United States Patent

[11] 3,622,151

[72] Inventors **Richard J. Range**
Silver Spring;
James T. Pfeiffer, Laurel, both of Md.

[21] Appl. No. **8,608**
[22] Filed **Feb. 4, 1970**
[45] Patented **Nov. 23, 1971**

[73] Assignee **Bowles Fluidics Corporation**
Silver Spring, Md.

[54] **FLUIDIC LETTER FLIPOVER METHOD AND APPARATUS**
12 Claims, 2 Drawing Figs.

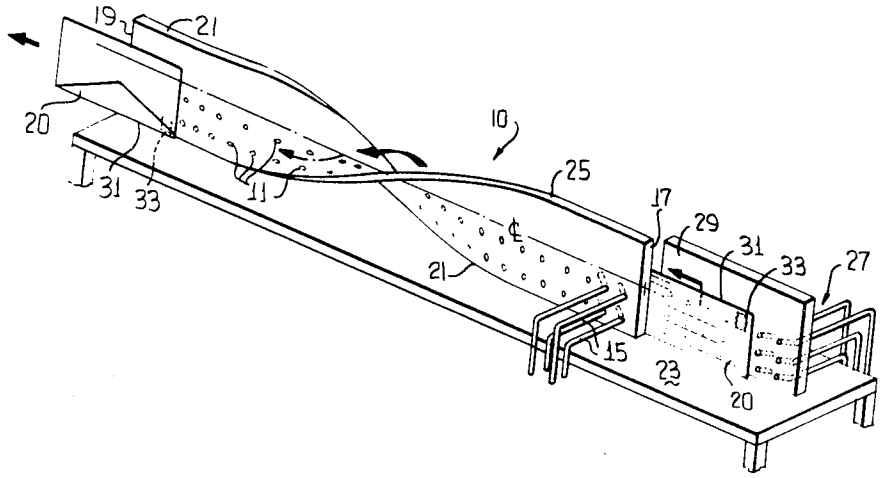
[52] **U.S. Cl.** ..... **271/74,** 198/33 AC
[51] **Int. Cl.** **B65h 29/32,** B65g 47/24
[50] **Field of Search** ..... 271/74, 65, 87, 26, 26 E; 198/33 AC, DIG. 16; 214/1 M

[56] **References Cited**
UNITED STATES PATENTS

3,136,539	6/1964	Lyman	271/26
2,947,406	8/1960	Hazleton	198/33 AC
2,905,295	9/1959	Anderson	198/33 AC

Primary Examiner—Joseph Wegbreit
Assistant Examiner—Bruce H. Stoner, Jr.
Attorney—Rose & Edell

ABSTRACT: A flipover device for flipping substantially flat articles out-of-plane includes a modified Bernoulli conveyor in which the conveyor surface is twisted out-of-plane in a graduated manner about an axis parallel to a transport path defined along the conveyor surface. Articles received by the conveyor are propelled therealong and attracted thereto by angled air jets issuing from the conveyor surface. The articles follow the surface contour and are thereby rotated out-of-plane. The conveyor may be disposed in a cylindrical guide tube with one longitudinally extending edge of the conveyor being disposed along the central axis of the tube and serving as the axis about which the conveyor surface is twisted. Angled air jets issued into the tube aid in propelling transported articles. The tube also serves to guide rigid articles which might not be capable of conforming to the twisted conveyor surface.



