APPARATUS FOR AND METHOD OF CLASSIFYING EMPTY CONTAINERS

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ABSTRACT

Empty containers, such as cans, bottles, and the like, are introduced in a random manner to a classifying station where they are acted upon by gravity and by at least another force which acts basically in opposition to gravity with the force and gravity operating to classify the containers into a plurality of classifications.

12 Claims, 4 Drawing Figures
APPROXUS FOR AND METHOD OF CLASSIFYING EMPTY CONTAINERS

BACKGROUND OF THE INVENTION

A serious world-wide problem is the contamination of our environment with throw-away containers made of various materials, including glass, magnetic materials such as steel, aluminum, and plastic. To help solve this problem, some manufacturers have proposed to recycle containers made of glass and aluminum, for example, in an effort to reclaim the basic materials which comprise these containers.

Many ecology-minded people and organizations have undertaken programs to classify or sort the various containers brought to collection centers by hand so that these containers may be recycled, where possible. Glass and plastic containers are comparatively easily classified or sorted manually; however, it is very difficult for unskilled personnel to separate aluminum and steel containers. This difficulty is further aggravated because many steel containers are often provided with one or more end closures made of aluminum and the steel in aluminum containers constitutes an impurity which makes these containers unacceptable in a program where it is desired to recycle only the aluminum, for example.

It is obvious that manual sorting of containers at its best is commercially impractical. Further, even in those instances where containers can be manually sorted successfully into categories or classifications, it has been found that aluminum containers (which hold the most promise for profitable commercial recycling) often contain foreign materials such as rocks, glass, lead, water, etc., in quantities which cannot be determined manually without the aid of scales and these foreign materials serve as contaminants and preclude recycling of the container containing such contaminants.

Therefore, the over-all problem in classifying or sorting containers is to economically classify or separate such containers into a plurality of categories defined by the materials used to make such containers including containers made of magnetic materials, aluminum, glass, etc. Further, to enable effective recycling of aluminum containers, for example, it is necessary that the containers not contain quantities of foreign materials which preclude successful recycling.

SUMMARY

This invention provides an improved apparatus for and method of classifying or separating containers into a plurality of categories defined by the materials used to make such containers and in such a manner that the containers thus classified may be effectively recycled. In particular, containers are introduced at random to a classifying station of a container-classifying apparatus where they are acted upon by gravity and by one or more forces acting basically in opposition to and simultaneously with gravity. The action by gravity and by such forces results in the classification of containers at the classifying station into a plurality of categories or classifications corresponding in number to the number of such forces plus one.

Other details, uses, and advantages of this invention will become apparent as the following description of the exemplary embodiments thereof presented in the accompanying drawing proceeds.

BRIEF DESCRIPTION OF THE DRAWING

The accompanying drawing shows present preferred embodiments of this invention, in which

FIG. 1 is a schematic presentation illustrating one exemplary embodiment of the apparatus and method of this invention which is used to classify empty containers into a plurality of three classifications and which employs gravity, magnetic forces, and high velocity air streams at a single classifying station;

FIG. 2 is a schematic presentation similar to FIG. 1 and illustrating another exemplary embodiment of an apparatus and method of this invention which is used to classify empty containers into a plurality of three classifications and which employs gravity, magnetic forces, and a partial vacuum at a single classifying station;

FIG. 3 is a schematic presentation with parts broken away illustrating still another exemplary embodiment of the apparatus and method of this invention which utilizes a plurality of two classifying stations; and

FIG. 4 is an enlarged fragmentary cross-sectional view illustrating a portion of a typical belt conveyor comprising the apparatus illustrated in FIGS. 1—3 and used to convey containers away from its associated collection bin.

DESCRIPTION OF ILLUSTRATED EMBODIMENTS

Reference is now made to FIG. 1 of the drawing which illustrates one exemplary embodiment of the apparatus and method of this invention which is designated generally by the reference numeral 20. The apparatus and method 20 is particularly adapted for classifying (i.e., sorting or separating) empty containers into a plurality of categories defined by the basic materials used to make such containers.

In particular, the apparatus and method 20 is used to separate or classify containers made of glass, magnetic materials such as steel, and non-magnetic metallic materials such as aluminum. For easy later reference thereto in this specification, the containers made of glass will be referred to as glass containers or bottles 21, the containers comprised primarily of magnetic materials (which, by definition, also are capable of being attracted by a magnet) will be referred to subsequently as magnetic containers or steel cans 22 and the containers made of non-magnetic metallic materials will be referred to as aluminum containers or cans 23.

