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(54) **DEVICE FOR MITIGATING THE PRODUCTION/REMOVAL OF PARTICULATE MATTER FROM A SUBSTRATE/MAILPIECE ENVELOPE**

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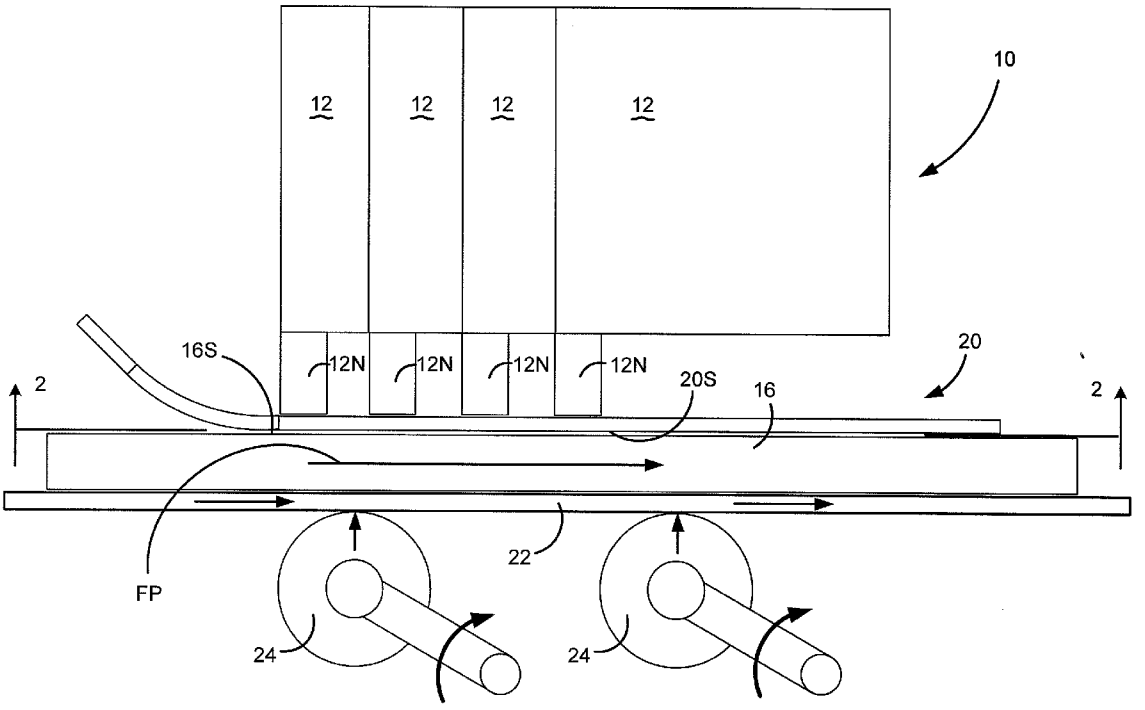
(57) **ABSTRACT**

A registration device for use in combination with an array of print head nozzles and operative to deposit ink on a substrate material. The registration device is operative to maintain a prescribed separation distance between an array of print head nozzles and a substrate material during print operations and includes a registration surface which opposes a face surface of the substrate material and is textured to define a plurality of contact points. The contact points are substantially evenly distributed over, and engage, the face surface of the substrate material, to reduce the total surface area in contact with the substrate material and the particulate matter which may be shed from, and/or produced by frictional engagement with, the substrate material.



