MAILPIECES THAT MITIGATE FLEXURE OF HELD ARTICLES DURING AUTOMATED HANDLING

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ABSTRACT

Mailpieces configured to mitigate flexure of flammable articles during handling by postal processing equipment. The mailpieces include spacers that intervene between the stress-sensitive article held by the mailer and a convex surface of a roller, drum, spindle, or other mechanical device used in the postal processing equipment for transporting the mailpieces.
MAILPIECES THAT MITIGATE FLEXURE OF HELD ARTICLES DURING AUTOMATED HANDLING

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of application Ser. No. 11/610,675, filed on Dec. 14, 2006, which claims the benefit of U.S. Provisional Application No. 60/805,416, filed Jun. 21, 2006, the disclosure of each document is hereby incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

[0002] The invention relates to mailpieces and, in particular, to mailpieces and mailpiece assemblies that are suitable for securing and protecting articles, such as stress-sensitive or frangible articles, to ensure safe processing by automated processing equipment.

BACKGROUND OF THE INVENTION

[0003] Mailpieces are routinely employed for mailing breakable, frangible or stress-sensitive articles, such as DVD’s, compact disks (CD’s), and mini-CD’s. Most mass mailings of frangible articles consist of letter-sized mailpieces, which are pre-sorted before possession is transferred to a postal service, such as the United States Postal Service. The pre-sorting qualifies the mass mailing for reduced postage rates because it easier for the United States Postal Service to sort and deliver the mail using automated equipment. To qualify for reduced postage rates, however, the processed mail must meet certain criteria set forth in various postal regulations.

[0004] Postal services sort large volumes of mail with high-speed automated processing equipment having drums, transport rollers, and pairs of opposing belts that grip and transport individual mailpieces at a volume of up to 40,000 pieces an hour. The automated processing equipment conveys the mailpieces at speeds approaching 500 to 600 feet per minute along a feed path. Various functions may be performed on the mailpieces at different locations along the feed path. For example, an optical scanner provided adjacent to the feed path identifies a destination address for each mailpiece. Ultimately, the mailpieces are sorted according to the destination address and routed along the feed path into assorted bins or stackers.

[0005] The rollers used to support the belts, which have a width approximately equal to the roller height, are crowned. The vertical convex shape of the crowned rollers keeps the belts tracking properly within the machinery and in the correct position on the rollers. The opposing belts are kept under tension to be able to hold and transport mailpieces through the machinery of the automated processing equipment. As the belts move through and change direction within the machinery, the tension of the belts exerts pressure on the rollers. Changes in direction are accommodated by providing a pulley, roller or drum over which the moving belts are trained at the change-of-direction point. For example, if the mailpiece is moving linearly in a horizontal direction and it is desired to effect a directional change to a different horizontal direction, a rotatable drum is placed at the change-of-direction point in the path of travel of the opposed belts. As the belts move about the rotating drum, the mailpiece travels through a curved path conforming to the drum periphery and emerges traveling between the moving belts in the different horizontal direction.

[0006] Letter-size mailpieces are constructed to comply with postal regulations, such as dimensional requirements, address positioning, and flexibility. Specifically, postal regulations require the mailpiece to be flexible enough to be bent and routed about the circumference of cylindrical pulleys, rollers and drums of the type used in automated processing systems. The United States Postal Service currently states that all letter-sized mailpieces must easily bend under 40 pounds of exerted belt pressure. If the dimensions of the mailpiece exceed a maximum dimension (e.g., are over-sized) as governed by postal regulations or the mailpiece fails to meet the flexibility requirements for letter sorting equipment, the United States Postal Service does not treat the mailpiece as a letter. Instead, the mailpiece is handled as a non-letter or flat by automated equipment that does not require routing about the exterior of drums or rollers. The postage rate is higher for flats than for letter-sized mailpieces.

[0007] Conventional mailpieces expose stress-sensitive articles to a significant risk of damage during processing by automated processing equipment. As the mailpiece is conveyed about the exterior of the roller (or pulley or drum), the belt pressure forces flexible items carried by the belts to conform to the vertical convex shape of the roller and to bend or bow horizontally around the circumference of the roller when the belt changes direction. The stress-sensitive article inside the mailpiece must also curve or bow in conformity with the mailpiece and, therefore, will experience a state of tension due to the flexure. The combination of bending to the vertical convex shape of the roller and bending horizontally around the circumference of the roller is believed to apply significant pressure on the article at the center of these two divergent forces. The applied pressure may damage, or even break or fracture, the article.

[0008] With reference to FIGS. 1, 2, and 3, a pair of confronting conventional belts 11 (one shown) rides over the surface of a vertically-oriented crown roller 12 mounted with bearings to an axle or spindle 15 projecting from the support base of a machine 17. The roller 12 is one of several similar rollers (not shown) used for guiding the belts 11 in a generally horizontal direction indicated by the single-headed arrows 14. As the belts 11 move in the horizontal direction 14, the belts 11 cause the crown roller 12 to rotate about an axis 15a (FIGS. 2, 3), as indicated by the single headed arrow 113 in FIG. 3. Crown roller 12 includes a convexly-contoured surface 13 such that the diameter of roller 12 at a circumference 26 is larger than the diameter of roller 12 at peripheral rims 30u, 30v.

[0009] A stress-sensitive, frangible article 16, which is contained or packaged inside of a mailpiece 22, is gripped on opposite sides by the moving belts 11. Frangible article 16 may be, but is not limited to, a CD, DVD, optical disk, or the like, having a hub 18, a center opening 21 defined in the hub 18, and a media portion 20. The hub 18 and media portion 20 are concentrically arranged about a central axis 19 of the center opening 21 with the hub 18 radially inside of the media portion 20.

[0010] Mailpiece 22, which may have a generally rectangular shape, has a height, h (FIG. 4) greater than the height of article 16, a length, L, and a thickness, w. The length, L, is measured generally along the horizontal direction of travel.
14. Mailpiece 22 includes two opposed panels 42, 44, peripheral edges 46, 48 substantially parallel to the length, L, and lateral or side edges 50, 52 substantially parallel to the height, h. The peripheral edges 46, 48 (FIG. 4) respectively represent the top and bottom edges of the mailpiece 22 when being conveyed by the belts 11. The side edges 50, 52 connect the peripheral edges 46, 48. Peripheral edge 46 may connect with a fold identified as flap 56 (FIG. 7).

[0011] The mailpiece 22 and frangible article 16 are conveyed past the crown roller 12. As the belts 11 pass the crown roller 12 in the horizontal direction 14 transport the mailpiece and frangible article 16, the hub 18 and/or media portion 20 of the article 16 generally ride over the surface 13 of the roller 12. The mailpiece 22 prevents direct contact between the article 16 and belts 11. At any instant in time, the mailpiece 22 contacts the roller 12 about contact point 24, which lies on a circumference 26 of the roller 12. As best shown in FIG. 2A, mailpiece 22 moves into and out of the plane of the page in a direction generally parallel to a plane 36 that is tangent to contact point 24. The moving belts 11 apply belt pressure in a direction generally indicated by arrows 28 to the mailpiece 22. As the mailpiece 22 is transported past the roller 12, contact point 24 traces a substantially linear path along the length, L, of the mailpiece 22.

[0012] Frangible article 16 is typically carried inside mailpiece 22 with at least a portion of the hub 18 located between the opposite rims 30a, 30b of roller 12. The mailpiece 22 and the article 16, which are somewhat flexible, conform to the convexly contoured surface 13 of the crown roller 12 between peripheral rims 30a, 30b under the influence of the belt pressure 28. Specifically, mailpiece 22 and article 16 bend or flex to adopt a convex curvature that corresponds to the convexly contoured surface 13 of the crown roller 12. Because of the curvature of the surface 13 of crown roller 12, the mailpiece 22 and article 16 in a direction perpendicular to the travel direction 14. The bending of the mailpiece 22 and article 16 closes the theoretical gaps 32a, 32b (FIG. 2A) defined by the respective distances from points 39a, 39b on the rims 30a, 30b to the nearest point along the plane 36, otherwise present in the absence of pressure symbolized by arrows 28. Each of the panels 42, 44 (FIG. 4) defining the mailpiece 22, which is relatively thin, operates as a thin membrane or film that readily conforms to the shape of the roller 12.

[0013] As best shown in FIG. 3, the mailpiece 22 also bends about the circumference 26 (FIG. 2) of the roller 12 to conform to the curvature. The frangible article 16, which is constrained by the mailpiece 22, must likewise flex to assume a curvature that conforms to the circumference 26 of the roller 12. Consequently, the belt pressure 28 also bends the article 16 about the roller 12 in a direction parallel to the travel direction indicated by arrow 14.