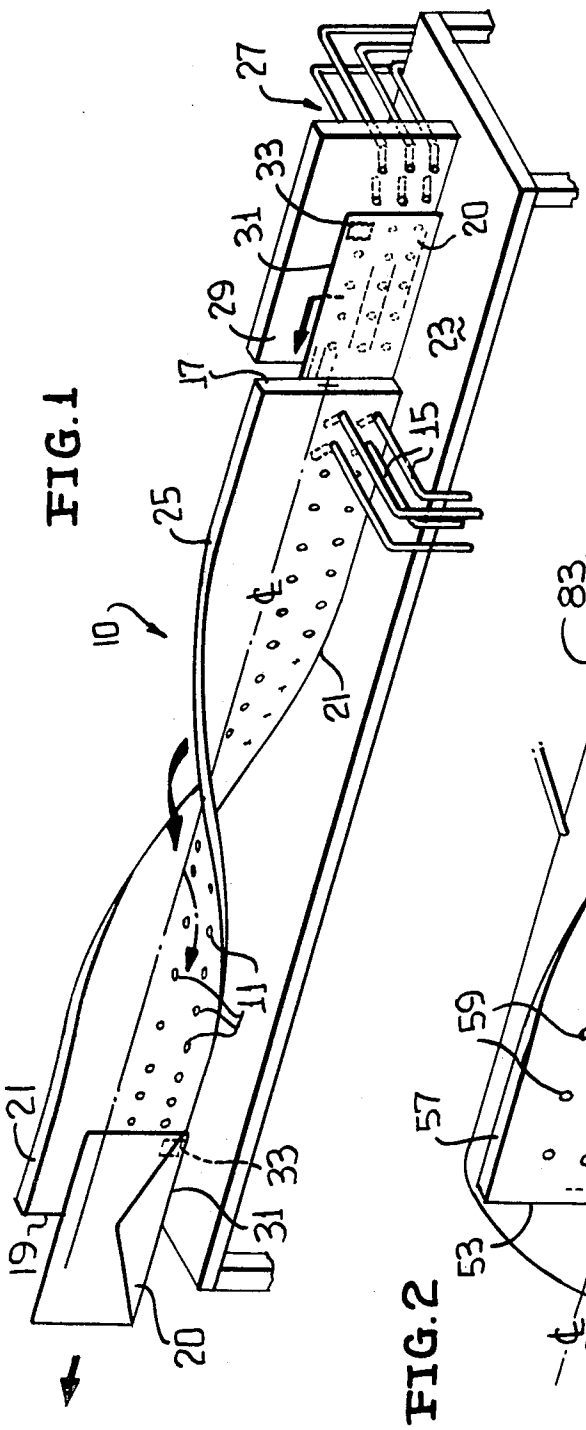


FIG. 1

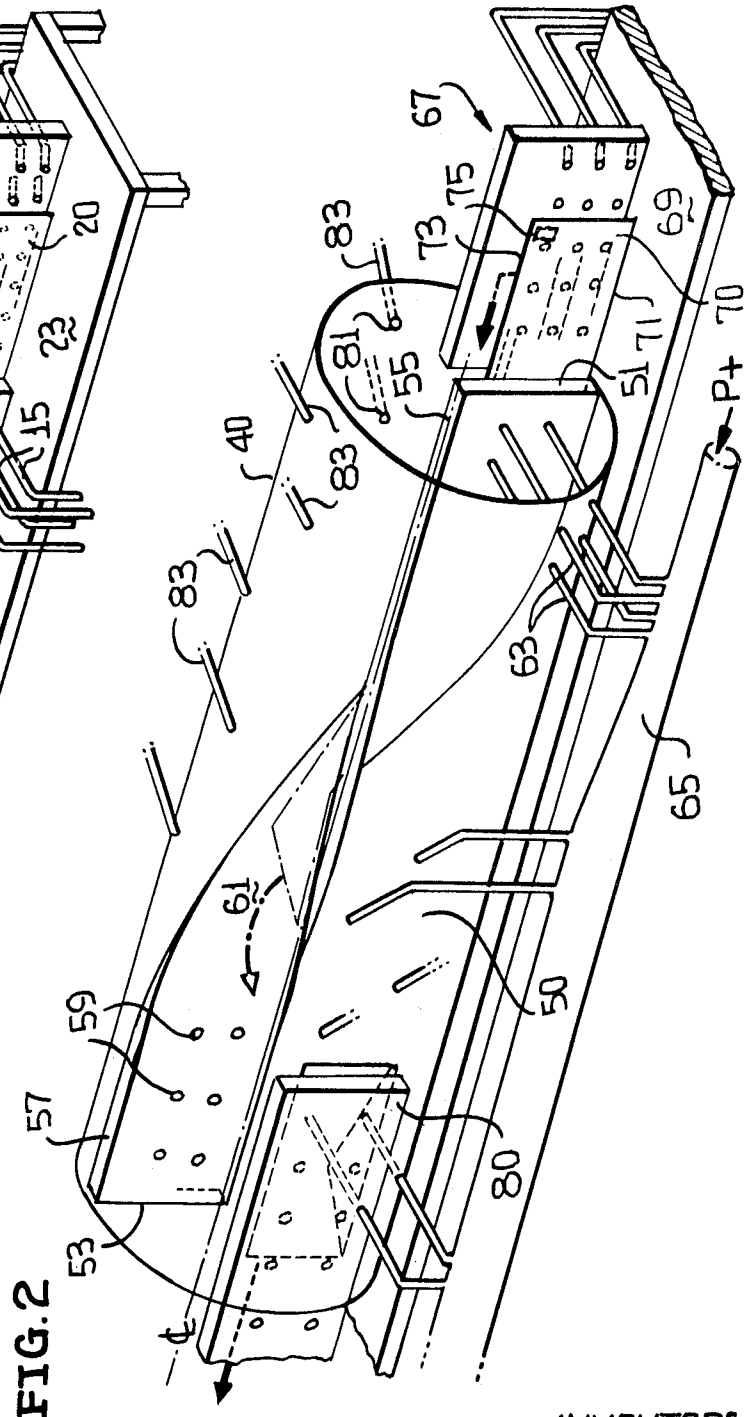


FIG. 2

INVENTORS
RICHARD J. RANGE &
JAMES T. PFEIFFER

By Hurwitz & Rose

ATTORNEYS

FLUIDIC LETTER FLIPOVER METHOD AND APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a method and apparatus for automatically flipping over a flat article being conveyed along a surface, and, more particularly, to accomplishing article flipover without the use of moving parts.

Processing of flat articles often requires that the articles be flipped or turned over at some point in the processing. For example, in the automated processing of letter mail by the Post Office, all of the envelopes must have their stamps proximate a conveyor guide in order to assure proper cancelling. Since all of the envelopes in a stack supplied for cancelling do not necessarily have their stamped corners aligned with a common edge of the stack, some envelopes must be flipped over. Presently, the Post Office determines which envelopes are to be flipped over by optically scanning the surface of each as it is conveyed along a surface toward the cancelling apparatus. Those envelopes which are determined by the scanning device to be in need of flipping over are done so with the use of vacuum belts, twisted belts, and electrically powered mechanical gates. The machinery is quite complex and, because of the numerous moving parts, requires a high degree of maintenance to prevent frequent failure.

It is an object of the present invention to provide a method and apparatus for flipping over letter mail and similar flat articles without the use of moving parts.

It is another object of the present invention to employ fluidic techniques to flip over letter mail and similar flat articles to be processed.

A prior art technique for conveying articles such as letter mail along a surface utilizes the Bernoulli effect and is described in copending U.S. Pat. application, Ser. No. 862,287, filed Sept. 30, 1969, by Richard J. Range, entitled "-Bernoulli Conveyor", and assigned to the same assignee as the present invention. As described therein, a conveyor surface is provided with a plurality of ports or nozzles for issuing jets of air angularly from the surface with a flow component in the direction in which articles are to be transported along the surface. A flat transported article is impacted in turn by each jet, the velocity of which is converted to a pressure at the impact point. This pressure applies a force against the