

Description

This invention relates to air-operated material handling apparatus for the transport of cylindrical objects from an upstream location to a downstream location, said apparatus comprising a table extending from said upstream location to said downstream location and having a surface, edges and an underside with a prearranged pattern of flotation air jets in said surface slanted in a downstream direction and communicating between said surface and said underside of said table, and a plenum connectable to a source of air under pressure and attached to said underside of said table surface, said table having a shape to accommodate a wide mass of objects at said upstream location and a single file of objects at the downstream location, and a vertical side along each edge of said table said sides converging toward each other.

There are many occasions in the mass production of containers of similar size made for example, of paper, glass, plastic or metal where a plurality of feed lines, as from a mass of containers, need to be fed into a single line or multiple single lines or that a single multiple line needs to be separated into one or more single lines. This is desirable for directing containers to testing stations, labelling, filling or other stations in a packaging operation and/or manufacturing operation.

Prior art devices provide minimal control in the merging of containers due to lack of control over contact and the use of mechanical belt conveyors to propel or push and guide the containers. Where air is used, it is used in a manner which would not allow for varying pressures in different zones and would create undesirable movement of the containers both in direction and speed which may cause damage to the containers.

More specifically US—A—4 347 022 describes an air cushion conveyor including an air table which serves to support, initially, a large number of objects which, at the end of one section of the table are brought to a single file configuration by the use of directional jets arranged in the side walls of the apparatus. Physically the change of multiple, random, objects to a single file is effected abruptly and despite the presence of special, additional, directional jets in side walls there is no possibility that the objects are accelerated progressively whereby to minimize risk of damage to the thin gauge cans or other objects in transit. The apparatus and method of this prior specification becomes less practical as speeds increase.

GB—A—1 236 237 describes an air cushion conveyor with a series of slots in a base surface and the conveyor reduces in width from an inlet to an outlet. However, no provision is made for accelerating the conveyed articles, so that if such articles are fragile risk of damage would be substantial.

According to the present invention there is provided in air operated material handling

apparatus for the transport of cylindrical objects from an upstream location to a downstream location of the type hereinbefore defined, a row of acceleration jets located adjacent to and in spaced parallel relation to each side of the table to provide a greater volume and velocity of air than said flotation air jets to accelerate progressively the objects as they move across said table from said upstream location to said downstream location so that the converging of said sides coacts with the acceleration jets to separate and then converge the objects in a prearranged pattern having a single object width.

The present invention further provides a method of conveying and converging a mass of vertically aligned cylindrical objects from an upstream location to a downstream location, said method comprising the steps of providing an air table having a surface with a plurality of flotation jets slanted in a downstream direction, supplying air through the flotation jets at sufficient speed and volume to lift, support and move the objects from the upstream location to the downstream location, and converging the objects from a mass of at least two objects width at the upstream location to single file at the downstream location, and accelerating the objects from the upstream location to the downstream location characterized by the provision of acceleration jets each providing a higher volume and velocity of air than the flotation jets and being arranged as rows located adjacent to and in spaced parallel relation to sides of the air table so as to separate the most downstream objects from the mass and progressively accelerating the objects to bring them into single file at the downstream location.

In particular, the objects to be transported are containers. Advantageously, the guide means include closed sides with a pair of spaced guide rails for guiding the containers. A cover may be spaced and supported above the table surface by the sides a distance slightly greater than the height of a container being worked upon to define, with the sides and table surface, a container conduit. The cover has exhaust openings of a size and pattern wherein the percentage of the area which the openings constitute increases along the length of the table from the upstream location to the downstream location to provide a progressively decreasing pressure in the container conduit. A separate distribution chamber may be operatively connected to the underside of the table at each of the zones. A supply conduit may supply air from the plenum to each distribution chamber and a valve means is located at each of the supply conduits for adjustment of the air pressure within each distribution chamber and the associated air table zone. The guide means and the acceleration jets cooperate to move the mass of containers so that groups of three of the containers are brought into side by side contact with each other and with the guide means so that their vertical axes define an equilateral triangle wherein the leading container is accelerated to separate it from the other of the containers which

contacts the same guide means to form an isosceles triangle, the containers each being progressively accelerated by the acceleration jets and conveyed by the guide means to form an isosceles configuration with an ever increasing base until the containers are brought into a straight line at the downstream location.

Thus, it can be seen that with applicant's invention the cooperation between the acceleration jets and the converging sides accelerates the leading most containers away from the mass of containers and the decreasing air pressure in the container conduit draws the containers toward the downstream end and into single file. By this means, the containers are sequentially propelled from the downstream end of the conveyor rather than being pushed by the mass of containers at the upstream end of the conveyor, thus minimizing any chance of jamming of the containers. Also, contact between adjacent containers is minimized thereby reducing the chance that the containers become damaged. As is well understood in the art, unfilled aluminum containers are quite fragile and subject to scratching and denting, whereas after they are filled, they are much more rigid and less fragile.

The invention will now be particularly described, by way of example, with reference to the accompanying drawings in which:—

Figure 1 is a top plan view of one embodiment of a single filer of the present invention showing a cover extending from the upstream random bulk storage location to the downstream single file location;

Figure 2 is an enlarged cross sectional view, taken along line 2—2 of Figure 1, showing the plenum construction and control for the first intermediate transport zone;

Figure 3 is an enlarged cross sectional view, taken along line 3—3 of Figure 1, showing the plenum construction and control for the fourth intermediate transport zone;

Figure 4 is a side view in elevation of the apparatus of Figure 1;

Figure 5 is a top plan view of the single filer, similar to Figure 1, but with the cover removed, showing the configuration of containers in progressing from the upstream, random mass location to the downstream single file location, with portions of the dense pack container pattern being omitted for clarity and ease of illustration;

Figure 6 is an enlarged top plan view of one upstream portion of the air table of the single filer of Figure 5, showing the jet hole pattern, with portions of the jet pattern omitted for clarity and ease of illustration;

Figure 7 is an enlarged cross sectional view, taken along line 7—7 of Figure 6, showing the size and angle of the stabilizing or flotation air jet openings at one location along the table;

Figure 8 is an enlarged cross sectional view, taken along line 8—8 of Figure 6, showing the size and angle of the acceleration jets at another location along the table;

Figure 9 is an enlarged top plan view of another

more downstream portion of the air table of the single filer of Figure 5, showing the air jet hole pattern with portions being omitted for clarity and ease of illustration;

Figure 10 is an enlarged cross sectional view, taken along line 10—10 of Figure 9, showing the size and angle of the air jet openings at one location along the table;

Figure 11 is an enlarged cross sectional view, taken along line 11—11 of Figure 9, showing the size and angle of the acceleration jets at another location along the table;

Figure 12 is an enlarged top plan view of still another more downstream portion of the air table of the single filer of Figure 5, showing the jet hole pattern with portions of the jet hole pattern omitted for clarity and ease of illustration;

Figure 13 is a greatly enlarged, fragmentary, top plan view of a portion of Figure 12, showing the cooperation between the flotation air jet hole pattern in a further downstream portion of the air table surface and the converging side walls to facilitate the transition of containers moving therealong from a double row to a single row;

Figure 14 is a greatly enlarged, fragmentary, top plan view of an edge portion of Figure 9, showing the position of the acceleration jets with respect to a container and the side edges and the flow of air between the container and the side wall;

Figure 15 is an enlarged cross sectional view, taken along line 15—15 of Figure 12, to illustrate the flow of air from the acceleration jets and its effect on the entrained air;

Figure 16 is a graphical representation of a speed curve illustrating the increase in acceleration of the containers through a speed change zone;

Figure 17 is a plan view of an air table single filer that illustrates another embodiment of the present invention with one side being straight;

Figure 18 is a diagrammatic illustration of the pattern of containers progressing from an equilateral triangle configuration through changing isosceles triangle configurations to a single file; and

Figure 19 is a diagrammatic illustration of the pattern of containers progressing from a substantially equilateral triangle configuration through a series of isosceles triangle configurations to another equilateral triangle configuration of Figure 18.

