lighter materials from the separation chamber.

8. The tower extractor described in claim 7 wherein the means for directing said airstream is adjustable to permit said axis of said airstream to intersect said first path at various angles.

9. The tower extractor of claim 1 which includes means for shredding the solid wastes prior to its introduction into the separation chamber.

10. The tower extractor of claim 1 which includes an inwardly extending wall positioned between the light material discharge opening and the heavy material discharge opening to intercept the light fraction in said chamber.

11. The tower extractor of claim 1 which includes rifles on the surface of said chute.

12. A method for continuously coarsely separating paper film plastic products and like lighter materials from the heavier components in a conglomerate of mixed municipal solid wastes which comprises the steps of:

- i. passing a mixed municipal solid waste down a chute inclined at an angle of about 60° to about 80° and of sufficient length to permit the components in the waste to reach their terminal velocity and to stratify said wastes into a slower moving upper light fraction and a faster moving heavy fraction;
- ii. contacting said waste stream with a high velocity air stream as the waste is about to descend down said chute to enhance said stratification; and
- iii. separating said light fraction from said heavy fraction.

13. A method as in claim 12 wherein said light fraction is separated by drawing said fraction into a suction.

14. A method as in claim 12 which includes grinding said waste prior to passage down said chute.

15. A method as in claim 14 wherein the waste is ground to provide a light fraction wherein the light waste is one to twelve inches in cross-section.

16. A method as in claim 12 wherein said air stream suspends at least a portion of said waste in air before passage down said chute.

17. A method as in claim 12 wherein said chute is at least 30 feet long.

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