article, one component of the force acting normal to the surface and tending to displace the article therefrom, the other component being viscous in nature and tending to drive the article in the transport direction. In addition, air from the jets is continuously escaping at a high velocity from the narrow space between the article and the surface, creating a low static pressure in this space because of the Bernoulli principle. When the article is very close to the transport surface this low static pressure is lower than atmospheric pressure and a resulting force attracts the article toward the surface. The article achieves a balance position above the surface when the Bernoulli force combined with the gravitational force acting on the letter are balanced by the normal component of the air jets. In this balance position the article is transported along the surface, following a path determined by the pattern formed by the jet-issuing ports in the transport surface.

It is another object of the present invention to employ the principles of the Bernoulli conveyor to flip over flat articles.

It is yet another object of the present invention to employ a modified Bernoulli conveyor to achieve flipover of letters and the like articles being transported or conveyed along a surface.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention, a Bernoulli conveyor surface is curved or contoured such that articles transported along the surface are rotated 180° about an axis parallel to the transport direction. More specifically, the conveyor surface is twisted out of plane in a graduated manner about the axis of rotation until a 180° rotation is effected. Angled air jets issued from the conveyor or surface act to attract the conveyed article to the surface as well as propelling the article in the transport direction. A conveyed article entering the twisted conveyor section with a longitudinal reference edge pointed in one direction, exits from the twisted conveyor section with its reference edge pointed in the opposite direction. The transport distance required for the twisted conveyor or surface to achieve a full 180° rotation depends upon the rigidity of conveyed articles, for the more rigid the article the less able it is to follow a sharply contoured surface. In addition, the Bernoulli forces which attract the article to the conveyor surface must be sufficiently great to overcome the gravitational forces acting on an article as it is being rotated out of the normal transport plane.