The structural and operative features of the vertical air single filer of this invention are shown in Figures 1 and 13. The movement of containers is from the left to right, the containers being supplied from an air table 10 such as that disclosed in U.S. Patent No. 4,347,002. The air table is identified as a bulk storage zone 12 as shown in Figures 1, 5 and 6. As best seen in Figure 5, the containers on an air table 10 at an upstream location are in bulk random mass. The single filer according to this invention differs from prior art single filers, in one respect, in that the containers 14 are fed thereto from random bulk such as that

found on air table 10 in an upright or vertical position and are processed through one or more stages or zones to a single file or series of vertically-positioned single containers 14.

The vertical single filer of Figures 1—4 is shown as having a first zone "A" with a bottom 18A with upstanding converging side walls 20 and 22, each having upper and lower rigid guide rails 24, 26, 28 and 30 respectively. The bottom 18A is provided with a plurality of flotation air jet openings 32 which pass through the bottom 18A and communicate with a distribution chamber 34 for zone "A". The chamber 34 is connected to a plenum 36 via conduit 38 and the plenum is connected to a suitable source of air under pressure, such as from a blower, not shown. The jet openings 32 as shown in Figures 2 and 7 are inclined at a 45° angle in a downstream direction or to the right in Figure 6. A suitable angle of the flotation jet openings 32 is in the range of from about 40° to 65° from the vertical and preferably from about 45° to 60°. The jet opening size and angle in various zones in concert with the static pressure of the air in the plenum 36 are chosen to provide the energy necessary to lift and stabilize and pull the containers 14 along, as desired. The size of the jets is selected with respect to the static pressure of the air supplied thereto to provide a vertical force sufficient to lift and support a container to be transported under stable conditions. The jet angles are selected to provide the force parallel to the surface required to move the containers at the desired speed. The containers must be greatly accelerated as they move across the air table in order to bring them into single file as they are discharged at a downstream location. Thus angle and size of the jets will increase toward the downstream end to provide a greater horizontal vector to propel the containers. The size and angles can increase within each zone or from zone to zone as will be more fully discussed below.

The side walls of zone "A" are secured to the bottom 18 by suitable bracket means 42, 44, 46 and 48. Side walls 50 and 52 are also provided on the air table 10 and are secured in like manner to the bottom of the air table by means of brackets 54 and 56. The bottom 18 is supported upon legs or columns 58 which rest upon a base (not shown). The plenum 36, conduit 38, and distribution chamber 34 are supported from bottom 18 by suitable means, not shown. The distribution chamber 34 is divided by partitions 60, 62, 64, 66 and 68 to correspond to zones "A", "B", "C", "D" and "E", each of which is fed from the common plenum 36 through conduits 38, 70, 72, 74 and 76, respectively. The flow of air volume through each conduit is controlled by means of a butterfly damper valve 78, 80, 82, 84 and 86 respectively.

The side walls 20 and 22 of Zone "A" are seen to converge at one pair of angles, while side walls 88 and 90 of zone "B" converge at another pair of angles, side walls 92 and 94 of Zone "C" converge at still another pair of angles and side walls 96 and 98 converge at another pair of angles into the single file zone "E" where the side walls 100 and

102 are straight and parallel. The side walls 88 through 102 are each secured to the bottom 18 by means of a pair of brackets 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128 and 130 respectively. By way of example, in one embodiment of the invention, zone "A" may be 16 3/4 inches (42.5 cms) wide at the upstream end, with the sides converging at an angle of 5° 11' 40" over a distance of 38 1/2 inches (97.8 cms). The sides of zone "B" then converge at an angle of 2° 59' 56" over a distance of 34 inches (86.4 cms). At this point, the sides of zone "C" converge at an angle of 2° 14' 13" for a distance of 28 inches (71.1 cms). In zone "D", the sides converge at an angle of 2° 23' 09" for a distance of 15 inches (38.1 cms). The sides are parallel in zone "E" and are spaced apart a distance of 2 3/4 inches (7.0 cms).

As can be seen in Figure 5, the number of containers 14 in moving to the right are reduced in width across the width of the vertical single filer and in moving from the air table bulk storage zone 12 across to the right or downstream extremity of zone "A". The air jet openings 32 in zone "A" may be 5/64-inch (0.2 cm) in diameter, by way of example, drilled at a 45° angle to a line perpendicular to the surface 18, on one-half inch (1.3 cms) centers along lines parallel to the sides 20 and 22 as shown in Figures 6, 7 and 8, and inclined downstream towards zone "B".

The flotation jet openings 32 in zones "B", "C", "D" and "E", Figure 6, for container stabilizing or floating jets, by way of example, may be 1/16-inch (0.16 cm) in diameter and on one-half inch (1.3 cms) centers along lines parallel to the sides of each zone. All jet openings are inclined in a downstream direction. Although the starting point may be varied, in the embodiment shown and as illustrated in Figure 6, larger acceleration jet openings 129 and 131 are provided as the second row of openings from each side wall starting with zone "B". As seen in Figure 14 and Figure 15, the acceleration jet openings, by way of example, may be 1/8-inch (0.32 cm) in diameter and inclined downstream at a 60° angle with respect to a line perpendicular to the surface. By way of further example, starting with zone "B", the stabilizing or flotation jets may be 1/16-inch (0.16 cm) at 60°. It will be noted that the acceleration jet openings are positioned with respect to the guides 24 through 30 such that the air issuing therefrom impinges on the superimposed container at approximately midway of the sides of the container bottom. It will be appreciated that some containers, notably beverage cans, will have a chamfered bottom edge and a concave bottom. It is the area of the concave bottom that functions as the effective container bottom area for lifting, supporting and moving the containers.

The containers are lifted and stabilized on a grid of smaller jet openings and move in the direction of incline of these jet openings while the acceleration jet openings accelerate the outer row of containers in contact with the guides 24, 26, 28 and 30 such that the leading containers tend to separate from the mass and be guided toward,

and finally, into, a single file arrangement by the cooperating and converging guides rather than being pushed one against another. Thus, the containers are pulled away from the upstream end toward the downstream end. Any pushing action on cans of extruded aluminum, fiber, plastic or steel is likely to cause deformation and result in bridging and stoppage of their transport. Pushing also sets up increased friction whereas the pulling or acceleration action of the container in accordance with this invention tends to reduce friction and container damage.