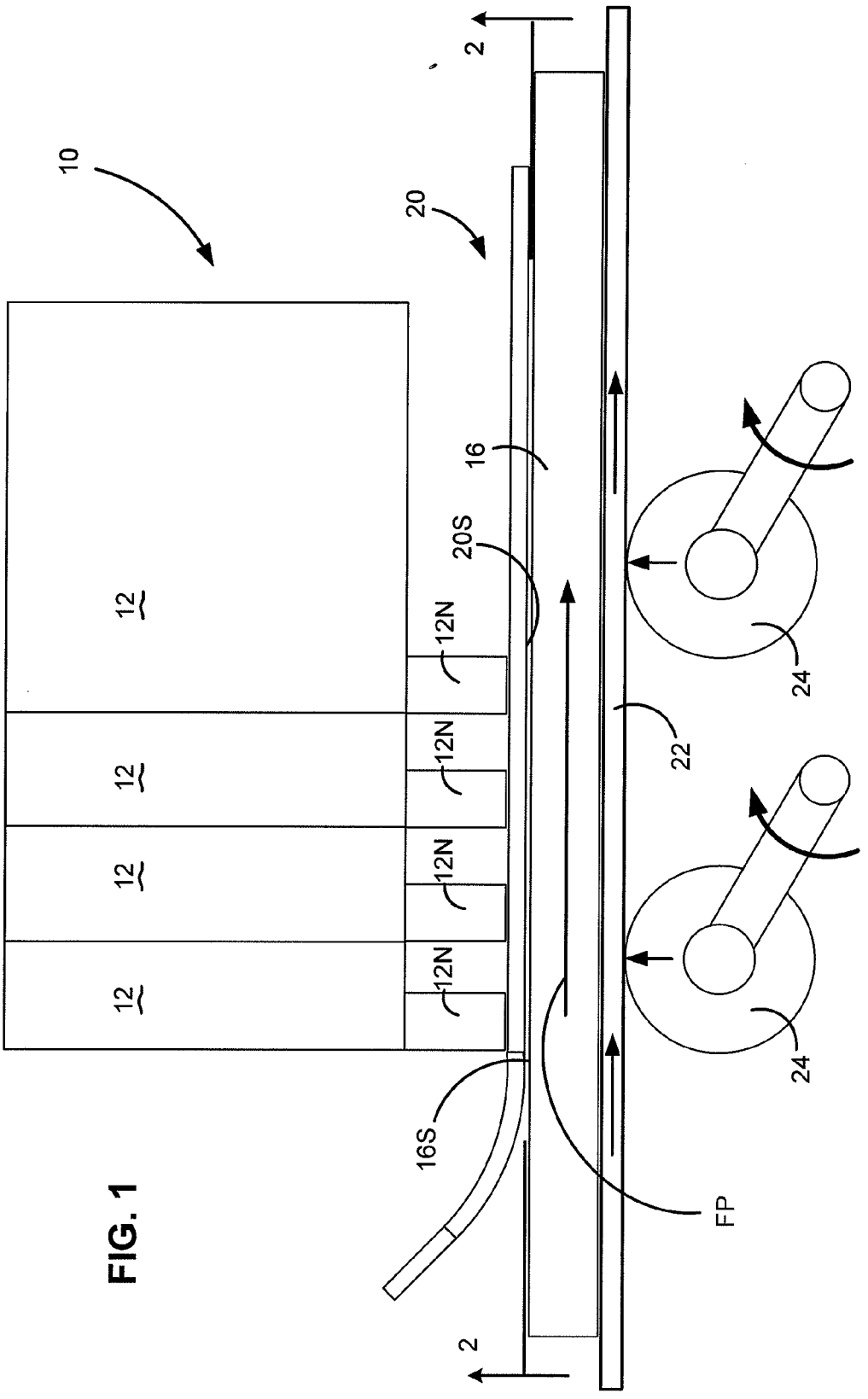
