

[54] **APPARATUS AND METHOD FOR
AUTOMATICALLY SEPARATING
MAGNETIC FROM NON-MAGNETIC
SUBSTANCES**

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[51] **Int. Cl.²** **B03C 1/16**

[58] **Field of Search** 209/214, 215, 223 A, 219,
209/218, 230, 216, 223 R; 198/41, DIG. 13

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[57]

ABSTRACT

An apparatus and method for automatically separating magnetic substances such as tableware from non-magnetic substances such as food and paper waste having a frame, pulleys mounted for rotation near opposite ends of the frame, an endless conveyor belt mounted over and carried by the pulleys on which un-separated substances may be placed and magnetic means mounted in one of the pulleys to establish a strong magnetic field through the conveyor belt thereby attracting and separating the magnetic substances from the non-magnetic substances and causing them to be retained adjacent the conveyor belt despite the removal of the non-magnetic substances from the conveyor belt by gravity as it moves around the pulley. A number of inductor bars placed adjacent the pulley containing the magnetic means and near the underside of the belt to develop induced magnetic fields which attract the magnetic substances but cooperate with one or more circuit shunt bars carried on the endless conveyor belt at spaced distances along it to automatically release these substances as the circuit shunt bars come adjacent the inductor bars and shunt or short circuit the magnetic field from these substances. An apparatus for automatically separating magnetic and nonmagnetic substances having at least two endless conveyor belts supported at their opposite ends on upper and lower pulleys, respectively, disposed in vertical relationship, in which one of the upper pulleys contains magnetic means of sufficient strength to attract magnetic substances moving on the lower conveyor belt below that pulley to separate such substances from non-magnetic substances on that belt.

20 Claims, 8 Drawing Figures

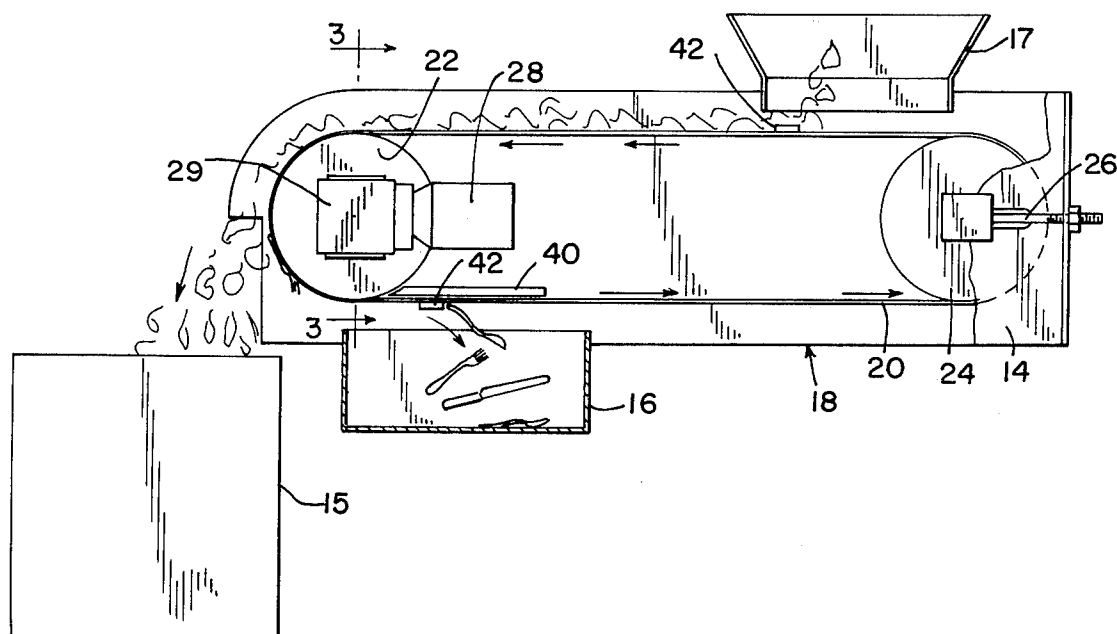


FIG. 1.