The spacing of the air jet openings 11 in the infeed or bulk storage zone 12 is quite close to provide adequate air flow beneath the containers. Air table 10 in bulk storage zone 12, by way of example, may use the same jet diameter as in zone "A", i.e., 5/64th of an inch (0.2 cm) and sufficient air to lift and stabilize the containers. The width of the infeed is selected to provide adequate storage of containers depending on the desired rate of flow of the containers. A narrower infeed for the same rate of flow will require the containers to move at a higher speed.

Since a principle of operation of the single filer of this invention is to accelerate and effectively pull the containers through the apparatus, a progressive increase in the acceleration must occur. In other words, the acceleration itself actually changes from the entry to the exit of the single filer. This is illustrated in Figure 16 where it can be seen that the acceleration decreases in any given zone from the entry to the exit. Progressive acceleration through the filer as a whole is accomplished by the use of different sizes of jet openings in each zone and different angles as required in each zone as previously discussed, and may be enhanced by providing individually adjustable and controlled pressures in the progressive discharge zones which will allow the static pressure in each zone to be adjusted individually to increase or decrease the static pressure. Where individual progressive discharge zones are used, the supply plenum pressure can be maintained constant.

The single filing of containers can be further enhanced by having them pass through a substantially closed container conduit having above ambient air pressure throughout, but wherein the air pressure decreases from the upstream end of the single filer to the downstream end. To provide such a conduit, the sides of each zone are solid. The sides of the respective zones support top covers, such as top cover 140 covering zone "A", cover 142 covering zone "B", cover 144 covering zone "C" and cover 146 covering zone "D". No cover is provided over the single file zone "E". The cover in each zone is provided with exhaust vents 150, 152, 154 and 156. Since the containers will move from a higher air pressure to a lower pressure, it is desirable to provide for a graduated reduction of air pressure within the container conduit which is represented in zone "A" by the area enclosed by bottom 18, sides 20 and 22 and top 140. The venting of air

through the vent openings is progressively increased by increasing the percentage of the area of the cover constituted by the vents in the various zones. This can be done by putting in more vents increasing their size thereby decreasing the spacing between vents, or both, in moving from the infeed zone 12 to zone "D". Once the containers reach the single file, "E", the containers will be subjected only to ambient pressure.

The operation of the apparatus of this invention is believed to be effected and enhanced by the Coanda effect in combination with Bernoulli's principle. The Coanda effect is the tendency of a jet of gas to follow the wall contour when discharged adjacent to a surface, even when that surface curves away from the jet discharge axis. This is accompanied by entrainment of air surrounding the wall, and thus reduces the pressure adjacent to it. Bernoulli's principle states that an increase in the speed of a fluid produces a decrease in pressure and a decrease in the speed produces an increase in pressure.

Referring now to Figures 13, 14 and 15, air flows out of jets 129 and 131, as shown by arrows 158 with respect to jets 131 in Figure 15. Also illustrated in Figure 14 is the further Bernoulli effect where air flows between the outer rows of cans 141 and the sides, such as side 88 as shown by arrows 159. The increased speed of flow within this area creates a lower pressure, in accordance with Bernoulli's principle, causing the containers to hug the rails. Although illustrated with respect to zone "B", it will be understood that the principle will be the same with respect to each zone. This effect may also take place where a separation occurs momentarily between adjacent containers creating a lower pressure therebetween so that the containers are urged to maintain or reestablish immediate contact. Because of the angle of the sides, the reduced pressure produced by the air passing between the sides and the outer row of containers creates a downstream force vector which tends to further enhance the pull-along or drafting effect of the containers to avoid any semblance of pushing on the containers. It will be noted that entrainment air, illustrated by arrows 158, Figure 15, picks up and entrains adjacent air 160 which is available to assist and provide a drafting effect on the entrained air. Whenever a jet flows into a body of fluid flowing at a different rate or direction, it entrains some of the surrounding air and imparts its own motion thereto, this tends to draw the containers into the air stream created by jets 129 and 131 to accelerate them.

The Coanda effect is sometimes referred to as the wall-attachment principle. The discharge of air jet 131 at an angle adjacent the bottom 18B will cause a lower pressure between the jet and the bottom 18B causing the jet 158 to deflect toward the bottom 18B accompanied by entrainment of air 160 above the jet. As the angle of the jet opening 131 is increased closer and closer to being parallel to a surface such as that of bottom 18B, Figure 15, the greater the Coanda effect. In

this application, it is believed the combination effect of the Bernoulli principle and the Coanda effect provides a high velocity near the edge of the jet 158 and the bottom 18B creating a low pressure drafting effect on the adjacent surfaces of the containers.

As previously pointed out, if a force is applied to the containers from the rear to push on the containers, particularly with very flexible containers, but also with rigid ones, this will cause a bridging and locking because of increased friction of the containers ahead. As the containers move from bulk storage to a single file, the speed at which the containers move must increase markedly. If the containers are not discharged at an equivalent rate, the characteristics of the present invention allow the containers to be stopped completely or run at any intermediate speeds without requiring any air pressure adjustments.

Assuming it is desired to combine or merge a random mass of containers from eight wide to a single file flow at the rate of 2,000 containers per minute and that the containers are 2.5 inches (6.4 cms) in diameter, the flow is 4.8 containers at the output or discharge. The single file containers must be moved at 416.67 feet per minute (211.68 cms/sec or CPS) to satisfy the above requirements. At the point along the single filer where the containers are two wide, the containers must be moved at a speed of 208.34 feet per minute or FPM (105.84 CPS); and, where three wide, 138.89 FPM (70.56 CPS); four wide, 104.2 FPM (52.94 CPS); five wide, 83.3 FPM (42.32 CPS); six wide, 69.4 FPM (35.26 CPS); seven wide, 59.5 FPM (30.23 CPS); and, eight wide, 52.1 FPM (26.47 CPS) as illustrated in Figure 16.

It must be remembered that the speed of the containers from one width reduction to another is not linear but increases progressively. In going from a condition where the containers are two wide to a single file within a linear distance of, for example, 17 3/8 inches (44.13 cms), the net speed change of a container, from one end of the speed change zone to the other, must be equal to an average rate of 11.99 FPM per inch (2.4 CPS per cm) of travel, see Figure 16. As readily seen, the required acceleration for any number of combining of containers, i.e., 5 to 4, 4 to 3, 3 to 2, etc., can be calculated.