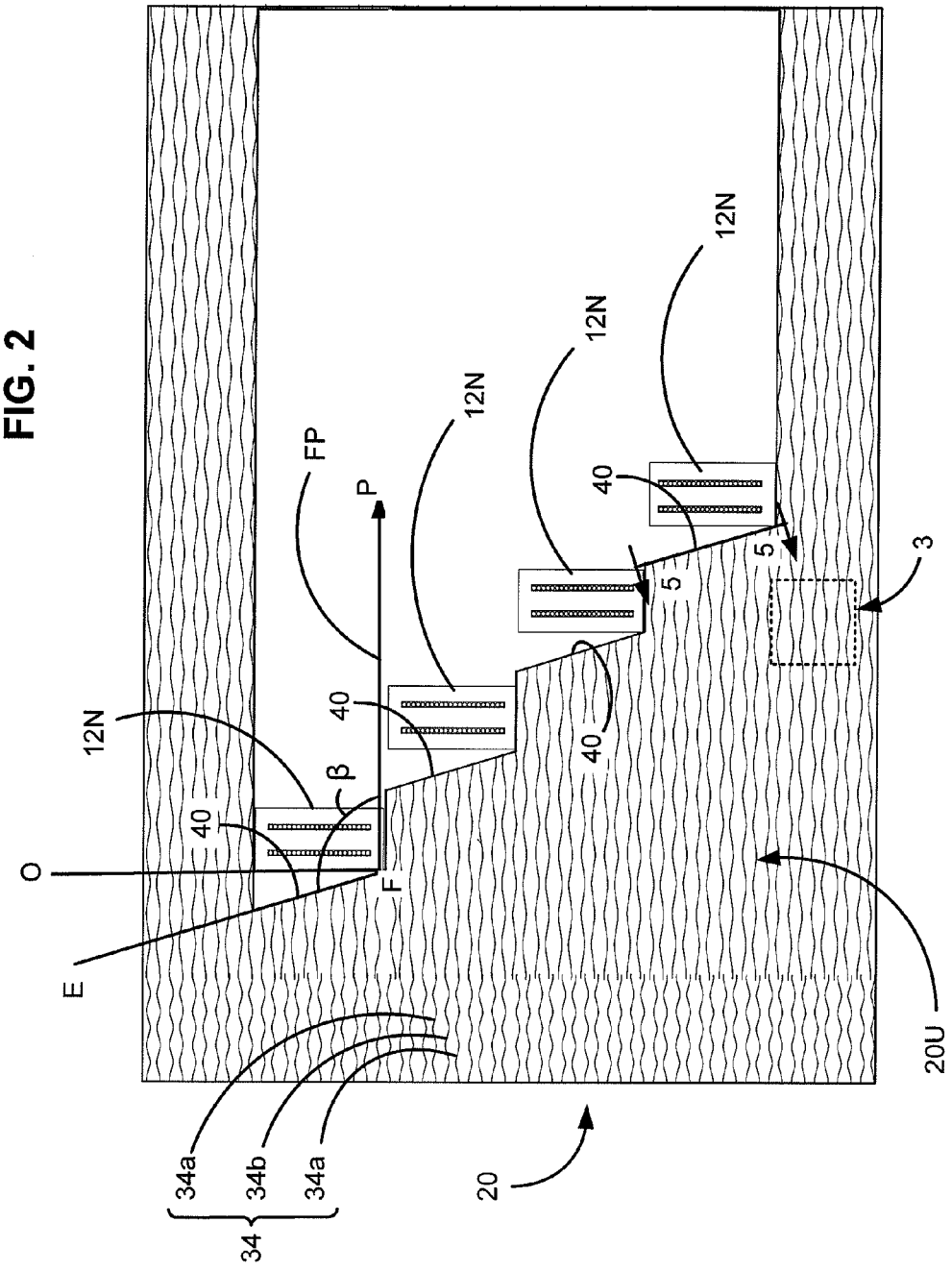