In a preferred embodiment the length of the twisted conveyor surface is significantly reduced by passing the twisted surface through a cylindrical guide tube. One longitudinally extending edge of the twisted conveyor surface extends along the longitudinal centerline of the guide tube; the other or outer edge of the conveyor surface forms a continuous helix about the centerline and along the interior surface of the guide tube. Both the twisted surface and the guide tube are provided with ports for issuing angled jets to propel articles in the transport direction. The guide tube thus serves to both guide and propel articles which would otherwise be too rigid to follow the relatively sharply curved flipover surface. If desired, articles approaching the discharge or exit end of the guide tube can be guided onto a straight Bernoulli conveyor surface to aid in propelling articles through the discharge end.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and still further objects, features, and advantages of the present invention will become apparent upon consideration of the following detailed description of specific embodiments thereof, especially when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a view in perspective of a Bernoulli conveyor contoured to flip over articles transported therealong;

FIG. 2 is a view in perspective of a modified form of the flipover conveyor of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

Referring now specifically to FIG. 1 of the accompanying drawings there is illustrated a contoured Bernoulli conveyor **10** having a plurality of angled nozzles or ports **11** defined in its transport surface **13**. Conveyor **10** is manufactured from plastic, metal, or other suitable material. Ports **11** receive pressurized gas (for example, air) from pressure lines **15** connected to respective fittings at surface **14**, the surface opposite transport surface **13**. Lines **15** in turn are connected to an appropriate manifold (not illustrated). The angle formed by ports **11** with surface **13** is such that air jets issued from ports **11** transport articles (for example, letter mail) along surface **13** from input end **17** to output end **19** of conveyor **10** as indicated by the arrows in FIG. 1. As illustrated, surface **13** is vertical at input end **17** with longitudinal edge **21** of conveyor **10** disposed adjacent a guide surface **23**. The opposite longitudinal edge **25** of conveyor **10** extends substantially equidistant from edge **21** throughout the transport length of the conveyor.

Viewing conveyor **10** from input end **17** toward output end **19**, surface **13** is observed to rotate increasingly counterclockwise as the distance from input end **17** increases. This counterclockwise rotation, which could just as readily be clockwise, proceeds about an axis parallel to the transport direction, for example, the longitudinal centerline C/L extending through conveyor **10**. Rotation of surface **13** with displacement from input end **17** continues for 180° at which point longitudinal edge **25** is positioned adjacent guide surface **23** and longitudinal edge **21** is exposed. The longitudinal distance (i.e., the distance in the transport direction) within which the 180° rotation is completed depends upon the rigidity of articles being transported and flipped over by conveyor **10**.

It is to be noted that surface 13, when viewed in transverse section at any point along its length, is planar; but no such section is coplanar with any other such section.

Articles to be flipped over, for example, letter mail such as envelope 20, are supplied to input end 17 of conveyor 10 from input Bernoulli conveyor 27. The transport surface 29 of conveyor 27 may either be a coplanar extension of surface 13 at input end 17 or as illustrated, may face in the opposite direction to that faced by surface 13 at input end 17. In either case, envelope 20 is conveyed along surface 29 and picked up by conveyor surface 13.

In a typical operation it is required that the longitudinal edge 31 of envelope 20, which is closest to postage stamp 33, be adjacent guide surface 23 to permit proper cancellation of the stamp. It is assumed that only envelopes whose stamps are remote from the guide surface 23 are conveyed to conveyor 27, the others being sorted out and conveyed away from the flipover conveyor 10 by conventional techniques. When envelope 20 reaches input 17 of conveyor 10 it is propelled therealong by the angled air jets issued from ports 11. The envelope follows the contour of transport surface 13 and is therefore rotated by 180° before reaching output end 19. Upon being so rotated, envelope 20 is oriented at output end 19 with longitudinal edge 31 adjacent guide surface 23. Transport of envelope 20 in such position continues and cancellation of stamp 33 is effected at some downstream location (not illustrated). Transport of envelope 20 from output end 19 may be along a Bernoulli surface coplanar with surface 13 at output end 19 or may be along a Bernoulli surface facing the opposite direction. In either case, the envelope is picked up by such surface and transported in a position with stamp 33 proximate guide surface 23.