The following is offered as an example of how this is achieved with a fluid, such as air, using variable jet sizes, angles and static pressures. The difference in velocities out of a 5/64-inch (0.2 cm) diameter jet at 0.6 inches (1.52 cms) and 1.0 inches (2.54 cms) of static pressure is about 1600 FPM (812.8 cms/sec) and about 2100 FPM (1066.8 CPS), respectively, or 125 FPM per 0.1 inch (1612.9 CPS per cm) of static pressure difference. The horizontal vector velocity of about 1600 FPM (812.8 CPS) at an angle of 34° to the surface of the table is about 617 FPM (313.4 CPS) while the horizontal vector velocity of about 1600 FPM (812.8 CPS) at an angle of 32° is about 570 FPM (289.6 CPS) and at an angle of 36° it is

about 662 FPM (336.3 CPS). As an example only, since other and various static pressures, jet opening sizes and angles may be used, if greater acceleration is desired, the jet opening size can be increased to say 3/32-inch (0.24 cm) diameter. With a static pressure in the distributor plenum 34 of 0.6 inches (1.52 cms) of water, a 3/32-inch (0.24 cm) diameter jet opening will give a velocity of about 2,300 FPM (1168.4 CPS) compared to about 1,600 FPM (812.8 CPS) with a 5/64-inch (0.198 cm) diameter jet opening and a 5/32-inch (0.4 cm) diameter jet opening will give a velocity of about 3,100 FPM (1574.8 CPS). With a static pressure of 1.0 inch (2.54 cms) of water in the distributor plenum, the velocity of air issuing from a 5/64-inch (0.198 cm) diameter jet opening is about 2,100 FPM (1066.8 CPS) while the velocity from a 5/32-inch (0.4 cm) diameter jet opening is about 4,100 FPM (2082.8 CPS). The volume of flow out of a 5/64-inch (0.198 cm) opening is about 0.0697 CFM (32.89 CCS) and from a 5/32-inch (0.4 cm) opening is about 0.5453 CFM (257.3 CCS) at 1.0 inch (2.54 CMS) of water static pressure.

The small flotation air jet openings 32 in the bottom of the air table of the single filer act to stabilize the containers 14 for transport while the acceleration jet openings 129 and 131 are positioned to impinge air on the center of the bottom of the containers forming the outer conveying rows of containers. Since most of the resistance to transport occurs between the outer row of containers and the guides, the acceleration jets 131 move the outer row of containers along the guides 24 as the converging action occurs.

Referring to Figures 16 and 18, it may be visualized how the containers have to accelerate in moving from one zone (two wide) to another (one wide) or a 100% speed increase. If we are moving 2,000 objects per minute and the objects start at 4 wide this requires a speed of 500 objects per minute. If the objects measure 4.8 objects per foot, the speed of the objects in feet per minute (FPM) is obtained from Equation 1.

Equation 1: rate/(4.8 per foot) (No. wide) = FPM
For four objects wide transferred to one object wide, the change and increase in speed would be:

$$2000/(4.8 \times 4) = 104 \text{ FPM (52.8 CPS)}$$

$$2000/(4.8 \times 3) = 138 \text{ FPM (70.1 CPS) = 32.69\% increase}$$

$$2000/(4.8 \times 2) = 208 \text{ FPM (105.7 CPS) = 50.72\% increase}$$

$$2000/(4.8 \times 1) = 416 \text{ FPM (211.3 CPS) = 100\% increase}$$

Thus, it is readily seen that the speeds are required to increase by monumental amounts to achieve the smooth transition from say 500 objects per minute to 2,000 objects per minute.

In Figure 18, containers 14a, 14b and 14c form an equilateral triangle with the containers in contact with each other and containers 14a and 14b are in contact with guide rail 24 and container 14c is in contact with guide rail 28. There is a small space between containers 14c and 14d so that these containers, along with container 14b,

19

form an isosceles triangle. Containers 14a and 14b are in longitudinal contact at 14ab. A space 14cd exists between 14c and 14d. Progressively larger spaces exist between the containers in the downstream direction such as: space 14be between containers 14b and 14e; space 14df between containers 14d and 14f; space 14eg between containers 14e and 14g; space 14fh between containers 14f and 14h; space 14gi between containers 14g and 14i; space 14hj between containers 14h and 14j; space 14ik between containers 14i and 14k; space 14jl between containers 14j and 14l; space 14km between containers 14k and 14m; and space 14ln between containers 14l and 14n. Thus, it is readily seen that the containers are accelerated most rapidly when separation first begins progressively to accelerate, but at a decreasing rate, toward the downstream end as illustrated by the graph of Figure 16. The graph of Figure 16 is a plot of the length of the space between the containers as a function of the distance travelled by the containers progression to a single file configuration, that is the distance the leading edge of container 14c in an equilateral triangular grouping to the leading edge of container 14k or a distance in the example of 17-3/8 inches (44.13 cms). In the same time interval, container 14d moves 1/4 inch (0.63 cm); container 14e moves 5/8 inch (1.59 cms); container 14f moves 15/16 inch (2.38 cms); container 14g moves 1-5/16 inch (3.33 cms); container 14h moves 1-13/16 inch (4.60 cms); container 14i moves 2 inches (5.1 cms); container 14j moves 2-3/16 inches (5.56 cms) and container 14k moves 2-5/16 inches (5.87 cms) to illustrate the progressively increasing speed of the containers as a result of the combination of selected angle or angles of the sides and the acceleration of the containers caused by the acceleration air jets. A container 14c travelling at a speed of 208.24 FPM (105.78 CPS) will be accelerated to a speed of 416.67 FPM (211.67 CPS) or a 100% increase in speed while maintaining contact proximity with adjacent containers.

Figure 19 is a continuation of the air table of Figure 18 in the upstream direction showing the pattern configuration of the containers in the zone where the number of containers goes from three wide to two wide. It will be noted that three containers form an equilateral triangular group in contact with one side while the group in contact with the opposite side form an isosceles triangular group with increasing space A, B, C, D, E, F, G and H until the formation of the equilateral triangular group 14a, 14b and 14c. Thus, in the zone where three containers move into a two wide configuration there is a continuing and changing isosceles triangular group in combination with a substantially equilateral triangular group.

It will also be noted in Figure 13 where the acceleration jets 129 and 131 converge in zone "D" to a separation distance just greater than a distance equal to the length of the radius of the

containers, a single centrally positioned row of acceleration jets 133 is provided with the initial jet 133 being positioned just under and impinging upon the leading edge 135 of a container 14 such that only one of the acceleration jets 129 and 131 provide both lift and propulsion of the containers while stabilizing or flotation jets 32 provide supplemental air lift, support and also assist in moving the containers downstream. This is accomplished by providing the smaller stabilizing jets in greater numbers giving equal distribution of air beneath the containers to provide the necessary stability. Of course, there is sufficient volume of air supplied by the stabilizing jets to support the containers of the order of about 0.004 inches (0.010 cm) to about 0.005 inches (0.013 cm) off the surface of the air table. It is also important to note that as the acceleration jets 131 converge there will be two acceleration jets 129 and 131 in side-by-side relation. To transfer the containers to a single row of acceleration jets, the double rows of acceleration jets are terminated at a point where by side-by-side separation is spaced apart a distance just slightly greater than the diameter of the containers. At the same time, a single row of acceleration jets 133 start with the first jet opening being positioned to just impinge on and pick up the leading edge 135 of a container when one acceleration jet of the last pair is uncovered by the superimposed containers. The single row of acceleration jets 133 may be of increased size, such as 9/64-inch (0.357 cm) diameter to provide sufficient air for transport and final acceleration to the required single file discharge speed.

Although the acceleration jets have been described and illustrated as being larger than the flotation jets, it will be understood that for particular applications they could be the same size or smaller than the flotation jets. This is possible as long as air is supplied to the acceleration jets at sufficient pressure that the air issuing from the acceleration jets is at greater speed and volume than the air issuing from the flotation jets.