The apparatus 20 comprises a collection bin 24 which is used as a temporary storage bin containing containers of all categories regardless of the materials used to make such containers. The apparatus 20 also has means for introducing the containers to a container classifying station indicated generally at 25 and in this example the introducing means is in the form of an endless belt conveyor 26 which has one end portion supported beneath the bin 24 for receipt of containers therefrom and its opposite end portion arranged to discharge containers at the classifying station 25. The conveyor 26 is supported for movement in an endless path by a pair of conveyor pulleys 27 and 30 arranged at its opposite ends.

The conveyor 26 has a load-carrying surface 31 which has a plurality of stops 32 suitably fixed thereto in parallel spaced relation and the stops 32 prevent containers 21—23 from moving downwardly along the
container-carrying portion of surface 31 as the containers are conveyed from the bin 24 to the classifying station 25. The apparatus 20 also has a plurality of force-exercising means which act at the classifying station 25 basically in opposition to gravity, i.e., each force-exercising means exerts forces which do not aid the force of gravity but instead act basically in a direction transverse the force imposed on the containers by gravity or in a direction substantially diametrically opposite the force of gravity. The force-exerting means comprise magnetic means in the form of magnets 33 which comprise the pulley 30 and fluid means in the form of a plurality of air streams indicated by arrows 34 and such streams are directed across the classifying station 25.

The plurality of air streams 34 are produced by air at high velocity which exits a corresponding plurality of nozzles 35 provided as an integral part of a pressure head assembly 36 which comprises the apparatus 20. The assembly 36 is provided with air at a controlled pressure through a conduit 37 which has its inlet operatively connected to a motor-driven blower 40. A control device 41 is installed in the conduit 37 between the blower 40 and the pressure head assembly 36 to thereby control the energy of the air streams 34. The device 41 includes a variable flow area valve and may include an air pressure regulator.

The conveyor 26 has a sprocket wheel 42 suitably fixed to its pulley 30 and the apparatus has a drive motor 43 provided with a rotatable shaft 44 which has a sprocket wheel 45 suitably fixed thereto. A chain drive 46 extends between and meshes with sprocket teeth comprising the sprocket wheels 42 and 45 so that the conveyor 26 may be moved in its endless path by the motor 43.

The apparatus 20 has a chute 50 spaced beneath the top portion of the conveyor 26 and in this example the chute 50 is supported by the assembly 36. The apparatus 20 has a second chute 51 which is suitably supported in an inclined manner below the vertical level of the classifying station 25 and this chute has a top portion 52 which is horizontally displaced by a distance 53 from the horizontal plane extending through the terminal end of the nozzles 35 and for reasons which will become apparent subsequently.

During normal operation, containers 21, 22, and 23 which are to be classified are introduced into the bin 24 and conveyed by the conveyor 26 in an upwardly inclined manner around the magnetic pulley 30 and into the classifying station 25. At station 25 these containers are acted upon substantially simultaneously by gravity and by force-exercising means in the form of magnetic pulley 30 exerting magnetic forces which attract the steel containers 22 toward the magnetic pulley 30 as well as high velocity air streams 34 which impinge against all magnetically unattracted containers before they are accelerated by the force of gravity.

The magnetic pulley 30 exerts its maximum magnetic attraction against the steel containers 22 at the classifying station 25 and simultaneously with this action the aluminum containers 23 are propelled by the air streams 34 across the horizontal distance 53 so that they will fall onto the top surface of the chute 51. However, the air streams 34 do not have sufficient energy to deflect the comparatively heavier glass containers 21 whereupon the glass containers 21 drop substantially vertically under the influence of gravity.

The apparatus 20 has a plurality of three collection receptacles 54, 55 and 56, which are adapted to receive steel containers 22 from chute 50, glass containers 21 falling by gravity from station 25, and aluminum containers 23 from chute 51 respectively. In addition, the total volume provided by combining the volumes of the receptacles 54, 55 and 56 is substantially greater than the volume of the bin 24 because as containers are introduced into the bin 24 at random they are rapidly conveyed away by the conveyor 26 to the classifying station 25.