FIG. 1

FIG. 2



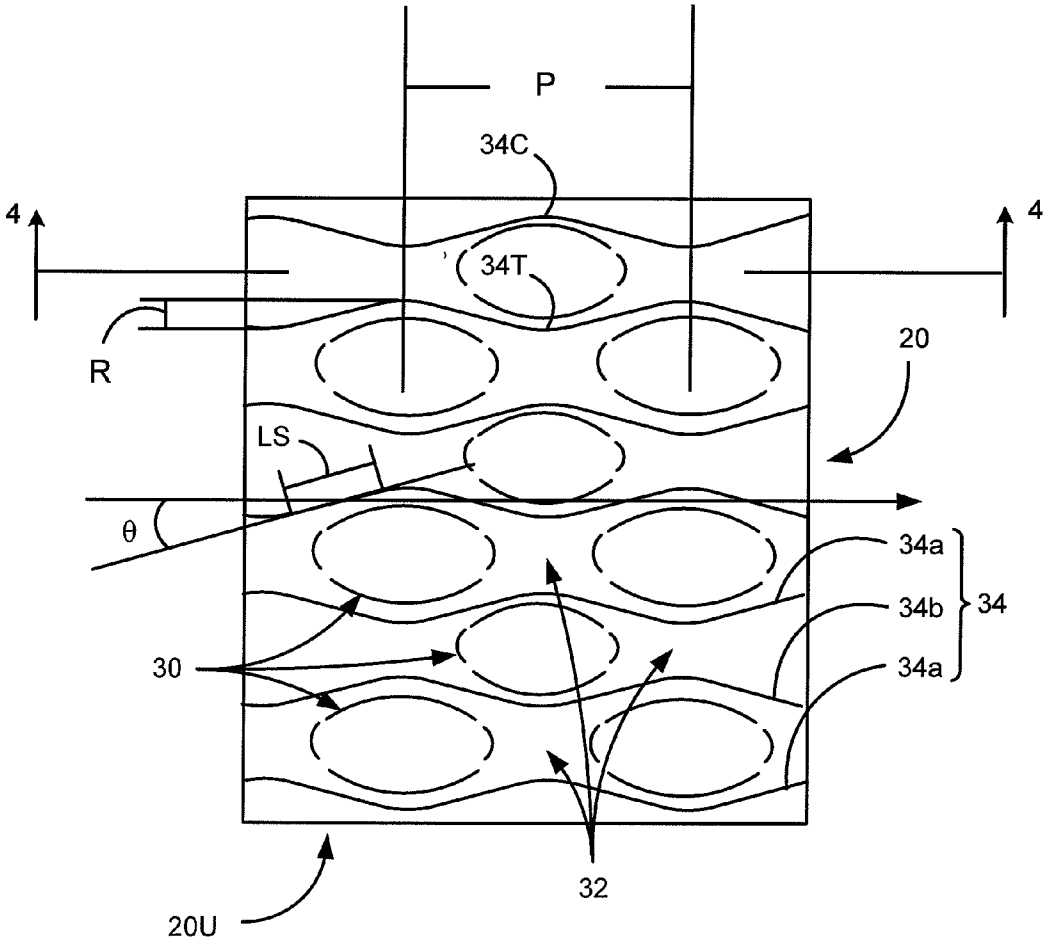


FIG. 3

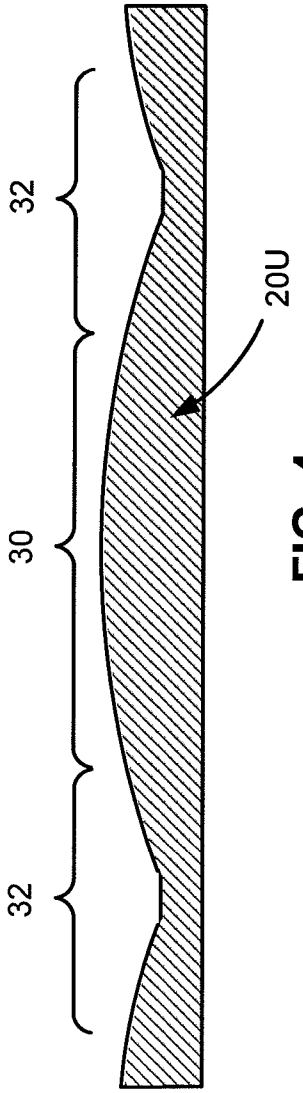


FIG. 4

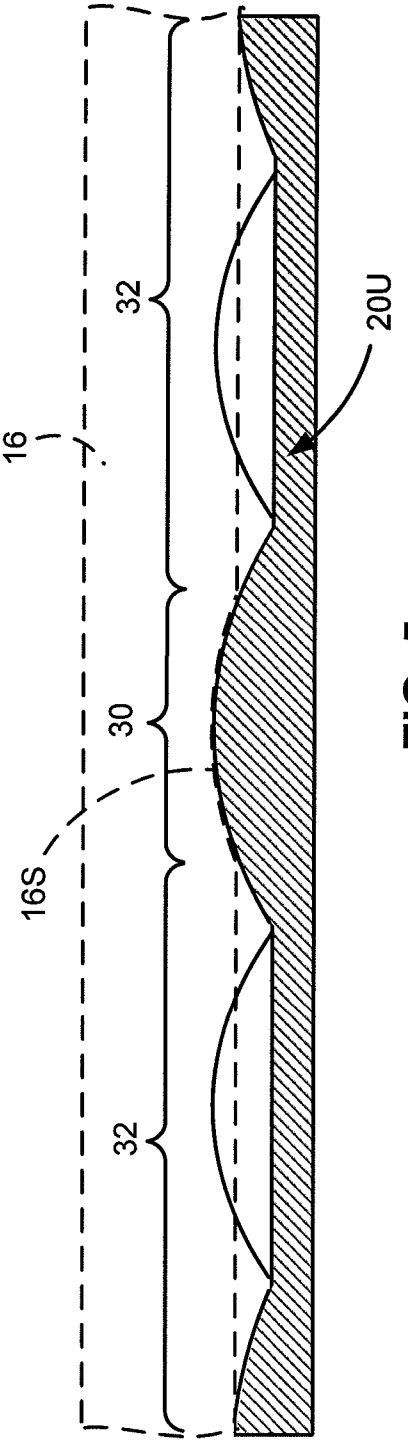


FIG. 5

DEVICE FOR MITIGATING THE PRODUCTION/REMOVAL OF PARTICULATE MATTER FROM A SUBSTRATE/MAILPIECE ENVELOPE

TECHNICAL FIELD

[0001] The present invention relates to a registration device for use in a substrate print station and, more particularly, to a new and useful registration device for mitigating the production/removal of particulate matter, i.e., dust and debris, from the substrate material/mailpiece envelope as it engages a registration surface during print operations.