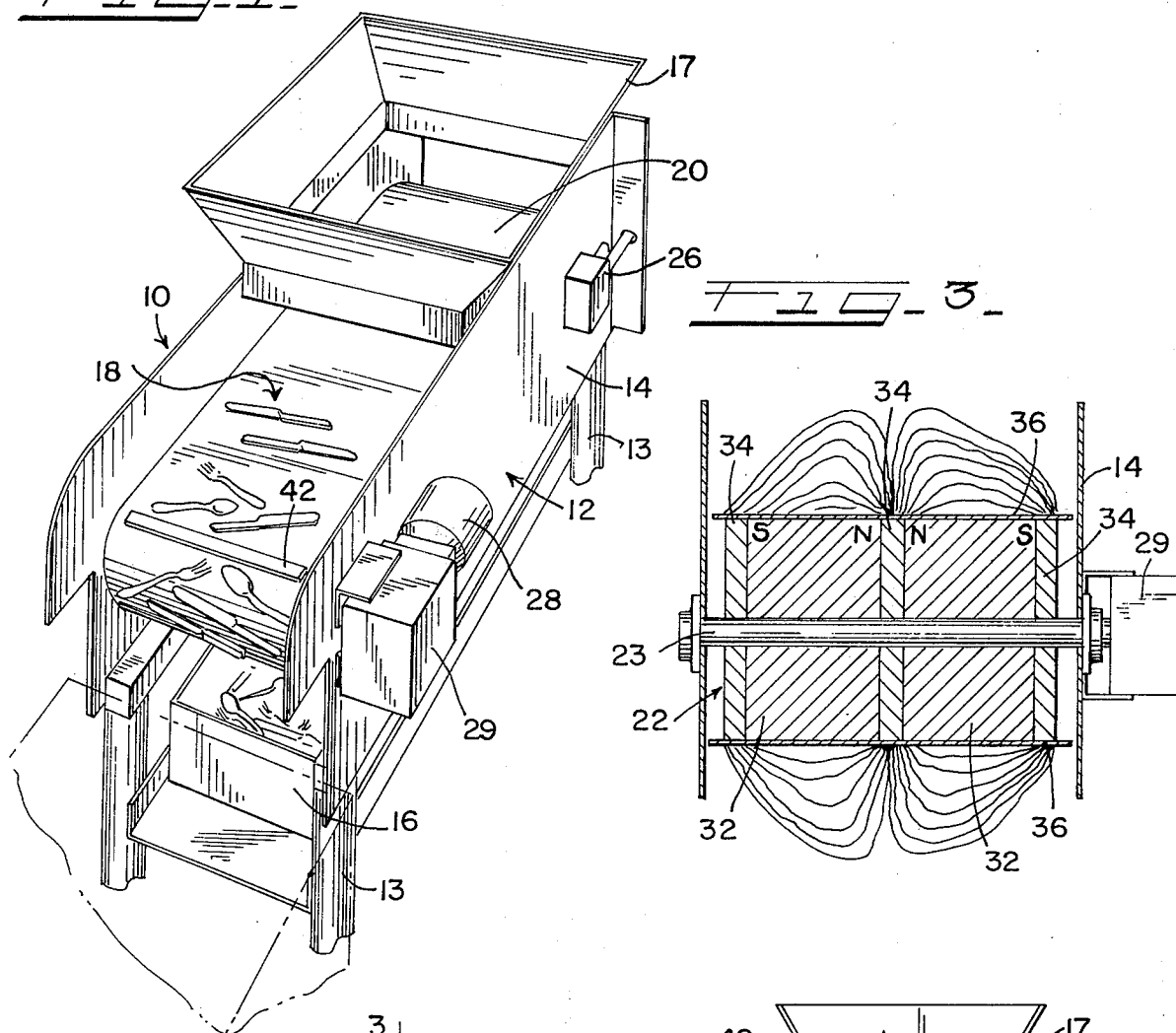


FIG. 3.