The above-described flipover device is effective in flipping over most flat articles. However, where space considerations require conveyor 10 to be relatively short, we have found that rigid articles do not satisfactorily traverse the conveyor. For example, if envelope 20 is relatively rigid it does not conform to a sharply curved surface 13; and, of course, the shorter one makes conveyor 10 the sharper is the curvature of surface 13. When envelope 20 does not conform to surface 13, the Bernoulli forces become insufficient to attract the envelope to the surface and the envelope leaves surface 13 of conveyor 10.

We have found that a flipover conveyor of the type described above can effect 180° rotation over a relatively short transport distance, irrespective of the rigidity of the transported article, by placing the flipover conveyor in a guide tube in the manner illustrated in FIG. 2. More particularly, there is provided a cylindrical guide tube 40 having a diameter D within which is disposed a flipover Bernoulli conveyor 50. Conveyor 50 is bounded by an input end 51, an output end 53, and two longitudinally extending edges 55 and 57 which are substantially equidistant throughout the length of conveyor 50. A plurality of angled nozzles of ports 59 terminate at transport surface 61 of conveyor 50 and are oriented to define a transport path along surface 61. Ports 59 are fed pressurized air by pressure lines 63 which in turn are connected to a pressurized manifold 65. Guide tube 40 and conveyor 50 are formed from plastic, metal, or other suitable material, tube 40 being illustrated as transparent to facilitate viewing of conveyor 50 in FIG. 2.

The transverse width of conveyor surface 61 (between longitudinal edges 55, 57) is approximately D/2, or one-half the diameter of tube 40. Rotation of conveyor 50 proceeds about an axis comprising longitudinal edge 55, which is aligned with the central longitudinal axis of cylindrical guide tube 40. Edge 57 is secured, by means of suitable adhesive or the like, to the interior wall of guide tube 40. Transport surface 61 is vertically oriented at both input end 51 and output end 53, there being a 180° rotation of surface 61 about edge 55 between these ends. Longitudinal edge 57 is disposed adjacent guide surface 69 at input end 51 and disposed remote from guide surface 69 at output end 53.

Conveyor 50 receives articles (such as envelope 70) to be flipped over at input end 51 from Bernoulli conveyor 70, which by way of example is analogous to conveyor 27 of FIG. 1. The bottom edge 71 of envelope 70 is disposed adjacent guide surface 69 as the envelope enters guide tube 40. Upon entering the guide tube, envelope 70 is propelled along surface 61 with envelope edge 71 partially disposed adjacent guide surface 69 and partially disposed adjacent the interior wall of guide tube 40. Edge 71 is in fact urged toward the interior surface of tube 40 at input end 51 by gravitational forces acting on envelope 70. This urging of edge 71 toward the tube wall lessens as the envelope proceeds along the transport path, primarily because the twisting surface gradually becomes horizontal. Once past the midportion of the flipover path, envelope 20 experiences gravitational forces which tend to draw envelope edge 71 away from the interior surface of guide tube 40. As surface 61 becomes more vertical edge 73 of envelope 70 is drawn toward and then over conveyor edge 55, whereupon the envelope eventually falls from surface 61. Upon falling the envelope is picked up by a further Bernoulli conveyor 80 which extends into guide tube 40 from output end 53 a distance sufficient to assure that all articles falling from surface 61 are picked up and propelled by conveyor 80. Conveyor 80 propels the fallen article or envelope out of the output end of tube 40 from which location the envelope may be conveyed to a cancelling machine or the like.

Conveyor 80 is preferably arranged with its transport surface facing surface 61 at output end 53; however, it is to be understood that conveyor 50 can be gradually widened to the width D of guide tube 40 in the region between the midportion of conveyor 50 and output end 53. The latter alternative prevents envelope 70 from leaving the widened surface 61 and therefore does away with the need for the additional conveyor 80 inserted into tube 40.