[0014] The bi-directional flexing of the mailpiece 22 and frangible article 16 may damage the frangible article 16. In one damage mode, the flexing may cause a fracture to initiate and propagate in the constituent material(s) of the frangible article 16. Often, the hub 18 and propagate radially outwardly into the media portion 20. The fractured hub 18 of the frangible article 16 may be damaged to an extent that the frangible article 16 cannot be engaged by a player for retrieving the data encoded in the media portion 20. Alternatively, the fracture may damage the media portion 20 such that any data encoded in the media portion 20 is unreadable by the player.

Because of this and other significant shortcomings, conventional letter-sized mailpieces fail to adequately safeguard stress-sensitive articles when handled by automated processing equipment of the type used by the United States Postal Service.

[0015] Accordingly, there is a need for mailpieces and mailpiece assemblies suitable for mailing stress-sensitive, frangible articles that can be handled by automated letter-sized processing equipment and, moreover, that fully comply with postal regulations while simultaneously protecting the article from damage during processing.

SUMMARY OF THE INVENTION

[0016] In one embodiment, a mailpiece is provided for mailing an article having a first side and a second side opposite to the first side. The mailpiece comprises first and second panels that are joined to define a first peripheral edge, a second peripheral edge, and side edges separating the second peripheral edge from the first peripheral edge. The first and second panels are disposed on the respective opposite sides of the article and the article is positioned between the first and second edges. The first panel carries a first spacer. The second panel carries a second spacer. The first spacer is disposed between the first side of the article and the first panel. The second spacer is disposed between the second side of the article and the second panel. The first and second spacers are aligned substantially parallel to the first and second peripheral edges.

[0017] In another embodiment, a mailpiece is provided for mailing an article having a first side and a second side opposite to the first side. The mailpiece comprises a first panel, a second panel joined to the first panel to define a first peripheral edge, a second peripheral edge, and side edges separating the second peripheral edge from the first peripheral edge. The mailpiece further includes a sleeve carrying the article. The sleeve is disposed between the first and second panels. The sleeve is also positioned between the first and second edges. The sleeve includes a first spacer disposed between the first side of the article and the first panel, and a second spacer disposed between the second side of the article and the second panel. The first and second spacers are aligned substantially parallel to the first and second peripheral edges.

[0018] In another embodiment, a mailpiece is provided for mailing an article having a first side and a second side opposite to the first side. The mailpiece comprises a first panel joined to a second panel to define a first peripheral edge, a second peripheral edge, and side edges separating the second peripheral edge from the first peripheral edge. The first and second panels are disposed on the respective opposite sides of the article. The article is positioned between the first and second edges. An insert is located between the first and second panels. The insert includes a first spacer disposed between the first side of the article and the first panel and a second spacer disposed between the second side of the article and the second panel. The first and second spacers may be aligned substantially parallel to the first and second peripheral edges.

[0019] In another embodiment, a mailpiece is provided for mailing an article having a first side and a second side opposite to the first side. The mailpiece comprises a first panel joined to a second panel to define a first peripheral edge, a second peripheral edge, and side edges separating
the second peripheral edge from the first peripheral edge. The first and second panels disposed on the respective opposite sides of the article. The article is positioned between the first and second edges. First and second inserts are disposed between the first and second panels. The first insert includes a first spacer disposed between the first side of the article and the first panel. The first insert includes a second spacer disposed between the second side of the article and the second panel. The first and second spacers are aligned substantially parallel to the first and second peripheral edges.

[0020] In another embodiment, a mailpiece is provided for mailing an article having a first side, a second side opposite to the first side, and a center opening extending between the first and second sides. The mailpiece comprises a first panel joined to a second panel to define a first peripheral edge, a second peripheral edge, and side edges connecting the first and second peripheral edges. The first and second panels are disposed on the respective opposite sides of the article. The article is positioned between the first and second edges. A spacer, which may be carried by the first panel, is adapted to be inserted into the center opening of the article. The spacer is at least partially disposed between the first side of the article and the first panel.

[0021] In another embodiment, an apparatus for use with a mailpiece that comprises a frangible article having a first side and a second side opposite to the first side. The apparatus further comprises a spacer projecting from the first side of the frangible article. The spacer is adapted to be disposed between the first side of the frangible article and the mailpiece.

[0022] The spacers of the embodiments of the invention operate to reduce one component of the bi-directional flexing of the mailpiece and the frangible article carried by the mailpiece. Specifically, the spacers reduce the flexing of the mailpiece and frangible article relative to the convexly contoured surface of a crown roller. This reduces the likelihood that the frangible article will be damaged when handled by automated letter-sized processing equipment.

[0023] The invention may be used in conjunction with mailpieces shown and described in U.S. Pat. No. 6,491,160 and in U.S. Publication Nos. 2004/256446 and 2005/224566. The respective disclosure of each of these patent documents is hereby incorporated by reference herein in its entirety.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with a general description of the invention given above and the detailed description of the embodiments given below, serve to explain the principles of the invention.

[0025] FIG. 1 is an elevational view of an article being transported by belts riding on a crown roller with a mailpiece, which is omitted for purposes of illustration, in accordance with the prior art.

[0026] FIG. 2 is an end view of an article held by a mailpiece in accordance with the prior art in which the mailpiece is being conveyed by belts past a crown roller and is distorted by the pressure applied by the belts in which bending about the roller is uncompensated.

[0027] FIG. 2A is a theoretical end view similar to FIG. 2 of the prior art mailpiece and the article in the absence of pressure applied by the belts.

[0028] FIG. 3 is a top view of FIG. 2 demonstrating the bending of the prior art mailpiece and article about the circumference of the crown roller and taken along a line through a circumference of the crown roller.

[0029] FIG. 4 is an end view of a mailpiece in accordance with an embodiment of the invention in which the mailpiece carries gap-filling spacers at respective locations above and below the central circumference of the roller.

[0030] FIG. 5A is an end view similar to FIG. 4 of a mailpiece in accordance with an embodiment of the invention.

[0031] FIG. 5B is an end view similar to FIG. 5A in which the mailpiece is conveyed past the roller with a different side of the mailpiece in contact with the roller.

[0032] FIG. 6 is an end view similar to FIG. 4 of a mailpiece in accordance with another embodiment of the invention.

[0033] FIG. 7 is a perspective view of a mailpiece in accordance with an embodiment of the invention and broken away to show an article held by the mailpiece.

[0034] FIG. 7A is an enlarged view of the encircled area of FIG. 7.

[0035] FIG. 8 is an end view of the mailpiece of FIG. 7.

[0036] FIGS. 9-12 are detailed perspective views similar to FIG. 7A of mailpieces in accordance with alternative embodiments of the invention.

[0037] FIG. 13A is a perspective view of a mailpiece comprising an envelope and a sleeve inserted into the envelope in accordance with an alternative embodiment of the invention.

[0038] FIG. 13B is an end cross-sectional view of the mailpiece of FIG. 13A.

[0039] FIG. 13C is a perspective view of a sleeve for the mailpiece of FIG. 13A in accordance with an alternative embodiment of the invention.

[0040] FIG. 13D is an end cross-sectional view of the sleeve of FIG. 13C.

[0041] FIGS. 14-16 are perspective views of mailpieces in accordance with alternative embodiments of the invention.

[0042] FIG. 17 is a partial perspective view of a mailpiece in accordance with an embodiment of the invention.

[0043] FIG. 18 is a partial perspective view of a portion of a mailpiece in accordance with an embodiment of the invention.

[0044] FIG. 19 is a partial perspective view of a mailpiece in accordance with an alternative embodiment of the invention.

[0045] FIG. 20 is a cross-sectional view of the mailpiece of FIG. 19 with the frangible article and spacer inserted into the mailpiece.

[0046] FIG. 20A is an enlarged cross-sectional view of a portion of FIG. 19.

[0047] FIG. 20B is an enlarged partial cross-sectional view similar to FIG. 20A of a mailpiece in accordance with an alternative embodiment.

[0048] FIG. 20C is an enlarged partial cross-sectional view similar to FIGS. 20A and 20B of a mailpiece in accordance with an alternative embodiment.

[0049] FIG. 21A is an end cross-sectional view of the mailpiece of FIGS. 20 and 20A held by belts and being transported past a crown roller.
FIG. 21B is an end cross-sectional view similar to FIG. 21A with the opposite panel of the mailpiece riding over a crown roller.

FIG. 22A is a perspective view of a frangible article in accordance with an embodiment of the invention.

FIG. 22B is a partial end cross-sectional view of the frangible article of FIG. 22A.

DETAILED DESCRIPTION

With reference to FIG. 4 in which like reference numerals refer to like features in FIGS. 1-3 and in accordance with an embodiment of the invention, a mailpiece 23, which is similar in most respects to mailpiece 22, includes spacers 38a, 40a disposed above contact point 24 and spacers 38b, 40b that are disposed below contact point 24. The spacers 38a, 40a, 38b, 40b are aligned generally parallel to the peripheral edges 46, 48.