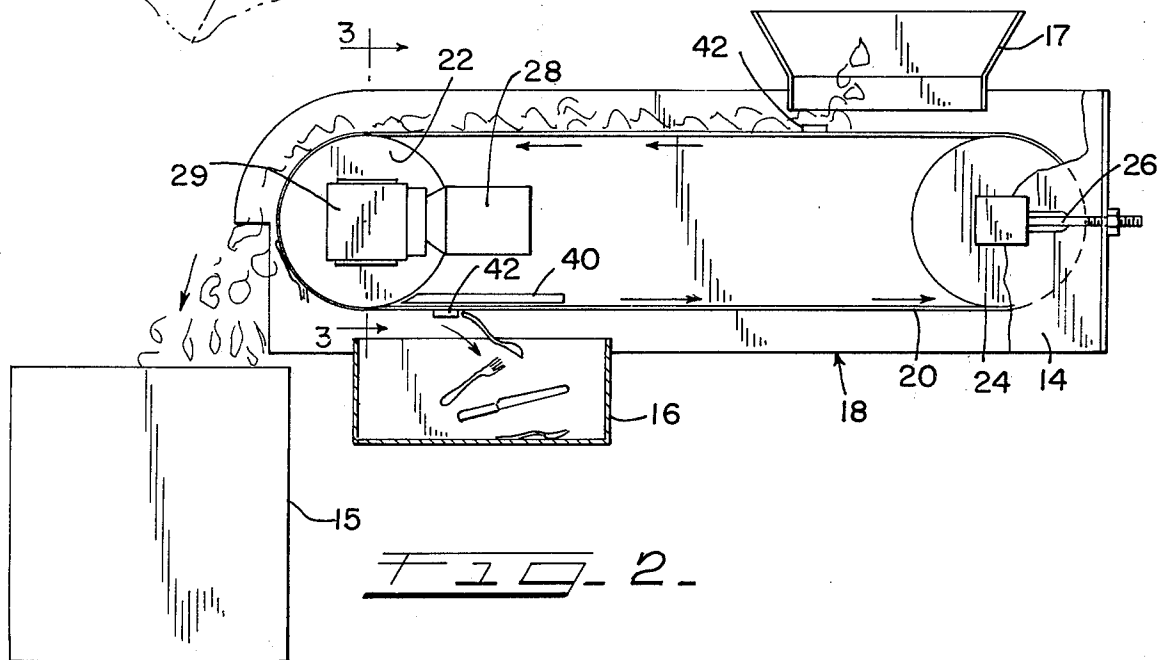
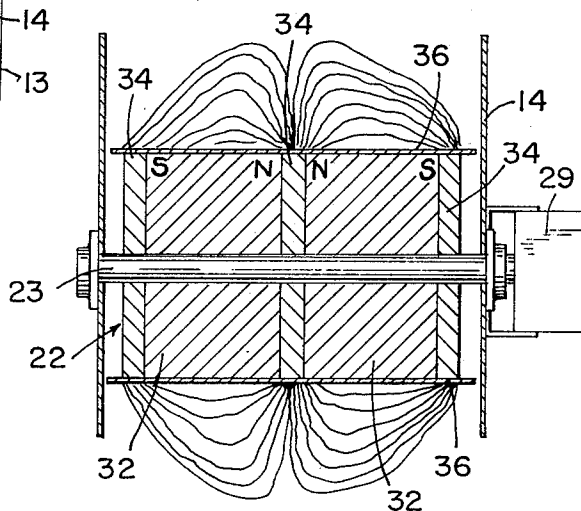
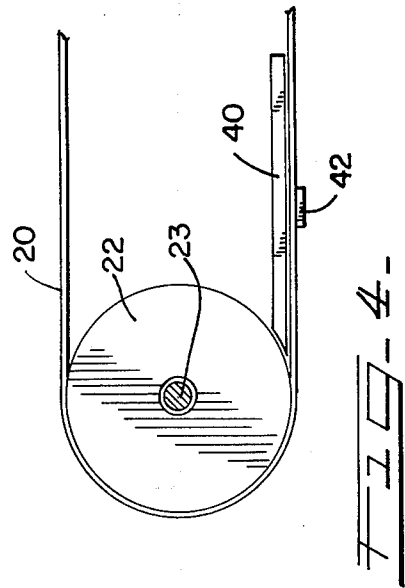
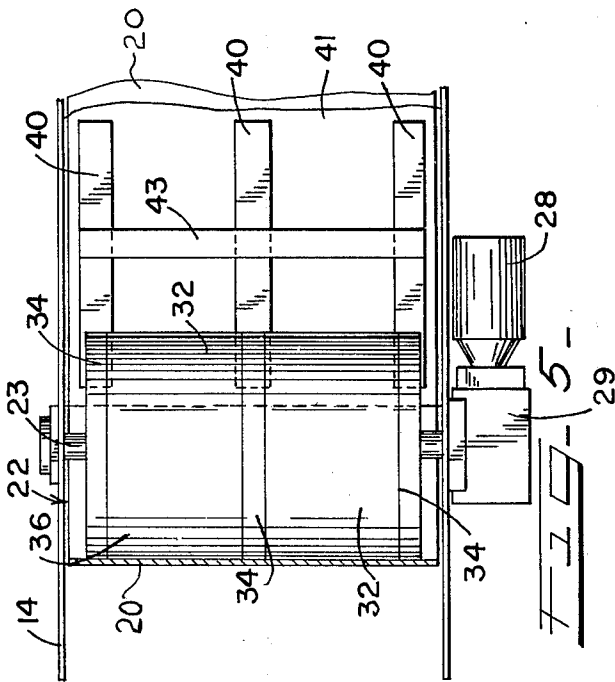
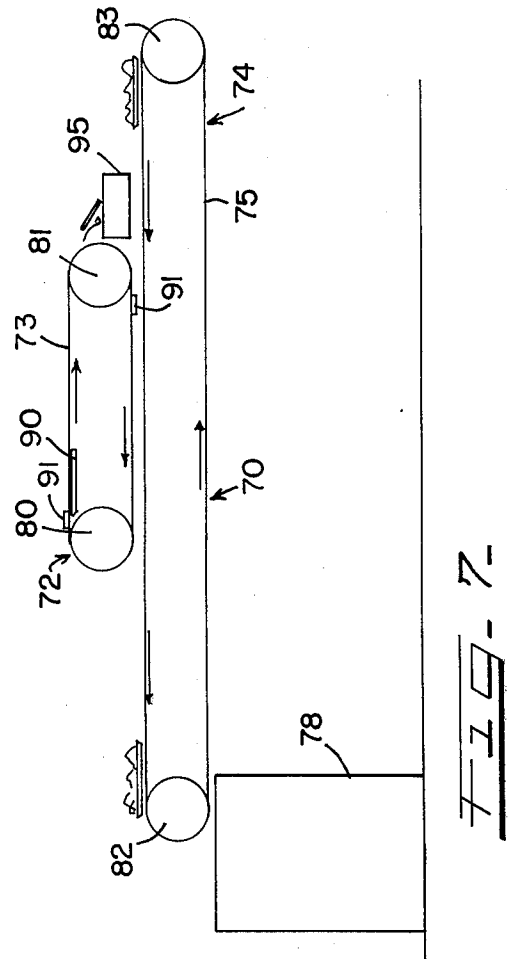
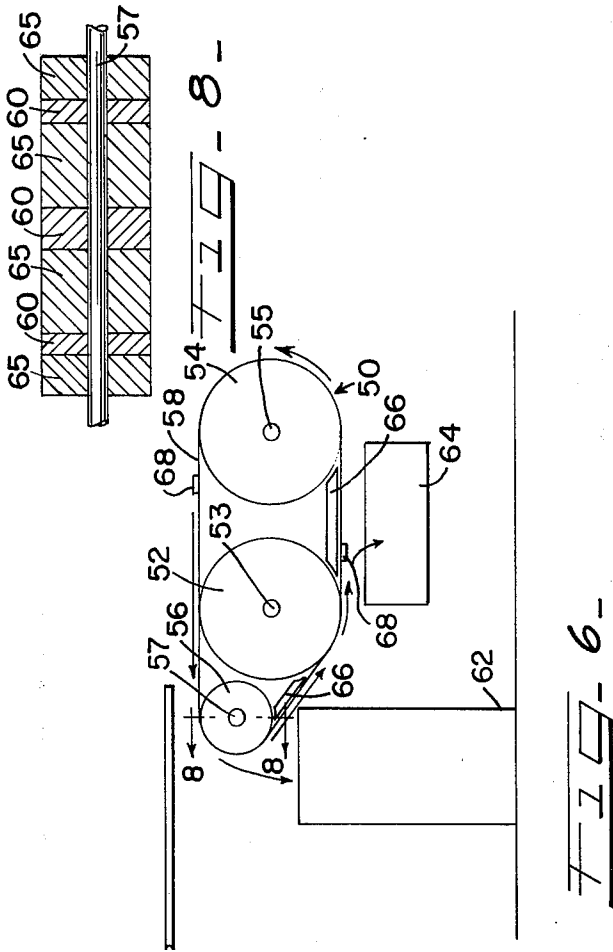


FIG. 2.



APPARATUS AND METHOD FOR AUTOMATICALLY SEPARATING MAGNETIC FROM NON-MAGNETIC SUBSTANCES

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for automatically separating valuable, reusable magnetic substances such as tableware from quantities of non-magnetic substances such as food and paper waste.

The food industry has long been plagued with the costly and time-consuming problem of separating valuable reusable items, such as metal tableware from solid waste, such as food, paper and other disposable items. This problem is prevalent in any food service facility, such as restaurants, cafeterias, schools, prisons and so on, in which plates must be scraped and/or tableware separated from garbage by hand sorting or by scavaging, and especially in the airline industry where there is no opportunity for sorting in flight. Even when manual sorting or scavaging is carried out, it has been found that a large amount of tableware is lost. For example, a set of airline tableware only lasts about seven flights. It is obvious that continued replacement of tableware is not only expensive, but economically wasteful. Some restaurants have found that most missing tableware is lost, rather than taken by customers, and that such losses run as high as \$1,300 on a traditionally heavy day.