BACKGROUND OF THE INVENTION

[0002] Mailpiece creation systems such as mailpiece inserters are typically used by organizations such as banks, insurance companies, and utility companies to periodically produce a large volume of mailpieces, e.g., monthly billing or shareholders income/dividend statements. In many respects, mailpiece inserters are analogous to automated assembly equipment inasmuch as sheets, inserts and envelopes are conveyed along a feed path and assembled in or at various modules of the mailpiece inserter. That is, the various modules work cooperatively to process the sheets until a finished mailpiece is produced.

[0003] A mailpiece inserter includes a variety of apparatus/modules for conveying and processing a substrate/sheet material along the feed path. Commonly mailpiece inserters include apparatus/modules for (i) feeding and singulating printed content material in a "feeder module", (ii) accumulating the content material to form a multi-sheet collation in an "accumulator", (iii) folding the content material to produce a variety of fold configurations such as a C-fold, Z-fold, bi-fold and gate fold, in a "folder", (iv) feeding mailpiece inserts such as coupons, brochures, and pamphlets, in combination with the content material, in a "chassis module" (v) inserting the folded/unfolded and/or nested content material into an envelope in an "envelope inserter", (vi) sealing the filled envelope in "sealing module" (vii) printing recipient/return addresses and/or postage indicia on the face of the mailpiece envelope at a "print station" and (viii) controlling the flow and speed of the content material at various locations along the feed path of the mailpiece inserter by a series of "buffer stations". In addition to these commonly employed apparatus/modules, mailpiece inserter may also include other modules for (i) binding/stitching an edge of sheet material to form a bound collation, i.e., via a stitcher/stapler module, and (ii) reversing the orientation of the substrate/sheet material, via a "sheet inverter" to print information on an opposite side of the sheet/content material.

[0004] With respect to the printing station, it is common to register a face surface of each mailpiece with a registration plate such that an array of print heads may print information such as destination and return addresses on the face of each mailpiece. More specifically, the registration plate includes an aperture for accepting a stepped array of print head nozzles. The thickness of the registration plate provides a threshold "stand-off" dimension from the face surface of each mailpiece to each of the print head nozzles such that ink droplets may be precisely deposited.

[0005] Furthermore, the array of print heads and registration plate are typically disposed over, and/or in opposed relation to, an underlying conveyance system such as one or more conveyor belts. Mailpieces are conveyed along the belt(s), move under the registration plate and passed by the print head nozzles as ink is deposited. To ensure that mailpieces slide smoothly beneath the registration plate, i.e., without jamming, the spacing between the underlying conveyance system, e.g., the conveyance belt (s), and the registration plate must be closely controlled. That is, with each mail run/print job performed by the print module, the necessary clearance gap must be established based upon the anticipated thickness of mailpieces being processed. Alternatively, the underlying conveyance system/belt may be compliant to allow envelopes of variable thickness dimension move under the registration plate while the deck the of conveyance system/belt is displaced by the geometric variation in envelope thickness.

[0006] Furthermore, as a mailpiece passes the registration plate, particulate matter, which may have collected on an envelope during pre-processing, can be disturbed and become airborne due to engagement of the envelope with the registration plate. Additionally, the frictional engagement with the registration plate may produce additional dust and debris. As more particulate matter is disturbed/removed/produced, the print station must perform additional purge cycles to clear the print head nozzles of dust and debris. As a result, the mailpiece inserter is halted, or momentarily/temporarily discontinued, to allow the purge cycle to clear/clean the print head nozzles. While such purge cycles must be tolerated to permit smooth operation of the print station, the down time is unproductive and costly to the operator. Furthermore, inasmuch as the ink used to purge the print head nozzles is costly, it is desirable to minimize the number of purge cycles that a print station performs to minimize the cost of the ink consumed.

[0007] A need, therefore, exists for a print station which mitigates the removal/production of particulate matter to optimize print station/inserter efficiency. Such increased efficiency may be achieved by reducing the number purge cycles necessary to clear/clean the print head nozzles and the cost associated with lost productivity and ink consumption.

SUMMARY OF THE INVENTION

[0008] A registration device is provided for use in combination with an array of print head nozzles operative to deposit ink on a substrate material. The registration device is operative to maintain a prescribed separation distance between an array of print head nozzles and a substrate material during print operations and includes a registration surface which opposes a face surface of the substrate material and is textured to define a plurality of contact points. The contact points are substantially evenly distributed over, and engage, the face surface of the substrate material, to reduce the total surface area in contact with the substrate material and the particulate matter which may be shed from, and/or produced by frictional engagement with, the substrate material.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompanying drawings illustrate presently preferred embodiments of the invention and, together with the general description given above and the detailed description given below serve to explain the principles of the invention. As shown throughout the drawings, like reference numerals designate like or corresponding parts.