Spacers 38a and 38b are spaced vertically along the height, h, of the mailpiece 23 relative to contact point 24, as are spacers 40a and 40b. The article 16, spacers 38a, 40a, and spacers 40a, 40b are positioned within the mailpiece 23 such that the circumference 26 of the crowned roller 12 (and, thus, the linear path traced by contact point 24 across the length, l, of the mailpiece 23 between lateral edges 50, 52 (FIG. 7)) is between spacers 38a and 38b and is also between spacers 40a and 40b. Typically, spacers 38a, 40a and spacers 38b, 40b are positioned within mailpiece 23 such that the central axis 19 of the article 16 is located between spacers 38a, 40a and spacers 38b, 40b. However, the precise location of the central axis 19 of the article 16 relative to spacers 38a, 40a and spacers 38b, 40b is contingent upon the positioning of the article 16 inside the mailpiece 23 and the location of the spacers 38a, 40a and spacers 38b, 40b. Accordingly, the article 16 may be positioned inside the mailpiece 23 to optimize the effectiveness of the spacers 38a, 40a, 40b in view of all mailpiece design parameters. For example, inserts or a pocket (not shown) may be used to position the article 16 inside the mailpiece 23 to optimize the effectiveness of the spacers 38a, 40a, 40b. Spacer 38a may be collinear or non-collinear with spacer 40a. Similarly, spacer 38b may be collinear or non-collinear with spacer 40b.

Spacers 38a, 40a, and spacers 40a, 40b have a thickness, t, measured relative to the thickness, w, of the mailpiece 23 that is selected to keep the frangible article 16 from being forced to conform to the vertically convex (i.e. crowned) surface 13 of the roller 12, as well as those of other rollers, drums, spindles or mechanical apparatus (not shown) used in postal processing equipment. Spacers 38a, 40a, and spacers 40a, 40b locally increase the thickness of mailpiece 23 and represent a minor deviation from planarity of the side surfaces of panels 42, 44 nearest to the article 16. The respective thicknesses, t, of the spacers 38a, 40a, and spacers 40a, 40b is suitably chosen to provide the amount of filler required to at least partially bridge one or both of the gaps 32a, 32b (FIG. 2A). This reduces the bending or conforming of the article 16 relative to the crowned surface 13 of the roller 12 and along the height of the roller 12. In certain embodiments, the curvature of the crown on roller 12 is slight so that the spacers 38a, 40a, and spacers 40a, 40b may be relatively thin, such as, for example, the thickness of two or three sheets of folded paper, or in the range of about $\frac{1}{60}$" to about $\frac{1}{12}$".

Spacers 38a, 40a are disposed between one side of article 16 and panel 44. Spacers 40a, 40b are disposed between the opposite side of the article 16 and panel 42. Article 16 is disposed between spacers 38a and 40a, which are positioned within the mailpiece 23 and relative to article 16 such that the portion of panel 42 adjacent to spacer 40b contacts the roller 12 between the peripheral rim 30a and contact point 24 on the circumference 26. Spacers 38a and 40b are positioned within the mailpiece 23 and relative to article 16 such that the portion of panel 42 adjacent to spacer 40b contacts the bottom of roller 12 between the peripheral rim 30b and contact point 24 on the circumference 26.

Spacers 38a, 40b operate to reduce the amount of flexing of the article 16 because of the tendency of the mailpiece 23 to conform to the crowned surface 13 of the roller 12. Thus, in the arrangement depicted in FIG. 4, the surface 13 of the roller 12 contacts the side surface of panel 42, while the surface 13 of the roller 12 may contact the side surface of panel 44 if the mailpiece 23 were oriented on the opposite side of the roller 12 (such orientation not shown but similar to FIGS. 5A, 5B). Positioning of one or more of spacers 38a, 40a, 40b on each side of the article 16 ensures that the article 16 will be protected against excessive bending regardless of whether or not edge 46 is the top or bottom edge, and regardless of whether panel 42 or panel 44 is in contact with the roller 12.

The design of the mailpiece 23 and the requirements for effectively limiting the amount of bending and flexing of the article 16 may determine the number of spacers 38a, 40a, 40b. In certain embodiments, fewer than all of the multiple spacers 38a, 40a, 40b may be required. Spacers 38a, 40a, 40b may be contained within the plane of the mailpiece 23 or may project as short aspersities (e.g., parallel ridges) from the opposite sides of the mailpiece 23 and inwardly toward the article 16 inside the mailpiece 23.

The mailpiece 23 may conform to the shape of the crowned surface 13 on the crowned roller 12 between the spacers 38a, 40a, and 40b, if the exposed side of panel 44 contacts the roller 12, or between spacers 40a and 40b, if panel 42 contacts the roller 12. The spacers 38a, 40a, 40b are shaped and have a thickness, t, sufficient to mitigate the effect of the curvature in the crowned roller 12 or other crown-profiled belt support members that may be used for proper carriage and tracking of drive belts (not shown) in mail or postal processing equipment. By keeping the article 16 from being forced to conform to the convex shape of the crowned roller 12 along the height, h, of the mailpiece 23 at the same time the article 16 is bending about the circumference 26 of the roller 12, damage to the article 16 may be eliminated or, at the least, the probability is reduced that article 16 will be damaged by the effect of conforming to the surface 13 of roller 12.

Spacers 38a, 40a, 40b may be sized and shaped to orient the frangible article 16 substantially parallel to a tangent plane 36 when pressure 28 is exerted. Spacers 38a, 40a, 40b may be integrally formed or attached to a mailpiece such as mailpiece 23 or may alternatively be made part of a sleeve or similar device holding the article 16 such that the sleeve or similar device is placed inside a mailpiece 23 for mailing. Likewise, spacers 38a, 40a, 40b may alternatively be made part of or be attached to the article 16 prior to being inserted into a mailpiece 23.

Spacers 38a, 40a, 40b may be rigid and non-compressible, such that no deformation occurs under the influence of the belt pressure 28 and thickness, t, is maintained. Alternatively, the spacers 38a, 40a, 40b may be substantially
rigid, such that negligible deformation occurs under the influence of the belt pressure 28 and thickness, t₁, is substantially maintained. In an alternative embodiment, if the spacers 38a,b, 40a,b are non-rigid, their thickness is chosen to compensate for any deformation that occurs under the influence of the belt pressure 28 such that the compressed thickness, t₁, is sufficient to mitigate the flexing. Any cushioning effect provided by the spacers 38a,b, 40a,b is incidental to the mitigation of the flexing of the article 16.

[0062] With reference to FIGS. 5A and 5B in which like reference numerals refer to like features in FIGS. 1-4 and in accordance with an alternative embodiment of the invention, a generally rectangular mailpiece 54, which is similar in most respects to mailpiece 22, includes two spacers 37a,b that separate the article 16 from the panels 42, 44. In this embodiment, spacers 37a,b are sized and positioned within the mailpiece 54 in such a manner as to engage roller 12 providing a straight surface against which article 16 will be pressed when the belt pressure 28 is exerted on the article 16. As a result, bending of the article 16 in accordance with the crowned surface 13 of the roller 12 is limited, which mitigates the flexure of the article 16.

[0063] Spacers 37a,b may be integrally formed or attached to mailpiece 54 or may alternatively be made part of a sleeve or similar device that includes the article 16 such that the sleeve or similar device is placed inside a mailpiece such as the conventional mailpiece 22 (FIGS. 1-3) for mailing. Likewise, spacers 37a,b may alternatively be made part of, or may be attached to, the flange article 16 prior to being inserted into a mailpiece. The materials and dimensions of spacers 37a,b may be suitable chosen to limit bending of article 16. Spacers 37a,b may, for example, comprise a thickness, t₁, measured in the same direction as the width, w₂, of mailpiece 54 that is larger, smaller or equal to the width, w₁, of article 16 (FIG. 4).

[0064] Spacers 37a,b may be rigid and non-compressible, such that no deformation occurs under the influence of the belt pressure 28. Alternatively, the spacers 37a,b may be substantially rigid, such that negligible deformation occurs under the influence of the belt pressure 28 and thickness, t₁, is substantially maintained. In an alternative embodiment, if the spacers 37a,b are non-rigid, their thickness is chosen to compensate for any deformation that occurs under the influence of the belt pressure 28 such that the compressed thickness, t₁, is sufficient to mitigate the flexing. Any cushioning effect provided by the spacers 38a,b, 40a,b is incidental to the mitigation of the flexing of the article 16.

[0065] Typically, the central axis 19 of the article 16 is located between spacers 37a,b. However, the precise location of the central axis 19 of the article 16 relative to spacers 37a,b is contingent upon the positioning of the article 16 inside the mailpiece 23 and the positioning of the spacers 37a,b inside the mailpiece 23. Accordingly, the article 16 may be positioned inside the mailpiece 23 to optimize the effectiveness of the spacers 37a,b in view of all mailpiece design parameters. For example, inserts or a pocket (not shown) may be used to position the article 16 inside the mailpiece 23 to optimize the effectiveness of the spacers 37a,b.