The present method of separating tableware from garbage or waste has been to have kitchen personnel go through each tray or the combined waste and manually separate the utensils from it. This process is slow and time consuming, and, if attempted at too rapid a rate, will result in increased losses of tableware. In addition, these methods require large numbers of personnel who are not necessarily thorough in their sorting, and wastes large areas such as the huge tiled room at the new O'Hare International Hotel in Chicago which is devoted to hand sorting.

Present magnetic conveyors and magnetic elevators have serious disadvantages and are not suitable for use in separating tableware. Such conveyors generally have a fixed magnet which is placed behind a moving belt and attracts magnetic substances such as cans. Such devices would merely accumulate tableware, however, by stopping its movement. They would not separate it from waste also moving on a conveyor. Such devices have no means of automatically and positively releasing tableware and, in addition, if such a fixed magnet were not cleaned of tableware continually by hand, its field would be reduced by each additional accumulated piece. Without any means for positively releasing substances from the fixed magnetic field, prior devices have depended on a successive piece, such as a can, to knock prior cans out of the field. Unfortunately, the last can will always remain in the field if not manually released.

SUMMARY OF THE INVENTION

The present invention provides an apparatus and method to automatically, quickly and effectively separate tableware from food, paper or other waste at a faster rate than is now possible while essentially eliminating loss of tableware.

It has been found that approximately 80% to 90% of the tableware now in use, including that with wooden

or plastic handles, is formed of a magnetic substance, that is, a material such as class 400 stainless steel or carbon steel, which may be attracted by a magnet. The present invention has been developed utilizing a conventional endless conveyor belt which is supported between and carried around pulleys mounted at opposite ends of a steel frame. A pair of magnets are mounted inside the shell of one of the pulleys to establish a magnetic force field extending radially through the conveyor belt around that pulley. This magnetic field positively attracts magnetic substances such as metallic tableware to the surface of the conveyor belt as the conveyor belt moves around the pulley. As the belt is moved around, the food and paper waste are removed from the belt by gravity into a suitable trash receptacle. The tableware, however, remains attracted to the conveyor belt and is thereby separated automatically from the non-metallic refuse. This tableware is carried to a point where it may be conveniently released into a receptacle of its own.

It has also been discovered that positive release of the tableware from the magnetic field created by the magnets may be provided by placing a number of inductor bars longitudinally adjacent an inside surface of the conveyor belt near the magnets and generally in line with their poles. These bars are capable of being magnetically induced by the magnets to create an induced magnetic field extending toward the receptacle where the tableware is to be dropped. A number of circuit shunt bars are then placed at spaced intervals laterally across either surface or woven into the endless conveyor belt so that they are perpendicular to the shunt bars. When these shunt bars come adjacent the inductor bars, they act as keepers to shunt the induced magnetic field of the inductor bars directly through the shunt bars thereby immediately releasing any tableware held by the magnetic field created by the inductor bars and allowing it to drop into the receptacle. This prevents accumulation of tableware at a point adjacent the magnets in the pulley while allowing use of stronger magnets to eliminate "chatter" caused by the frictional force of the belt on tableware overcoming the magnetic force.

In a modified embodiment of the present invention, upper and lower conveyor belts are used which are each carried on pulleys mounted in frames. The upper conveyor belt may be disposed along the lower one or at a desired angle to it with the pulley containing the magnets disposed above a portion of the lower conveyor belt. The combined tableware and waste are then placed on the lower conveyor belt or a bus tray containing waste and tableware is directly placed on the lower conveyor. When the lower conveyor approaches the magnetic field created by the magnets in the upper conveyor, tableware will be attracted by the strong magnetic field, extracted from the waste and brought adjacent to the upper conveyor belt. It will then be carried by this conveyor belt from the lower side of the belt onto the upper side of the belt where it may be positively released and carried rearward to be deposited by gravity in a suitable container at the opposite end of the belt.

Accordingly, it is an object of the present invention to provide an apparatus for quickly, efficiently and automatically separating magnetic substances from nonmagnetic substances.

It is also an object of the present invention to provide an apparatus which quickly, efficiently and automati-

3

cally separates tableware from food and paper waste thereby eliminating hand sorting and scavaging costs and tableware loss.

It is a further object of the present invention to provide an apparatus for automatically separating magnetic substances from non-magnetic substances which provides a means for quickly and positively releasing the separated magnetic substances at a desired point and time.

It is a still further object of the present invention to provide an apparatus for automatically separating magnetic substances from non-magnetic substances which is simple in construction, easy to clean and maintain and easy for even unskilled personnel to operate.

These and other important objects of the present invention will become apparent from the following description taken in conjunction with the drawings illustrating preferred embodiments wherein:

FIG. 1 is a perspective view of the apparatus for automatically separating magnetic substances from nonmagnetic substances;

FIG. 2 is a side elevational schematic view generally illustrating the operation of the apparatus for automatically separating magnetic substances from non-magnetic substances shown in FIG. 1;

FIG. 3 is a vertical cross-sectional view of the apparatus for separating magnetic substances from nonmagnetic substances illustrated in FIG. 1, taken generally along line 3—3 of FIG. 2 and showing the radially extending magnetic field;

FIG. 4 is a side elevational schematic view of a portion of the apparatus for separating magnetic substances from non-magnetic substances shown in FIG. 2, showing in detail the means for positively releasing the magnetic substances;

FIG. 5 is a top plan view of the pulley and magnetic means of the apparatus for separating magnetic substances from non-magnetic substances shown in FIG. 2;

FIG. 6 is a slightly modified version of the apparatus for separating magnetic substances from non-magnetic substances shown in FIG. 2 using a smaller diameter pulley to extend the travel of the conveyor belts into small clearance spaces;

FIG. 7 is a further embodiment of the apparatus for separating magnetic substances from non-magnetic substances in which two conveyor belts are used and the tableware is automatically extracted by attraction to the upper conveyor belt; and,

FIG. 8 is a vertical cross-sectional view of the modified apparatus for separating magnetic substances from non-magnetic substances taken generally along line 8—8 of FIG. 6.