Figure 17 illustrates another embodiment of the present invention wherein single filer table 16a is provided with a side 22a that is straight while side 20a is provided with a converging side configuration for zone "A" and a side 88a converging at a different angle in zone "B" and a side 92a converging at another angle in zone "C". The air jet openings and cover may be quite similar to that for filer table 16 as well as the plenum and air distribution and rigid guides along both the straight and converging sides.

From the foregoing, the advantages of this invention are readily apparent. A device has been provided for bringing a mass of vertically aligned cans into single file over a relatively short distance. This is accomplished by cooperation between converging sides of the single filer together with acceleration jets which pull the containers at the forward edge of the mass away from the others and accelerate them so that they come into single file arrangement by the time they reach the

downstream end of the single filer. The containers are lifted, supported and transported by normally smaller flotation air jets positioned in a table surface along the single filer over which the containers move. Furthermore, a conduit may be provided through which the containers move across the table wherein the air pressure therein is greater than ambient, but decreases from the upstream end to the downstream end so that the cans move toward the lower pressure, i.e., the downstream end. Control of the air pressure is obtained by a cover having exhaust openings which are sized and spaced so as to provide greater discharge of air toward the downstream end of the container conduit. The conduit can be divided into separate sections having separate air control means for supporting and transporting the containers, as well as for creating the above ambient air pressures desired. Also, the angle of the converging walls can be adjusted in each section, as required.

Although the objects being transported by the single filer of this invention have been described as "containers", it will be understood, as used herein, the term "container" is intended to refer to any cylindrical object, such for example as cans, cartons and bottle taps.

Claims

1. Air-operated material handling apparatus for the transport of cylindrical objects (14) from an upstream location to a downstream location, said apparatus comprising a table (10) extending from said upstream location to said downstream location and having a surface (18), edges and an underside with a prearranged pattern of flotation air jets (32) in said surface slanted in a downstream direction and communicating between said surface and said underside of said table, and a plenum (34) connectable to a source of air under pressure and attached to said underside of said table surface, said table having a shape to accommodate a wide mass of objects at said upstream location (A) and a single file of objects at the downstream location (E), and a vertical side (20, 22) along each edge of said table said sides converging toward each other, characterized by a row of acceleration jets (129, 131) located adjacent to and in spaced parallel relation to each side of the table to provide a greater volume and velocity of air than said flotation air jets (32) to accelerate progressively the objects (14) as they move across said table from said upstream location (A) to said downstream location (E) so that the converging of said sides (20, 22) coacts with the acceleration jets (129, 131) to separate and then converge the objects in a prearranged pattern having a single object width.

2. Apparatus as claimed in claim 1, characterized in that the sides (20, 22) are enclosed by top covers (140, 142, 144, 146) so that the sides, the covers and the surface define a conduit.

3. Apparatus as claimed in claim 1, characterized in that the flotation air jets (32) and

acceleration jets (129, 131) are inclined at from about 45° to about 60° from perpendicular to the upper surface of the table (10), and the angle of the flotation air jets (32) is selected in conjunction with the size of the flotation air jets (32) and the static pressure of the air supplied to the flotation air jets to lift, support and move the objects above the table surface (18) due to a mass air flow over the table (10).

4. Apparatus as claimed in claim 1, characterized in that said prearranged pattern of objects (14) in progressing from greater than a two object width to a two object width begins at the upstream end as a cluster of three or more cylindrical objects whose axes of vertical rotation form an equilateral triangle and whose surfaces touch each other and said converging sides and which change to a series of isosceles triangles with a base of ever increasing length as the objects are accelerated by said acceleration jets until the objects form a second equilateral triangle as a cluster of three cylindrical objects with touching surfaces which also touch said converging sides and have a two object width.

5. Apparatus as claimed in claim 1, characterized in that said prearranged pattern of objects in progressing from a two object width to a single file begins as a cluster of three cylindrical objects at said upstream location (c) whose vertical axes form an equilateral triangle and whose surfaces touch each other and said converging sides (92, 94) which changes to a series of isosceles triangles with a base of ever increasing length as the objects are accelerated by said acceleration jets (129, 131) until the objects move into single file (100) at said downstream location (E).

6. Apparatus as claimed in claim 2, characterized in that said object conduit is divided into a plurality of zones (A, B, C, D, E) along the length thereof, and said sides (20, 22, 88, 90, 92, 94, 96, 98) along each of said zones converge at a different angle.

7. Apparatus as claimed in claim 1, characterized in that said rows of acceleration jets (129, 131) are spaced inwardly from said respective sides a distance equal to one-half the width of the objects being transported.

8. Apparatus according to any one of the preceding claims, characterized in that each acceleration jet is of larger cross-section than each of said flotation air jets.

9. Apparatus as claimed in any one of the preceding claims, characterized in that said vertical sides (20, 22) include side walls with a pair of spaced guide rails (24, 26, 28, 30) secured thereto.

10. Apparatus as claimed in claim 2 and any one of claims 3 to 9, characterized in that the top covers (140, 142, 144, 146) are spaced and supported above the table surface by said sides (20, 22) a distance slightly greater than the height of an object (14) being worked upon, said covers having exhaust openings (150, 152, 154) therein of a size and pattern wherein the total percentage of opening area increases along the length of the table from said upstream location (A) to said

downstream end of the single filer. The containers are lifted, supported and transported by normally smaller flotation air jets positioned in a table surface along the single filer over which the containers move. Furthermore, a conduit may be provided through which the containers move across the table wherein the air pressure therein is greater than ambient, but decreases from the upstream end to the downstream end so that the cans move toward the lower pressure, i.e., the downstream end. Control of the air pressure is obtained by a cover having exhaust openings which are sized and spaced so as to provide greater discharge of air toward the downstream end of the container conduit. The conduit can be divided into separate sections having separate air control means for supporting and transporting the containers, as well as for creating the above ambient air pressures desired. Also, the angle of the converging walls can be adjusted in each section, as required.

Although the objects being transported by the single filer of this invention have been described as "containers", it will be understood, as used herein, the term "container" is intended to refer to any cylindrical object, such for example as cans, cartons and bottle taps.

Claims

1. Air-operated material handling apparatus for the transport of cylindrical objects (14) from an upstream location to a downstream location, said apparatus comprising a table (10) extending from said upstream location to said downstream location and having a surface (18), edges and an underside with a prearranged pattern of flotation air jets (32) in said surface slanted in a downstream direction and communicating between said surface and said underside of said table, and a plenum (34) connectable to a source of air under pressure and attached to said underside of said table surface, said table having a shape to accommodate a wide mass of objects at said upstream location (A) and a single file of objects at the downstream location (E), and a vertical side (20, 22) along each edge of said table said sides converging toward each other, characterized by a row of acceleration jets (129, 131) located adjacent to and in spaced parallel relation to each side of the table to provide a greater volume and velocity of air than said flotation air jets (32) to accelerate progressively the objects (14) as they move across said table from said upstream location (A) to said downstream location (E) so that the converging of said sides (20, 22) coacts with the acceleration jets (129, 131) to separate and then converge the objects in a prearranged pattern having a single object width.

2. Apparatus as claimed in claim 1, characterized in that the sides (20, 22) are enclosed by top covers (140, 142, 144, 146) so that the sides, the covers and the surface define a conduit.