[0010] FIG. **1** is a side view of a registration device and print station according to the present invention wherein an

array of print heads is disposed in combination with the registration device to deposit ink on a face surface of a mailpiece envelope.

[0011] FIG. **2** is a view taken substantially along line **2-2** of FIG. **1** depicting a textured surface of the registration device which includes a plurality of raised contact surfaces and at least one upstream edge which is inclined relative to a line orthogonal to the feed path of the mailpiece envelope.

[0012] FIG. **3** is an enlarged view of the textured registration surface within a region **3** of FIG. **2**, wherein the contact surfaces are defined by a plurality of serpentine-shaped surface grooves which are out-of-phase to stagger the arrangement of contact surfaces.

[0013] FIG. **4** is an enlarged cross sectional view taken substantially along line **4-4** of FIG. **3** depicting a convex or arcuate surface of each contact surface.

[0014] FIG. **5** is an enlarged cross sectional view taken substantially along line **5-5** of FIG. **3** depicting an upstream edge to emphasize the effect of severing/cutting the textured surface of the registration device along an edge which is off-axis relative to a line orthogonal to the feed path of the mailpiece envelope.

DETAILED DESCRIPTION OF THE INVENTION

[0015] A registration device and print station are described for printing information on a mailpiece envelope such as a destination address, return address and postage indicia for delivery of the mailpiece. While the invention is described in the context of a mailpiece inserter, the registration device and print station described herein are applicable to any printer wherein a substrate material is registered against a registration device for maintaining a prescribed separation distance between an array of print head nozzles and a substrate material during print operations. Consequently, the detailed description and illustrations are merely indicative of an embodiment of the invention, and, accordingly, the invention should be broadly interpreted in accordance with the appended claims.

[0016] FIG. **1** depicts a side view of a print station **10** having a plurality of print heads **12**. Each print head **12** deposits ink, i.e., prints, on a face surface **14** of a substrate material **16** (e.g., such as a mailpiece envelope) as the substrate material **16** is conveyed through the print station **10**. Inasmuch as the invention is principally described in the context of a print station **12** for a mailpiece inserter, the term mailpiece envelope **16** will, hereinafter, be used to mean any sheet and/or substrate material. Each of the print heads **12** includes one or more rows of print head nozzles **12**N which deposit ink through an aperture/opening **18** in a registration device **20**.

[0017] The registration device **20** is disposed in combination with the print heads **12** and functions to maintain a prescribed separation distance between a face surface **16**S of the mailpiece envelope **16** and each of the print head nozzles **12**N. The separation distance ensures the efficacy of print operations inasmuch as the deposited ink requires a certain stand-off distance, i.e., spacing from the exit of the nozzles **12**N to the face surface **14**, to be deposited at a precise location on the face surface **16**S of the mailpiece envelope **16**.

[0018] The mailpiece envelope **16** is conveyed through the print station **10** by a conventional transport system such as a conveyor belt **22** which may be supported on, or by, a series of spring-biased rollers **24**. The spring-biased rollers **24** urge the conveyor belt **22**, and consequently, mailpiece envelope **16**, upwardly toward a registration surface **20**S of the registration device **20**. By urging the envelope **16** upwardly against the registration surface **20**S, the separation distance between the print head nozzles **12**N and the top face surface **20**S of the mailpiece envelope may be accurately controlled. As a consequence, print quality is accurately maintained for optimum print performance.

[0019] In FIGS. **1** through **4**, the registration surface **20**S opposes and engages the face surface **16**S (see FIG. **1**) of the envelope **16** as the conveyor belt **22** transports the envelope **16** beneath the print head nozzles **12**N of the print station **12**. The registration surface **20**S is textured to contact the face surface **16**S of the mailpiece envelope **16** at multiple points, or regions, along the face surface **16**S. The registration surface **20**S defines a plurality of contact surfaces **30** which are substantially evenly distributed across the registration surface **20**S and a plurality of non-contact regions **32** disposed therebetween. The contact surfaces **30** are (i) raised, (ii) have a substantially convex or arcuate contour, and, (iii) are operative to effect bridging of the mailpiece envelope **16**, i.e., across the non-contact regions **32**, such that registration surface **20**S does not frictionally engage the face surface **16**S of the mailpiece envelope at these regions **32**.

[0020] As will be discussed in greater detail hereinafter, the textured surface, i.e., which includes the contact surfaces **30** and non-contact regions **32**, reduces the surface area in contact with the face surface **16**S of the mailpiece envelope **16**, i.e., as compared to the total surface area of a purely planar/flat registration surface employed in prior art registration devices. That is, the textured surface of the registration device **20** mitigates particulate matter removed/shed from the mailpiece envelope **16** by minimizing the friction and/or profile drag developed between the registration surface **20**S of the registration device **20** and the face surface **16**S of the mailpiece envelope **16**.