DESCRIPTION OF THE INVENTION

Referring now to the drawings, and, in particular, to FIG. 1, one embodiment of the automatic tableware separating apparatus of this invention is shown in general at 10. This separator 10 includes a frame 12 made from any sturdy, easy to clean and maintain, non-magnetic material, such as stainless steel, having a body 14 enclosing the sides of a conveying means 18 and supported by legs 13 which also support shelves beneath the body. Normally positioned at one end of the frame, directly in line with the conveying means 18, is a waste or trash receptacle 15 of conventional design. Supported on a shelf beneath the conveying means 18 is a tableware receptacle 16, also of conventional design.

4

Conveying means 18 includes an endless conveyor belt 20 formed of any suitable smooth, easy to clean material such as an elastomer which may be tensioned to present a relatively solid and continuous surface upon which the combined tableware and food and paper waste may be emptied or upon which trays holding such substances may be placed. A hopper 17 may be also formed above body 14 and conveyor 18 to funnel combined tableware and waste materials dumped therein directly onto the conveyor belt to eliminate loss from the sides of the belt or outside of the separator 10.

The conveyor belt 20 is supported between and carried by a first pulley 22 and a second pulley 24 disposed at its opposite ends. First pulley 22 is mounted on a nonmagnetic shaft 23 and second pulley 24 is mounted on a similar stainless steel shaft 25. The longitudinal position of second pulley 24 and shaft 25 relative to the body 14 is preferably adjustable by a pulley takeup 26 to move shaft 25 relative to the frame 12 to adjust the tension in the conveyor belt 20. This takeup 26 may have threaded adjusting members on each side of belt 20 to assure that the belt tracks properly between the sides of frame 12 during operation.

Pulleys 22 and 24 are mounted for rotation relative to frame 12 on shafts 23 and 25 so that when they are rotated they will move conveyor belt 20 over them in a desired direction. Conveying means 18 may be driven by a conventional electric motor 28 which is adaptable to available power sources and which may be operatively connected to one of the pulleys either directly as shown, through a reduction gear, worm gear and drive gear, disposed in drive box 29, or through a drive belt or chain extending between the motor 28 and a sprocket on the outer end of the shaft 23 of the first pulley 22, or by any suitable means. The direct drive may be mounted outside and on either side of the conveying means to permit easy access for repair of the drive or to allow loading of the conveyor from either side.

First pulley 22 has an outer, stainless steel shell 36 mounted in spaced relation to the shaft 23. Second pulley 24 is of similar construction. Inside first pulley 22, on shaft 23, however, are mounted two donut-shaped permanent magnets 32 which move with the shaft 23 and, therefore, with pulley 22 in an angular direction and which have like poles adjacent near the mid-point of pulley 22. These magnets have mild or soft steel pole pieces 34 placed between them and over their ends which are magnetically excited by magnets 32 to establish a magnetic circuit which significantly increases the strength of the magnetic field. The magnetic field thus established extends radially relative to the shaft 23 and pulley 22 any desired distance, depending on the strength of magnet used, upwardly through the stainless steel shell 36, as shown in FIG. 3. FIG. 3 shows that the lines of force of the magnetic field extend between the opposite end pole pieces of each magnet and into the pole piece 34 at the center between the north poles of the two permanent magnets. This particular arrangement assures that the magnetic field will be strongest at the center of the conveyor belt 18 since it is well known that a magnetic field has its greatest strength at the poles of the permanent magnet.

As explained above, this magnetic field, which extends about the entire circumference of the pulley in a radial direction, acts to physically separate tableware formed of magnetic substances such as Class 400 stain-

less steel from the non-magnetic food and paper waste. It is clear that tableware, as used in this description, also includes any metallic, magnetic substances such as fruit or dessert cups, creamers and so on. Thus, as the pulley 22 is rotated in a counterclockwise direction, as shown in FIG. 2, the food and paper waste will, upon reaching the left hand end of conveyor belt 20, fall into the waste receptacle 15, while the tableware will be held adjacent the belt 20 by the effect of the magnetic field, even though the belt 20 has moved to the underside of the conveying means 18. Even tableware located on top of refuse or garbage will be unscrambled as the belt moves around the magnetic pulley, since the waste drops vertically while the tableware is drawn radially into the belt by the strong magnetic field.

In order to obtain timely and positive release of the tableware which is magnetically held adjacent the conveyor belt 20, the present invention may include a positive releasing means formed by a number of parallel steel inductor bars 40 extending longitudinally along the conveyor belt 20 generally parallel to or in line with and having one end adjacent the steel pole pieces 34. These mild or soft steel inductor bars 40 are magnetically induced by the permanent magnetic circuit and establish a longitudinal extension of the radial magnetic field between them which is of sufficient strength to maintain the tableware adjacent the conveyor belt 20 for a distance of travel of the conveyor belt 20 past pulley 22 relative to the frame 12. The tableware receptacle 16 is positioned below these inductor bars 40 and the tableware is suspended by the induced magnetic field, above this receptacle, while belt 20 continues to move. If the tableware were allowed to accumulate in this position, its mass would ultimately overcome or cause a reduction in the magnetic field causing pieces to drop prematurely and allowing contact between pieces which could damage them. To overcome this problem, a series of steel circuit shunt bars 42 are placed laterally across the conveyor belt 20 at desired, spaced distances along its length. These shunt bars 42 are positioned to travel perpendicular to and across inductor bars 40. They are designed to provide a superior path for magnetism and thereby act as keepers for the magnetic field created by inductor bars 40. Thus, when a circuit shunt bar 42 is moved across the parallel inductor bars 40, it acts to short circuit the magnetic field to the inductor bars 40 by routing their induced magnetic field, which extends outwardly from them, directly through the shunt bar 42. Shunt bar 42 extends laterally across conveyor belt 20 between the end pole plates 34 and is attracted and oriented in the magnetic field in a similar fashion to the captive tableware. Thus, as shunt bar 42 moves toward the position where the tableware is held suspended relative to the moving belt, it short circuits the induced magnetic field through itself causing the pieces of tableware to be immediately released to drop directly into the receptacle 16. These shunt bars may be fastened to belt 20 by a strong adhesive, or other suitable means, and spaced along the conveyor belt 20 so that the inductor bars 40 will be short circuited and the tableware released before an accumulation of tableware is built up on the conveyor. Moreover, since the magnetic poles of the shunt bars are oriented in the same direction as the poles in the tableware, i.e., north poles adjacent, the shunt bars will repel any piece of tableware which may remain attracted by magnetism adjacent the conveyor, and push it off the belt without ever physically touching it.