3. Apparatus as claimed in claim 1, characterized in that the flotation air jets (32) and

acceleration jets (129, 131) are inclined at from about 45° to about 60° from perpendicular to the upper surface of the table (10), and the angle of the flotation air jets (32) is selected in conjunction with the size of the flotation air jets (32) and the static pressure of the air supplied to the flotation air jets to lift, support and move the objects above the table surface (18) due to a mass air flow over the table (10).

4. Apparatus as claimed in claim 1, characterized in that said prearranged pattern of objects (14) in progressing from greater than a two object width to a two object width begins at the upstream end as a cluster of three or more cylindrical objects whose axes of vertical rotation form an equilateral triangle and whose surfaces touch each other and said converging sides and which change to a series of isosceles triangles with a base of ever increasing length as the objects are accelerated by said acceleration jets until the objects form a second equilateral triangle as a cluster of three cylindrical objects with touching surfaces which also touch said converging sides and have a two object width.

5. Apparatus as claimed in claim 1, characterized in that said prearranged pattern of objects in progressing from a two object width to a single file begins as a cluster of three cylindrical objects at said upstream location (c) whose vertical axes form an equilateral triangle and whose surfaces touch each other and said converging sides (92, 94) which changes to a series of isosceles triangles with a base of ever increasing length as the objects are accelerated by said acceleration jets (129, 131) until the objects move into single file (100) at said downstream location (E).

6. Apparatus as claimed in claim 2, characterized in that said object conduit is divided into a plurality of zones (A, B, C, D, E) along the length thereof, and said sides (20, 22, 88, 90, 92, 94, 96, 98) along each of said zones converge at a different angle.

7. Apparatus as claimed in claim 1, characterized in that said rows of acceleration jets (129, 131) are spaced inwardly from said respective sides a distance equal to one-half the width of the objects being transported.

8. Apparatus according to any one of the preceding claims, characterized in that each acceleration jet is of larger cross-section than each of said flotation air jets.

9. Apparatus as claimed in any one of the preceding claims, characterized in that said vertical sides (20, 22) include side walls with a pair of spaced guide rails (24, 26, 28, 30) secured thereto.

10. Apparatus as claimed in claim 2 and any one of claims 3 to 9, characterized in that the top covers (140, 142, 144, 146) are spaced and supported above the table surface by said sides (20, 22) a distance slightly greater than the height of an object (14) being worked upon, said covers having exhaust openings (150, 152, 154) therein of a size and pattern wherein the total percentage of opening area increases along the length of the table from said upstream location (A) to said



downstream location (E) to provide a progressively decreasing pressure in the object conduit from said upstream location (A) to said downstream location (E) while establishing and maintaining a greater than ambient pressure therein.

11. Apparatus as claimed in claim 6 or in claims 6 and 10, characterized by a separate distribution chamber operatively connected to said underside of said table at each of said zones (A...E), a supply conduit (38, 70, 72, 74, 76) to supply air from said plenum to each said distribution chamber, and valve means (78, 80, 82, 84, 86) at each said supply conduit for adjustment of air pressure within each distribution chamber and associated air table zone (A...E) whereby the air mass flow through the jets of each zone can be adjusted to be higher in successive zones from upstream to downstream.

12. Apparatus as claimed in any one of the preceding claims, characterized in that the slant of said flotation air jets (32) and said acceleration jets (129, 131) increases from said upstream location (A) to said downstream location (E) to accelerate the containers.

13. Apparatus as claimed in any one of claims 1 to 12, characterized in that the sides (20, 22) at the downstream zone (E) have portions (100, 102) which are parallel to the centreline spaced a distance slightly greater than the diameter of the containers of which a single file is to be formed, the two converging rows (129, 131) of acceleration jets terminating upstream of the parallel portions (100, 102) of the sides, a third row of acceleration jets (133) in the table surface at the downstream location (E) located along the centre line between the parallel portions (100, 102) and extending upstream to a location adjacent the termination of the converging rows of acceleration jets (129, 131), and at least one row of flotation air jets (32) between each parallel portion of the sides and the third row (133) of acceleration jets balancing the containers over the third row of acceleration jets.

14. A method of conveying and converging a mass of vertically aligned cylindrical objects (14) from an upstream location to a downstream location, said method comprising the steps of providing an air table (10) having a surface with a plurality of flotation jets (32) slanted in a downstream direction, supplying air through the flotation jets (32) at sufficient speed and volume to lift, support and move the objects from the upstream location to the downstream location, and converging the objects (14) from a mass of at least two objects width at the upstream location to single file at the downstream location, and accelerating the objects from the upstream location to the downstream location characterized by the provision of acceleration jets (129, 131) each providing a higher volume and velocity of air than the flotation jets (32) and being arranged as rows located adjacent to and in spaced parallel relation to sides (20, 22) of the air table so as to separate the most downstream objects from the mass and progressively accelerating the objects to bring them into single file at the downstream location.

15. A method, as claimed in claim 14, characterized by the further steps of moving the objects (14) through a conduit from said upstream location to said downstream location; and providing an above ambient air pressure within the conduit which decreases from the upstream location (A) to the downstream location (E) to draw the objects toward the downstream location.

16. A method as claimed in claim 15, characterized by the further steps of providing separate zones (A, B, C, D, E) along the conduit, converging the containers at different rates in each zone, and providing a different above ambient air pressure to each zone.

17. A method as claimed in claim 16 characterized in that the conduit zones are supplied from plenums beneath the surface having the air jets and the pressures in the conduit zones being made successively lower from upstream to downstream by the provision of apertures in the conduit zones.

Patentansprüche

1. Mit Luft betriebene Materialumschlagsvorrichtung für den Transport von zylindrischen Gegenständen (14) von einer zulaufseitigen Stelle zu einer ablaufseitigen Stelle, mit einem sich von der zulaufseitigen Stelle bis zur ablaufseitigen Stelle erstreckenden, eine Oberseite (18), Ränder und eine Unterseite aufweisenden Tisch (10), in dessen Oberseite ein vorbestimmtes Muster von Tragluftdüsen (32) ausgebildet ist, welche in der ablaufseitigen Richtung geneigt sind und eine Strömungsverbindung zwischen der Oberseite und der Unterseite des Tisches herstellen, und mit einer mit einer Druckluftquelle verbindbaren und an der Unterseite des Tisches angebrachten Luftkammer (34), wobei der Tisch für die Aufnahme einer breiten Masse von Gegenständen an der zulaufseitigen Stelle (A) und einer einzigen Reihe von Gegenständen an der ablaufseitigen Stelle (E) ausgebildet ist und sich entlang jedem Rand des Tisches senkrechte Seitenwände (20, 22) konvergierend erstrecken, gekennzeichnet durch jeweils eine zunächst jeder Seite des Tisches und in Parallelabstand dazu angeordnete Reihe von Beschleunigungsdüsen (129, 131) für die Lieferung eines größeren Volumens von Luft mit einer höheren Geschwindigkeit als die Tragluftdüsen (32) zum fortschreitenden Beschleunigen der Gegenstände (14) bei deren Bewegung über den Tisch von der zulaufseitigen Stelle (A) zur ablaufseitigen Stelle (E), so daß die Konvergenz der Seitenwände (20, 22) mit den Beschleunigungsdüsen (129, 131) zusammenwirkt, um die Gegenstände voneinander zu lösen und sie zu einem vorbestimmten Muster von der Breite eines einzigen Gegenstands zusammenzuführen.