[0021] The contact surfaces **30** may be produced by plurality of serpentine-shaped grooves **34** which extend in a direction substantially parallel to the feed path of the mailpiece envelope **16** (shown in the direction of arrow FP in FIG. **3**). The grooves **34** may be aligned, i.e., in phase, or staggered, i.e., out-of-phase, relative to the feed path FP of the mailpiece envelope **16**. FIGS. **2** and **3** show the grooves in a staggered pattern such that the crest **34**C of one groove **34***a* aligns a trough **34**T of an adjacent groove **34***b*. Furthermore, by aligning grooves **34** in an out-of-phase arrangement, the contact surfaces **30** are staggered from one, or a first, row of tandem contact surfaces **30** to an adjacent, or second, row of tandem contact surfaces **30**. Moreover, as a consequence of the shape and alignment of the grooves **34**, each of the contact surfaces **30** define an elongate-diamond or elliptical shape (best seen in FIG. **3**).

[0022] Upon examination of various patterns, shapes and sizes, it has been determined that serpentine-shaped grooves **34** having a pitch P (i.e., a distance or length between a pair of adjacent crests **34**C or a pair of adjacent troughs **34**T), of between about three-eights inches (⅜") to about one-quarter inches (¼"), and a rise R (i.e., a distance or height from a minimum depth along one trough **34**T to a maximum height along an adjacent crest **34**C) of between about five thirty-seconds inches (5/34") to about seven thirty-seconds inches (7/34"), produces favorable results. Moreover, a groove **34** having a substantially linear segment LS (i.e., a segment shown in FIG. **3** connecting curvilinear segments at the apex of one crest **34**C and the base of an adjacent trough **34**T) such

as the serpentine groove shown in the described embodiment, defines a lead angle θ which is between about five degrees (5°) to about fifteen degrees (15°) yields favorable results. In the described embodiment, a textured registration surface **20**S of the type described above may be fabricated from 304 polished stainless steel sheets having a 5-SM surface pattern available from RIMEX Metals Inc. located in the town of Edison, State of New Jersey.

[0023] Thus far in our discussion, the surface texture of the registration device **20** has been discussed to mitigate particulate matter produced/removed/shed from the mailpiece envelope **16**. Yet another characteristic of the registration device **20**, which synergistically reduces the particulate matter, relates to the shape of the opening **18**, and, more particularly, to the shape or angle of the edges **40** upstream of each of the print head nozzles **12**N. Referring back to FIG. **2**, the edges **40** define an obtuse angle β relative to the feed path FP of the mailpiece envelope **16** (i.e., the angle produced between line segments FP and FE). More particularly, in the described embodiment, the obtuse angle β is greater than about one-hundred and five degrees) (105°) relative to the feed path of the substrate material. More preferably, the obtuse angle β is greater than about ninety-five degrees (95°) relative to the feed path of the substrate material.

[0024] The significance of producing/cutting the upstream edges **40** along an incline will be appreciated by examining FIG. **5**. Therein, the registration surface **20**S has been cut to produce an edge **40**, i.e., along the lead angle β, wherein several of the contact surfaces **30** are severed at a point corresponding, or proximal, to the apex of a respective one of the contact surfaces **30**. Additionally, the registration surface **20**S has been cut such that the edge **40** is severed at a point corresponding to the non-contact areas **32**, i.e., between adjacent contact surfaces **30**.

[0025] In as much a discontinuous edge, or portion, of the registration device **20** has a tendency to whip, or disturb, the surface **16**S of a mailpiece envelope **16** more thoroughly, than a continuous surface, an edge **40** having fewer contact surfaces **30** and more non-contact regions **32** will shed/remove less particulate matter from the face surface **16**S of the mailpiece envelope **16** than one with more contact surfaces and less non-contact regions **32**. By cutting the upstream edge **40** at an angle relative to a line FO orthogonal to the feed path, the edge **40** will be severed at several locations along the surface **20**, however, at least one location will correspond to at least one non-contact region **32** of the surface **20**S. Consequently, this configuration, i.e., an edge which is cut along an incline, or at an obtuse angle relative to the feed path, ensures that the edge **40** will produce less particulate matter by reducing its tendency to whip or disturb the surface **16**S of the mailpiece envelope **16**.