FIG. 6 illustrates a slight modification of the tableware separating apparatus 10 shown in FIG. 1 which is adapted for use as an under-the-counter separator, or to feed disposals or pulverizers which have a minimum height greater than the bottom edge of the conveying means of FIG. 1. This separator, generally denoted at 50, includes a first pulley 52 and a second pulley 54 mounted within a frame on shafts 53 and 55, respectively, for angular movement relative to the frame and supporting a conveyor belt 58 in a similar construction to that described above. Adjacent the first pulley 52, however, is a smaller radius auxiliary pulley 56 mounted on a non-magnetic shaft 57 also extending between the sides of the body of the frame, but positioned at a distance slightly greater than the total radius of pulleys 52 and 56 from the shaft of first pulley 52. This first pulley 52, which contains permanent magnets and pole plates arranged in the same manner as described above, will act to induce a magnetic field into smaller radius pulley 56 which is preferably formed of three donuts of steel, or other suitable magnetic material 60, aligned with the steel pole plates of pulley 52 and spaced by non-magnetic material, such as aluminum 65, as shown in FIG. 8. The smaller radius pulley thus extends the magnetic field of the permanent magnetic circuit in the same fashion as the inductor bars previously described. This use of an auxiliary pulley 56 allows the conveyor belt 58, which is similar in construction to conveyor belt 20, to be extended under a counter top, but above a refuse receptacle or garbage disposal 62, as shown in FIG. 6. Combined tableware and waste may be scraped directly onto belt 58 as it is moved by the rotating pulleys through the permanent magnetic field and the induced magnetic field to allow the waste to drop into the refuse receptacle and the separated tableware to be positively released by the inductor bars 66 and shunt bars 68, similar to those described above, into a tableware receptacle 64.

A modified embodiment of the apparatus for separating magnetic and non-magnetic substances of the present invention is shown in FIG. 7. This embodiment, called a double conveyor separator and referred to in general at 70, includes an upper conveying means 72 having an upper conveyor belt 73 which is supported over and carried by pulleys 80 and 81 at its opposite ends, as described above. This upper conveying means 72 is positioned in a frame and mounted over a lower conveying means 74 which also has a conveyor belt 75 supported between and carried by pulleys 82 and 83 mounted at its opposite ends and supported by a frame. In this embodiment, the pulley having the permanent magnetic circuit is installed in upper pulley 80. Thus, a radially extending magnetic field is established about the circumference of pulley 80 which extends in a downward direction through conveyor belt 73 toward the surface of the lower conveyor belt 75. In operation, conveyors 72 and 74 are driven by one or more suitable driving means (not shown). Though movement of these belts in similar directions is illustrated in FIG. 7, the direction of movement is a matter of choice, the critical element in the construction of this embodiment being the positioning of the magnetic upper pulley 80 of the upper conveyor 72 over a portion of the path of travel of belt 75 of the lower conveyor 74.

This embodiment is particularly adapted for removing the tableware from bus trays directly placed on the moving lower conveyor belt. This would be desirable in airline operations so that the trays may be merely re-

moved from the plane and placed directly on the lower conveyor of this separator. As the tray containing combined waste and tableware moves under the magnetic pulley 80, the tableware is physically extracted and drawn upward by a magnetic field established about the pulley 80 and attracted to the belt 73 of the upper conveyor 72. The separated tableware is then carried to the upper side of the conveyor 72 where it may be positively released from the field by inductor bars 90 and shunt bars 91 and then carried rearward toward the end of the conveyor where it is allowed to drop into a suitable receptacle 95. In the meanwhile, the trays with the food and paper waste are carried toward the opposite end of the lower conveyor 74 to a suitable trash receptacle 78 or to further sorting. It is clear that the upper conveyor 72 may be positioned along the length of the lower conveyor 74, as shown, or any other position depending upon space requirements. Conveyor 72 could be disposed vertically relative to conveyor 74, and further inductor bars and permanent magnets added to separate and convey tableware upward into a receptacle

While this invention could use electromagnets, permanent magnets are preferred because of their long life, strength and freedom from maintenance and electrical hazard. Material suitable for use as permanent magnets include, but are not limited to, barium ferric oxide, ceramic magnets or alnico which has greater durability if high temperatures are involved. The magnets used can be of any strength desired, increasing with the size of the operation and volume of waste to be handled. The radial extent of the field will, of course, vary with the size magnet used when placed in a circuit with the pole plates. By way of example only, a magnet circuit generating a field approximately 3 inches beyond the surface of the conveyor belt has been found adequate to handle combined waste and tableware at a rate in excess of 7 cubic yards per hour.

Stainless steel slider beds placed directly under the top and bottom spans of the conveyor belt may be used to help support the belt between pulleys, particularly when large amounts of waste and tableware are being carried. Such flat beds are welded to the opposite sides of the frame body 14. It is also desirable, in order to maintain the inductor bars in position, that these bars be tack welded to a stainless steel slider plate 41, as shown in FIG. 5, and capped by a non-magnetic hold-down bar 43.

To generally summarize, the method of automatically separating magnetic and non-magnetic substances illustrated by this invention involves placing unseparated tableware or other reusable magnetic substances and refuse on a conveyor belt, moving this belt through a radial magnetic field which actually attracts and physically extracts and separates the tableware from the combined tableware and waste, and positively releasing the attracted tableware from the force of the magnetic field.

This invention not only represents the solution to a long-felt commercial need but also provides a preliminary process that eliminates steel, such as tableware, to permit the pulping and pumping of garbage. Such "cleaned" garbage may be disposed of or burned as an energy source to fulfill modern ecological demands and legislative requirements.

While this invention has been described in relation to preferred embodiments thereof, it will be apparent to those skilled in the art that the structural details are

capable of wide variation without departing from the principles and spirit of the invention.