The containers made of magnetic materials or steel containers 22 are held firmly against the surface 31 of the conveyor 26 until they are moved past the location indicated generally at 60 where the portion of conveyor 26 which they adjoin moves away from the magnetic pulley 30 whereupon the containers 22 drop onto the chute 50 and are conveyed into their associated receptacle 54.

To assure that the air streams 34 have sufficient velocity, the control device 41 may be adjusted to vary the velocity of such streams and thereby assure that empty aluminum containers 23 are diverted across the horizontal distance 53 so that they will then fall by gravity onto chute 51 which conveys such containers into their receptacle 56.

The bin 24 is provided with a controlled exit opening 61 which prevents the containers from being stacked on the load-carrying surface of the belt conveyor 26. Also, the height of the opening 61 is such that containers are placed lengthwise onto the conveyor with their longitudinal axes arranged substantially parallel to the surface 31 and this assures that a substantial portion of the container surface area engages surface 31 of the conveyor 26 and the containers do not extend an appreciable distance over the top edges 62 of the stops 32 and as indicated at 63. The lengthwise placement of containers assures that steel containers will be subject to maximum magnetic attraction as they are moved around pulley 30 and such placement assures that the remaining containers have a substantial surface area thereof positioned so that the air streams will impinge thereon for maximum effectiveness.

Another exemplary embodiment of the apparatus and method of this invention is illustrated in FIG. 2 of the drawing. The apparatus and method illustrated in FIG. 2 is very similar to the apparatus 20; therefore, such apparatus will be designated generally by the reference numeral 20A and parts thereof which are very similar to corresponding parts of the apparatus 20 will be designated by the same reference numeral as in the apparatus 20A also followed by the letter designation A and not described again. Only those component parts of the apparatus which are substantially different from corresponding parts of the apparatus 20 will be designated by a new reference numeral also followed by the letter designation A and described in detail.

The main difference between the apparatus 20 and the apparatus 20A is that instead of using fluid means in the form of air under pressure exiting from one or more nozzles to define a corresponding number of air streams, the apparatus 20A utilizes a vacuum head designated generally by the reference numeral 64A at the classifying station 25A. The vacuum head 64A is suitably supported in position adjacent the classifying sta-
tion 25A and has a conduit 65A which operatively connects the vacuum head 64A to a high capacity vacuum pump 66A which produces a partial vacuum and a high suction which is effective in removing aluminum containers 23 at station 25A. A discharge conduit 67A is connected to the downstream end of the vacuum pump 66A and is positioned above receptacle 56A so that aluminum containers 23 removed by the vacuum head 64A exit the conduit 67A and fall into receptacle 56A.

As in the case of the apparatus 20, a suitable adjustable control device 41A is provided in the conduit 65A and serves to regulate the magnitude of the partial vacuum exerted by the vacuum head 64A.

The vacuum head 64A provides the partial vacuum across the classifying station 25A and the magnetic head 30A provides maximum magnetic attraction at station 25A so that steel containers 22 are virtually unaffected by the suction produced by head 64A. The partial vacuum or suction produced at station 25A is insufficient to remove the comparatively heavy glass containers 21 whereupon the containers 21 commence accelerating out of the classifying station 25A under the influence of gravity and are received in receptacle 55A. Further, it will be appreciated that the adjustable control device 41A is utilized to control the amount of suction produced at the classifying station 25A by assuring such suction is sufficient to remove aluminum containers 23, yet insufficient to adversely affect containers 21 and 22.

Another exemplary embodiment of the apparatus and method of this invention is illustrated in FIG. 3 of the drawing. The apparatus and method illustrated in FIG. 3 is very similar to the apparatus 20; therefore, such apparatus will be designated generally by the reference numeral 20B and parts of the apparatus 20B which are similar to corresponding parts of the apparatus 20 will be designated by the same reference numeral as in the apparatus 20, also followed by the letter designation B and not described again. Only those component parts which are substantially different from corresponding parts of the apparatus 20 will be designated by a new reference numeral also followed by the letter designation B and described in detail.

The apparatus 20B has a belt conveyor 26B provided with a magnetic pulley 30B including magnets 33B and has a collection bin, not shown, which is substantially identical to the bin 24 of the apparatus 20. The apparatus 20B also has a chute 50B and a receptacle 54B for receiving containers 22 made of magnetic materials.