[0026] In summary, the present invention provides a registration device for a print station which mitigates the removal/production of particulate matter to optimize print station/inserter efficiency. The registration surface minimizes the disturbance of existing particulate matter by reducing the surface area contacting the surface of a substrate material/mailpiece envelope. By cutting an opening, through which ink is deposited, along an incline (i.e., at an obtuse angle relative to the feed path, or off-axis relative to a line orthogonal to the feed path) the tendency of the edge to disturb or remove particulate mater is also reduced. Increased efficiency is achieved by reducing the number purge cycles necessary to clear/clean the print head nozzles and the cost associated with lost productivity and ink consumption.

[0027] It is to be understood that all of the present figures, and the accompanying narrative discussions of preferred embodiments, do not purport to be completely rigorous treatments of the methods and systems under consideration. For example, while the invention describes an interval of time for completing a phase of sorting operations, it should be appreciated that the processing time may differ. A person skilled in the art will understand that the steps of the present application represent general cause-and-effect relationships that do not exclude intermediate interactions of various types, and will further understand that the various structures and mechanisms described in this application can be implemented by a variety of different combinations of hardware and software, methods of escorting and storing individual mailpieces and in various configurations which need not be further elaborated herein.

1. A registration device operative to maintain a prescribed separation distance between an array of print head nozzles and a substrate material during print operations, the registration device comprising:

a registration surface opposing a face surface of the substrate material and being textured to define a plurality of contact surfaces substantially evenly distributed over the face surface of the substrate material, the contact surfaces reducing a surface area in contact with the substrate material to mitigate particulate matter shed from the substrate material.

2. The registration device according to claim **1** wherein the contact surfaces have a substantially arcuate shaped surface contour.

3. The registration device according to claim **1** wherein the contact surfaces have a substantially elongate diamond shape.

4. The registration device according to claim **1** wherein the contact surfaces are defined by a plurality of grooves oriented substantially parallel to a feed path of the substrate material.

5. The registration device according to claim **4** wherein each of the grooves defines a substantially serpentine-shape.

6. The registration device according to claim **5** wherein adjacent grooves are out-of-phase and the contact surfaces are staggered from one row of contact surfaces to an adjacent row of contact surfaces.

7. The registration device according to claim **4** wherein each groove defines a lead angle within a range of between about five degrees (5°) to about fifteen degrees (15°).

8. The registration device according to claim **1** wherein the registration surface includes an opening through which ink is deposited, the opening having a trailing edge upstream of at least one of the nozzles and wherein the trailing edge defines an obtuse angle relative to the feed path of the substrate material.

9. The registration device according to claim **1** wherein the obtuse angle is greater than about one-hundred and five degrees (105°) relative to the feed path of the substrate material.

10. The registration device accord to claim **10** wherein the obtuse angle is greater than about ninety-five degrees (95°) relative to the feed path of the substrate material.

11. A print station for a mailpiece inserter comprising:

an array of print head nozzles operative to deposit ink on a mailpiece envelope being conveyed along a feed path; and

a registration plate spatially positioned relative to the print head nozzles and operative to maintain a prescribed separation distance between the registration plate and the print head nozzles, the registration plate having a registration surface opposing a top face surface of the mailpiece envelope and being textured to define a plurality of contact surfaces substantially evenly-distributed over, and engaging, the face surface of the substrate material, the contact points reducing a surface area in contact with the substrate material to mitigate particulate matter shed from the substrate material.

12. The print station according to claim **11** wherein the contact surfaces have a substantially arcuate shaped surface contour.

13. The print station according to claim **11** wherein the contact surfaces have a substantially elongate diamond shape.

14. The print station according to claim **11** wherein the contact surfaces are defined by a plurality of grooves oriented substantially parallel to a feed path of the mailpiece envelope.

15. The print station according to claim **14** wherein each of the grooves defines a substantially serpentine-shape.

16. The print station according to claim **15** wherein adjacent grooves are out-of-phase and the contact surfaces are staggered from one row of contact surfaces to an adjacent row of contact surfaces.

17. The print station according to claim **14** wherein each groove defines a lead angle within a range of between about five degrees (5°) to about fifteen degrees (15°.

18. The print station according to claim **11** wherein the registration surface includes an opening through which ink is deposited, the opening having a trailing edge upstream of at least one of the nozzles and wherein the trailing edge defines an obtuse angle relative to the feed path of the mailpiece envelope.

19. The registration device according to claim **11** wherein the obtuse angle is greater than about one-hundred and five degrees (105°) relative to the feed path of the mailpiece envelope.

20. The registration device accord to claim **19** wherein the obtuse angle is greater than about ninety-five degrees (95°) relative to the feed path of the mailpiece envelope.

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