Another alternative feature is the provision of angled ports 81 in tube 40, fed by pressure lines 83, which are arranged to issue air jets into guide tube 40 having flow components parallel to the transport direction. This feature provides additional propulsion forces for transported articles within the guide tube.

The guidance offered by tube 40, we have found, permits reliable article flipover in about one-half the transport distance required to reliably flip over articles without a guide tube, assuming of course that like parameters (pressures, article dimensions, etc.) are employed.

It will become apparent to those skilled in the art that the twisted Bernoulli surface of the present invention need not be limited to a complete 180° flip over but may also be employed to reorient transported articles out-of-plane by some lesser angle. In addition, the invention is obviously not limited to the handling of letter mail, but rather is useful for out-of-plane reorientation of any flat article being conveyed along a surface.

While we have described and illustrated specific embodiments of our invention, it will be clear that variations of the details of construction which are specifically illustrated and described may be resorted to without departing from the true spirit and scope of the invention as defined in the appended claims.

We claim:

1. A Bernoulli conveyor for reorienting relatively flat articles out-of-plane while transporting said articles along a transport path, said conveyor comprising a member having a transport surface along which said transport path is defined, said transport surface being twisted out-of-plane about an axis parallel to said transport path, said member having a plurality of nozzles defined therethrough and terminating at said transport surface, said nozzles being oriented relative to one another to define said transport path, each nozzle being angled relative to said transport surface to impart to fluid flowing through that nozzle a flow component directed along said transport path.

2. The conveyor according to claim 2 wherein all cross sections of said transport surface taken transversely of said transport path are planar and wherein no two of said cross sections are coplanar.

3. The conveyor according to claim 2 wherein said axis is coaxial with a first longitudinally extending edge of said transport surface, said conveyor further comprising a guide tube of generally cylindrical configuration and having a central longitudinal axis, said member being disposed with said guide tube with said first longitudinally extending edge of said transport surface coaxially aligned with said central longitudinal axis, said guide tube having a diameter D and said transport surface having a width approximately D/2.

4. The conveyor according to claim 3 wherein said guide tube includes means for issuing pressurized fluid from a plurality of ports defined in said guide tube, said plurality of ports being arranged to issue said fluid internally of said guide tube with a flow component in the direction in which articles are transported along said transport path.

5. The conveyor according to claim 4 further comprising output means for receiving articles which have traversed said transport path and propelling such articles away from said member.

6. The conveyor according to claim 2 wherein the out-of-plane twist of said transport surface is approximately 180°.

7. A device for turning relatively flat articles approximately 180° out-of-plane, said device comprising;

a modified Bernoulli conveyor having a transport surface with an input end, an output end and two generally longitudinally extending sides, said transport surface being twisted out-of-plane about an axis comprising a first of said longitudinally extending sides such that all cross sections of said transport surface taken normal to said first longitudinally extending side are planar and none of said cross sections between said input and output ends are coplanar, said conveyor having a plurality of nozzles defined therethrough and terminating at said transport surface, said nozzles being oriented along said transport surface to define a transport path from said input end to said output end between said longitudinally extending sides, each nozzle being angled relative to said transport surface to impart to fluid flowing through that nozzle a flow component directed along said transport path;

a guide tube of generally cylindrical configuration within which said conveyor is disposed, said guide tube having a central longitudinal axis disposed coaxially with said first longitudinally extending side; and

means for applying pressurized fluid to said nozzles.

8. The device according to claim 7 wherein a plurality of ports are defined through said guide tube and arranged to issue pressurized fluid interiorly of said guide tube with flow components generally parallel to said transport path.

9. The device according to claim 8 wherein said transport surface is twisted a total of approximately 180° about said first longitudinally extending side.

10. The device according to claim 9 wherein the width of said transport surface between said longitudinally extending sides is substantially uniform and equal to one-half the diameter of said guide tube.

11. The device according to claim 10 wherein said input and output ends of said transport surface are disposed generally vertically, said input end being at a lower vertical level than said output end, said device further comprising:

a generally planar guide surface extending substantially coplanar with the second of said longitudinally extending sides at said input end; and

means for delivering substantially flat articles to said transport surface at said input end, said articles being so delivered with one edge resting on said guide surface.

12. The device according to claim 10 further comprising a further Bernoulli conveyor having a transport surface arranged to receive articles from said output end.

* * * * *