The apparatus 20B comprises a second conveyor in the form of a belt conveyor 70B which has a pulley 71B at one end and a pulley 72B at its opposite end. The pulley 71B has a toothed sprocket wheel 73B suitably fixed thereto and a sprocket chain 74B is provided and operatively engages the sprocket wheel 73B of pulley 71B, sprocket wheel 42B of pulley 30B, and sprocket wheel 45B fixed to shaft 44B of the motor 43B whereby the motor 43B serves as the prime mover or drive not only for the belt conveyor 26B but also for the belt conveyor 70B.

The apparatus 20B, in essence, has a plurality of two classifying stations defined as classifying station 25B where containers 22 made of magnetic materials are separated from the remainder of the containers and classifying station 77B to be discussed subsequently. At classifying station 25B the containers 22 are separated by the magnetic pulley 30B and the remainder of the containers, which will be referred to as roughly classified containers, drop by gravity onto the load-carrying surface 75B of the belt conveyor 70B and are conveyed away from the classifying station 25B to the classifying station 77B which is defined at the end of the conveyor 70B supported by pulley 72B.

The roughly classified containers are acted upon at station 77B by gravity and by at least one other force so that gravity and the other force classify the roughly classified containers into a plurality of sub-classifications. In particular, it will be seen that the roughly classified containers comprised of glass containers or bottles 21 and aluminum containers 23 are transferred by the belt conveyor 70B to the classifying station 77B where fluid means in the form of a single stream 34B of high velocity air is impinged against the containers so that the lighter weight aluminum containers 23 are deflected or propelled horizontally a horizontal distance 78B from a vertical plane extending through a nozzle 80B defining stream 34B to the top portion 52B of chute 51B where the containers drop onto chute 51B and are conveyed to receptacle 56B. The remainder of the roughly classified containers are primarily glass containers which are unaffected by stream 34B and drop into receptacle 55B.

The air used to define the air stream 34B flows through nozzle 80B which has an elongated slot defined therein and the arrangement of the nozzle is such that the stream 34B is directed upwardly away from and roughly tangent to the end of conveyor 70B supported by pulley 72B at an angle 81B of roughly 60 degrees with a horizontal plane. The air under pressure for the nozzle 80B is provided through a chamber 82B having a special configuration which assures smooth air flow and minimum turbulence and the chamber 82B is in fluid flow communication with the conduit 37B which is in flow communication with a high pressure blower 40B. A control device 41B is provided in the conduit 37B and the device 41B enables either manual or automatic control of the air stream 34B.

The apparatus 20B utilizes two classifying stations 25B and 77B and gravity is employed at each classifying station together with at least another force exerting means in the form of magnetic means or fluid means to thereby classify the containers into at least a pair of classifications at each classifying station. It will also be appreciated that instead of the stream 34B of air under high pressure at the classifying station 77B it may be desirable to use a vacuum head substantially identical to the vacuum head 64A of the apparatus 20A and thereby separate containers 23 by vacuum.

Each belt conveyor 26, 26A, and 26B is made of a suitable non-magnetic material preferably in the form of an elastomeric material, see FIG. 4, and having suitable reinforcing layers or strands. In addition, each stop 32, 32A, and 32B is preferably in the form of a roughly L-shaped or angle-shaped stop which is fixed to its associated conveyor by a plurality of threaded bolts and associated nuts in accordance with standard practice and a typical stop is shown fastened in this manner at 83 in FIG. 4.

The apparatus and method of this invention is particularly effective in classifying or separating aluminum containers 23 from the remainder of the containers brought to a collection center for classification and, as previously mentioned, the aluminum containers may contain foreign materials such as rocks, glass, debris,
water, etc., in different amounts. In the event that such aluminum containers contain these foreign materials, they are not acceptable for recycling. By utilizing gravity and fluid means at the classifying station, whether the classifying station be station 25, 25A, 25B or 77B, containers have comparatively heavy impurities therein are not diverted by the fluid means into their associated receptacle and these containers will generally be collected in the container which collects the glass container or bottles. The aluminum containers thus collected may be either subsequently discarded or emptied of their foreign materials so that they may be reintroduced into their associated collection bin and processed through the classifying apparatus. This technique of employing fluid means in the form of either pressure or vacuum lends itself to precise fluid control which assures aluminum containers containing excessive amounts of impurities will not be mixed with the substantially empty aluminum containers and in a manner which is more reliable than manual sorting which attempts to guess at the weight of each container without weighing.