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Seitenwände (20, 22) durch Deckwände (140, 142, 144, 146) abgedeckt sind, so daß die Seitenwände, die Deckwände und die Oberseite einen Durchlaß umgrenzen.

3. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Tragluftdüsen (32) und



die Beschleunigungsdüsen (129, 131) gegenüber der Senkrechten zur Oberseite des Tisches (10) im Winkel zwischen etwa 45° und 60° geneigt sind und daß der Winkel der Tragluftdüsen (32) im Hinblick auf die Größe der Tragluftdüsen (32) und auf den statischen Druck der den Tragluftdüsen zugeführten Luft so gewählt ist, daß ein Massenluftstrom über den Tisch (10) entsteht, welcher die Gegenstände über die Oberfläche (18) des Tisches anhebt, sie trägt und fortbewegt.

4. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß das vorbestimmte Muster von Gegenständen (14) beim Fortschreiten von einer Breite von mehr als zwei Gegenständen auf eine Breite von zwei Gegenständen am zulaufseitigen Ende als eine Gruppe von drei oder mehr zylindrischen Gegenständen beginnt, deren senkrechte Rotationsachsen ein gleichseitiges Dreieck bilden und deren Außenflächen miteinander und mit den konvergierenden Seitenwänden in Berührung stehen, und welche sich bei ihrer Beschleunigung durch die Beschleunigungsdüsen zu einer Reihe von gleichschenkligen Dreiecken mit einer Basis von stetig zunehmender Länge umgruppieren, bis sie ein zweites gleichseitiges Dreieck in Form einer Gruppe von drei zylindrischen Gegenständen bilden, deren Außenflächen miteinander sowie mit den konvergierenden Seitenwänden in Berührung stehen, und welche eine Breite von zwei Gegenständen einnehmen.

5. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß das vorbestimmte Muster von Gegenständen beim Fortschreiten von einer Breite von zwei Gegenständen zu einer einzigen Reihe an der zulaufseitigen Stelle (c) als eine Gruppe von drei zylindrischen Gegenständen beginnt, deren senkrechte Achsen ein gleichseitiges Dreieck bilden und deren Außenflächen miteinander und mit den konvergierenden Seitenwänden (92, 94) in Berührung stehen, und welche sich bei ihrer Beschleunigung durch die Beschleunigungsdüsen (129, 131) zu einer Reihe von gleichschenkligen Dreiecken mit einer Basis von stetig zunehmender Länge umgruppieren, bis sich die Gegenstände an der ablaufseitigen Stelle (E) in eine einzige Reihe (100) bewegen.

6. Vorrichtung nach Anspruch 2, dadurch gekennzeichnet, daß der Durchlaß für die Gegenstände über seine Länge in mehrere Abschnitte (A, B, C, D, E) unterteilt ist und daß die Seitenwände (20, 22, 88, 90, 92, 94, 96, 98) entlang jedem der Abschnitte in einem verschiedenen Winkel konvergieren.

7. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Reihen von Beschleunigungsdüsen (129, 131) jeweils um ein der halben Breite der transportierten Gegenstände entsprechendes Stück einwärts der jeweiligen Seitenwände angeordnet sind.

8. Vorrichtung nach einem der vorstehenden Ansprüche, dadurch gekennzeichnet, daß jede Beschleunigungsdüse einen größeren Querschnitt hat als jede der Tragluftdüsen.

9. Vorrichtung nach einem der vorstehenden Ansprüche, dadurch gekennzeichnet, daß die

senkrechten Seiten (20, 22) als Seitenwände ausgebildet sind, an denen in gegenseitigem Abstand ein Paar Führungsschienen (24, 26, 28, 30) befestigt sind.

10. Vorrichtung nach Anspruch 2 und einem der Ansprüche 3 bis 9, dadurch gekennzeichnet, daß die Deckwandungen (140, 142, 144, 146) durch die Seitenwände (20, 22) in einem Abstand über der Tischfläche gehalten sind, welcher etwas größer ist als die Höhe eines umzuschlagenden Gegenstands (14), und daß die Deckwände von Auslaßöffnungen (150, 152, 154) durchsetzt sind, deren Größe und Anordnung so gewählt sind, daß der Gesamtanteil der Öffnungsfläche von der zulaufseitigen Stelle (A) über die Länge des Tisches zur abströmseitigen Stelle (E) zunimmt, so daß in dem Durchlaß für die Gegenstände ein von der zulaufseitigen Stelle (A) zur ablaufseitigen Stelle (E) stetig abnehmender Druck vorhanden ist, wobei darin ein über dem Umgebungsdruck liegender Druck hergestellt und aufrecht erhalten wird.

11. Vorrichtung nach Anspruch 6 oder Ansprüchen 6 und 10, gekennzeichnet durch eine in jedem der genannten Abschnitte (A...E) in Wirkbeziehung mit der Unterseite des Tisches verbundene, getrennte Verteilerkammer, durch eine Zufuhrleitung (38, 70, 72, 74, 76) für die Zufuhr von Luft von der Luftkammer zu jeder Verteilerkammer und durch an jeder Zufuhrleitung angeordnete Absperreinrichtungen (78, 80, 82, 84, 86) zum Einstellen des Luftdrucks in jeder Verteilerkammer und dem zugeordneten Tischabschnitt (A...E), so daß der Massenstrom der Luft durch die Düsen jedes Abschnitts so eingestellt werden kann, daß er von der Zulaufseite zur Ablaufseite in aufeinander folgenden Abschnitten jeweils stärker ist.

12. Vorrichtung nach einem der vorstehenden Ansprüche, dadurch gekennzeichnet, daß sich die Neigung der Tragluftdüsen (32) und der Beschleunigungsdüsen (129, 131) von der zulaufseitigen Stelle (A) zur ablaufseitigen Stelle (E) verstärkt, um die Behälter zu beschleunigen.

13. Vorrichtung nach einem der Ansprüche 1 bis 12, dadurch gekennzeichnet, daß die Seitenwände (20, 22) im ablaufseitigen Bereich (E) parallel zur Mittellinie verlaufende Abschnitte (100, 102) haben, deren gegenseitiger Abstand etwas größer ist als der Durchmesser der in eine einzige Reihe zu bringenden Behälter, daß die beiden konvergierenden Reihen von Beschleunigungsdüsen (129, 131) an der Zulaufseite der parallelen Abschnitte (100, 102) der Seitenwände auslaufen, daß sich eine dritte Reihe von in der Tischfläche ausgebildeten Beschleunigungsdüsen (133) den der ablaufseitigen Stelle (E) entlang der Mittellinie zwischen den parallelen Abschnitten (100, 102) bis an eine zulaufseitige Stelle nahe den Enden der konvergierenden Reihen von Beschleunigungsdüsen (129, 131) erstreckt und daß zwischen der dritten Reihe von Beschleunigungsdüsen (133) und jedem der parallelen Abschnitte der Seitenwände jeweils wenigstens eine Reihe von Tragluftdüsen (32) ange-



ordnet ist, um die Behälter über der dritten Reihe von Beschleunigungsdüsen im Gleichgewicht zu halten.