I claim:

1. An apparatus for separating magnetic substances from non-magnetic substances including frame means, pulley means mounted on said frame means and rotatable relative thereto, endless conveying means disposed between and carried by said pulley means, said conveying means being movable relative to said frame means when said pulley means are rotated, drive means connected to at least one of said pulley means to rotate said pulley means and thereby move said conveying means, and magnet means associated with at least one of said pulley means and disposed with respect to said conveying means to establish a magnetic field through said conveying means about said one of said pulley means which positively attracts said magnetic substances placed on said endless conveying means and maintains said magnetic substances adjacent said conveying means for a desired distance of travel of said conveying means relative to said frame to thereby separate said magnetic substances from any non-magnetic substances placed adjacent said conveying means, inductor means mounted in a stationary position relative to said frame adjacent said pulley means associated with said magnet means and disposed near the point relative to said frame means at which release of said magnetic substances is desired, and circuit shunt means carried on said endless conveying means for movement therewith relative to said frame, said circuit shunt means being spaced along the length of said endless conveying means, said magnetic substances being held adjacent said endless conveying means as said conveying means is moved past said magnet means and over said inductor means by the magnetic field exerted through said conveying means directly by said magnet means and inductively by said inductor means until said circuit shunt means is moved adjacent said inductor means to shunt the magnetic field into said shunt means and keep it momentarily thereby releasing said magnetic substances from adjacent said endless conveying means.

2. The apparatus set forth in claim 1 wherein said pulley means includes at least two pulleys mounted near opposite ends of an elongated frame, each of said pulleys having a shaft forming a central axis around which said pulley rotates relative to said frame and an outer shell mounted in radially spaced relationship to said shaft and in contact with a portion of said conveying means to support said conveying means, one of said pulleys having a number of magnets mounted on said shaft within said shell with like poles of said magnets being axially adjacent and separated by a magnetic material to form a strong, permanent magnetic core which emits a radially extending magnetic field through said shell and said endless conveying means about the circumference of said pulley.

3. The apparatus of claim 1 wherein two pulleys are mounted adjacent one another near one end of said frame means, each of said pulleys carrying and supporting a portion of said endless conveying means, one of said pulleys having a smaller diameter than the other of said pulleys, said two pulley means being arranged relative to said frame to allow said endless conveying means to be extended outwardly into a space lesser in dimension than the diameter of said larger diameter pulley, said larger diameter pulley having said magnet means associated therewith, said smaller diameter pul-

ley having a central core having spaced inductor rings capable of having magnetism induced therein by the disposition of said magnet means in close association therewith such that said smaller diameter pulley will emit an induced magnetic field to attract magnetic substances placed on said endless conveying means.

4. An apparatus for separating magnetically attracted substances, such as tableware and the like, from non-magnetic substances, such as food and paper waste, including lower conveying means having an endless lower conveyor belt disposed between and carried by lower pulley means supported on a lower frame, said lower pulley means being rotatable relative to said lower frame to move said lower conveyor belt relative to said lower frame, upper conveyor means having an endless upper conveyor belt disposed between and carried by upper pulley means mounted on an upper frame, said upper pulley means being rotatable relative to said upper frame to move said upper conveyor belt relative to said upper frame, said upper conveying means having magnet means associated with at least one of said upper pulley means and arranged to exert a radially extending magnetic field through said upper conveyor belt of sufficient strength to attract magnetic substances to said upper conveyor belt, said upper conveying means being maintained in spaced relationship above said lower conveying means and disposed relative to said lower conveying means such that said upper pulley means having said magnet means cooperatively associated therewith is positioned directly above a portion of said lower conveyor belt such that when magnetic and non-magnetic substances disposed on said lower conveying means are carried under said magnet means associated with said upper pulley means, said magnetic substances will be attracted adjacent said upper conveyor belt by the magnetic field exerted therethrough and then carried by said upper conveying means to a desired point of deposit and thereby separated from the non-magnetic substances disposed on said lower conveying means, inductor means mounted in a stationary position relative to said upper frame adjacent said upper pulley means associated with said magnet means and disposed near the point relative to said upper frame means at which release of said magnetic substances is desired, and circuit shunt means carried on said upper conveying belt for movement therewith relative to said upper frame, said circuit shunt means being spaced along the length of said upper conveying belt, said magnetic substances being held adjacent said upper conveying belt as said conveying belt is moved past said magnet means and over said inductor means by the magnetic field exerted through said upper conveying belt directly by said magnet means and inductively by said inductor means until said circuit shunt means is moved adjacent said inductor means to shunt the magnetic field into said shunt means and keep it momentarily thereby releasing said magnetic substances from adjacent said upper conveying belt

5. The apparatus set forth in claim 4 wherein said upper pulley means includes at least two pulleys mounted near opposite ends of an elongated upper frame, each of said pulleys having a shaft forming a central axis around which each of said pulleys rotates relative to said frame and an outer shell mounted in radially spaced relationship to said shaft and in contact with a portion of said upper conveyor belt to support said conveyor belt, one of said pulleys having a number

of magnets mounted on said shaft within said shell with like poles of said magnets being axially adjacent and separated by a magnetic material to form a strong, permanent magnetic core which emits a radially extending magnetic field through said shell and said endless conveyor belt.

6. Apparatus for separating magnetic from non-magnetic substances comprising: conveying means; input means for bringing a mixture of magnetic and non-magnetic substances adjacent said conveying means; drive means for causing said conveying means to move relative to said input means; first magnetic means producing a magnetic field of sufficiently high intensity at a distance from said conveying means to draw the magnetic substances through the nonmagnetic substances and to hold the magnetic substances to said conveying means for a first length of travel thereof; second magnetic means positioned adjacent said conveying means near the end of said first length of travel to hold the magnetic substances to said conveying means for a second length of travel thereof beyond said first length, the positioning of said second magnetic means being independent of the movement of said conveying means; and release means for periodically demagnetizing at least a portion of said second magnetic means in order to produce a positive discharge of the magnetic substances from said conveyor belt.

7. Apparatus as claimed in claim 6 wherein: said first magnetic means comprises a permanent magnet; said second magnetic means comprises a plurality of inductor bars which are magnetically induced by said permanent magnet; and said release means comprises at least one shunt bar affixed to said conveying means to periodically shunt said inductor bars, thereby causing the magnetic substances to be released from the conveying means.