It will also be appreciated that certain plastic containers which do not contain water, rocks, etc., may be comparatively light in weight and will be diverted by the fluid means whether in the form of pressure or vacuum means into the receptacle which receives aluminum containers. This is generally recognized and as a practical matter plastic containers are easily spotted and removed prior to introduction into the supply bin so that classification may be achieved in accordance with the teachings of this invention or the plastic containers may be easily manually separated from the classified aluminum containers in either receptacle 56, 56A, or 56B. The drawing presented in this disclosure illustrates empty containers which have their original shapes. However, this invention is also fully effective in separating containers which are broken, partially bent, or torn, and even containers which are mashed flat.

In this disclosure of the invention the pulleys 30, 30A, and 30B are each shown with a pair of associated magnets 33, 33A, and 33B attached thereto. However, it is to be understood that each of these pulleys has associated magnets extending around its entire peripheral outline.

While present exemplary embodiments of this invention, and methods of practicing the same, have been illustrated and described, it will be recognized that this invention may be otherwise variously embodied and practiced within the scope of the following claims.

What is claimed is:

1. An article classifying apparatus comprising, means introducing articles to a classifying station where they are acted upon by gravity, fluid means and magnetic means at said classifying station acting in opposition to gravity, said fluid means, magnetic means, and gravity acting substantially simultaneously at said classifying station to classify said articles into a plurality of at least three classifications, said magnetic means serving to render removable by magnetic attraction articles comprised of magnetic materials.

2. An apparatus as set forth in claim 1 in which said fluid means comprises at least one air nozzle providing an air stream across said classifying station, said air stream being adapted to impinge and deflect certain ones of said articles and define one of said plurality of classifications.

3. An apparatus as set forth in claim 1 in which said fluid means comprises a vacuum head producing a partial vacuum across said classifying station and serving to remove by suction certain ones of said articles which define one of said plurality of classifications.

4. An apparatus as set forth in claim 1 in which said magnetic means comprises a magnetized pulley and said introducing means comprises an endless conveyor made of a non-magnetic material and being supported at one end thereof by said pulley, said pulley being positioned adjoining said classifying station.

5. An apparatus for classifying articles comprising, means introducing articles to be classified to a classifying station where they are unsupported and acted upon by gravity, and fluid means and magnetic means at said classifying station each acting in opposition to gravity, said fluid means, magnetic means, and gravity acting substantially simultaneously at said classifying station to classify said articles into at least three classifications.

6. An apparatus as set forth in claim 5 in which said introducing means comprises an endless belt conveyor comprised of an elastomeric non-magnetic material and having a conveyor pulley at one end thereof positioned adjoining said classifying station, said magnetic means being in the form of magnets provided as an integral part of said pulley, said magnets serving to remove by magnetic attraction articles comprised of magnetic materials and said fluid means serving to remove comparatively light articles with the remainder of the articles being comparatively heavy and falling by gravity into an associated receptacle.

7. An apparatus as set forth in claim 6 and further comprising a control device for controlling said fluid means and hence the force exerted thereby.

8. An apparatus as set forth in claim 6 in which said fluid means comprises at least one air nozzle providing an air stream across said classifying station, said stream being adapted to impinge against said comparatively light articles at said classifying station prior to acceleration thereof by gravity and deflect the comparatively light articles toward another receptacle.

9. An apparatus as set forth in claim 6 in which said fluid means comprises a vacuum head producing a partial vacuum across said classifying station and serving to remove by suction said comparatively light articles.

10. A method of classifying articles into a plurality of classifications comprising the steps of, introducing articles to a classifying station where they are unsupported and acted upon by gravity, exerting a magnetic force and a force produced by fluid means on said articles at said classifying station so that said magnetic force and said force produced by fluid means act in opposition to gravity, said forces and gravity acting substantially simultaneously at said classifying station to classify said articles into at least three classifications.

11. A method as set forth in claim 10 in which said force produced by fluid means is in the form of a high velocity air stream.

12. A method as set forth in claim 10 in which said force produced by fluid means is in the form of a partial vacuum.

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