[0066] With specific reference to FIG. 5A, the belt pressure 28 on the mailpiece 54 and the article 16 will result in the article 16 being tilted such that article 16 is pushed against a portion of panel 42 between the rim 30a and contact point 24 of the roller 12 and against spacer 37b. This force profile is such that the bending or flexure of the article 16 along the height, h, of the mailpiece 54 is reduced, or eliminated, as mailpiece 54 is transported past the roller 12.

[0067] With specific reference to FIG. 5H, the mailpiece 54 rides over the surface of roller 12 with an outer surface of the opposite panel 44 riding against the surface 13. The belt pressure 28 on the mailpiece 54 and the article 16 will result in the article 16 and mailpiece 54 being tilted such that article 16 is pushed against a portion of panel 44 between the rim 30b and circumference 26 of the roller 12 and against spacer 37a. This force profile is such that there is reduced bending or flexure of the article 16 along the height, h, of the mailpiece 54 as mailpiece 54 is transported past the roller 12.

[0068] With reference to FIG. 6 in which like reference numerals refer to like features in FIGS. 1-5 and in accordance with an alternative embodiment of the invention, a generally rectangular mailpiece 64, which is similar in most respects to mailpiece 22, includes a pair of spacers 37c,d on the same side of the contact point 24. The spacers 37c,d may be adjusted so that they lie either above or below contact point 24. The spacers 37c,d are sized, including a thickness, t₂, and positioned in such a manner as to engage roller 12 providing a straight surface against which article 16 will be pressed when the belt pressure 28 is applied to the article 16. Accordingly, the article 16 may be positioned inside the mailpiece 23 to optimize the effectiveness of the spacers 37c,d in view of all mailpiece design parameters. For example, inserts or a pocket (not shown) may be used to position the article 16 inside the mailpiece 23 to optimize the effectiveness of the spacers 37c,d. The spacers 37c,d, thereby limit bending of the article 16 about the crowned surface 13 of the roller 12 along the height, h, of the mailpiece 64.

[0069] The belt pressure 28 exerted on the mailpiece 64 and the article 16 will result in the article 16 and mailpiece 64 being canted or tilted such that article 16 is pushed against a portion of the mailpiece panel 42 between the rim 30b and contact point 24 of the roller 12 and against spacer 37d. This force profile is such that bending or flexure of the article 16 is reduced as it rides over the surface 13 of the roller 12. While the embodiment of FIG. 6 depicts mailpiece 64 oriented such that panel 42 rides against the surface 13 of the roller 12, mailpiece 64 would be similarly suitably adapted to be oriented such that panel 44 rides against the surface 13 of the roller 12. In this case, the belt pressure 28 would result in the article 16 and mailpiece 64 being tilted such that article 16 is pushed against a portion of the mailpiece panel 44 between the rim 30b and contact point 24 of the roller 12 and against spacer 37c. The resulting force profile would be such that bending or flexure of the article 16 is reduced as the mailpiece 64 is transported across the surface 13 of the roller 12.

[0070] Spacers 37c,d and article 16 are located in the mailpiece 64 such that the spacers 37c,d are disposed between the article 16 and roller 12. Spacers 37c,d may be rigid and non-compressible, such that no deformation occurs under the influence of the belt pressure 28. Alternatively, the spacers 37c,d may be substantially rigid, such that negligible deformation occurs under the influence of the belt pressure 28 and thickness, t₂, is substantially maintained. In an alternative embodiment, if the spacers 37c,d are non-rigid, their thickness is chosen to compensate for any deformation that occurs under the influence of the belt pressure 28 such
that the compressed thickness, \( t_b \), is sufficient to mitigate the flexing. Any cushioning effect provided by the spacers 37c, d is incidental to the mitigation of the flexing of the article 16.

[0071] With reference to FIGS. 7-12, in which like reference numerals refer to like features in FIGS. 4-6, various exemplary embodiments of mailpieces in accordance with the principles of the invention are shown.

[0072] With reference to FIGS. 7, 7A, and 8 in which like reference numerals refer to like features in FIGS. 1-6 and in accordance with an alternative embodiment of the invention, a mailpiece 23a includes spacers 60a-c arranged in a configuration similar to spacers 38a, b, 40a, b (FIG. 4). Spacers 60a, b each comprise a respective elongated member 61a, b secured by securing members 63a, b, respectively, with the inner surface of panel 42 of mailpiece 23a. Spacers 60c, d each comprise a respective elongated member 61c, d secured by securing members 63c, d, respectively, with the inner surface of panel 44 of mailpiece 23a. Elongated members 63a-d may have a length substantially equal to the length, L, of the mailpiece 23a, and may extend between the lateral edges 50, 52, although the invention is not so limited. Securing members 63a-d may each include adhesive portions at least in the areas that contact the inner surface of the respective one of the panels 42, 44. Alternatively, other suitable bonding methods or components such as, for example, thermal-bonding components or mechanical stitching, may be substituted instead of securing members 63a-d for securing the elongated members 61a-d with the inner surface of the respective panels 42, 44.

[0073] When belt pressure 28 (FIG. 4) is applied, the behavior of mailpiece 23a and article 16 is similar to that described in the embodiment of FIG. 4, which shows the general principles for the behavior of mailpieces with this type of spacer configuration. A person having ordinary skill in the art will appreciate that elongated members 61a-d and securing members 63a-d may have any other length relative to the length, L, of mailpiece 23a, or may alternatively have different lengths with respect to each other. In an alternative embodiment, the invention contemplates that mailpiece 23a may include only spacers 60a, 60d (or 60b, 60c) arranged in compliance with the arrangement of spacers 37a, b (FIGS. 5A, B). In another alternative embodiment, the invention contemplates that mailpiece 23a may include only spacers 60a, c (or 60b, d) arranged in compliance with the arrangement of spacers 37c, d (FIG. 6).

[0074] Mailpiece 23a may further include a flap 56 integrally formed with panel 42 along a fold line 47 and adjoining an opening 43 into the space between panels 42, 44. The flap 56 has an adhesive region 58 suitable to adhere flap 56 to the outer surface of panel 44 or, alternatively, any other non-adhesive coupling components suitable to couple the two involved surfaces. A person having ordinary skill in the art will appreciate that the flap 56 may be characterized by a different shape, size, material, and/or relative location on mailpiece 23a. Alternatively, the flap 56 may be omitted from the construction of mailpiece 23a.

[0075] With reference to FIG. 9 in which like reference numerals refer to like features in FIGS. 1-8 and in accordance with an alternative embodiment of the invention, a mailpiece 23b has spacers 68 (of which only a portion of one spacer 68 is shown for illustrative purposes) consisting of elongated adhesive beads bonded, adhered, or otherwise coupled to the inner surface of, for example, panel 42. The spacers 68 may be of any other material suitable to be coupled to the inner surfaces of the panels 42, 44, such as hot melt adhesives, cohesives, caulking materials, and the like. Spacers 68 may have a length substantially equal to the length, L, of mailpiece 23b and substantially extending between lateral edges 50, 52. Alternatively, spacers 68 may be of any relative length and location with respect to the mailpiece 23b and have any non-tubular geometry or even an irregular cross-section effective to mitigate the flexing of the article 16.

[0076] In one embodiment, the spacers 68 may be arranged on panels 42, 44 of mailpiece 23b in compliance with the arrangement of spacers 38a, b, 40a, b (FIG. 4) or spacers 60a, b, 60c, d (FIG. 8). In an alternative embodiment, the invention contemplates that spacers 68 may be arranged on panels 42, 44 of mailpiece 23b in compliance with the arrangement of spacers 37a, b (FIGS. 5A, B). In another alternative embodiment, the invention contemplates that the spacers 68 may be arranged on panels 42, 44 of mailpiece 23b in compliance with the arrangement of spacers 37c, d (FIG. 6).

[0077] With reference to FIG. 10 in which like reference numerals refer to like features in FIGS. 1-9 and in accordance with an alternative embodiment of the invention, a mailpiece 23c includes a plurality of spacers 70 (only a portion of one row of spacers 70 is shown for illustrative purposes), each of a length substantially smaller than the length, L, (FIG. 7) of mailpiece 23a, positioned in series (e.g., a row) such that their cumulative end-to-end length may substantially extend between lateral edges 50, 52 (FIGS. 7, 10). Spacer 70 comprises a staple-like structure made of deformable metal, plastic, or any other suitable material, having a general U-shape and including a main portion 70a and two opposed leg members 70b extending from the ends of main portion 70a. Each of the spacers 70 is adapted to deform between an open position and a closed position coupled with a respective one of the panels 42, 44. Spacer 70 engages the inner surface of, for example, panel 42 in the direction shown by arrows 71, such that the leg members 70b fold behind the opposite, outer surface of each panel, as depicted by spacer 70. While this embodiment describes serially positioned spacers 70 extending substantially along the entire length, L, of mailpiece 23c, persons of ordinary skill in the art will appreciate that spacers 70 may be of any relative length and location with respect to the mailpiece 23c and have any cross-sectional shape effective to mitigate the flexing of the article 16.

[0078] In one embodiment, the spacers 70 of mailpiece 23c may be arranged on panels 42, 44 of mailpiece 23c in compliance with the arrangement of spacers 38a, b, 40a, b (FIG. 4) or spacers 60a, b, 60c, d (FIG. 8). In an alternative embodiment, the invention contemplates that spacers 70 may be arranged on panels 42, 44 of mailpiece 23c in compliance with the arrangement of spacers 37a, b (FIGS. 5A, B). In another alternative embodiment, the invention contemplates that spacers 70 may be arranged on panels 42, 44 of mailpiece 23c in compliance with the arrangement of spacers 37c, d (FIG. 6).

[0079] With reference to FIG. 11 in which like reference numerals refer to like features in FIGS. 1-10 and in accordance with an alternative embodiment of the invention, a mailpiece 23d includes spacers 72 (only a portion of one spacer 72 is shown for illustrative purposes) of a length substantially equal to the length, L, (FIG. 7) of mailpiece 23d, and substantially extending between lateral edges 50,
52 (FIGS. 7, 11). Spacer 72 comprises a Z-folded section 73 of, for example, panel 42 that locally increases the relative thickness of panel 42. A securing member 74 may be applied over the Z-folded section 73 to secure the fold in place and prevent unfolding. Securing member 74, having a length substantially equal to that of the Z-folded section 73, may have adhesive portions (not shown) or other suitable coupling components such as, for example, mechanical, thermal or chemical components to secure it against the inner surface of each panel. Alternatively, Z-folded sections 73 may include adhesive portions allowing it to retain the fold(s) in place without the need for securing members 74.

[0080] In one embodiment, the spacers 72 may be arranged on panels 42, 44 of mailpiece 23d in compliance with the arrangement of spacers 38a,b, 40a,b (FIG. 4) or spacers 60a,b, 60c,d (FIG. 8). In an alternative embodiment, the invention contemplates that spacers 72 may be arranged on panels 42, 44 of mailpiece 23d to comply with the arrangement of spacers 37a,b (FIGS. 5A,B). In another alternative embodiment, the invention contemplates that spacers 72 may be arranged on panels 42, 44 of mailpiece 23d in compliance with the arrangement of spacers 37c,d (FIG. 6).

[0081] While the embodiment of FIG. 11 depicts and describes Z-folded sections 73 and securing members 74 of respective lengths substantially equal to length 1, of mailpiece 23d, persons of ordinary skill in the art will appreciate that the folded sections may adopt a different non-Z-shape folded configuration effective to mitigate the flexing of the article 16. Likewise, Z-folded sections 73 and securing members 74 may have any other length relative to the length 1, of mailpiece 23d, or may alternatively have different lengths with respect to each other effective to mitigate the flexing of the article 16.

[0082] With reference to FIG. 12 in which like reference numerals refer to like features in FIGS. 1-11 and in accordance with an alternative embodiment of the invention, a mailpiece 23e includes spacers 76 (only one spacer 76 is shown for illustrative purposes) of a length substantially equal to the length 1, (FIG. 7) of mailpiece 23e, and substantially extending between lateral edges 50, 52 (FIGS. 7, 12). Spacer 76 may, for example, comprise a stack of laminated flat members 78, 78, 78" coupled to the inner surface of, for example, panel 42. The flat members 78, 78, 78" increase the local relative thickness of panel 42 in that particular section, thereby creating an effective spacer 76 on panel 42. Flat members 78, 78, 78" may be made of the same or different substrates, have equal or unequal respective lengths, and have adhesive portions (not shown) or other suitable coupling components such as, for example, mechanical, thermal or chemical components to permit coupling with adjacent flat rectangular members or the inner surface of a panel. Flat rectangular members 78, 78, 78" may be, for example, made of the same substrate, have equal lengths and each have adhesive portions on one the respective sides.

[0083] While the embodiment of FIG. 12 depicts and describes spacers 76 comprising flat members 78, 78, 78", persons of ordinary skill in the art will appreciate that the flat members 78, 78, 78" may adopt a different shape than rectangular. Alternate shapes for the flat members 78, 78, 78" may, for example, include square, round, oval, triangular or polygonal members in any number and of any suitable dimensions and thickness effective to mitigate the flexing of the article 16. Likewise, flat, members 78, 78, 78" may have any other length relative to the length 1, of mailpiece 23e effective to mitigate the flexing of the article 16.

[0084] In one embodiment, the spacers 76 may be arranged on panels 42, 44 of mailpiece 23e in compliance with the arrangement of spacers 38a,b, 40a,b (FIG. 4) or spacers 60a,b, 60c,d (FIG. 8). In an alternative embodiment, the invention contemplates that spacers 76 may be arranged on panels 42, 44 of mailpiece 23e in compliance with the arrangement of spacers 37a,b (FIGS. 5A,B). In another alternative embodiment, the invention contemplates that spacers 76 may be arranged on panels 42, 44 of mailpiece 23e in compliance with the arrangement of spacers 37c,d (FIG. 6).

[0085] Embodiments of the invention contemplate that the spacers may be carried on a separate sleeve that is inserted into the mailpiece, as opposed to spacers directly carried by the mailpiece. The spacers may also comprise an insert that is loosely placed inside a mailpiece. The invention contemplates that the sleeve or insert(s) may include any of the spacer structures described above in connection with FIGS. 7-12 for mitigating or reducing the stress applied to the article when the belt pressure causes the mailpiece and the sleeve or insert to conform to the curved shape of the crown of a crowned roller.

[0086] With reference to FIGS. 13A,B in which like reference numerals refer to like features in FIG. 7 and in accordance with an alternative embodiment of the invention, a mailpiece 23g, which is otherwise similar in most respects to mailpiece 23a (FIG. 7), includes a sleeve 84 adapted to hold the frangible article 16. Sleeve 84 is configured with spacers in the form of a series of semi-circular foldable flaps 94a, b folded against the respective back surfaces of each panel 85, 87 in respective directions indicated by arrows 95a, 95b. The flaps 94a, b effectively increase the local thickness of the sleeve 84.

[0087] Sleeve 84 may be a generally rectangular or square assembly formed of two opposed panels 85, 87, having top and bottom peripheral edges 90, 92, and lateral or side edges 86, 88. Bottom edge 92 may be folded to contact the outer side of panel 85, thereby enclosing the sleeve 84 and containing article 16. The folded section along bottom edge 92 may or may not have adhesive, or other suitable coupling components, permitting coupling with the outer side of panel 85. Alternatively, the folded section along the bottom edge 92 may be omitted.

[0088] The flaps 94a,b originate from semi-circular apertures 93a,b punched through the constituent material of sleeve 84. The apertures 93a,b are formed at selected locations on each of the panels 85, 87 so that the flaps 94a,b comply with the arrangement of spacers 37a,b (FIGS. 5A,B). Apertures 93a,b and flaps 94a,b may be generally aligned in a direction parallel to top and bottom edges 90, 92 of sleeve 84, such that a first set of flaps 94a may be adapted to lie on panel 85 either above or below the central axis 19 of article 16, while a second set of flaps 94b may be adapted to lie on panel 87 on the opposite side (i.e. above or below) of central axis 19 of article 16. In the exemplary embodiment of FIGS. 13A,B, the first set of flaps 94a from apertures 93a on panel 85 lies below central axis 19 of article 16 and the second set of flaps from apertures 93b on panel 87 lies above central axis 19 of article 16. Alternatively, the first set of flaps 94a on panel 85 may lie above central axis 19 of article 16 while the second set of flaps 94a
on panel 87 may lie below central axis 19 of article 16, which is in compliance with the arrangement of spacers 37c,d (FIG. 6).

[0089] While sleeve 84 is depicted having two sets of flaps 94a,b from three semi-circular apertures 93a,b, persons of ordinary skill in the art will appreciate that sleeve 84 may alternatively, comprise any other number of flaps and apertures of any suitable shape (other than semi-circular), such as square, rectangular, triangular, oval or polygonal.

[0090] Article 16 may be placed within sleeve 84, which may in turn be inserted into mainpiece 23g in the direction indicated by arrow 98, thereby defining the configuration of the general embodiment depicted in FIGS. 5A,B. Upon application of belt pressure 28, the mainpiece 23g and article 16 behave similar to the behavior described with regard to the embodiment of FIGS. 5A,B. The sleeve 84 is located inside the mainpiece 23g, the flaps 94a,b are located on the sleeve 84, and the article 16 is located inside the sleeve 84 such that the flaps 94a,b intervene between the article 16 and roller 12.

[0091] With reference to FIGS. 13C,D in which like reference numerals refer to like features in FIGS. 13A,B and in accordance with an alternative embodiment of the invention, a sleeve 100, which is otherwise similar to sleeve 84, includes spacers in the form of round members 102 coupled with the apertures 93c,d. The sleeve 100 replaces sleeve 84 (FIGS. 13A,B) in mainpiece 23g. The apertures 93c,d and round members 102 are aligned in a direction generally parallel to top and bottom edges 90, 92 of sleeve 100. Apertures 93c,d are adapted to lie on panel 85 either above or below the central axis 19 of article 16. Apertures 93c,d are adapted to lie on panel 87 on the opposite side of central axis 19. The first set of apertures 93c round members 102 on panel 85 lies below central axis 19 of article 16 and the second set of apertures 93c,d and round members 102 on panel 87 lies above central axis 19 of article 16. Alternatively, the first set of apertures 93c and round members 102 on panel 85 may lie above central axis 19 of article 16 while the second set of apertures 93c,d on panel 87 and round members 102 may lie below central axis 19 of article 16. While apertures 93c,d are depicted having a generally square or rectangular shape, persons of ordinary skill in the art will appreciate that apertures 93c,d may have any suitable shape so long as such shape includes at least one straight edge.

[0092] Round members 102 are folded and coupled about a straight edge of each aperture 93c,d such that, when folded against the respective back surfaces of each panel 85, 87, they effectively increase the thickness of the sleeve 100 in the portions including the round members 102, thereby defining spacers similar to spacers 37a,b (FIGS. 5A,B). Round members 102 may be made, for example, of paper, cardboard, plastic, rubber, or other materials of suitable thickness. Round members 102 may be adhesively bonded with the surfaces of panels 85, 87 or may be coupled therewith in a different manner.

[0093] While sleeve 100 is depicted having two sets of apertures 93a,b, persons of ordinary skill in the art will appreciate that sleeve 100 may, alternatively, comprise any other number of apertures of any suitable shape (other than square) such as rectangular, triangular, oval or polygonal. Sleeve 100 is depicted having two rows of diametrically opposed (with respect to central axis 19 of article 16) apertures 93a,b, thus attaining the arrangement of spacers 37a,b (FIGS. 5A,B). However, sleeve 100 may alternatively comprise two confronting sets of apertures 93a lying on the same side (i.e. above or below) of central axis 19, thereby attaining the arrangement of spacers 37c,d (FIG. 6). Similarly, round members 102 may be replaced with members of any other shape suitable to be coupled about an edge or portion of apertures 93a,b which may alternatively be a slit instead of an aperture.

[0094] Article 16 may be placed within sleeve 100, which may in turn be inserted into mainpiece 23g (FIG. 13A). Upon application of belt pressure 28, the behavior of the mainpiece 23g, sleeve 100, and article 16 is similar to that described in the embodiment of FIGS. 5A,B. The sleeve 100 is located inside the mainpiece 23g, the round members 102 and apertures 93c,d are located on the sleeve 100, and the article 16 is located inside the sleeve 100 such that the round members 102 intervene between the article 16 and roller 12.

[0095] With reference to FIG. 14 in which like reference numerals refer to like features in FIG. 13A and in accordance with an alternative embodiment of the invention, a generally rectangular sleeve 104, which is similar to sleeve 84 (FIGS. 13A,B) and sleeve 100 (FIGS. 13C,D), includes a series of spacers in the form of projections or disks 105a,b which are coupled to respective inner surfaces of the panels 85, 87 at selected locations so as to meet the spacer configuration of the general embodiment of FIGS. 5A,B. The sleeve 104 is folded in the direction indicated by arrow 114 to thereby enclose frangible article 16. The sleeve 104 may replace sleeve 84 (FIGS. 13A,B) in mainpiece 23g (FIGS. 13A,B).

[0096] Disks 105a,b may be aligned in a direction generally parallel to top and bottom edges 90, 92 of sleeve 104, such that a first set of disks 105a,b is coupled to panel 85 either above or below the central axis 19 of article 16, while a second set of disks 105a,b is coupled to panel 87 on the opposite side of central axis 19. In the exemplary embodiment of FIG. 14, a first set of three disks 105a on panel 85 lie below central axis 19 of article 16 while a second set of three disks 105a on panel 87 lie above central axis 19 of article 16. Alternatively, the first set of disks 105a on panel 85 may lie above central axis 19 while the second set of disks 105a on panel 87 may lie below central axis 19.

[0097] Disks 105a,b which project from the plane of the corresponding panel 85, 87, effectively increase the local thickness of the sleeve 100. As a result, the disks 105a,b thereby define spacers with an arrangement similar to spacers 37a,b (FIGS. 5A,B). In an alternative embodiment, the disks 105a,b and another pair of similar disks (not shown) may be arranged in compliance with the arrangement of spacers 38a,b, 40a,b (FIG. 4) or spacers 60a,b, 60c,d (FIG. 8). In another alternative embodiment, the invention contemplates that disks 105a,b may be arranged in compliance with the arrangement of spacers 37c,d (FIG. 6). While sleeve 104 is depicted having two rows of circular disks 105a,b of three, persons of ordinary skill in the art will appreciate that sleeve 104 may alternatively comprises any one or more of circular disks 105a,b of any suitable size and shape (circular or non-circular), such as square, rectangular, triangular, oval or polygonal.

[0098] Disks 105a,b may be made of any suitable material such as rubber, plastic, cardboard, paper, film or any other type of substrate and may have a thickness in accordance with the amount of bending to which article 16 would otherwise be exposed. Disks 105a,b may be constructed from a non-rigid material, such as a cellular foam, with a thickness chosen to compensate for any deformation or
compression that occurs under the influence of the belt pressure 28 (FIG. 2) such that the compressed thickness is sufficient to mitigate the flexing of article 16.

[0099] Disks 105a,b may be adhesively bonded to the respective inner surfaces of panels 85, 87 of sleeve 104. Alternatively, other suitable coupling components may be included to secure disks 105a,b on the surface of panels 85, 87. Alternatively, disks 105a,b may be integrally formed with panels 85, 87. Disks 105a,b may alternatively comprise pockets filled with a fluid either injected into the panels 85, 87 or created by layering or laminating multiple sheets to form panels 85, 87.

[0100] Article 16 may be placed within sleeve 104, which may in turn be inserted into malleipiece 23g (FIGS. 13A,B), thereby defining the configuration of the general embodiment depicted in FIGS. 5A,B. Upon application of pressure against the belts 11 (FIGS. 5A,B), the behavior of the malleipiece, sleeve 104 and article 16 is similar to that described in the embodiment of FIGS. 5A,B, showing the general principles of the behavior of malleipieces having spacers with this type of configuration. The sleeve 104 is located inside the malleipiece 23g, the disks 105a,b are located on the sleeve 104, and the article 16 is located inside the sleeve 104 such that the disks 105a,b intervene between the article 16 and roller 12.

[0101] With reference to FIG. 15 in which like reference numerals refer to like features in FIG. 13A and in accordance with an alternative embodiment of the invention, malleipiece 23h similar in most respects to malleipiece 23a (FIG. 7), includes a pair of spacers in the form of rectangular inserts 118a,b. Each of the inserts 118a,b may be a generally flat, rectangular member defined by top and bottom edges 124, 126 and lateral edges 120, 122 and having a length substantially extending across the opening 43 of malleipiece 23h. Inserts 118a,b may be made of any suitable material to provide the functionality of the spacers 37c,d (FIG. 6), thereby limiting bending of article 16 when riding over the surface 13 of a crown roller 12 (FIGS. 1-3). Since inserts 118a,b may be in direct contact with the article 16, the material and construction of inserts 18 may also be suitable to contact the surfaces of frangible article 16 without damaging such contacting surfaces.

[0102] In an alternative embodiment, the invention contemplates that one of the spacers 118a,b and one of the spacers 112a,b may be arranged to comply with the arrangement of spacers 37a,b (FIGS. 5A,B). In another alternative embodiment, the invention contemplates that one pair of the spacers 110a,b, 112a,b may be omitted to provide an arrangement in compliance with the arrangement of spacers 37c,d (FIG. 6). While sleeve 108 is depicted having two pairs of circular spacers 110a,b, 112a,b, persons of ordinary skill in the art will appreciate that sleeve 108 may alternatively comprise any other number of pairs of spacers of any suitable size or shape (other than circular), such as square, rectangular, triangular, oval or polygonal.

[0103] Article 16 may be placed within sleeve 108, which may in turn be inserted into malleipiece 23g (FIGS. 13A,B), thereby defining the configuration of the general embodiment depicted in FIG. 4. Upon application of pressure 28 against the belts 11 (FIG. 4), the behavior of the malleipiece and article 16 is similar to that described in the embodiment of FIG. 4, showing the general principles of the behavior of malleipieces having spacers with this type of configuration. The sleeve 108 is located inside the malleipiece 23g, the 110a,b, 112a are located on the sleeve 108, and the article 16 is located inside the sleeve 108 such that the 110a,b, 112a intervene between the article 16 and roller 12.

[0105] With reference to FIG. 16 in which like reference numerals refer to like features in FIG. 7 and in accordance with an alternative embodiment of the invention, a malleipiece 23h similar in most respects to malleipiece 23a (FIG. 7), includes a pair of spacers in the form of rectangular inserts 118a,b. Each of the inserts 118a,b may be a generally flat, rectangular member defined by top and bottom edges 124, 126 and lateral edges 120, 122 and having a length substantially extending across the opening 43 of malleipiece 23h. Inserts 118a,b may be made of any suitable material to provide the functionality of the spacers 37c,d (FIG. 6), thereby limiting bending of article 16 when riding over the surface 13 of a crown roller 12 (FIGS. 1-3). Since inserts 118a,b may be in direct contact with the article 16, the material and construction of inserts 18 may also be suitable to contact the surfaces of frangible article 16 without damaging such contacting surfaces.

[0106] Inserts 118a,b are positioned such that they both lie generally facing each other but respectively adjacent opposite sides 117, 119 of the article 16. Persons of ordinary skill in the art will appreciate that inserts 118a,b may have a different length and/or height, have a shape other than rectangular, have different respective thicknesses, be made of two different materials or both be placed at a different location with respect to central axis 19 of article 16. Inserts 118a,b may alternatively be coupled along their respective lateral edges 120, 122 thereby defining a sleeve of suitable dimensions to retain of article 16. Inserts 118a,b may also be coupled along their respective lateral edges 120, 122 and bottom edges 126 so as to define a pocket into which article 16 may be inserted prior to insertion of the article 16 and defined pocket into the malleipiece 23h.

[0107] Article 16 and inserts 118a,b may be inserted into malleipiece 23h in the direction indicated by arrow 130, with a final resting position as indicated by the phantom-line rectangle 132, thereby defining the configuration of the general embodiment depicted in FIG. 6. While the embodiment of FIG. 16 is depicted having two individual inserts 118a,b separable from malleipiece 23h, an alternative embodiment may include an insert 118a,b re-attached to the inner surface of either panel 42, 44 and a separable insert 118a,b adapted to be inserted along with article 16 such that both inserts 118a,b lie adjacent opposite sides 117, 119 of the article 16 when article 16 is within malleipiece 23h. Upon application of pressure 28 (FIG. 6) against the belts 11, the behavior of malleipiece 23h and article 16 is similar to that of
spacers 37c,d (FIG. 6), showing the general principles of the behavior of mailpiece having spacers with this type of configuration.

[0108] With reference to FIG. 17 in which like reference numerals refer to like features of FIG. 16 and in accordance with an alternative embodiment of the invention, a mailpiece 23i similar to mailpiece 23h (FIG. 16) includes a Z-shape sleeve 134 that is assembled with the frangible article 16. Sleeve 134 comprises a main panel 141 and two end panels 140, 142 integrally formed with main panel 141. Sleeve 134 may be folded along fold lines 144, 146 in a Z-fold configuration, thereby defining the end panels 140, 142 and main panel 141. The Z-fold of sleeve 134 is such that end panels 140, 142 lie diametrically opposed and adjacent to equal length of sleeve 108, and substantially extending end panel 140 may be disposed adjacent to side 117 of the article 16 while end panel 142 may be disposed adjacent to side 119 of article 16. Alternatively, end panel 140 may confront against side 119 while end panel 142 may confront side 117 of the article 16.

[0109] Sleeve 134 may be made of any suitable material to provide the functionality of the pairs of spacers 37a,b (FIGS. 5B, 8A,B) thereby limiting bending of article 16 or when riding over the surface 13 of crown rollers 12 (FIGS. 1-3). Because sleeve 134 may be in direct contact with article 16, the material and construction of sleeve 134 may also be suitable to contact the surfaces of article 16 without damaging such surfaces. While sleeve 134 is depicted in FIG. 17 as shown, persons of ordinary skill in the art will appreciate that, alternatively, sleeve 134 may have end panels of unequal respective lengths and/or heights or jointly have respective lengths and/or heights other than those shown, have a shape other than rectangular, have different respective thicknesses, be made of different materials or both be placed at different locations with respect to central axis 19 of article 16.

[0110] Article 16 and sleeve 134 may be inserted into mailpiece 23i in the direction indicated by arrow 130, thereby defining the configuration of the generall embodiment depicted in FIGS. 5A-5F. Upon application of pressure 28 against the belts 11 (FIG. 4), the behavior of mailpiece 23i and article 16 is similar to that described in the embodiment of FIGS. 5A-5F. FIG. 11 shows the general principles of the behavior of mailpieces having spacers with this type of configuration.

[0111] With reference to FIG. 18 in which like reference numerals refer to like features in FIG. 15 and in accordance with an alternative embodiment of the invention, sleeve 108 may be modified to omit spacers 110a,b, 112a,b but, in their place, to include spacers 80a,b of a length substantially equal to the length of sleeve 108, and substantially extending between lateral edges 86, 88. Spacer 80a comprises a folded section along edge 92 of panel 87 so as to locally increase the effective thickness of panel 87. Spacer 80b comprises a folded section along edge 79 of panel 85 so as to locally increase the effective thickness of panel 85. The spacers 80a,b may each comprise any type of fold such as a bifold, trifold or z-fold, such as to create a suitable effective local thickness increase. Spacers 80a,b may comprise adhesive members (not shown) to facilitate retention of the fold along each of the top and bottom edges 79a. Alternatively, securing members, such as adhesive tape, or coupling components, such as staples, may be applied over the folded sections to secure the respective folds of spacers 80a,b. The spacers 80a,b are arranged in compliance with the arrangement of spacers 37c,d (FIG. 6). The spacers 80a,b may extend along substantially the entire length of sleeve 108 or may have unequal lengths and/or respective lengths that are shorter than 108 effective to mitigate the flexing of the article 16.

[0112] With reference to FIGS. 19-20A, and 20A in which like reference numerals refer to like features in FIGS. 1-3 and in accordance with an alternative embodiment of the invention, a generally square or rectangular mailpiece 150 includes opposed panels 151, 153 defining a mailpiece opening 155. The mailpiece 150 has top and bottom edges 154, 156 and lateral edges 152a,b. Mailpiece 150 may further include a flap 157, integrally formed with panel 153 along a fold line (not shown), having an adhesive portion 157a suitable to adhere flap 157 to the outer surface of panel 151 or any other non-adhesive components suitable to couple the two surfaces involved. A person having ordinary skill in the art will appreciate that the flap 157 of mailpiece 150 may have a different shape, size, material, or relative location or the flap 157 may be omitted so as long as the configuration or mailpiece 150 is such that it protects and generally encloses the contents therein.

[0113] Mailpiece 150 further includes a spacer 158 coupled to the inner surface of one of the panels 151, 153 or integrally formed therewith. Spacer 158 is adapted to fit into the center opening 21 of the article 16 and is vertically positioned within mailpiece 150 such that the spacer 158 will traverse a path above or below circumference 26 of roller 12 (FIG. 2). Spacer 158 has a thickness or axial dimension, A, that is larger than the thickness of the article 16.

[0114] As best shown in FIG. 20A, spacer 158 includes a hub portion 160 and a flange portion 162 coupled to one end of the hub portion 160. While the spacer 158 is inserted into center opening 21, the hub portion 160 projects beyond the plane of one side 117 of the article 16 and the flange portion 162 projects beyond the plane of the opposed side 119. The flange portion 162 is disposed between side 119 of the article 16 and panel 153. Hub portion 160 may be of any suitable shape to provide a surface area against which panel 151 may be abutted. Flange portion 162 may be of any suitable shape to provide a surface area against which panel 153 may be abutted. Once article 16 is placed into mailpiece 150, the effective thickness of the mailpiece 150 local to the central axis 19 of the article 16 is increased. The diameter of flange portion 162 is greater than the diameter of the center opening 21 of article 16. Consequently, belt pressure 28 (FIG. 3) cannot displace the spacer 158 relative to the center opening 21 and hub 19.

[0115] The hub region 160 of the spacer 158 is diametrically smaller than the center opening 158. As a result, the article 16 is free to move and freely rotate relative to the hub region 160, as opposed to being anchored in the mailpiece 150. The location of the spacer 158 inside the mailpiece 150 is based on the position of the article 16 relative to the circumference 26 and opposite rims 20a,b of the roller 12 (FIG. 2) in order to optimize the mitigation. The shape of hub portion 160 can be circular, oblong or oval, squared, square, etc.

[0116] With reference to FIG. 20B, a mailpiece 150a with opposed panels 151, 153 includes a spacer 158a. Spacer 158a is illustrated as having a uniform diameter across its axial dimension, A, which is perpendicular to the radius. As
a result, spacer 158a differs from spacer 158 (FIGS. 19, 20, 20A) in that the hub and flange portions 160, 162 have a constant diameter. When spacer 158a is positioned in the center opening 21, spacer 158a does not contact either side 117, 119 of the article 16. Spacer 158a has a smaller diameter than the diameter of the center opening 21 of article 16. The length is greater than a thickness between the sides 117, 119 of the article 16. The invention contemplates that the spacer 158a may be tapered along its length so long as the maximum diameter is less than the diameter of the center opening 21 of article 16.

With reference to FIG. 20C, a mailpiece 150b has opposed panels 151, 153 and a radially compressible and resilient spacer 158b. Spacer 158b may be manually pre-compressed prior to engaging it into center opening 21 of the article 16. Alternatively, the article 16 may be pushed onto spacer 158b, which causes radial compression of spacer 158b to occur and thereby allows positioning of the spacer 158b inside the center opening 21. Once positioned in the center opening 21, spacer 158b may expand, thereby comprising a central hub portion 161b and opposed cylindrical flange portions 160b, 162b. Flange portion 160b contacts side 117 and flange portion 162b contacts side 119. Alternatively, spacer 158b may be such that, once engaged into center opening 21, spacer 158b expands to thereby comprise a spacer having a non-cylindrical central portion and/or non-cylindrical flange portions.

With reference to FIGS. 21A,B in which like reference numerals refer to like features in FIGS. 1-3 and FIGS. 19, 20, 20A, and in accordance with an alternative embodiment of the invention, mailpiece 150, including spacer 158 and holding article 16, is shown transported by belts 11 over the crown surface 13 of a roller 12 such as the roller in the embodiment of FIG. 4 and the description of which may be referred to for an understanding of the roller of FIGS. 21A,B as well. The article 16 and spacer 158 are positioned inside the mailpiece 150 to optimize the effectiveness of spacer 158 in view of all mailpiece design parameters. For example, a lifting mechanism, such as inserts or a pocket (not shown), may be used to position the article 16 inside the mailpiece 150 to optimize the effectiveness of the spacer 150 by ensuring that the centerline of spacer 150 (which coincides with axis 19) does not coincide with the circumference 26 of roller 12.

With reference to FIG. 21A, mailpiece 150 is oriented such that panel 153 sides the roller 12 while belt pressure is applied in a direction as indicated by arrows 28a. Spacer 158 is vertically positioned in mailpiece 150 such that the spacer 158 will traverse a path above circumference 26 of roller 12. Alternatively and although not shown, spacer 158 is positioned inside the mailpiece 150 to optimize the effectiveness of spacer 158 in view of all mailpiece design parameters. For example, a lifting mechanism, such as inserts or a pocket (not shown), may be used to position the article 16 inside the mailpiece 150 to optimize the effectiveness of the spacer 150 by ensuring that the centerline of spacer 150 (which coincides with axis 19) does not coincide with the circumference 26 of roller 12. Pressure 28a exerted by the belts 11 onto the mailpiece 150 and the article 16 will result in the mailpiece 150 contacting the roller at a point proximate contact point 24 of roller 12 and the outer surface of the spacer 158 adjacent to panel 153 deforming to conform to the crown surface of the roller 12. Spacer 158 will indirectly contact (through panel 153) the roller 12 in a region generally above circumference 26. The bending or flexing of article 16 is substantially limited due to the pressure of the belts 11 being exerted onto the spacer 158, and not onto the article 16, causing the deformation and relative motion of spacer 158 with respect to the center opening 21 of article 16.

With reference to FIG. 21B, mailpiece 150 is oriented such that panel 151 sides the roller 12 while belt pressure is applied in a direction as indicated by arrows 28b. Spacer 158 is vertically positioned in mailpiece 150 such that the spacer 158 will traverse a path above circumference 26 of roller 12. Alternatively, spacer 158 may be vertically positioned in mailpiece 150 such that the spacer 158 will traverse a path below circumference 26 of roller 12. Pressure exerted by the belts 11 onto the mailpiece 150 and the article 16 will result in the mailpiece contacting the roller at a point proximate contact point 24 and in the outer surface of the spacer 158 adjacent to panel 151 being deformed to conform to the crown profile of the roller 12. Spacer 158 will indirectly contact (through panel 151) the roller 12 in a region generally below circumference 26. The bending or flexing of article 16 is substantially limited due to the pressure of the belts 11 being exerted onto the spacer 158, and not onto the article 16, causing the deformation and relative motion of spacer 158 with respect to the center opening 21 of article 16.

With reference to FIGS. 22A,B and in accordance with an alternative embodiment of the invention, the invention contemplates that one or more spacers may be placed directly on the frangible article, as opposed to carried on an insert loosely positioned inside a mailpiece, directly coupled with a mailpiece, or carried by a sleeve inserted into the mailpiece. Specifically, a frangible article 16a, which is constructed otherwise similarly to article 16, includes a front side 117a, a back side 119a, a hub 18a, a center opening 21a, and a central axis 19a. Article 16a further includes annular spacers 170a, b that are concentric with center opening 21a and located on the hub 18a on a respective one of opposed sides 117a, 119a. Annular spacers 170a, b may be constructed from a flexible material that permits deformation when pressure 28a from conventional belts 11 (FIGS. 21A, B) acts thereon or may be composed of a rigid material that does not deform under the influence of pressure 28a. Annular spacers 170a, b have a diameter larger than the diameter of the center opening 21a such that they do not interfere with the writing and reading of information respectively to and from a media region 20a of article 16a.

The annular spacers 170a, b may be adhesively bonded to the sides 117a, 119a of the hub 18a. Alternatively, the annular spacers 170a, b may be integrally formed with the article 16a during, for example, a molding process.

Article 16a may be placed in mailpiece 150 with the central axis 19a positioned such that the spacer 170a, b traverse a path above or below circumference 26 of roller 12 (FIGS. 21A,B). The mailpiece 150 may be configured with a pocket, interior sleeve or the like, to place the article 16a in this location. Upon exertion of belt pressure 28b (FIGS. 21A, B), the behavior of article 16a and the mailpiece 150 will be as described for the general embodiment of FIGS. 21A, B, which may be referred to for an understanding of this exemplary embodiment as well.

While the present invention has been illustrated by a description of various embodiments and while these embodiments have been described in considerable detail, it is not the intention of the inventor to restrict or in any way limit the scope of the appended claims to such detail.
Additional advantages and modifications will readily appear to those skilled in the art. Thus, the invention in its broader aspects is therefore not limited to the specific details, representative apparatus and method, and illustrative example shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of the general inventive concept.

What is claimed is:

1. A mailpiece for mailing an article having a first side and a second side opposite to the first side, the mailpiece comprising:
   a first panel;
   a second panel joined to said first panel to define a first peripheral edge, a second peripheral edge, and side edges connecting said first and second peripheral edges, said first and second panels disposed on the respective opposite sides of the article, and the article being positioned between said first and second edges;
   a first spacer carried by said first panel, said first spacer disposed between the first side of the article and said first panel; and
   a second spacer carried by said second panel, said second spacer disposed between the second side of the article and said second panel.

2. A mailpiece for mailing an article having a first side and a second side opposite to the first side, the mailpiece comprising:
   a first panel;
   a second panel joined to said first panel to define a first peripheral edge, a second peripheral edge, and side edges separating said second peripheral edge from said first peripheral edge; and
   a sleeve carrying the article, said sleeve disposed between said first and second panels, and said sleeve positioned between said first and second edges, said sleeve including a first spacer disposed between the first side of the article and said first panel, and a second spacer disposed between the second side of the article and said second panel.

3. A mailpiece for mailing an article having a first side and a second side opposite to the first side, the mailpiece comprising:
   a first panel;
   a second panel joined to said first panel to define a first peripheral edge, a second peripheral edge, and side edges separating said second peripheral edge from said first peripheral edge, said first and second panels disposed on the respective opposite sides of the article, and the article being positioned between said first and second edges; and
   an insert between said first and second panels, said insert including a first spacer disposed between the first side of the article and said first panel and a second spacer disposed between the second side of the article and said second panel.

4. A mailpiece for use with an article having a first side, a second side opposite to the first side, and a center opening extending between the first and second sides, the mailpiece comprising:
   a first panel;
   a second panel joined to said first panel to define a first peripheral edge, a second peripheral edge, and side edges separating said second peripheral edge from said first peripheral edge, said first and second panels disposed on the respective opposite sides of the article, and the article being positioned between said first and second edges; and
   a spacer adapted to be inserted into the center opening of the article, and the spacer at least partially disposed between the first side of the article and said first panel.

5. An apparatus for use with a mailpiece, the apparatus comprising:
   a frangible article having a first side and a second side opposite to the first side; and
   a first spacer projecting from said first side of said frangible article, said first spacer adapted to be disposed between said first side of said frangible article and the mailpiece.

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