14. Verfahren zum Transportieren und Zusammenführen einer Masse von senkrecht ausgerichteten zylindrischen Gegenständen (14) von einer zulaufseitigen Stelle zu einer ablaufseitigen Stelle, umfassend die Schritte der Bereitstellung eines Traglufttisches (10), welcher eine Oberfläche mit einer Anzahl von in der Ablaufrichtung geneigten Tragluftdüsen (32) aufweist, Speisung der Tragluftdüsen (32) mit Luft mit einer ausreichenden Strömungsgeschwindigkeit und in einem ausreichenden Volumen zum Anheben der Gegenstände und zum Bewegen derselben von der zulaufseitigen Stelle zur ablaufseitigen Stelle, Zusammenführen der Gegenstände (14) von einer die Breite von wenigstens zwei Gegenständen aufweisenden Breite an der zulaufseitigen Stelle zu einer einzigen Reihe an der ablaufseitigen Stelle, und Beschleunigen der Gegenstände von der zulaufseitigen Stelle zur ablaufseitigen Stelle, gekennzeichnet durch die Verwendung von Beschleunigungsdüsen (129, 131), welche jeweils ein größeres Luftvolumen mit einer höheren Geschwindigkeit liefern als die Tragluftdüsen (32) und in Reihen angeordnet sind, welche zunächst den Seiten (20, 22) des Tisches und im Parallelabstand dazu verlaufen, um der Ablaufseite zunächst befindliche Gegenstände von der Masse zu trennen und sie zu beschleunigen, um die Gegenstände an der ablaufseitigen Stelle in eine einzige Reihe zu bringen.

15. Verfahren nach Anspruch 14, gekennzeichnet durch die weiteren Schritte des Transports der Gegenstände durch einen Durchlaß von der zulaufseitigen Stelle zur ablaufseitigen Stelle und der Schaffung eines über dem Umgebungsdruck liegenden Drucks in dem Durchlaß, welcher sich von der zulaufseitigen Stelle (A) zur ablaufseitigen Stelle (E) verringert, um die Gegenstände in Richtung auf die ablaufseitige Stelle zu saugen.

16. Verfahren nach Anspruch 15, gekennzeichnet durch die weiteren Schritte der Schaffung von getrennten Abschnitten (A, B, C, D, E) entlang dem Durchlaß, Zusammenführen der Gegenstände zu unterschiedlichen Graden in jedem Abschnitt und Speisung jedes Abschnitts mit einem verschiedenen, über dem Umgebungsdruck liegenden Druck.

17. Verfahren nach Anspruch 16, dadurch gekennzeichnet, daß die Abschnitte des Durchlasses von Luftkammern unterhalb der die Luftdüsen aufweisenden Oberfläche gespeist werden und daß die Drücke in den Abschnitten des Durchlasses durch Anordnung von Öffnungen in den Abschnitten des Durchlasses von der Zulaufseite zur Ablaufseite fortschreitend niedriger gehalten werden.

Revendications

1. Appareil de manipulation de matière à commande pneumatique pour le transport d'objets cylindriques (14) d'un emplacement amont vers

un emplacement aval, cet appareil comprenant une table (10) s'étendant à partir de cet emplacement amont jusqu'à cet emplacement aval et comportant une surface (18), des bords et une face inférieure pourvue d'un réseau préalablement agencé de tuyères d'air de flottation (32) dans ladite surface inclinées dans une direction aval et communiquant entre cette surface et la face inférieure de ladite table, une chambre de surpression (34) étant reliée à une source d'air sous pression et fixée à la face inférieure de cette surface de table, ladite table ayant une forme permettant de s'adapter à une masse étendue d'objets en l'emplacement amont précité (A) et à une seule rangée d'objets en l'emplacement aval (E), une paroi verticale (20, 22) étant agencée le long de chaque bord de la table, ces parois convergeant l'une vers l'autre, caractérisé par une rangée de jets d'accélération (129, 131) agencés à proximité et espacés parallèlement de chaque côté de la table pour créer un volume et une vitesse d'air plus élevés que les jets des tuyères d'air de flottation (32) précitées de manière à accélérer progressivement les objets (14) au fur et à mesure qu'ils traversent la table de l'emplacement amont (A) précité vers l'emplacement aval (E) précité, de telle sorte que la convergence des parois ou côtés précités (20, 22) agisse conjointement avec les jets d'accélération (129, 131) pour séparer et faire converger ensuite les objets en un réseau préalablement agencé comportant un seul objet en largeur.

2. Appareil suivant la revendication 1, caractérisé en ce que les parois (20, 22) sont recouvertes par des recouvrements supérieurs (140, 142, 144, 146) de telle sorte que les parois, les recouvrements et la surface définissent un conduit.

3. Appareil suivant la revendication 1, caractérisé en ce que les tuyères d'air de flottation (32) et les tuyères d'accélération (129, 131) sont inclinées d'un angle d'environ 45° à environ 60° par rapport à une perpendiculaire à la surface supérieure de la table (10) et en ce que l'angle des tuyères d'air de flottation (32) est choisi conjointement à la dimension des tuyères d'air de flottation (32) et à la pression statique de l'air amené aux tuyères d'air de flottation pour soulever, supporter et déplacer les objets au-dessus de la surface (18) de la table du fait d'une circulation de masse d'air au-dessus de la table (10).

4. Appareil suivant la revendication 1, caractérisé en ce que le réseau d'objets (14) préalablement agencé progressant de plus de deux objets en largeur à deux objets en largeur commence à l'extrémité amont sous la forme d'un groupe de trois ou de plus de trois objets cylindriques dont les axes de rotation verticale forment un triangle équilatéral et dont les surfaces se touchent mutuellement ainsi que les parois convergentes précitées, et qui se transforme en une série de triangles isocèles avec une base d'une longueur toujours plus grande au fur et à mesure que les objets sont accélérés par les jets d'accélération précités jusqu'à ce que ces objets forment un



15. Procédé suivant la revendication 14, caractérisé par les étapes additionnelles qui consistent à déplacer les objets (14) dans un conduit de cet emplacement amont vers cet emplacement aval, et à créer une pression d'air supérieure à la pression ambiante à l'intérieur du conduit, qui diminue de l'emplacement amont (A) vers l'emplacement aval (E) de manière à entraîner les objets vers l'emplacement aval.

16. Procédé suivant la revendication 15, caractérisé par les étapes additionnelles qui consistent à prévoir des zones séparées (A, B, C, D, E) le long

du conduit pour faire converger les récipients à des degrés différents dans chaque zone et à créer une pression d'air différente, supérieure à la pression ambiante dans chaque zone.

17. Procédé suivant la revendication 16, caractérisé en ce que les zones de conduit sont alimentées à partir de chambres de surpression agencées en dessous de la surface comportant les tuyères d'air, les pressions dans les zones de conduit étant rendues progressivement de plus en plus faibles de l'amont vers l'aval par la présence d'ouvertures dans les zones de conduit.

15

20



25

30

35

40

45

50

55

60

65

13