8. Apparatus as claimed in claim 6 wherein: said conveying means is an endless conveyor belt that passes over a pulley; said first magnetic means holds the magnetic substances to said conveyor belt as it passes over said pulley, while the non-magnetic substances are allowed to fall under the force of gravity; and said second magnetic means holds the magnetic substances to said conveyor belt beyond the point at which it leaves said pulley.

9. Apparatus as claimed in claim 8 wherein: said first magnetic means comprises a permanent magnet; said second magnetic means comprises a plurality of inductor bars which are magnetically induced by said permanent magnet; and said release means comprises at least one shunt bar connected to said conveyor belt to periodically shunt said inductor bars, thereby causing the magnetic substances to be released to fall under force of gravity.

10. Apparatus as claimed in claim 9 and further comprising a second pulley having a smaller diameter than said pulley and spaced outwardly therefrom with said conveyor belt passing thereover, said second pulley having a central core with spaced inductor rings which are magnetically induced by said permanent magnet.

11. Apparatus as claimed in claim 6 wherein: said conveying means is a conveyor belt; and said input means comprises a second conveyor belt passing under said conveyor belt, said first magnetic means causing the magnetic substances on said second conveyor belt to be transferred to said conveyor belt while the non-magnetic substances remain on said second conveyor belt.

11

12. Apparatus as claimed in claim 11 wherein: said conveyor belt passes upward over a pulley; said first magnetic means comprises a permanent magnet that holds the magnetic substances to said conveyor belt as it passes over said pulley; said second magnetic means comprises a plurality of inductor bars which are magnetically induced by said permanent magnet to produce a magnetic field that causes the magnetic substances to be conveyed past the top of said pulley; and said release means comprises at least one shunt bar connected to said conveyor belt to periodically shunt said inductor bars, thereby causing the magnetic substances to be released to be transported by said conveyor belt to a desired repository.

13. Apparatus for separating magnetic tableware from garbage comprising: a conveyor belt; input means for depositing a mixture of tableware and garbage on said conveyor belt; a pulley; drive means for causing said conveyor belt with the tableware and garbage on it to move around said pulley; first magnetic means producing a magnetic field of sufficiently high intensity at a distance from said conveyor belt to draw the tableware through the garbage and to hold the tableware to said conveyor belt while said conveyor belt is moving around said pulley, the garbage being allowed to fall from said conveyor belt under the force of gravity; second magnetic means positioned adjacent said conveyor belt beyond the tangent point at which said conveyor belt separates from said pulley to hold the tableware to said conveyor belt after said conveyor belt has moved around said pulley, the positioning of said second magnetic means being independent of the movement of said conveyor belt; and release means for periodically demagnetizing at least a portion of said second magnetic means in order to produce a positive discharge of tableware from said conveyor belt.

14. Apparatus as claimed in claim 13 wherein said first magnetic means comprises a permanent magnet arrangement located in said pulley to produce a radial magnetic field.

15. Apparatus as claimed in claim 14 wherein said second magnetic means comprises a plurality of inductor bars which are magnetically induced by said first magnetic means to produce a magnetic field that maintains said tableware on said conveyor belt after it passes the bottom of said pulley.

16. Apparatus as claimed in claim 15 wherein said release means comprises at least one shunt bar connected to said conveyor belt to periodically shunt said inductor bars, thereby releasing the tableware to fall under the force of gravity.

17. Apparatus as claimed in claim 16 wherein: said conveyor belt is an endless conveyor belt that passes between said pulley and a second pulley; and said input means is a hopper for depositing the mixture of table-

12

ware and garbage on the top surface of said endless conveyor belt.

18. Apparatus for separating magnetic tableware from garbage comprising: conveying means; input means for bringing a mixture of tableware and garbage adjacent said conveying means; drive means for causing said conveying means to move relative to said input means; first magnetic means producing a magnetic field of sufficiently high intensity at a distance from said conveying means to draw the tableware through the garbage and to hold the tableware to said conveying means for a first length of travel thereof; and magnetic induction means positioned adjacent said conveying means near the end of said first length of travel, said magnetic induction means being separate from and magnetically induced by said first magnetic means to hold the tableware to said conveying means for a second length of travel beyond said first length of travel, the positioning of said magnetic induction means being independent of the movement of said conveying means and a receptacle adjacent said magnetic induction means to receive the tableware from said conveying means.

19. Apparatus as claimed in claim 18 wherein: said conveying means is a conveyor belt that passes over a pulley; said first magnetic means is associated with said pulley to hold the tableware to said conveyor belt as it passes over said pulley; and said second magnetic means comprises inductor bars extending beyond the tangent point between said pulley and said conveyor belt at the bottom of said pulley.

20. A method of automatically separating magnetically attracted, reusable tableware and the like, from non-magnetic food and paper waste in a quick and efficient manner including the steps of:

placing the unseparated tableware and food and paper waste on a conveyor means;

establishing a magnetic field by magnet means positioned adjacent said conveyor means to radiate said magnetic field generally transversely to the surface of said conveyor means;

moving said conveyor means and said unseparated tableware and waste carried thereon into said magnetic field such that said tableware is positively attracted toward said magnet means and thereby magnetically separated from said nonmagnetic substances;

extending said magnetic field by magnetically induced means in order to transport said tableware beyond the point to which it would be transported by the effects of said magnet means alone; and

automatically shunting the extended magnetic field through keeper means periodically brought adjacent said induced means, such that said tableware is thereby positively released at a desired point.

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UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,926,792
DATED : December 16, 1975
INVENTOR(S) : J. Philip Buford

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, lines 19 and 20, delete the word "scavaging" and insert therefore--scavenging--;

line 22, delete the word "scavaging" and insert therefore--scavenging--;

Column 2, line 65, delete the word "form" and substitute therefore--from--;

Column 3, line 2, delete the word "scavaging" and insert therefore--scavenging--;

Column 9, line 15, delete the word "conveyor" and substitute therefore--conveying--; and

Column 12, line 28, delete the word "second" and after the word "magnetic" insert--induction--.

Signed and Sealed this

Sixth Day of July 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks