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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 :		(11) International Publication Number:
B65D 33/16, 69/00	**A2**	**WO 00/43281**
		(43) International Publication Date: 27 July 2000 (27.07.00)

(21) International Application Number: PCT/US00/00003

(22) International Filing Date: 7 January 2000 (07.01.00)

(30) Priority Data:

60/114,967	7 January 1999 (07.01.99)	US
60/124,486	15 March 1999 (15.03.99)	US

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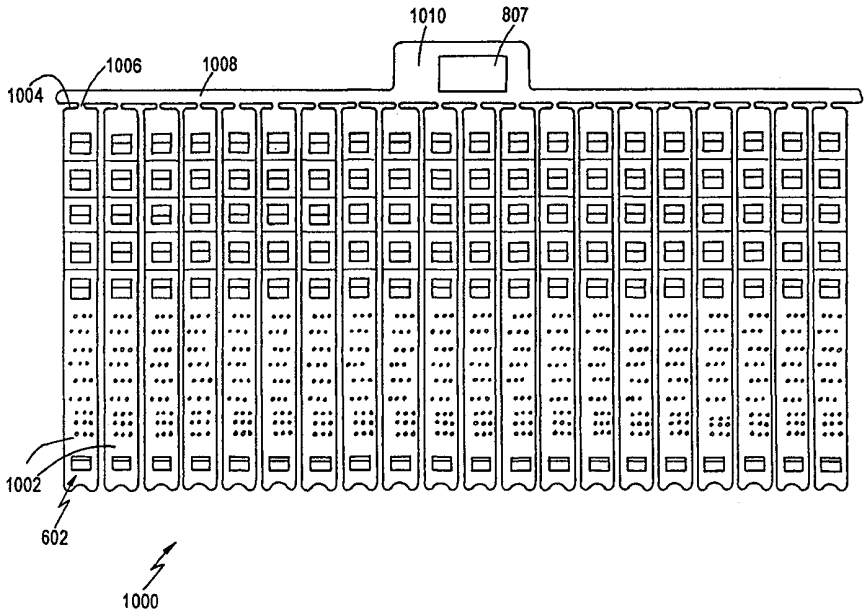
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

Without international search report and to be republished upon receipt of that report.

(54) Title: FASTENING, BUNDLING AND CLOSURE DEVICE AND DISPENSING ARRANGEMENTS THEREFOR



(57) Abstract

A device (10) for fastening and bundling materials and for closing an end of a plastic bag comprising two oppositely disposed, elongated strip sections (12, 14) each joined at a proximal end thereof to a hinge area (16). Also disclosed are dispenser arrangements (1000) comprising a plurality of strip elements (1002) successively attached to each other and adapted to be successively detached from each other for use.

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FASTENING, BUNDLING AND CLOSURE DEVICE AND DISPENSING ARRANGEMENTS THEREFOR

RELATED APPLICATIONS:

This application claims priority of U.S. Provisional Appl. Nos. 60/114,967, filed January 7, 1999 and 60/124,486, filed March 15, 1999, both application being incorporated by reference herein in their entireties.

TECHNICAL FIELD

The present invention relates generally to fastening, bundling and closure devices.

BACKGROUND ART

Bags made of paper, plastic, cloth and other flexible materials are well known. Such bags are typically open at one end thereof and many different types of closures for closing the filled bag have been developed. Common commercially available closures for a plastic bag are the zipper type (the zipper is an integral part of the bag structure), the interfolding bag flap type, the twist tie type (usually metal wire encased in paper or plastic), and the drawstring type. There is also in common use a modification of the twist tie in the form of a plastic band with at least one transverse slot along its length and one or more areas that have transversely disposed shoulders. The plastic band is first wrapped around the bunched end of a plastic bag, and the end of the band is then fitted through an appropriate transverse slot until the shoulders engage. Alternatively, a single transverse slot can be provided and the end of the band can have a plurality of shoulder elements. The plastic band is passed through the slot until the appropriate shoulder element engages with the slot. In either case, the engaged shoulder(s) tend to prevent the inserted end from slipping out through the slot. This type of closure is referred to herein as a band closure.

Another bag closure device consists of a flat strip of material, usually plastic, having an opening cutout adjacent to one side. The cutout portion is shaped so that the opening is constricted to form shoulders on the side of the cutout toward the closest edge of the strip. Such devices are installed by gathering and twisting bag material near the opening of the bag to allow this portion of the bag to slide into the cutout portion of the strip past the opposing shoulders which constrict the opening. The bag opening is then released, and its resiliency causes it to expand until it is blocked by the edges of the cutout area and the shoulders. This type of closure is referred to herein as a bread closure.

All of these closures have deficiencies. The zipper closure, for example, requires two hands to use, one to hold the bag and the other to effect the closure of the zipper. Bags with zippers have the advantage of being substantially water and air tight, but the zippers tend to open at the most inopportune times, either due to internal pressure from the filled contents or from external shifting forces acting on the bag or zipper. The zipper closure is also quite expensive in that it requires additional plastic material and additional molding tooling. Further, incorporating a zipper makes for complications in the manufacture of the bags. Closures of this type are not typically used with large size bags, or with bags designed to contain more than a couple of pounds of content material.

Twist ties are very inexpensive to manufacture and use. However, these ties are difficult to install because both ends must be intertwined to secure the twist tie while holding the bag. Twist ties also do not provide air or water tightness. Further, it is difficult to reuse twist ties any significant number of times because the metal wire gets too twisted to be sure of closure. Additionally, twist ties are not generally adapted to be attached to the bag before use. Therefore, the twist tie must be separately obtained by the consumer, either from the box in which the bags were bought or elsewhere.

Interfolded flap closures for bags, especially sandwich bags, have been used, but are generally out of commercial favor since they do not keep the contents of the sandwich bag fresh nor do they provide air or water tightness. These bags are relatively simple to

manufacture but they typically require two hands to engage the folds.

Drawstring type closures are reasonably expensive to manufacture and merely shrink the mouth opening of the bag without sealing. Some users have had problems in employing this type of closure because they find it difficult to insert the shouldered end of the band sufficiently far enough into the slot to make for a tight bag mouth closure.

Band closures are not generally adapted to be attached to the bag before use. Therefore, these closures must be separately obtained from the box in which the bags are packaged and then separately applied to the bag that has also been separately removed from the box. It is conventional for these band closures to be put up in a detachable group and each band detached from the group just prior to use.

Some of the advantages of bread closures are that they are inexpensive to make, and may be packaged so they occupy little space. Unlike twist ties, they may be applied to a bag with one hand. However, like twist ties, they may not readily be fastened to the bag while the bag is being filled so that they will be at hand when closure of the bag is desired.

In use, twist tie and band closures and bread closures sometimes have a tendency to slip off the bag end after closure. This is particularly so with plastic bags or when the bag is made of other types of relatively slippery material and is very full, or if the bag is carried by its closed end. The risk of the closure element slipping off is also increased when the closed bag is full and is subjected to internal expansive forces, such as by the bag being dropped. Internal expansive forces have a greater tendency to disengage a bag closure or pull a bag out of a closure when the contents of the bag are not relatively small and of uniform size, shape, and weight. Such contents exert substantially greater distortional force against the side of the bag as the contents move past each other when the bag is moved or carried. Such contents may be described as dynamic, as opposed to static, weight. For example, these forces are significantly greater in a bag containing groceries than in a bag containing an equal mass of flour or sand. Twist ties and band closures tend to have great resistance to being opened, that is untwisting or extraction of the shouldered tongue of the band from the

slot in which it has been inserted. However, these closures, particularly the band closure, have little resistance to forces that tend to pull the closed bag neck out of the closure without opening the closure itself.

The foregoing closures are not always effective to provide the user with confirmation that the closure elements have cooperated to ensure complete locking engagement in order to securely close the bag. One prior art closure of which we are aware provides different coloring agents on male and female closure portions that appear as a third color when the male and female elements completely engage each other. However, this prior art arrangement requires the closure elements to be an integral part of the bag mouth and also necessitates the use of molding and/or extrusion equipment capable of imparting different coloring agents to the various male and female closure elements.

There is a substantial need for a bag closure, regardless of the material from which the bag is made, that will be easy to use, secure in its closing means, reusable, readily attachable to the bag even before actual use as a closure, and is very inexpensive to manufacture. Should it be possible for such closure to also provide water and/ or air tightness, that would be an added benefit.

SUMMARY OF THE INVENTION

This invention is a closure, bundling and fastening device comprising a strip that is divided into two substantially aligned strip sections that are joined to each other at one end of each through a hinge area that is substantially transverse to the length of the strip. The hinge element is preferably one or more areas, which are substantially parallel to each other if there is more than one, in the strip that are compressed, scored, or tapered, etc. and thereby thinned, to simultaneously form the required two strip sections. Preferably, the

alignment and memory inherent in the hinge area creates an alignment of the two ends of the strip such that when the opposite ends of the strip are relatively rotated toward each other about the hinge area, the two strip sections tend to maintain alignment with each other. The location and orientation of the hinge area is preferably such that when the distal ends of the strip sections are rotated toward each other to an extent that they come into contact with each other, the ends of the strip sections on either side of the hinge area tend to be substantially superposed on each other.

On the other hand, the hinge area may be located along the strip so that the strip sections on either side of the hinge are not identical to the other either in length, width, shape or any combination thereof. It is preferred, however, that the portions of the strip sections on either side of the hinge at least overlap in size over a portion of their surface areas.

For ease of understanding and differentiation, these two strip sections on either side of the hinge area will be referred to hereinafter as a first strip section and a second strip section. These designations are for convenience only and should not be considered to connote a requirement of any significant differences in the two opposing strip sections other than as expressly set forth herein. Also for convenience, these strip sections are shown to be the same size and shape, although, as noted above, this is not required.

The closure device further comprises one or more of male locking lugs, at least one of which protrudes from at least one side of at least one of the strips. The plurality of locking lugs may all protrude in one direction from one side of one of the strip sections. These lugs may be, and preferably are parallel in sectional view, all substantially collinear with each other in plan view, or at least some of them should be substantially parallel to each other. In the alternative, some of the plurality of locking lugs may be disposed on one

side of one of the strip sections and one or more of the other of the plurality of locking lugs may be disposed on one side of the other of the strip sections. In a preferred embodiment, when viewed in an open position, that is with the two strip sections forming an angle about the hinge area of about 180°, all of the lugs face in the same direction, regardless of whether they extend from one or both of the strip sections. The locking lugs may be positioned on both sides of at least one of the strip sections.

The positions of the male locking lugs on a first strip section will spatially correspond to positions of female lug receiving openings or receptacles (the terms being used interchangeably in this specification) on the second strip section based on the alignment of the two strip sections defined by the hinge area. Additional female lug receiving openings may be positioned on the second strip to provide alternate alignments. Where locking lugs are provided on both the first and second strip sections, lug receiving openings will be disposed on the other of the strip sections in locations that correspond to the positions of the locking lugs when the strip sections are closed, that is when the strip sections are juxtaposed to each other about the hinge area. The transverse angle of the hinge area and the positions of the mating locking lugs and lug openings cooperate to permit the strip sections to be closed upon each other about the hinge area, and the lugs and receptacles to interlock, by the action of one hand. Most preferably, the engaging of the device of the closure should be achievable by the use of two fingers of one hand. It is preferred that the angle of the hinge area be normal to the relative positions of the two strip sections so as to cause the lugs and lug receptacles to line up upon simple two fingered rotation of the strip sections relative to each other.

Tabs may be included at the ends of the strip sections that are disposed away from the hinge area, that is at the distal ends of the strip sections. These tabs, or at least

substantial portions thereof, may or may not be superposed upon each other when the strip sections are juxtaposed in a closed, engaged condition. The purpose of these tabs is to enable simple and efficient separation or disengagement of the engaged strip sections after their corresponding lugs and lug receptacles have become interlocked. One suitable position of the tabs is for them to extend from the distal end of only a portion of the width of each of the strip sections, respectively, with the tabs on each strip section extending from a portion of the width thereof that is at least partially offset from the portion of the width of the other strip section from which the other tab extends when the strip sections are juxtaposed in a closed engaged position. Another suitable disposition of the opening tabs is for at least one of them to extend obliquely from some portion, or all, of the distal end(s) of the strip section(s) from which it projects.

In one of the preferred embodiments, an essential characteristic of the bag closure device are the features and operation of the locking lugs and the lug openings. It is important that, when in a locked condition, the locked lugs, and the receptacles therefor, are more easily disengageable in one direction than in another. Thus, at least some of the lugs should be more easily disengaged from their respective receptacles when the strip sections, and their respective opening tabs if such are provided, are pulled apart from the distal ends of the strip sections than when they are pulled apart from their hinge directed (proximal) end regions. This function can be accomplished in any of several different ways.

For example, the locking lugs may have engageable shoulders thereon, with mating shoulder receiving structures disposed on the inside, or at the ends, of the lug openings when engaged without any additional mating shoulders being incorporated with the receptacles, or such engaged shoulders may protrude over the edge of the lug receptacles. Alternatively, the shoulder(s) may be located in or on the lug openings and the mating

locking structures disposed on the locking lugs. It does not matter which of the locking lugs or lug openings has the shoulder(s) and which has the mating surface(s). As used herein, the terms "shoulder(s)" and "mating surface(s)" are intended to be as generic as possible. The specific shapes of the shoulders and the engaging mating locking structures may vary and these terms are intended to encompass any such structure or configuration that accomplishes a locking action between the lugs and lug openings.

The lugs, and/or the lug receptacles, may be made of resilient materials, or they may be structured in such a manner (*per se* known) that they have resiliency even if they are not made of particularly resilient materials. As a locking lug is forced into and/or through the lug receptacle by the action of the strip sections being rotated toward each other about the hinge area, the shoulder(s) of the lug(s) engage(s) with the respective mating surface(s) to retain the male lug in the female receptacle against the application of some minimum opening force.

It is preferred that there be sufficient resiliency in the lug structure, and/or the lug receptacle structure, and that these structures be so designed, that the mated lug can be extracted from the lug receptacle without the shoulder or the mating surface being permanently damaged or broken off. This feature allows the closure to be reused after it is engaged. It also allows the closure to be attached to the top edge of the bag before the bag is used so that the closure is at hand when closure of the bag is desired.

The locking lug and the lug receptacle may be so sized. The lug may be longer or shorter than the thickness of the receptacle strip section. The respective lengths of the lug and depths of the lug receptacles are such that the locking mechanism of the lug and receptacle engage upon juxtaposing the strip sections. Depending upon the use to which the closure device of this invention will be put, the lug locking structures may engage only

when the strip sections actually touch each other. Alternatively, the shoulder and mating structures may become engaged when the strip sections are still some distance apart. The proximity of the strip sections that is required before the lug and receptacle engage may be a function of the thickness of the bag end being closed. If the bunched material of the bag mouth is thick, the strip sections may be somewhat separated from each other when one or more of the lugs and receptacles engage so as to leave room for the bag material. When the bag material is thin, the lug and receptacle mating may leave less or no room between them in order to insure the grasping of the bag mouth material.

Alternatively, the lug receptacle structures or openings may not pass all the way through the strip section. The receptacle depth may extend to only a fraction of the thickness of the strip section. However, the relative lengths of the lug and the receptacle must be such that there is disengageable engagement of the lug shoulder(s) with the mating surface(s).

As aforesaid, the lugs and their receptacles must be configured such that when they are locked, they are easier to disengage by separating force applied from one direction than another. As a general proposition, it has been found to be useful for the locked lugs and their receptacles to be more easily disengaged by separating force applied to the strip sections from the distal ends thereof, rather than by separating force applied from the proximal end of the strip sections. In order to accomplish this, shoulders (generically including any specific structure that accomplishes the purpose of a shoulder) are suitably provided on the proximal sides of at least some of the lugs/lug receptacles, but are omitted, or at least reduced in size or increased in resiliency, on the distal sides of at least some of these same lugs/lug receptacles, respectively. In this manner, the lugs will more readily disengage from the lug receptacles at their distal sides than at their proximal sides. As a

general proposition, engaging shoulder structures, and mating surfaces therefore, can be provided on the lug/receptacle surfaces that are oriented between the proximal and distal sides of the lugs/receptacles. In the alternative, shoulders and mating surfaces therefore need not be disposed at these intermediate positions.

In a further alternative embodiment, the shoulder/ mating surfaces disposed in such intermediate positions may be made to be more readily and easily disengageable than the shoulder/ mating surface combination that is disposed on the proximal directed side of the lug/receptacle. These intermediate shoulder/mating surface combinations may be made to be less readily and easily disengageable than the shoulder/ mating surface combination that is disposed on the distal directed side of the lug/receptacle. Thus, a graduated strength of engagement, increasing from the distal directed side of at least some of the lug/receptacle combinations to the proximal directed side of at least some of the lug/receptacle combinations, is well contemplated by this invention.

The specific structure of the shoulders and their mating surfaces, and of the lugs and their corresponding receptacles, are not considered to be critical. In the most simplistic form, the lugs and the receptacles may be cylindrical in shape. The shoulders and mating surfaces may be simple protrusions, and respectively depressions, on the respective cylindrical surfaces. The shoulders may be outwardly extending protrusions and the distal end of the receptacle or the lug, respectively, may form ledge surface(s) that engage the shoulder protrusion(s). The lugs and receptacles may be more complicated structures such as cones or pyramids, truncated or not, and the shoulders and mating surfaces may accordingly be more complicated as well.

In one embodiment it is preferred, that one or more of the lugs the lugs and/or openings be constructed in a way that will enhance their flexibility so they may be readily

engaged. The characteristic may be achieved in several ways including an opening in the base of the lug or lugs which comprise a compound structure of two or more projections with a gap between them. This gap should be of such width that the two projections are sufficiently proximate to each other that they may be simultaneously inserted into a single receptacle. The structure should be such that the application of a slight force to the edges of the receptacle will cause the projections that constitute the compound structural members to flex toward each other and reduce the size of the gap. Thus, the force needed to cause the lug to engage with the receptacle will be minimized. The resiliency of the material causes the projections of the compound structure to move apart once the shoulder of the lug is engaged with the mating surface of the receptacle. Therefore, greater force will be required to disengage the shoulder/lug from the mating surface/receptacle than was required to insert the lug in the receptacle and engage them.

The art is replete with disclosures of different specific shapes and sizes of lugs and corresponding receptacles therefore, and of shoulders and mating surfaces therefore, all of which are generally adapted to use in the instant invention. However, in one preferred embodiment, the critical departure from the prior art is the structure of the lugs and receptacles, respectively, and the locations and characteristics of the shoulders and mating surfaces therefor, that enables a lesser separating force on the distal ends of the strip sections to open the closure as compared with a greater separating force on the proximal ends of the strip sections to open the closure.

Bags that are filled and have a mouth that is closed by a closure device that clamps around the mouth have internal pressure that tends to force the closure to open from its proximal end, that is by forcing the proximal ends of the strip sections apart. By making the lug/mating surface engaging and locking means uneven in strength, the closed bag can be

made to have substantially greater resistance to being inadvertently or unintentionally opened as a consequence of having been dropped or over filled, as compared to the lesser resistance that the closure presents to the user who is intentionally opening the closed bag.

At least one embodiment may also be characterized as a closure element including a first section and a second section connected together through a third section that enables the first and second sections to be pivoted into contact with each other. At least one locking lug is formed on the first section and at least one opening is formed on the second section to receive the lug and secure the first and second sections together. A portion of the lug facing toward the third section and a portion of the second section formed adjacent the opening and located on a side of the opening closest to the third section defines first profiled surface characteristics. Another portion of the lug facing away from the third section and another portion of the second section formed adjacent the opening on a side of the opening located farther from the third section defines second profiled characteristics. The first profiled surface characteristics are different from the second profiled surface characteristics.

The closure elements may be temporarily fastened to the bag sidewall or to an edge of the bag mouth, without closing the mouth. The closure element is immediately accessible to the user, simply by unclipping the closure element from the bag, so that the open end may by closed in the manner described above.

The closure elements may also be dispensed from a dispensing arrangement that is attachable to a support surface (e.g., a cabinet door or trash receptacle sidewall) located adjacent the filled bag. In one embodiment, the dispensing arrangement may take the form of successively attaching adjacent closure elements to each other along a series of scores or serrations. A mounting tab permanently or releasably secured to an endmost one of the closure elements may have an adhesive surface for attaching the gang of closure elements to

the support surface. In an alternative arrangement, the closure elements may be disposed in a dispensing box adhesively or otherwise secured to the support surface.

The foregoing dispensing arrangements may be used to dispense any of the fastening, bundling and closure device embodiments disclosed in this application. Alternatively, the dispensing arrangement may be used to dispense other types of closure devices, whether fashioned in strip-like or other forms.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a plan view of a closure;

Fig. 2 is a side elevation of the closure depicted in Fig. 1;

Figs. 3A and 3B are enlarged partial sectional views of two examples of lug structures depicted in Fig. 2;

Fig. 3C is an alternate preferred embodiment depicting a variation of the Fig. 1 embodiment;

Fig. 3D is a side-elevational view of a variation of the Fig. 3C embodiment;

Fig. 3E is also a side-elevational view of another variation of the Fig. 3C embodiment;

Fig. 4 is a perspective view of another embodiment of the closure;

Fig. 5 is a detailed sectional view of the interaction between clamped portions of the closure of Fig.1 under varying types of release forces;

Fig. 6A is a detailed sectional view of the interaction between clamped portions of the closure of Fig. 4 in a first position in which the closure strip elements are detachable from each other;

Fig. 6B is a view similar to Fig. 6A in a second position of the closure elements in which they are permanently engaged to each other;

Fig. 7A is an alternate preferred embodiment of a male lug element combining features from the Fig. 3A and 4 embodiments;

Fig. 7B is a view similar to Fig. 7A in which first and second strips of the closure element are separably or releasible engaged to each other;

Fig. 7C is a view similar to Fig. 7B in which the strip elements are permanently engaged to each other;

Fig. 8A is an alternate arrangement of the embodiment depicted in Fig. 7A;

Fig. 8B is a sectional view of the Fig. 8A embodiment similar to Fig. 7B;

Fig. 8C is a sectional view of the Fig. 8A embodiment similar to the view of Fig 7C;

Fig. 9 is a plan view of another embodiment of a closure element;

Fig. 10 is a perspective view of the Fig. 9 embodiment operably engaged to clamp the open end of a bag.

Fig. 11 is a perspective view of a variation of the embodiment depicted in Figs. 9 and 10;

Fig. 12 is a perspective view illustration of a prior art closure element;

Fig. 13 is a perspective view of the Fig. 11 embodiment operably engaged to clamp the open end of the bag;

Fig. 14 is a top plan view of another preferred embodiment;

Fig. 15 is an elevational view of the embodiment of Fig. 14;

Fig. 16 is a sectional view taken along the line 16-16 of Fig. 15;

Fig. 17A-17C are sectional views similar to Fig. 16 but of a modification to the Fig. 14 embodiment;

Fig. 18 is a top plan view of yet another alternative preferred embodiment;

Fig. 19 is a sectional view taken along the line 19-19 of Fig. 18;

Fig. 20 is an exploded partial longitudinal sectional view depicting locking engagement between a lug and associated opening of the Fig. 18 embodiment;

Fig. 21 is a longitudinal sectional view of still another preferred alternative embodiment;

Fig. 22 is a top plan view of the Fig. 21 embodiment;

Fig. 23 is a bottom plan view of the Fig. 21 embodiment;

Fig. 24 is a sectional view, partly in schematic form, depicting the Fig. 21 embodiment in a first clamping position;

Fig. 25 is a view similar to Fig. 24 depicting the Fig. 21 embodiment in a second clamping position;

Fig. 26 is a longitudinal sectional view of still another preferred alternative embodiment;

Fig. 27 is a view similar to Fig. 26 depicting the Fig. 26 embodiment in a clamping position;

Fig. 28 is a partial longitudinal sectional view of a multiple hinge section of a closure or bundling element formed with luke like gripping surfaces;

Fig. 29 is similar to Fig. 28 with a corrugated gripping surface;

Fig. 30 is similar to Fig. 29 except with a honeycomb gripping surface;

Fig. 31 is similar to Fig. 30 except with a plurality of flexible gripping fingers;

Fig. 32 is a partial sectional view of the Fig. 30 structure in bundled contact with a series of wires in transverse sectional view;

Fig. 33 is a plan view of a mechanism of a dispenser that may be used to dispense

the strip elements of the Fig. 26 embodiment or the other embodiments;

Fig. 34 is a perspective view of an alternative dispensing arrangement for the aforementioned strip elements;

Fig. 35 is a front plan view of a dispenser arrangement similar to the Fig. 33 embodiment that may be used to dispense the strip elements of Figs. 21-25 or the strip elements of the other disclosed embodiments;

Fig. 36 is a rear plan view of the Fig. 35 embodiment;

Fig. 37 is a sectional view taken along the line 37-37 of Fig. 36 to depict minor modifications of the strip element depicted in the Fig. 21 embodiment; and

Fig. 37a is a sectional view of the strip element depicted in Fig. 37 in a locking position.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Figures 1 and 2, a closure 10 comprises a preferably single elongate strip divided into first and second elongate strip sections 12 and 14 separated with a transverse hinge portion 16. The hinge 16 preferably bisects the strip into two equal sections 12 and 14. At least one strip section 12 or 14 is preferably formed with one or more longitudinally spaced locking lugs 18 adapted to interfit with openings 20 or recesses preferably formed on at least one of the other strip section to lock the strip sections together with the bunched or folded open end of a bag sandwiched therebetween under clamping pressure.

In the preferred embodiment, a plurality of transverse gripping ridges 28 are longitudinally spaced from each other and formed between hinge 16 and associated locking lugs 18 or openings 20. The ridges 28 on one strip section 12 or 14 will tend to either

loosely interfit between opposing ridges on the other strip section by pressing through the bunched or folded open end portions of the bag therebetween, or may be simply pressed towards each other without mating depending on the amount of bag material being clamped, in order to preferably anchor the locked strip sections to the bag end under the clamping pressure of the locking lugs 18 engaging the openings 20.

The lugs 18 and/or openings 20 are structured and/or positioned in the unique manner described below to securely close the open bag end and resist unintentional opening. However, to allow for intentional removal of closure 10 to open the bag, the distal ends 22,24 of the first and second strip sections 12,14, respectively, are preferably roughened or knurled at 26 to facilitate manual gripping of these ends to pull the first and second strip sections apart.

In one presently preferred embodiment such as depicted in Figure 3A, it can be seen that each lug 18 is formed with a pair of longitudinally spaced projections 30 and 32 extending upwardly from the surface of first strip section 12. The two projections 30 and 32 are collectively, in a top plan view, dimensioned to resiliently engage with a selected one of openings 20 as a result of relatively rotating strip sections 12,14 about hinge 16 into locking engagement with each other as depicted in Figure 5. A slot 36 (shown to extend transversely relative to the longitudinal axis of the strip section but which may also be oriented in any desired direction) enables the projections 30 and 32 to be resiliently forced closer together upon insertion of lug 18 into opening 20 to enable a locking shoulder 34 to extend through the opening 20 after which the squeezed locking lug shoulder will resiliently return to its normal Figure 5 position.

The first locking projection 32 is formed closest to hinge 16 so that the shoulder 34, in a longitudinal sectional view as depicted in Figure 3A, forms a locking recess 35 adapted

to receive a portion 37 of strip section 14 located between the engaged opening 20 and hinge 16. The upper extent of locking recess 35 is defined by a downward facing surface 34a projecting towards hinge 16 in preferably parallel relation with the upper surface (defining the lower extent of the recess) of strip section 12 and connected thereto by means of an upward projecting wall 32a also facing towards hinge 16. The rearwardmost point 34b of the locking recess upper wall 34a, in longitudinal sectional view depicted in Figure 3A and Figure 5, preferably forms a sharp corner with the upper vertically extending surface 34c which defines the uppermost extent of shoulder 34. The sharp corner 34b is thereby formed by the intersection of walls 34a and 34c which, in the longitudinal sectional profile view of Figure 3A, have a planar profile. This sharp corner 34b, as best depicted in Figure 5, is operable to engage the upper surface of adjacent first strip portion 37 when an inadvertent separation force F1 is applied to lift the portion of the first strip 12 located between the engaged lug 18 and hinge 16, away from the second strip section 14. This separation pressure occurs, for example, as a result of internal pressure within the filled bag due to fill volume or weight, or may also occur as a result of the natural outward resilience of the folded or bunched portions of the open bag end clamped between the first and second strip sections 12,14 during closure. In either event, it will be appreciated that the feature of forming lug shoulder 34 with planar profiles (at least in longitudinal sectional view) to form sharp corner 34a advantageously enables the distal portions of strips 12,14 to remain locked together by virtue of engagement between the adjacent strip portion 37 with the locking projection corner 34b.

The spacing between strip 12 and overhanging shoulder wall 34a is preferably greater than, or equal to, the thickness of second strip section 14 in the area of adjacent portion 37. This type of dimensioning ensures that adjacent strip portion 37 will either

encounter the locking resistance of corner 34b under the action of unintentional release force F1, or will encounter locking resistance by virtue of engagement with overhanging wall 34a with or without encountering corner 34b as well. It is theorized that the latter force dynamics may occur when the thickness of adjacent portion 37 is equal to the spacing between the upper surface of first strip section 12 and overhanging shoulder wall 34a.

From the foregoing description, it can be seen that slot 36 is not necessary and may be substituted by forming the locking lug 18 from a material that will enable shoulder 34 to resiliently compress in order to pass through a selected opening 20.

The second projection 30 of locking lug 18 is formed with an upper curved surface facing towards distal end 22 as well as distal end 24 when strips 12,14 are in the locked position shown in Figure 5. In the event that a user desires to unclamp closure 10 from a bag by applying an intentional release force F2 as a result of grabbing and separating distal ends 22 and 24 from each other, the feature of curved surface 38 enables a portion 39 of second strip 14 located adjacent an associated opening 20 to ride smoothly up and along the curved surface without encountering any significant resistance. As the outermost adjacent portion 39 begins to approach shoulder 34, the intentional release force F2 is operable to enable the inner adjacent portion 37 to pull back from locking shoulder 34 without encountering the aforementioned locking resistance that would otherwise occur under the action of unintentional release force F1.

Referring now to Fig. 3B, it will be apparent that the lug structure is substantially the same as that shown and described in relation to the lug illustrated in Fig. 3A. The one modification is that both the release and locking portions 30 and 32 of the lug have rounded surfaces 38 and 40, respectively, at their uppermost ends. Such a structure enables ease of entry of the lug 18 into the receptacle 20, but does not impact on the above described

operation of the closure 10 under forces F1 and F2,

Referring now to Fig. 4, a perspective view of a somewhat different type of locking arrangement is shown for a closure device 50. First and second strip sections 52 and 54 are shown to be joined together at their proximal ends by a hinge area 56. Opening tabs 58 and 60 are disposed at the distal ends of the strip sections 52 and 54, respectively. It should be noted that the tab 58 extends from only about half the width of the distal end of the strip 52, and is sized to be thicker than the strip 52 so as to bulge out from the face 62 of the strip 52 into proximity to the proximal end of the strip 54. The tab 60 extends from only about half of the distal end of the strip 54, and is so sized as to be thicker than the strip 54 so as to extend beyond the face 64 of the strip 54 into proximity to the distal end of the strip 52. In this preferred form of the pull tabs, the tabs 58 and 60 are so sized (in thickness) that when the closure is closed and locked, these tabs appear to be a cumulative extension of the superposed strip sections. The cumulative width of these tabs is depicted as being greater than the width of the strip section(s). This may be desirable, but is not an essential characteristic of the closure device.

The closure device 50 is equipped with complementary bag gripping areas 66 and 68. These gripping areas are suitably disposed near the hinge area 56, but may alternatively or additionally be disposed at other locations along the length of the strip sections. The purpose of these gripping areas is to insure that the closure device gets and retains a good grip on the material of the top of the bag that is being closed. It is preferred that the closure device be so sized and shaped that a single structure will accommodate any size bag with any thickness of bag material. However, the thickness of the elements of the gripping areas may vary according to the thickness of the material of which the bag is made. The ridges of the gripping areas are depicted as being transversely oriented and parallel to the hinge.

However, such ridges may be oriented longitudinally or in any desired direction. Alternatively, one or more rows of collinear teeth may be located parallel and adjacent to the edges of the closure such that when the strip sections are brought together in the alignment afforded by rotation, the strip section above the hinges, the teeth or one of the strip sections rest with the teeth on the other strip section. These teeth are suitably disposed in or near the hinge area, but may alternatively or additionally be disposed at other locations along the length of the strip sections. Similarly such rows of teeth may be oriented parallel to the hinge or many desired directions.

Fig. 3C is a variation of the closure device 10 depicted in Fig. 1. In Fig. 3C, one or more of lugs 18 are replaced with one or more of lugs 18' that may have a triangular shape in plan view and therefore a prismatic shape in perspective view. In this embodiment, one of the sides 18a' extends upwardly from and preferably perpendicular to the surface of strip section 12 while the other two sides 18b' converge towards each other in the direction of associated strip end 22 to terminate in a point (in top plan view) which is actually a straight edge in perspective view which extends upward from and perpendicular to the surface of strip 12. The wall or triangle base 18a' is preferably oriented parallel to hinge 16 to provide greater resistance to opening 20' of the closure 10 when one or more lugs 18' mate with one or more openings 20'. Conversely, the apices or edge of lug 19' located further from hinge 16 than the associated wall 18a' will tend to provide less resistance to opening when an intentional release force F2 is applied to one of the strip ends.

The Fig. 3D embodiment is virtually identical to the Fig. 3C embodiment described above with the exception that the top surface of one or more lugs 18' projects rearwardly (i.e towards hinge 16) past wall 18a' to form a overhanging flange 19'. This flange 19' will perform the same or similar functions as shoulder 34 in the Figure 3A or 3B embodiment in

order to resist unintentional release force F1.

In the Fig. 3D embodiment, it should be understood that the side edges of flange 19' extending in the direction of hinge 16 may diverge from each other, i.e. by following the inclination of walls 18b' in top plan view. Alternatively, the longitudinal edges of flange 19' may be parallel to the longitudinal sides of strip 12 so that the resulting width of flange 19' (in top plan view) is approximately equal to the length of the corresponding side of opening 20'.

Fig. 3E is a variation of the triangular lugs of Fig. 3C. In Fig. 3E, the wall 18a' of Fig. 3C is formed with a rearwardly directed notch 19a' that preferably extends a predetermined height above the surface of strip 12 in parallel relation to the strip surface. In this embodiment, notch 19a' is preferably dimensioned to receive the corresponding edge of an associated opening 20' so that an overhanging portion of the triangular projection defining the uppermost extent of notch 19a' functions in structure and operation as shoulder 34 in the Fig. 3A or 3B embodiment. Therefore, in the Fig. 3E embodiment, it is to be understood that the associated edge of opening 20' will tend to be received within the associated notch 19a'.

The locking structures depicted in the Fig. 4 embodiment is an alternative to the locking mechanisms shown in Figs. 3A and B. In the Fig. 4 embodiment, there is provided a longitudinally extending locking lug element 70 and a transverse locking lug element 72. The transverse lug locking element 72 is suitably made up of resilient members comprising a distal element 80 and a proximal element 82. These can be similar in structure to the locking elements shown in Fig 3A or B. However, unlike projection 30 in the embodiment depicted in Fig. 3A, the distal lug element 80 does not have a curved surface 38 and preferably has an arcuate or chamfered surface 84 to ease entry of the transverse lug 72 into

an opening 76 that is mated therewith. It should be further noted that the transverse opening 76 can be a single opening, or it can be a multiplicity of openings. It can also be a multiplicity of openings that are intended to be mated with a multiplicity of lugs.

The number of these openings to be used can be determined by the requirements of any particular application. It is to be noted that this shoulder element 86 is designed and intended to engage with a mating surface 88 of the opening. As the opening and the lug come into interlocking positions, the shoulder 86 will slip over the mating surface 88 and be held in that position due to its resiliency. A chamfered or arcuate surface 90 is preferably provided between the shoulder and the top of the longitudinal lug 70 (that is the portion of the lug 70 that is disposed away from the strip section 62). In the particular embodiment shown, a preferably transverse space 92 is provided between the distal portion of the lug 84 and the proximal portion of the lug 82 to increase resiliency in an element and therefore it can be disposed at any angle provided that the shoulder element 86 is aligned in a substantially transverse orientation, most preferably substantially parallel to the hinge area 56. Of course, the transverse openings 76 should be aligned to cooperate with the transverse lug 72. Plural transverse lugs and openings are contemplated by this invention. These plural lugs and openings can be the same or structurally different.

The longitudinal lug 70 can be positioned at any point on either strip section, such as the strip section 52. In fact, it can abut the transverse lug(s) 72 or it can be spaced from the transverse lug(s). The longitudinal lug 70 can be disposed between two transverse lugs. In the embodiment of Fig. 4, the longitudinal lug 70 is shown to comprise two sub-elements 94 and 96. The sub-elements are separated by a space 102 in order to impart resilience to the longitudinal lug 70. Each of the sub-elements is shown to comprise a shoulder region 98 and 100 and each has a chamfered, or arcuate, section 104 and 106, respectively to facilitate

entry into the longitudinal receptacle 74. The shoulder regions 98 and 100 are shown to be substantially the same as each other and to be substantially the same from proximal end to distal end. The height of the longitudinal lug 70, that is its height above the surface of the strip section 52, may be less than the height of the transverse lug 72 so that the transverse lug 72 may engage its receptacle without the longitudinal lug 70 engaging its receptacle. By structuring this device in this manner, the transverse lug 72 may be disengaged to permit the bag to be opened (Fig. 6A) and closed, and the longitudinal lug 70 may then be engaged only when it is desired that the closure not be reopened (Fig. 6B).

The specific materials from which the strip sections, the hinge area, the lugs and the mating surfaces are made are *per se* conventional in the art. Substantially any material having an appropriate degree of resiliency, such as metal or plastic, may be used. Relatively rigid materials can be used for the strip sections, since they do not need to necessarily bend to any appreciable extent, but rigid materials are not required to be used. The resiliency of the lugs and the receptacles can be achieved either by using inherently resilient materials or by structuring these elements to make them resilient. The cost of the materials is a significant factor in choosing appropriate plastic or metal elements. Polyolefins, such as polyethylene, have been found to be excellent materials of construction, but these are not to be considered to be the exclusively applicable materials. Other suitable materials of constructions will be apparent and will suggest themselves to those of ordinary skill in this art.

In summary, and in terms of functionality, a highly preferred feature of the foregoing embodiment is the provision of a locking lug structure and locking reception openings or holes, collectively having relatively profiled surfaces adapted to (1) achieve intentional release of the locked closure from the closed bag end and (2) prevent

unintentional release of the closure. The first profiled surface generally faces in the direction of the distal ends of the closure strip (in the clamped position) and are either smoothly curved or otherwise formed so that, as the distal ends of the closure strips are pulled apart such as with manual force F2, the first profiled surfaces between the locking lug 18 and opening 20 tend to slip past each other without substantial interference. The second profiled surfaces tend to face inwardly towards the hinge 16. Under the action of an inadvertent force F1 emanating from a pressure caused by the interior contents of the filled bag and\or the outward resiliency of the bunched or folded portions of the clamped closed end of the bag, the profiled surfaces are configured to obstruct each other and not slip smoothly over each other in order to successfully resist these inadvertent opening forces.

One embodiment is operable with only one locking lug and one opening having profiled characteristics as described hereinabove. While ridges 28,66 are highly desirable for gripping bunched portions of the bag to prevent slippage, use of the embodiment may not necessarily require the presence of these gripping ridges. Likewise, while knurled or roughened distal ends 26 are desirable to facilitate release through application of force F2, they are not critical to successful use.

On the other hand, in one commercial use of the embodiment, the combination of the gripping ridges between the hinge and at least one locking lug/opening arrangement could enable practice of the embodiment with a locking lug of any known configuration, including a lug formed as a cylindrical projection. This may be possible since the feature of gripping ridges, particularly if the ridges are capable of mating or interpenetrating with each other through the bag side walls, are capable of resisting sliding movement of (1) one strip section relative to the other or (2) the bag material toward the locking lug, so as to reduce or nullify inadvertent releasing forces. Such sliding is particularly likely to occur when the bag

walls are made of a slippery plastic material, such as commonly used in trash bags.

Additional alternate preferred embodiments are depicted in Figs. 7A-7C and Figs. 8A-8C. In Fig.7A, a male lug element 100 may be formed on one or both strip elements 13 and 14 as two longitudinally spaced projections 102 and 104 similar to the projections 30 and 32 of the Fig. 3A embodiment. An upper end of projection 102 is formed with a shoulder 134 (similar in shape and function to shoulder 34 in Fig. 3A) and the second projection 104 is formed with a rounded or substantially rounded surface 138 similar to the structure and function of surfaces 38 or 72 in the Fig. 3A, 3B, or Fig. 4 embodiments of the invention. Disposed respectively beneath shoulder 134 and rounded surface 138 are longitudinally extending projections 140 and 142 having upper surfaces spaced sufficiently below the lower surface of shoulder 134 by a distance equal to or greater than the thickness of the opposite closure strip 14. The projections 102 and 104 are longitudinally spaced apart a sufficient distance from each other so as to be receivable within one of opening or receptacles 20 to achieve the locking retention and functionality as depicted in Fig. 5 hereinabove. When strip 14 is disposed in the Fig. 7B position, it is to be understood that the hinge 16 is to the left of the lug 100 depicted in Fig. 7B and that shoulder 134 thereby resists an unintentional release force F1 in the same manner as the Fig. 5 embodiment. However, rounded upper end 138 facilitates detachment of strips 12 and 14 from each other under intentional separation force F2 also as depicted in Fig. 5.

In accordance with the Fig. 7A-7C alternate preferred embodiment, it will now be appreciated that longitudinally extending projections 140 and 142 operate to permanently secure strips 12 and 14 together in a clamping position when strip 14 is relatively pressed towards strip 12 from the Fig. 7B releasable position to the Fig. 7C permanently engaged position. The transition from the Fig. 7B to the Fig. 7C position will occur by resilient

relative movement of projection 102 towards 104 to enable projections 140 and 142 as well as lug opening or receptacle 20 to relatively resiliently deform as the projections 140, 142 pass through the opening for resilient restoration into their normal positions depicted in Fig. 7A. In the permanently engaged position of Fig. 7C, it is theorized that it is extremely difficult to separate strips 12 and 14 from each other without permanently distorting or destroying one or both projections 102 and 104 and possibly tearing the opening 20 as well or cutting either of the strips.

The lugs 100 of the alternate preferred embodiment of Figs. 7A-7C generally have the same shape as lugs 18 in the Fig.1 embodiment in top plan view while incorporating the structures and functionalities of the locking element 72 and longitudinal lug 70 in the Fig.4 embodiment.

A variation of the three-way snap depicted in Figs. 7A-7C is illustrated in Figs. 8a-8C. Therein, a lug 200 comprises a single projection (instead of two separate projections 102 and 104) in which an uppermost projecting portion 246 is of smaller diameter then the lowermost projecting portion 248 as depicted in Fig. 8A. A shoulder 234 (similar to shoulder 134) extends in the direction of hinge 16 from the upper end of upper projecting portion 246 and longitudinally extending projections 240 and 242 (similar to projections 140, 142, respectively) extend parallel to strip 12 between the small and large diameter projections 246, 248. In this embodiment, the diameter of upper extending projection 246 is sized to be received within opening or receptacle 20 when strip 14 is in the detachable position of Fig. 8B by affording the same type of functionality as achieved with the bifurcated structure of Fig. 7B. The diameter of lower projecting portion 248 is dimensioned to provide the same type of functionality described above in connection with Fig. 7C when strips 12 and 14 are in the permanently engaged position of Fig. 8C.

Fig. 9 is an illustration of another bag closure device 300 comprising a flat strip 302 of flexible material (e.g. plastic) having a preferably rectangular construction in plan view. Strip 302 preferably has parallel longitudinally extending side edges 304 connected at opposite ends thereof with transverse edges 306. In accordance with this embodiment, each transverse edge 306 is formed with a cutout 308 having a constricted entrance 310 located immediately adjacent transverse edge 306 and terminating in an enlarged opening 312 adapted to receive the bunched portions of the closed bag as depicted in Fig 10. More specifically, the entrance opening 310 is separated from the enlarged opening 312 with a pair of shoulders 314 that project inwardly into entrance 310 on opposite sides thereof to constrict the enlarged opening.

The foregoing cutout construction is similar to cutout portions that are conventionally used on bread bag closures in which one single cutout is formed along one of four sides of a square shaped tag. However, the feature of forming two cutouts 308 at opposite ends of a elongate closure strip 304, in combination with a hingeless strip section extending between the cutouts, is novel since each cutout is adapted to respectively receive vertically spaced bunched portions of the closed bag mouth to securely close the bag as depicted in Fig. 10. In the Fig. 10 position, it can be seen that strip 302 is bent into a looped configuration between both cutouts 308 wherein the resiliently formed loop advantageously exerts tension or resilient forces causing the inwardmost located surface 316 of opening 312 to urged the bunched portions of the bag against the abutment shoulders 314 to positively capture and retain the bunched portions within the associated opening 312.

In use, as depicted in Fig. 10, the user may single handedly grasp strip 302 adjacent one of cutouts 308 in order to allow a portion of the closed bag mouth to slide through opening 310, past the protruding shoulders 314 into the enlarged opening 312. The bunched

portions of the bag opening, under its own resiliency, will expand to fill enlarged opening 312 until expansion is blocked by the edges of shoulders 314 which prevent the expanded bunched portions from exiting through entrance opening 310. Still single handedly, the user may bend strip 302 through appropriate finger manipulation to caused the opposite cutout portion to engaged another bunched portion of the closed end in the same manner as also depicted in Fig. 10. Thusly secured, the user releases strip 302 whereupon the resiliency of the resulting loop acts to positively urge the bunched portions in their respective cutout 308 into yet tighter abutment with associated shoulders 314.

In accordance with a further feature of the Fig. 9 embodiment, one or more of the edged surfaces defining either entrance 310 or enlarged opening 312 may respectively be formed with serrations 320 that preferably but not necessarily extend perpendicular to the opposing flat surfaces of strip 302. These gripping serrations provide improved grippability to prevent the bunched portions of the closed bag mouth from exiting the cut outs.

Fig. 11 is a variation of the closure 300 depicted in Fig. 9. The Fig. 11 embodiment has the same cutouts 308 but is formed, at an intermediate portion thereof, with a pair of preferably parallel creases or permanent folds 350 that tend to give the closure its relaxed shaped depicted in Fig. 11. The folds 350 facilitate the alignment of both cutouts 308 with each other for ease of attachment to the open bag end as depicted in Fig. 13. The folds 350 also add additional springiness that enhance the lockability of the device as discussed above in conjunction with Fig. 10.

Fig. 12 a is prior art illustration of a bag closure device in which a flat strip of flexible material formed with slitted cutouts at opposite ends thereof includes a single transverse hinge to facilitate the alignment of both cutouts. It is theorized that the use of the single hinge line in the device disclosed in the prior art Fig. 12 illustration will not have the

advantages of springiness as discussed above in connection with the Fig. 9 and 11 embodiments.

Figs. 14-16 are side and elevational view illustrations, respectively, of another preferred embodiment in which a closure element 400 includes first and second substantially equal length strip sections 402 and 404 interconnected to each other by a flexible hinge 406 that permits the strip sections to be independently and freely rotatable into and out of juxtaposed contact with each other. The opposite distal ends 408 of the respective strip sections 402, 404 may have the knurling characteristics described in connection with the Fig. 1 embodiment to ensure ease of grippability of the closure ends by the user.

Gripping portions 410, respectively disposed on portions of strips 402, 404 immediately adjacent hinge 406, are preferably provided with a plurality of pin-like gripping projections 412 which are adapted to engage, and bite into, bunched or folded portions of the closed bag end being clamped shut with the closure 400. The feature of utilizing projections 410 (which may also be substituted with gripping ridges 28 or vice versa) advantageously serves to grip and retain the closed or bunched portions of the bag in a fixed position relative to hinge 406 so that the locking projections 412 remain in alignment with the locking projection retention cutouts 414 as these components are relatively pivoted into locking and clamping contact with each other.

In the preferred embodiment of Figs. 14-16, a plurality of transversely spaced pairs of locking projections 412 are preferably formed at longitudinally spaced intervals along strip section 404 between the gripping projections 410 and the free end 408 of the strip. As best depicted in Fig. 16, each locking projection or lug 412 is a snap lock formed with an upstanding leg 416 which terminates at an upper end thereof in an inwardly extending

chamfered shoulder 418 projecting inwardly towards the longitudinal axis of the strip. Each shoulder 418 has an underside 420 which defines a ridge adapted to engage the exterior surface of strip section 402 (i.e. inwardly of the associated cutout 414) upon locking.

In this embodiment, to lock the strip sections 402, 404 together, the bunched or folded side wall portions of the closed bag end are initially placed between the gripping projections 410 of one strip, 402, 404, or against the hinge 406 to thereby overlap the gripping projections of both strips. The user, by using two fingers (e.g the thumb and forefinger) of one hand to apply pressure against the exterior surfaces 403 of the strips 402,404, exerts manual pressure to rotate the strip sections together. It will be appreciated that the hinge 406 maintains the strip sections 402, 404 in alignment while the gripping projections 410 served to stabilize and retain the bunched or folded bag sidewall portions within the area located inwardly from the locking projections 416 and the associated cutouts 414. As the strip sections 402, 404 are rotated towards each other, one or more of the corresponding pairs of projections 412 begin to enter the associated cutout pairs 414. As the tips 422 of chamfered shoulders 418 clear the longitudinally extending edge 424 of the associated cutout 414 as a result of resiliently outward deformable flexure of legs 416, the locking projections snap back towards their Fig. 16 condition with an audible snap which indicates that shoulder underside 422 has now captured the exterior surface 403 of strip 402 located inwardly adjacent the recessed cutout edge 424 to ensure locking retention.

The feature of providing the locking projections 416 in laterally spaced cooperating pairs along the longitudinal edges of strip section 404 ensures greater locking stability and retention of the strips 402, 404 in the clamped position against the closed bag end.

Figs. 17A-17C are a variation of the embodiment depicted in Fig. 16. In accordance

with the Fig. 17A embodiment, the strip section 404 is formed with a concave curvature in the transverse direction of the strip (at least in the area containing locking projections 416) which enables the chamfered shoulders 418 and legs 416 to be pushed apart into the Fig. 17B flexed position as the strips 402, 404 are relatively forced together. After the shoulders 418 clear the cutouts 414 to assume the engaged relaxed position of Fig. 17C, the flexure force provided by strip 404 ensures that the shoulders 418 remain in clamping contact with the cutouts 414.

The thickness of strip section 402 in Fig. 14 may be greater than the combined height of leg 416 and chamfered shoulders 418. With this variation, cutouts 414 would not extend through the entire thickness of strip section 402 but would terminate to present an upward facing shelf or surface (i.e., facing toward the exterior surface 403) which would interlock with the chamfered shoulders 418. Providing a thickened portion in the above manner may protect the user's fingers from contacting and the applying opposing force to, the chamfered shoulders 418 as the strip sections 402,404 are pivoted and pinched together into locking engagement.

With reference to the Fig. 17A-17C variations, it should be apparent that the width of strip section 402 may be less than the width of strip section 404 by an amount equal to the depth of a corresponding pair of cutouts 414. In other words, the width of strip section 402 in the area corresponding to the location of cutouts 414 may be equal to the reduced width formed between recessed cutout edges 424. In this embodiment variation, one or more pairs of locking projections 412 would not engage associated cutouts 414. The enlarged width of the tab end 408 formed on strip section 402 would effectively abut against one of the pairs of projections 412 to prevent the strip section 402 from sliding out from underneath the locking projections.

The embodiment depicted in Figs. 14-16 may also be advantageous due to the ease of tooling which would result in lower manufacturing costs. Additionally, by providing associated pairs of locking projections 412, more positive locking retention forces may be generated as compared with the Fig. 1-10 embodiments due to the coaction of a pair of lugs simultaneously withstanding an unintentional release force. It is believed that the embodiment of Fig. 14 may be easily used by young children as well as elderly or infirm persons suffering a weakened or possibly arthritic condition.

Figs. 18-20 illustrate yet another embodiment wherein a closure strip 500 is also formed with two preferably equal length strip sections 502,504 located on opposite sides of a transverse hinge 16. Gripping projections 412 or 28 are provided along portions of each strip section 502,504 located adjacent hinge 16. One or more lugs 506 are formed at longitudinally spaced intervals along one strip section 502 while one or more lug receiving openings or receptacles 508 are formed at longitudinally spaced intervals along the other strip section 504. Both strip sections 502,504 have preferably identical ends 22,24 corresponding to the ends depicted in the Fig. 1 embodiment.

With reference to Figs. 19 and 20, each lug 506 is preferably formed with a shoulder 512 that defines an overhanging surface or ridge 514 extending in the direction of tab end 22, i.e., away from the hinge 16 and not towards the hinge 16 as in the Fig. 1 embodiment. As best depicted in Fig. 20, each lug receiving opening 508 is formed with an upward facing step or shelf 516 upon which the overhanging ridge 514 rests in locking engagement following resiliently deformable penetration of one of lugs 506 into one of openings 508. Preferably, the thickness of strip section 504 proximate openings 508 is greater than the height of a lug 506 to protect the user's fingers against harsh contact with the lug as the strip sections are being pressed together.

Notwithstanding the advantages described in detail above by virtue of having shoulder 34 extend towards hinge line 16 as described in connection with Fig. 5, it is theorized that, under certain types of applications, there may be advantages in having the lug shoulder project away from the hinge 16, i.e., towards the free end 22 as in the Fig. 18 embodiment. For example, depending on the amount of bag material (or other material located between the juxtaposed strips 502,504 during use, such as may occur in the bundling of wires), the material being closed or bundled may actually generate a force F3 (see Fig. 20) as the material seeks to resiliently expand between the strip sections 502,504. Therefore, under certain types of bag closure, fastening or bundling conditions, the lug shoulder embodiments of the embodiments disclosed herein may operate more effectively if the shoulder extends away from the hinge 16 and not towards it. The orientation of the shoulder will therefore preferably depend upon the use to which the closure or bundling elements are being applied. In other words, if the use tends to generate a force F1 as depicted in Fig. 5, then preferably the lug shoulder is formed to extend towards hinge 16. However, if the intended use results in the generation of force F3 as depicted in Fig. 20 (which would tend to urge 514 into tighter locking engagement with shelve 516), then the shoulder preferably extends away from the hinge.

Figs. 21-25 are illustrations of still another alternative preferred embodiment in which a closure or bundling element 600 is preferably formed as an elongate strip having a single lug 602 at one end thereof and two or more longitudinally spaced openings 604 at the opposite strip end. One of openings 604 selectively interfitting with locking lug 602 advantageously enables the closure or bundling element 600 to vary the closure area 606, 608 by adjusting the closure periphery defined by the strip length located between the lug 602 and the selected one of opening 604. For example, with reference to Fig. 24, locking

engagement of lug 602 with the closest or proximal opening 604a will create a smaller closure or bundling area 606 compared to the larger area 608 achieved when lug 602 engages a remote opening(s) 604b as depicted in Fig. 25.

The closure or bundling element 600 is preferably formed with at least one, and preferably with a series of longitudinally spaced hinges 610 in which each hinge may be formed by oppositely inclined surfaces 612 and 614 transversely intersecting each other to form a thinned region or hinge line 616 as depicted in Fig.21. Multiple hinge lines may therefore be formed by providing a series of alternating oppositely inclined surfaces 612, 614 to facilitate the pivoting of sections of closure strip 600 formed on opposite sides of one of the hinge lines to ensure easy and positive alignment of the lug 602 with a user selected one of openings 604. To facilitate this positive alignment, respective ones of transverse hinges 610 are preferably disposed halfway between the lug 602 and an associated one of openings 604. For example, with reference again to Fig. 24, hinge 610a is formed halfway between lug 602 and opening 604a and will therefore establish the hinge axis enabling the lug to pivot into positive alignment with the opening 604a. With reference to Fig. 25, hinge 610b is formed halfway between lug 602 and remote opening 604b and will therefore experience the most flexure to ensure positive alignment between the lug and the selected remote opening.

It will be appreciated that the alternating oppositely inclined surfaces 612 and 614 (which may be formed in one or both sides of the strip) create the appearance of a series of undulations or corrugations in the intermediate region of the strip. Therefore, if desired, the closure bundling strip 600 of this embodiment may be formed with other cross sectional shapes of corrugations or undulations that define a series of longitudinally spaced thinned regions 616 respectively establishing multiple hinge or pivot axes to ensure the easy and

rapid selection and alignment of the lug 602 with one of openings 604.

With reference to Fig. 22 depicting the interior surface 618 of strip 600 which is adapted to be the clamping surface or bundling boundary, it will be appreciated that pin- like projections 412 or gripping ridges 28 may be formed on opposite sides of each respective hinge 610 to grip or retain materials being closed or bundled as described in detail above.

With reference to Fig. 23 depicting the exterior surface 620 of the strip 600, a knurled or otherwise roughened gripping surface 622 is provided adjacent each opening 604a, 604b on the side closest the hinge area to facilitate two fingered operation by allowing one of the user's fingers to grip against one of areas 622 while the other finger engages the exterior surface underlying lug 602 so that the strip portions may be relatively rotated or pivoted towards each other to achieve closure.

The locking lug 602 may have the same cross-sectional configuration of lug 416 in the Fig. 16 embodiment or lug 506 in the Fig. 18 embodiment in elevational sectional view, and is therefore formed with a shoulder having an overhanging ridge 624 extending longitudinally in the direction of hinges 610. While each opening 604 may have any shape and dimension capable of providing a snap fitting interference fit with lug 602, i.e. so that ridge 624 overlays against the strip exterior surface 620 in locking contact therewith, the alternative preferred embodiment of Fig. 21 preferably includes a locking tongue or tab 625 formed on the transversely extending side of the opening closest to the hinge. More specifically, with reference to Figs. 21 and 22, each locking tab 625 has a distal edge 629 projecting downwardly below exterior surface 620 while jutting into and beneath opening 604 to partially obstruct the opening. An upper tab surface 631 (see Fig. 22) is preferably inclined downwardly away from hinge 610 (from the interior surface 618 towards exterior surface 620) to terminate in a distal transversely extending edge 632 located below or

outwardly from exterior surface 620. This distal edge 632 is longitudinally spaced a distance D (see Fig. 23) from the outer transverse edge 644 of opening 604. This distance D is less than the overall longitudinal thickness D1 of locking lug 602 as measured from the outermost extent of the lug to the innermost edge of ridge 624.

With the above described geometry and dimensional extent of locking lug 602 and opening 604 (partially obscured by tab 625), locking closure and retention is as follows. Using two fingers, the user engages one of gripping surfaces 622 with one finger while also engaging a portion of the exterior surface 620 underlying locking lug 602. This portion of the exterior surface may be formed with an opening or recess 640 which provides finger gripping retentive ability. The user then proceeds to pivot lug 602 towards one of selected openings 604 and the hinge 610 closest to the midpoint between the lug and selected opening will begin to experience predominant bending as the strip sections are relatively pivoted towards each other. As the lug shoulder begins to enter the selected opening 604 from the interior side 618, the outermost vertical surface 642 of the lug 602 will engage and slid against the outermost transverse surface 644 of the selected opening 604. As penetration occurs, the preferably rounded uppermost surface 646 of the lug shoulder will engage the inclined tab surface 631 and resiliently force the tab 625 downwardly. Due to the presence of longitudinal slits 648 on opposite sides of tab 625, both the tab and the shoulder will experience resilient deformation as the distal edge of the overhanging ridge 624 clears the distal edge 632 of the tab 625. As these surfaces slide past each other and the overhanging ridge 624 clears the tab edge 632, an audible snap alerts the user that locking engagement between the lug and opening has occurred. The tab 625 now engages the overhanging ridge 624 to resist withdrawal of the tug shoulder back through the opening 604. By orienting the tab 625 so that the distal edge 632 protrudes downwardly and into the

opening 604 as described above, there tends to be a wedging of the tab against overhanging ridge 624 in the event, for example, an interior or inadvertent release force F1 attempts to separate the strip sections from each other.

The opening 640, in both the Fig. 21 and Fig. 26 embodiments, helps to maintain the engaged positions of the lug shoulders 704 and opening side edges 644, 706 with each other when an internal force F1 is applied to separate the strip sections. The opening 640 accomplishes this by allowing the force F1 to distort the strip sections adjacent the opening 640 rather then disengaging the lug.

Figs. 26 and 27 are illustrations of a modification to the embodiment depicted in Figs. 21-25. The Fig. 21 and 26 embodiments are structurally identical with the following differences. First, tab 625 is formed to project downwardly below exterior surface 620 while jutting into and below opening 604 towards the hinge instead of away from the hinge as in the Fig. 21 embodiment. Additionally, tab 625 is formed on the transversely extending side 644 of the opening 604 furthest from the hinge.

The second difference is that the locking lug 702 is formed with two flanges or shoulders 704 each having an overhanging ridge 624a and 624b respectively extending away from the hinge and towards the hinge. The outermost extent of the lug head has a diameter D1 which is greater than the longitudinal distance D2 between the distal edge 632 of tab 625 and the transversely extending side 706 of opening 604 located closest to the hinge. The longitudinal extent D3 of the trunk or stalk 710 of lug 702 is preferably equal to or less than the obstructed opening distance D2. Thus, as penetration of opening 604 with lug 702 occurs as a result of two fingered operation, either the shoulders 704, or tab 625 as a result of longitudinal slits 648, or both of them, will experience resilient deformation as the distal edge of both overhanging ridges 624a, 624b clears the tab distal edge 632 and the

lowermost edge of transverse side 706 with an audible snap as these surfaces slide past each other.

As depicted in Fig. 27, the tab 625 now firmly engages the overhanging shoulder ridge 624a and urges the overhanging ridge 624b into firm locking contact with exterior surface 620. With the Fig. 26 embodiment, an inadvertent opening force F1 will be resisted by both overhanging ridges 624a, 624b. However, in the event that a user desires to release lug 702 from opening 604 by grasping ends 712, 714, the resulting intentional release force F2 will be resisted primarily only by locking tab 625 and overhanging ridge 624a, both of which parts will tend to experience resilient deformation (in the case of lug 702, assisted by opening 640) so as to enable the lug to be withdrawn from the opening without damaging the structural integrity of either the lug or the opening and surrounding structure.

Fig. 28-31 are illustrations of alternate preferred embodiments of multiple hinges (e.g. hinges 610) that may be utilized in any of the aforementioned embodiments between the lugs and openings or receptacles. In addition to the pin like projections or gripping ridges disclosed in the above identified embodiments, Figs. 28-31 illustrate other types of materials and configurations that may be utilized to grip a material being closed or bundled. For example, with reference to Fig. 28, a plurality of resiliently deformable loops fixed to surfaces of the closure strips on opposite sides of each hinge 610 are capable of resilient deformation against a material being clamped or bundled as the closure strip sections are pivoted towards each other into clamping position.

Fig. 29 is an illustration of strip sections defining multiple hinges 16 wherein interior facing surfaces of the respective strip sections are provided with a corrugated gripping surface which may be similar in structure and function or material characteristics to corrugated paperboard. The corrugations will deform into conforming intimate contact with

the material being clamped or bundled as the strip sections are pivoted into the closed position.

A similar result is achieved with the Fig. 30 embodiment in which the strip sections defining opposite sides of one or more hinges 610 is coated with a honeycomb type of material (e.g. foam) capable of deforming in the manner described with respect to the Fig. 29 embodiment, for example.

In the Fig. 31 embodiment, the strip sections defining opposite sides of one or more of multiple hinges 610 may be in the form of resilient fingers projecting upwardly from the strip surface in sufficient density to deform against, in intimate contact with, a material being bundled or closed.

Fig. 32 is a partial sectional illustration of the deformable honeycomb material of Fig. 30 in intimate deformed contact with a cluster of wires being bundled together with the closure strip.

Although the various gripping materials depicted in Figs. 28-31 appear to be formed from a material that is separate from the underlying strip and preferably bonded or otherwise secured to the strip, it is within the scope of this feature to provide a surface of a strip that inherently is capable of being manufactured or processed to define a textured surface having deformable properties and the texture of corrugated, honeycomb, loop-like, or fingers and the grippability associated with these structures.

The foregoing embodiments may be constructed from a wide variety of materials having flexible and possibly resiliently deformable characteristics depending on the functionalities of the structures described in detail above. It is contemplated that plastics having elastomeric characteristics, such as thermo-polyester elastomers, may be used for various embodiments disclosed above, such as the Fig. 26 embodiment.

Fig. 33 is a plan view of a unique dispensing arrangement 800 that may be utilized to successively dispense the bag closure elements 600 depicted in Fig. 26, or for that matter any of the closure elements depicted in the other embodiments described above. In accordance with the Fig. 33 design, each closure element 600 is successively attached to an adjacent closure element, along lengthwise or longitudinal edges 800a thereof, through a series of serrations or scores 802 that permit successive detachment of the individual strip elements during use.

The successively attached closure elements 600 may be mounted to a convenient support surface by means of a mounting tab 805 that is attached to one of the end strips 600a (in either a permanently secured or releasable manner from that end strip). The mounting tab 805 preferably has an adhesive surface 807 that enables the tab to be adhesively secured, for example, to a cabinet door or a side or end wall of a trash container, i.e., in close proximity to the trash bag and its place of use.

The adhesive surface 807 is preferably protected with a release layer. It is also within the scope of this invention to secure tab 805 to a support surface using other means, e.g., nails, thumbtacks, screws, magnets, etc. However, the use of an adhesive surface 807 intimately associated with tab 805 has certain advantages, i.e., avoiding the need for external fasteners.

Fig. 34 is a perspective view of another dispensing arrangement 900 in which plural closure elements 600 (or elements in accordance with any of the other disclosed embodiments herein) are loosely packed within a dispensing box 900. Dispensing box 900 may be manufactured from paperboard materials to include a pair of parallel side walls 902 and 904, end walls 906 and 908, a bottom wall 910 and a top wall 912 formed with an end flap 914 to facilitate selective opening and closing of the top wall for selective removal of

the bag closure elements. One of side walls or panels 902,904 may include adhesive material 916 to mount the dispensing box 900 to a support surface. Adhesive material 916 is preferably protected with a release layer (not shown) that is peelable to expose the adhesive material.

End wall or panel 908 may include a cutout covered with cellophane or other transparent material 918 that will enable users to visually observe the presence of closure elements 600 within the dispenser box.

A plurality of dispensing boxes 900 may be manufactured together and be selectively detached from each other along perforations 920 formed between bottoms 910.

The dispensing boxes 900, whether manufactured individually or together (as described in the immediately preceding paragraph), may be separately sold at a point of retail purchase with a plurality of closure elements contained therein. The closure elements 600 may be loosely contained within a dispensing box 900 or may be connected together with adhesive means or along perforations.

It is also contemplated that one or more filled dispensing boxes 900 may be sold as a unit at a point of retail purchase with a plurality of trash bags to enable consumers to purchase all materials necessary to store and dispose of garbage or for closed containment of other materials. When the dispensing boxes 900 are sold as a unit with trash bags, the number of closure elements 600 packaged within the associated box or boxes can correspond with the number of trash bags being sold as a unit.

The dispensing arrangements of Figs. 33 and 34 may be attached to a cabinet door covering, for example, the location of the trash bags as they are being filled (e.g., the area underneath a kitchen sink). Therefore, as a trash bag is filled, the user may conveniently remove a closure element 600 from either dispensing arrangement 800 or 900 and then

immediately apply the removed closure strip to close the open end of the filled trash bag. Either dispensing arrangement 800 or 900 may also be adhesively secured, for example, to the inner or outer surface of a trash container end or side wall, preferably adjacent the open top end thereof, to enable the user to conveniently remove a closure element from the dispensing arrangement for immediate use.

Figs. 35-37 are illustrations of a further dispensing arrangement 1000 in which a plurality of bag closure elements 1002, or for that matter any of the closure elements depicted in the other embodiments described above, are connected at one short side 1004 thereof through a breakable frangible section 1006 to a connecting rod 1008 extending the full length of the closure element array. In this embodiment, each closure element 1002 is not successively attached to an adjacent closure element but is attached only through the frangible section 1006 to the connecting rod 1004. As with the Fig. 33 embodiment, the plurality of closure elements 1002 may be mounted to a convenient support surface by means of a mounting tab 1010 that projects away from the closure strips from a center portion of the connecting rod. The mounting tab 1010, as with mounting tab 805 in the Fig. 33 embodiment, may be permanently or releasably secured to, for example, a cabinet door or a side or end wall of the trash container, i.e. in close proximity to the trash bag (preferably the open end thereof) and its place of use. For that purpose, mounting tab 1010 may also have an adhesive surface 807.

The Fig. 35 embodiment and all constituent parts thereof may be integrally formed together from plastic, for example, using injection molding or techniques to form an easily and inexpensively manufactured product.

Referring now to Fig. 37, it can be seen that the individual closure elements 1002 are substantially similar to the closure strip 600 depicted in the Fig. 21-25 embodiment with the

following differences. One such difference is that the oppositely inclined surfaces 612 and 614 are also preferably formed in one side of the strip between adjacent openings 604 to impart additional flexibility enabling the lug 602 to pivot into and out of positive alignment with one opening 604 and to further provide additional flexure of the lug when interlocked with one of the openings to permit inadvertent disengagement thereof.

Another distinction is that each strip 1002 is preferably formed with five identical openings 604 to provide greater versatility of use.

A further distinction is that roughened areas 622 are optional and may not necessarily be formed between adjacent openings 604.

Additionally, a further distinction is that the overhanging ridge 624 can extend at an angle A downwardly towards the center of the strip at preferably the same angle of inclination as inclined tab surface 631. This enables the overhanging ridge 624 and the inclined surface 631 to positively engage each other in full mating engagement along their entire surfaces to promote locking retention when used in the Fig. 24, 25 or 37a position. However, it is to be understood that the Fig. 35-37 embodiment of the invention may be formed wherein inclined tab surface 631 and overhanging ridge 624 have different angular inclinations relative to each other and may not engage each other in full mating engagement along their entire surfaces. The angle of inclinations (which may also be flat) of the hook and tongues may vary depending on the material and pliability being used to manufacture the strips and the desired difficulty of force needed to engage or disengage the lugs from the opening. Thus, the ridge 624 need not engage inclined surface 361 in flush contact, as is evidenced from Fig. 37a.

It will be readily seen by one of ordinary skill in the art that the present invention fulfills all of the objects set forth above. After reading the foregoing specification, one of

ordinary skill will be able to effect various changes, substitutions of equivalents and various other aspects of the invention as broadly disclosed herein. It is therefore intended that the protection granted hereon be limited only by the definition contained in the appended claims and equivalents thereof.

WHAT IS CLAIMED IS:

1. A device for fastening and bundling materials and for closing an end of a plastic bag comprising two oppositely disposed, elongated strip sections each joined at a proximal end thereof to a hinge area; wherein said hinge area is disposed transverse to said strip sections in such position that upon bending said strip sections toward each other about said hinge area into a juxtaposed position, at least a substantial portion of said strip sections overlap each other;

said device comprising one or more lug elements disposed on at least one of said strip sections and directed toward the other strip section when said strip sections are bent toward each other about said hinge area into a juxtaposed position;

said device comprising at least as many receptacles as there are lug elements, wherein said receptacles are disposed on at least one of said strip sections in substantial alignment with said lug elements; and

said device comprising at least one interlocking shoulder and mating surface operatively associated with at least one of said lug and receptacle combinations;

wherein at least one shoulder and mating surface element combination is directed toward said hinge area; and

wherein, when said device is closed and said shoulder and mating surfaces are engaged, a greater force is required to disengage said engaged shoulder/mating surface combination when said force is exerted on a portion of said strip sections that is directed toward said hinge area than when said force is exerted on a portion of said strip sections directed away from said hinge area.

2. A bundling, fastening, and closure element, comprising a first section and a second section connected together through a third section that enables the first and second sections to be pivoted into contact with each other;

at least one locking lug formed on the first section and at least one opening formed on the second section to receive the lug and secure the first and second sections together, a portion of said lug facing toward the third section and a portion of the second section formed adjacent the opening and being located on a side of the opening closest to the third section including first profiled surface characteristics, and another portion of said lug facing away from the third section and another portion of the second section formed adjacent the opening on a side of the opening located farther from the third section including second profiled surface characteristics which are different from the first profiled surface characteristics

3. A bundling, fastening, and closure element, comprising a first section and a second section connected together through a third section that enables the first and second sections to be pivoted into contact with each other;

at least one locking lug formed on the first section and at least one opening formed on the second section to receive the lug and secure the first and second sections together; and

a plurality of gripping projections formed between a bendable portion of the third section and at least one of the lug and opening, said projections adapted to press against and clampingly engage a material being closed by said closure element when said lug and opening interact with each other.

4. A bag closure element, comprising an elongate strip having a pair of transversely extending edges at opposite ends thereof, and a cutout portion formed in each

of said transverse edges, each cutout portion formed with an entrance opening, a pair of shoulders, and an enlarged internal opening, said strip being formed with one of a plurality of creases located between said opposite ends which create multiple hinge lines or without one or more hinges.

5. A dispenser, comprising:

a plurality of strip elements successively attached to each other and adapted to be successively detached from each other for use; and

a mounting tab attached to at least one of said strip elements, said mounting tab including an attachment surface adapted to be secured to a support surface.

6. The dispenser of claim 5, wherein said strip elements are successively attached adjacent each other along a long side edge thereof.

7. The dispenser of claim 6, wherein a scored line or plurality of serrations are used to successively attach said strip elements to each other along said long sides.

8. The dispenser of claim 7, wherein said mounting tab includes an adhesive surface adapted to secure the tab and thereby the plurality of strip elements to said support surface.

9. The dispenser of claim 5, wherein said dispenser is sold as a unit in combination with a plurality of plastic trash disposal bags, each bag including an open end adapted to be closed with one of said strip elements, wherein each said strip element has the structure according to claim 3.

10. A dispenser, comprising:

a plurality of strip elements; and

a box containing said plurality of strip elements.

11. The dispenser of claim 10, further comprising said box including at least one

panel having an adhesive surface adapted to contact a support surface to mount said box to said support surface.

12. The dispenser of claim 11, wherein said support surface is a cabinet door or a wall formed in a trash container.

13. The dispenser of claim 10, wherein said dispenser is sold as a unit with a plurality of trash bags.

14. The dispenser and trash bag combination of claim 13, wherein said dispenser and said trash bags are packaged in a common package saleable for retail sale as a unit.

15. The dispenser of claim 14, wherein said box includes a transparent window enabling users to visually confirm the presence of plural said strip elements within the box.

16. The dispenser of claim 10, wherein a plurality of boxes are manufactured with each other as a unit, and further including a mechanism for detachably securing said boxes to each other to enable both said boxes to be sold together as a unit and in optional further combination with a plurality of trash bags.

17. A device for fastening a bundling material and for closing an end of a plastic bag comprising two oppositely disposed elongate strip sections each joined to each other and bendable about an area located between opposite ends of the strip sections, one said strip section including a plurality of longitudinally spaced openings, a transverse edge of at least one said opening being formed with a tongue having a distal edge projecting in the direction of the other said transverse opening edge, the other strip section being formed with a locking lug having a hooked distal end portion adopted to enter one of the openings when said strip sections are bent towards each other to lockingly engage with said tongue.

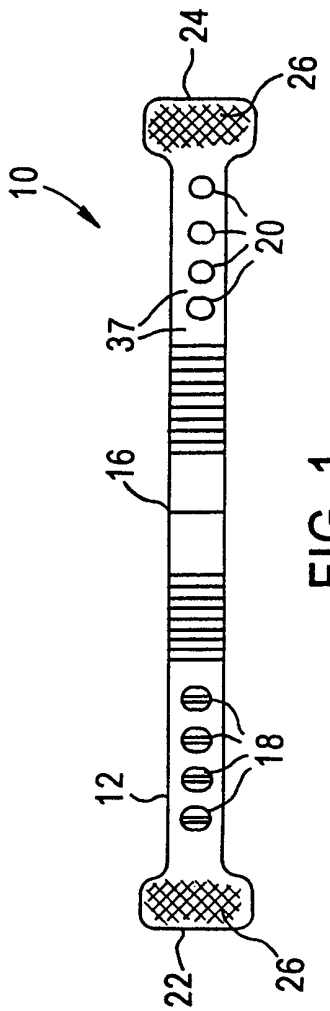

FIG. 1

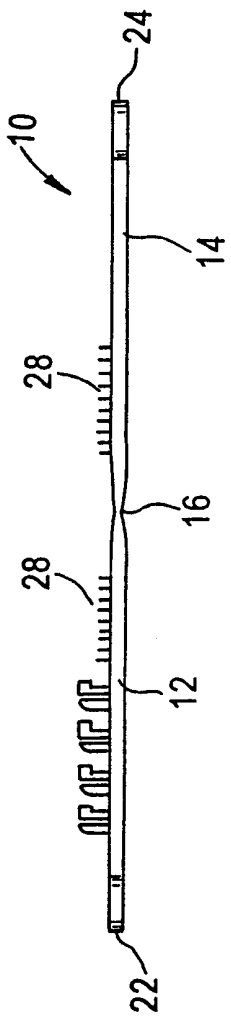

FIG. 2

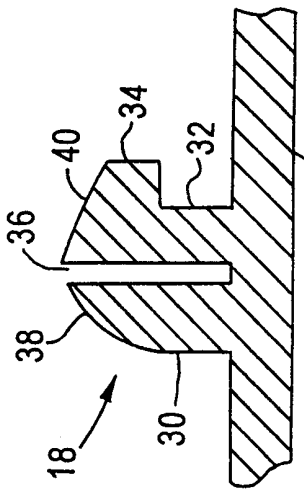

FIG. 3B

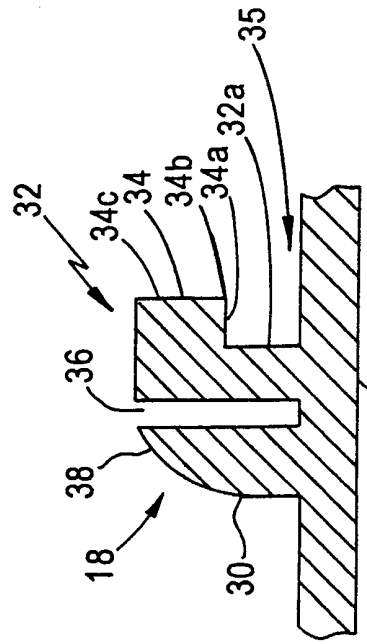

FIG. 3A

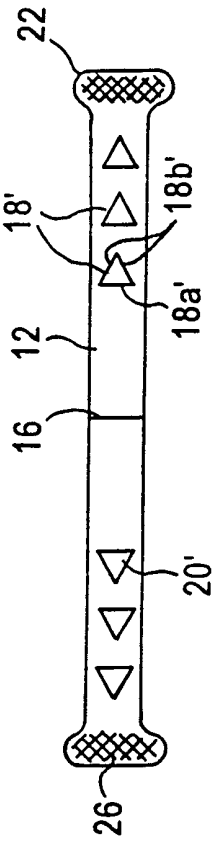

FIG. 3C

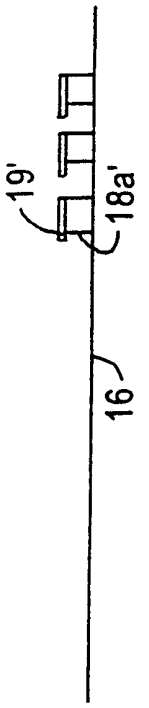

FIG. 3D

FIG. 3E

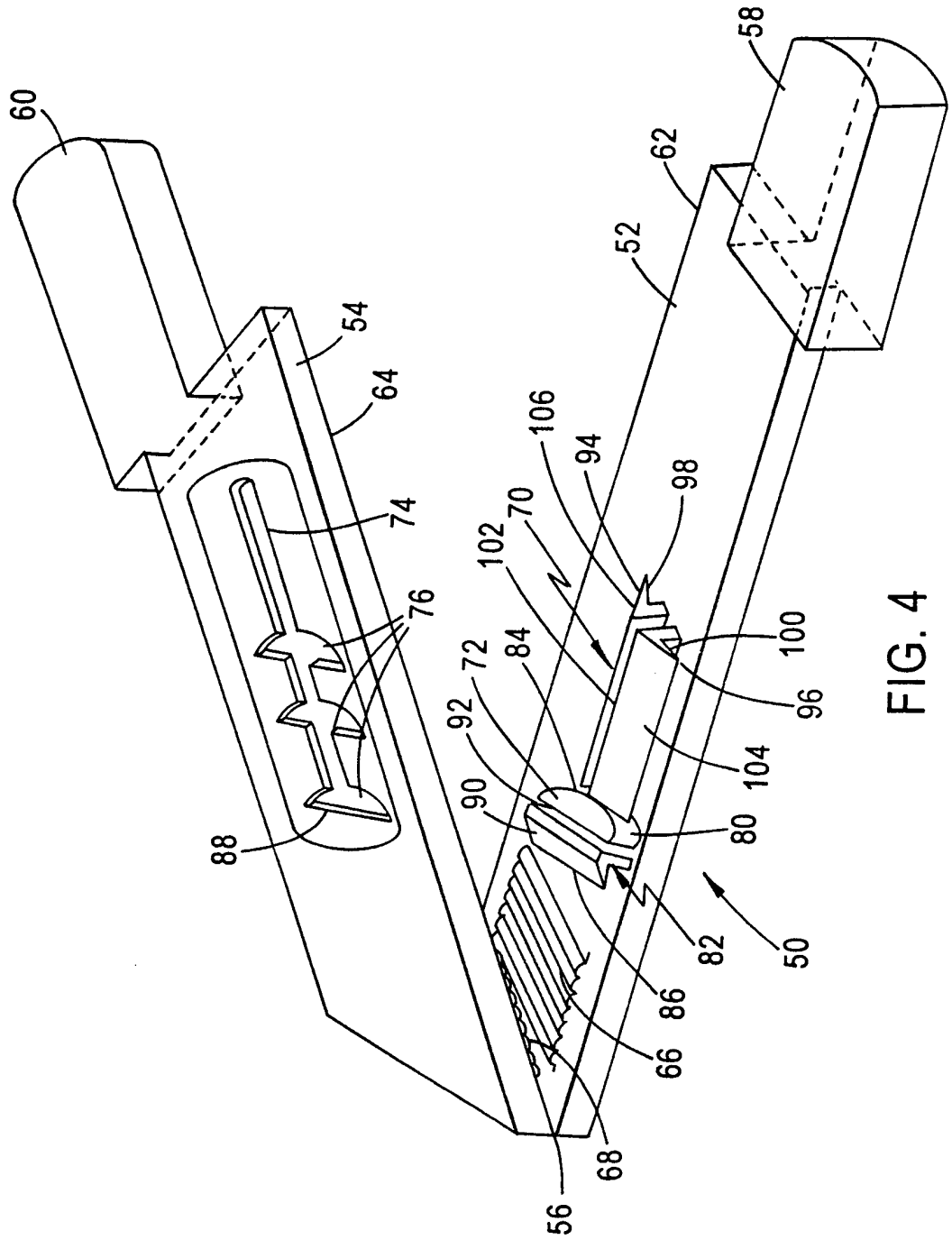
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FIG. 4

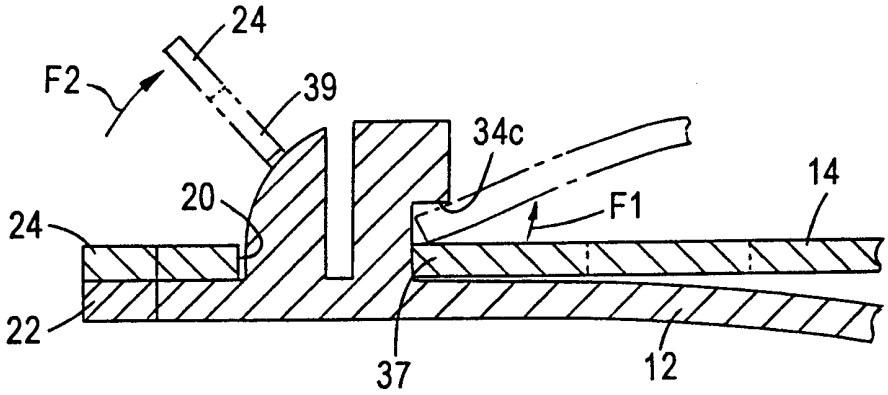


FIG. 5

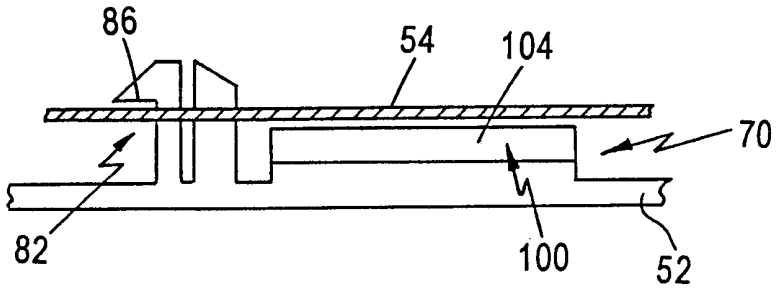


FIG. 6A

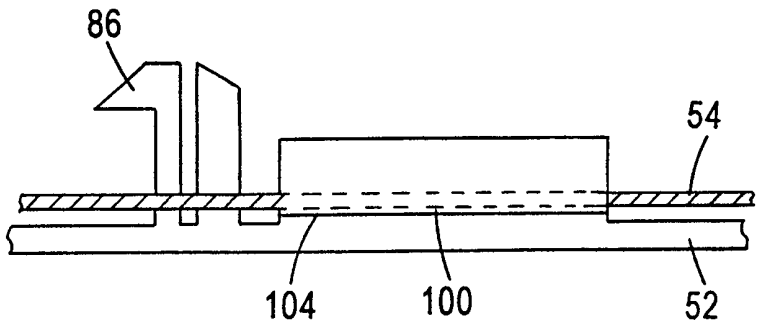


FIG. 6B

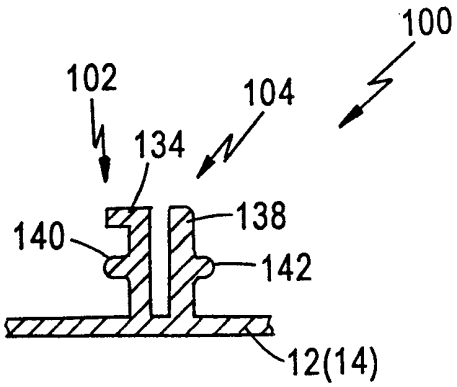


FIG. 7A

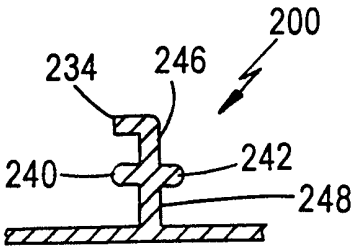


FIG. 8A

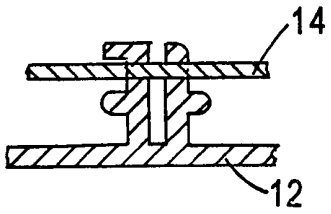


FIG. 7B

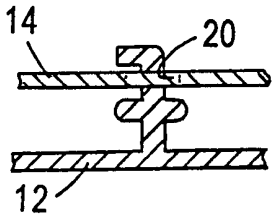


FIG. 8B

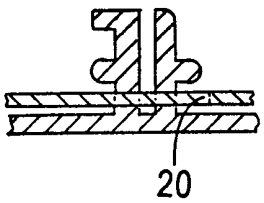


FIG. 7C

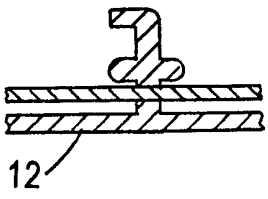


FIG. 8C

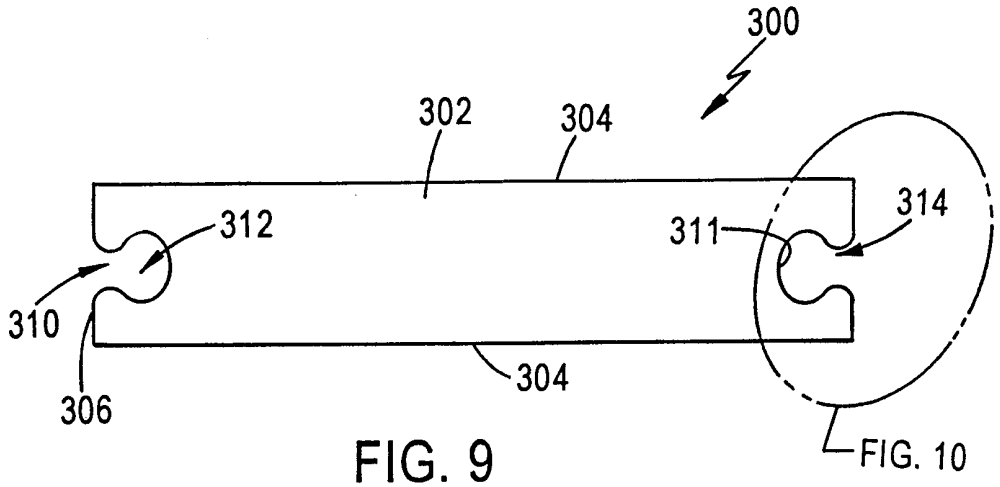


FIG. 9

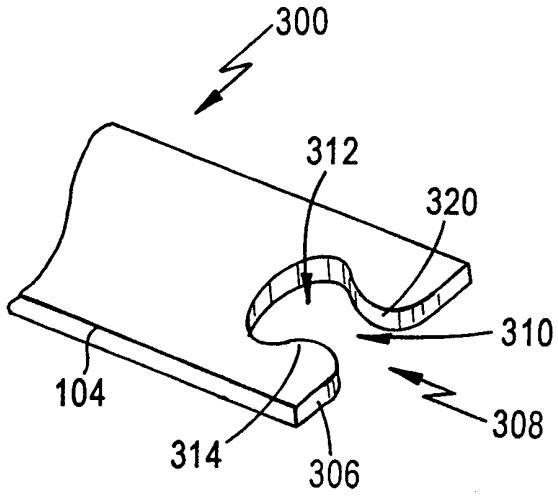


FIG. 10

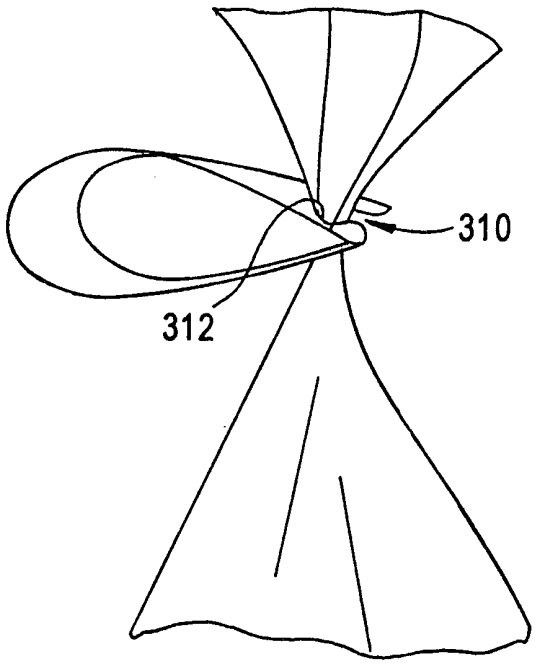


FIG. 10A

FIG. 11

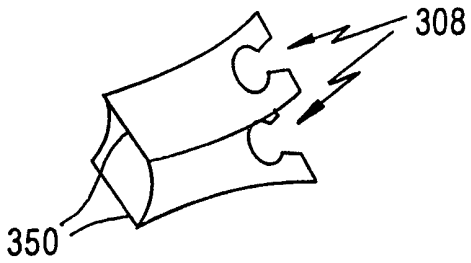


FIG. 12
(PRIOR ART)

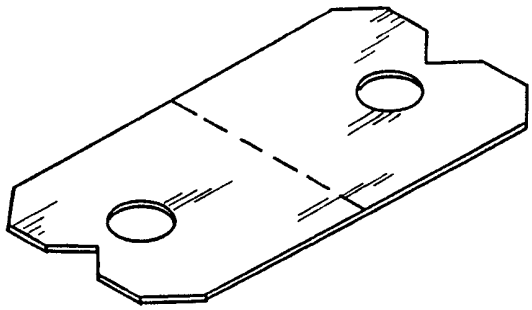
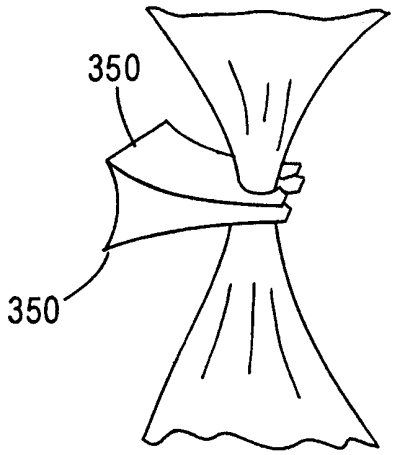


FIG. 13



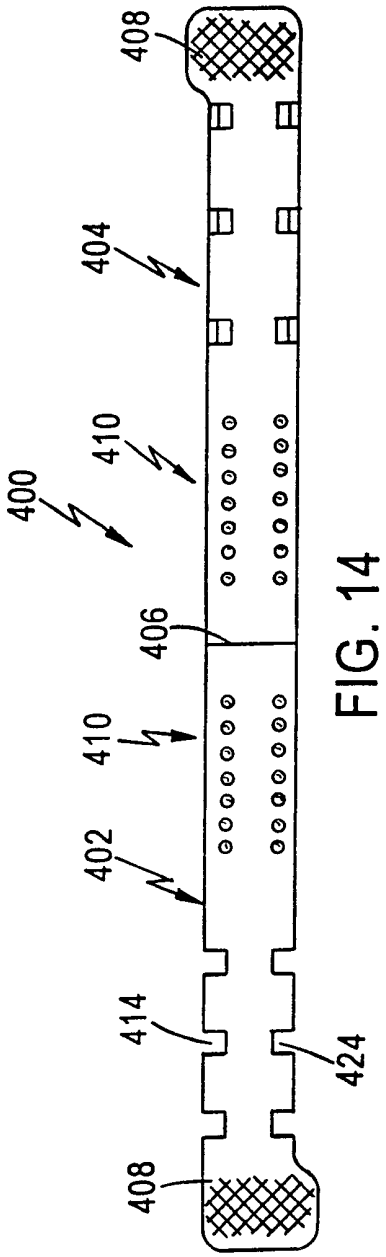


FIG. 14

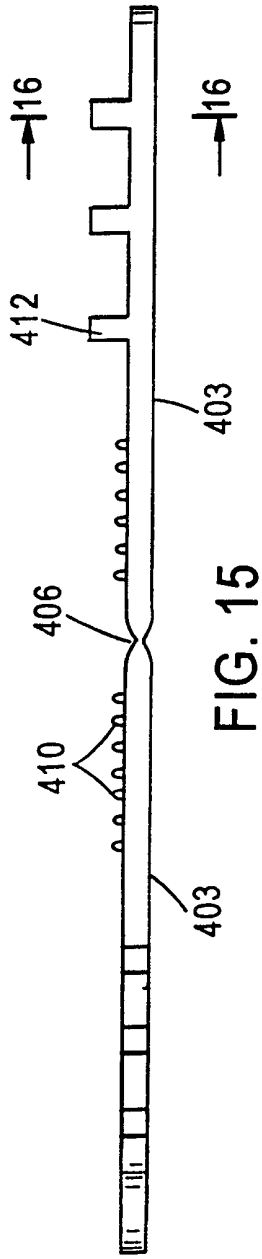


FIG. 15

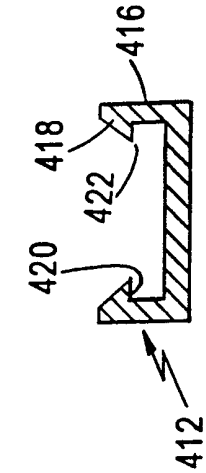


FIG. 16

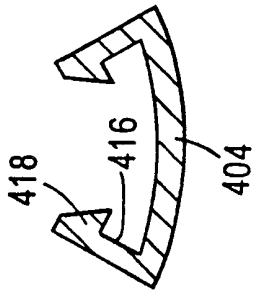


FIG. 17A

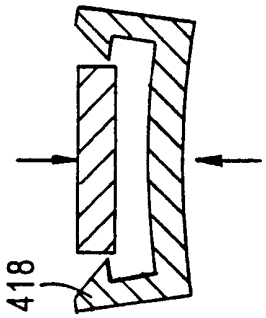


FIG. 17B

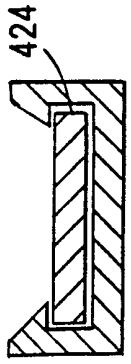


FIG. 17C

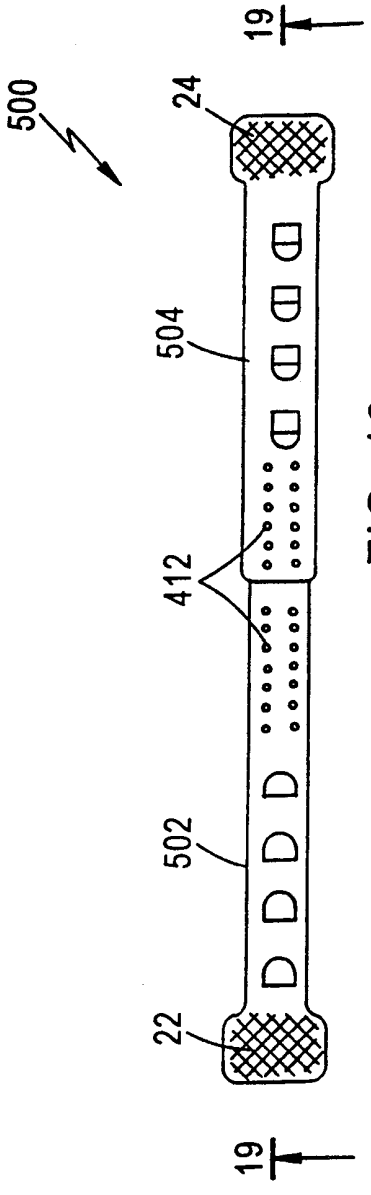


FIG. 18

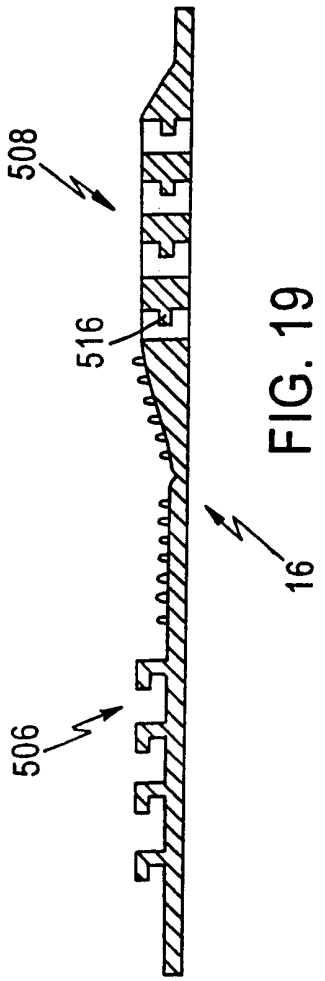


FIG. 19

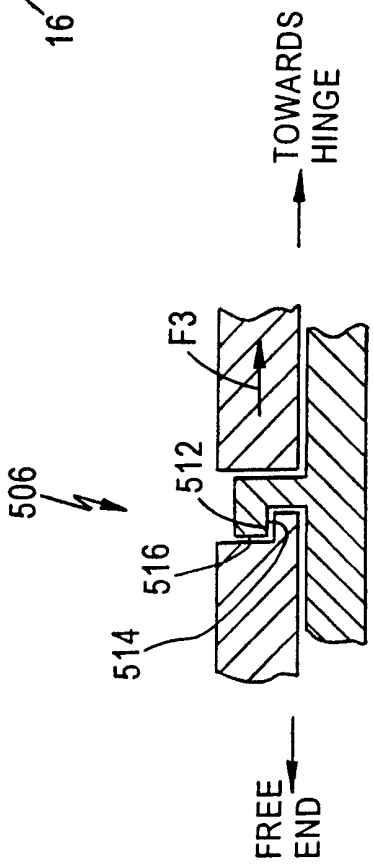


FIG. 20

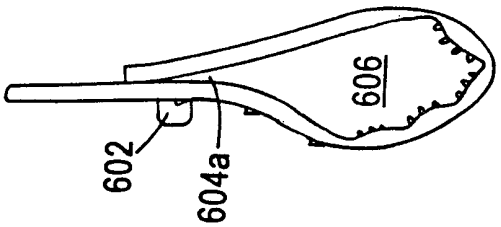


FIG. 24

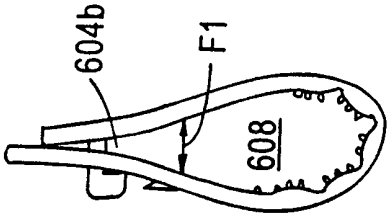


FIG. 25

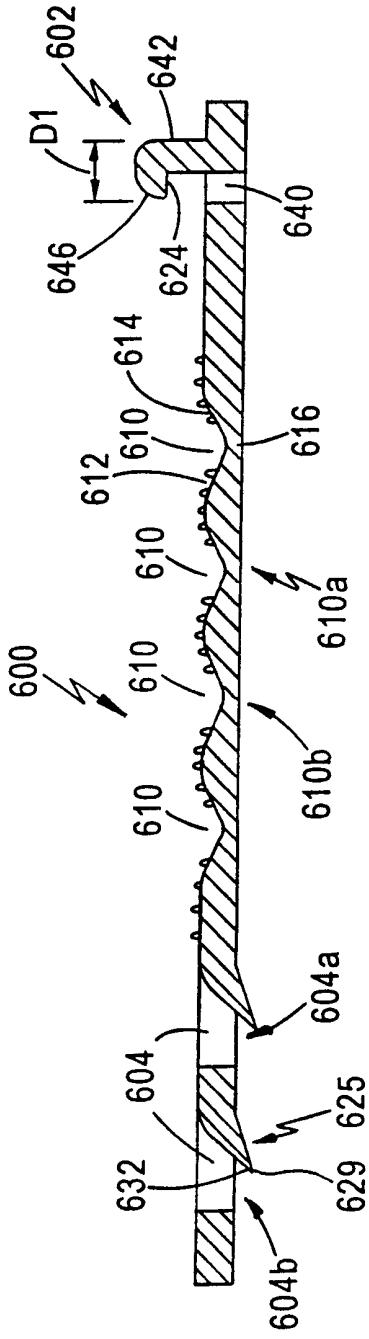


FIG. 21

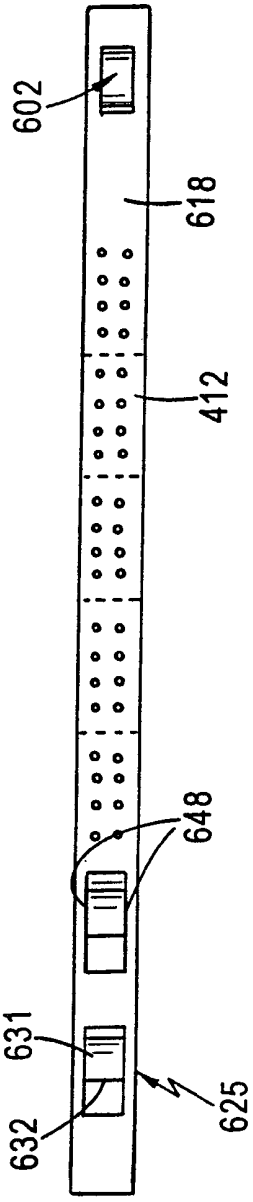


FIG. 22

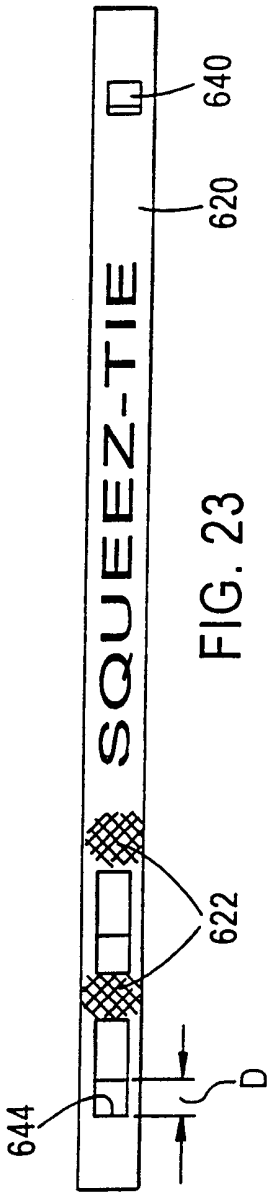


FIG. 23

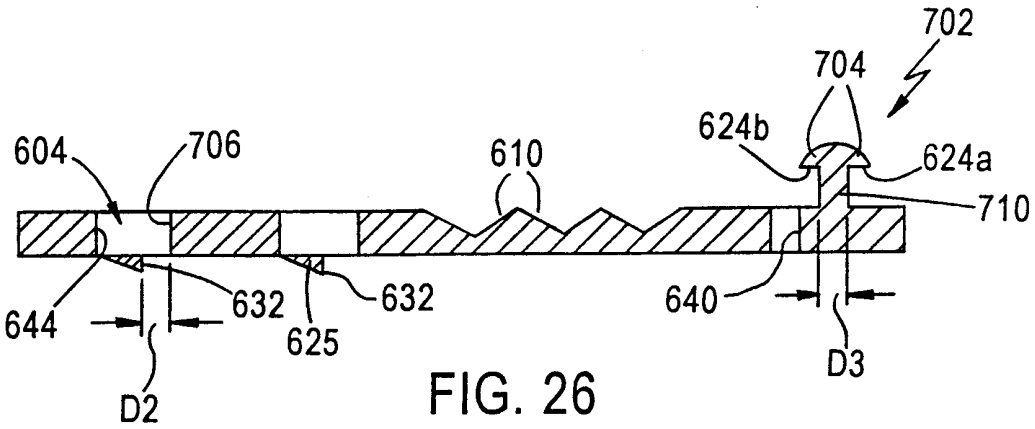


FIG. 26

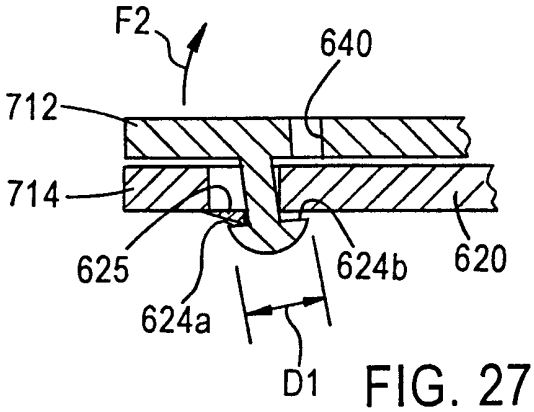


FIG. 27

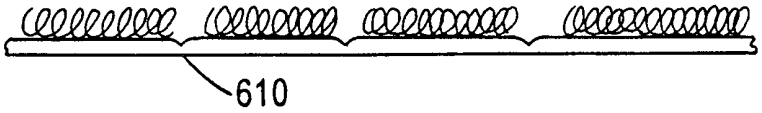


FIG. 28

FIG. 29

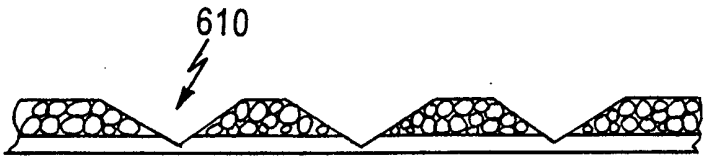


FIG. 30

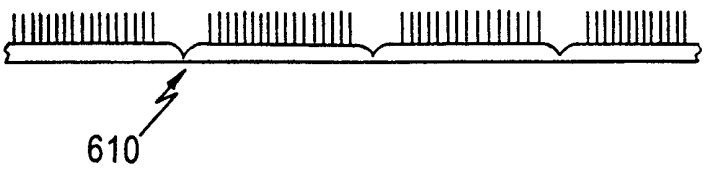


FIG. 31

FIG. 32

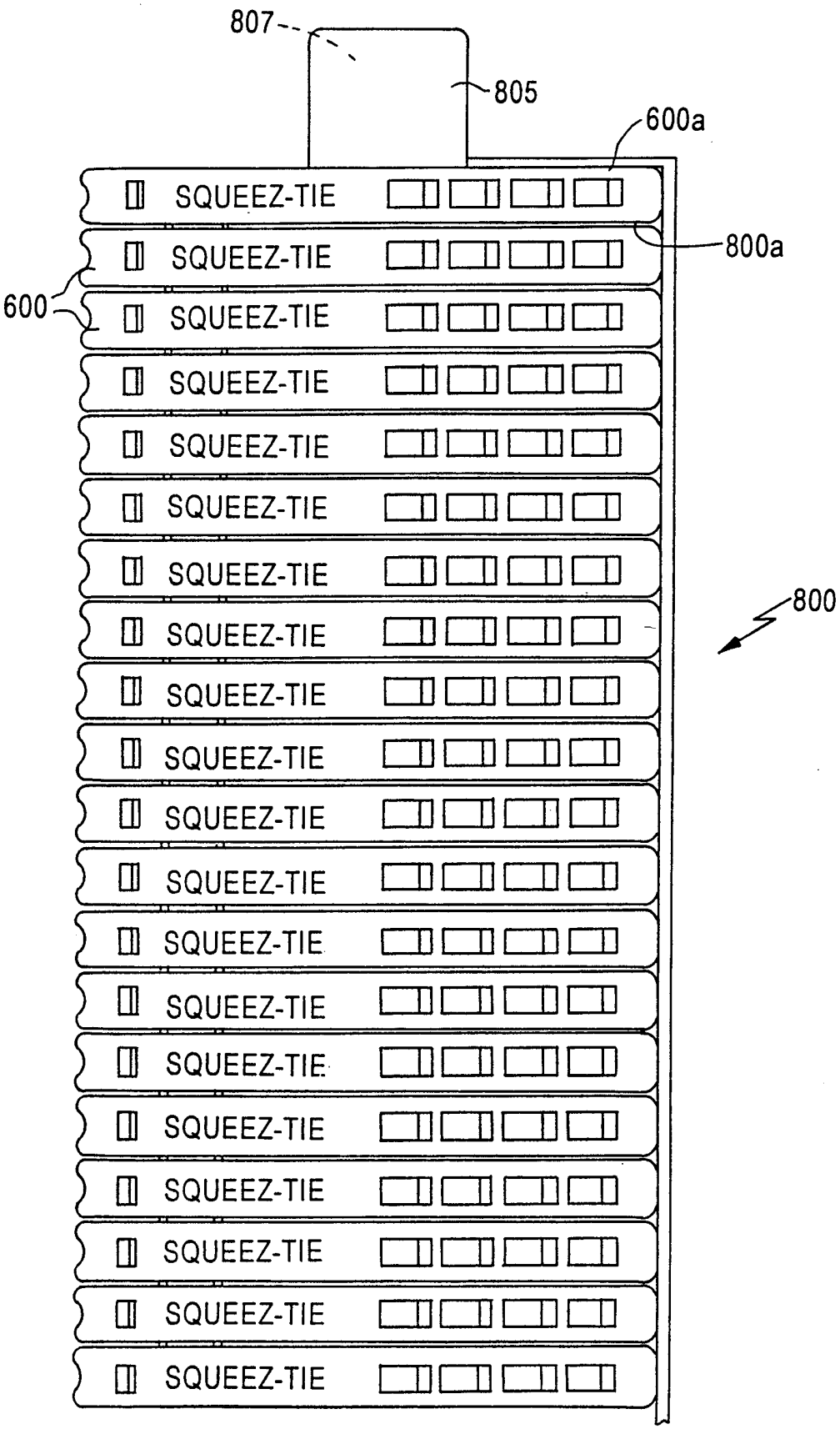


FIG. 33

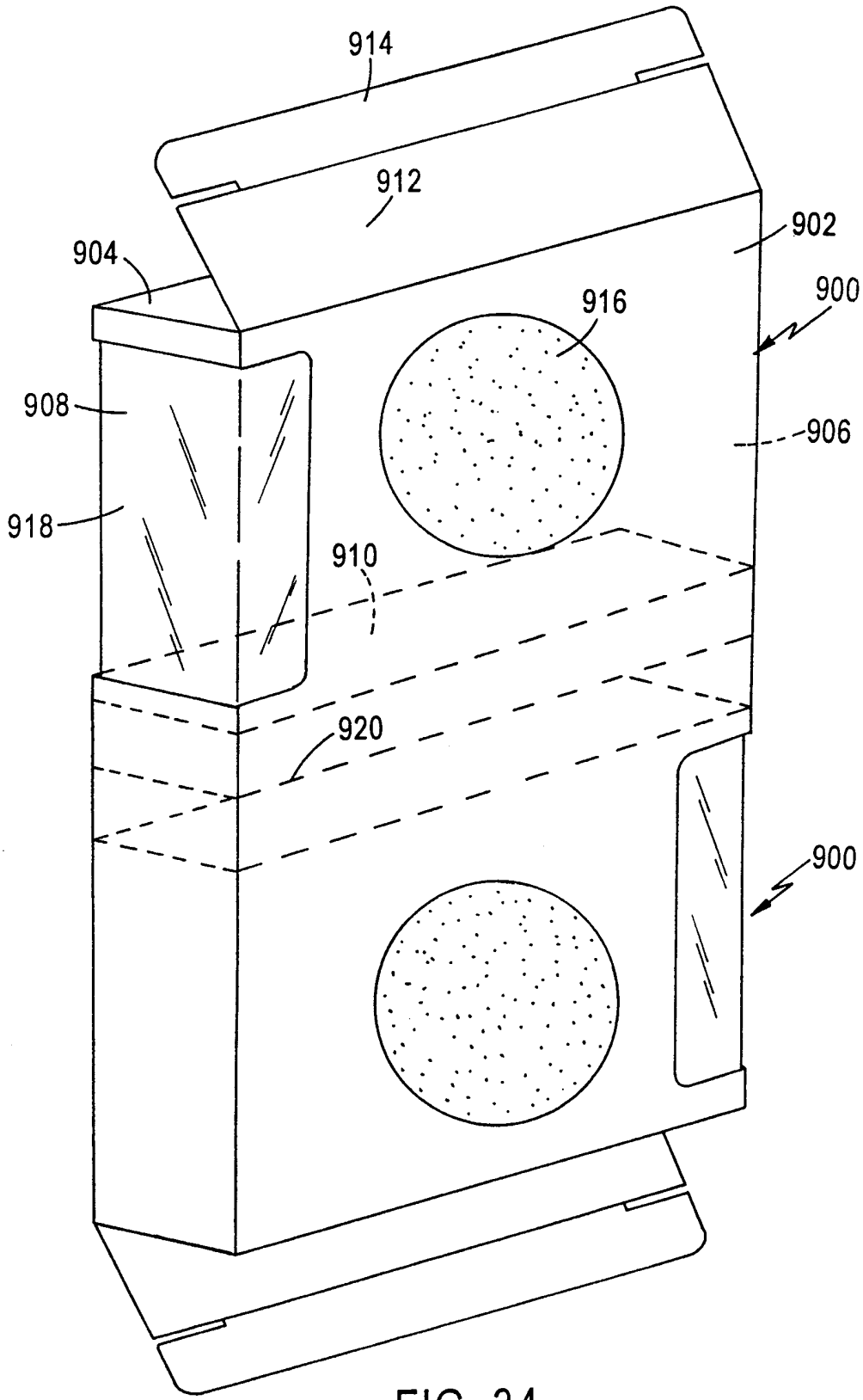


FIG. 34

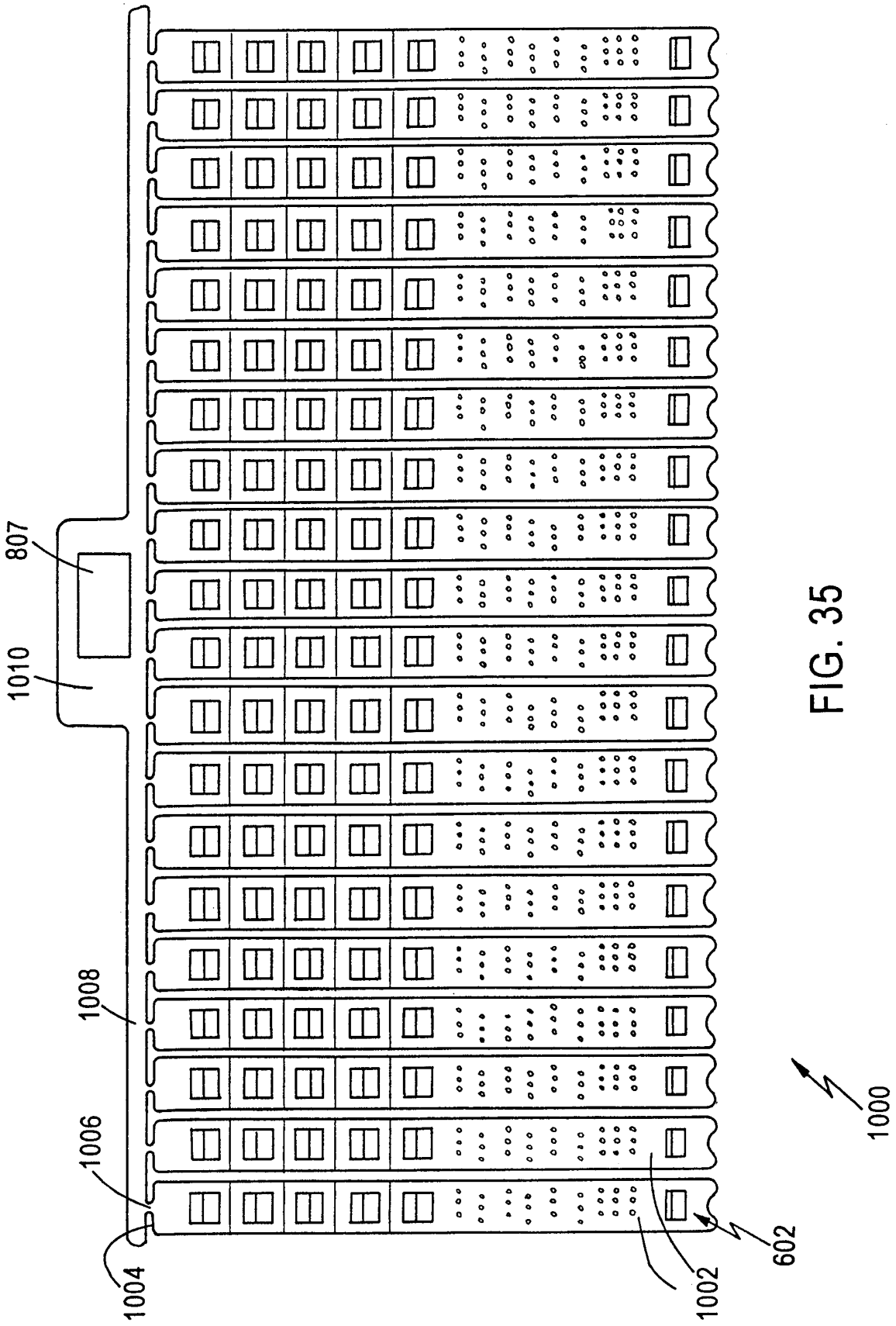


FIG. 35

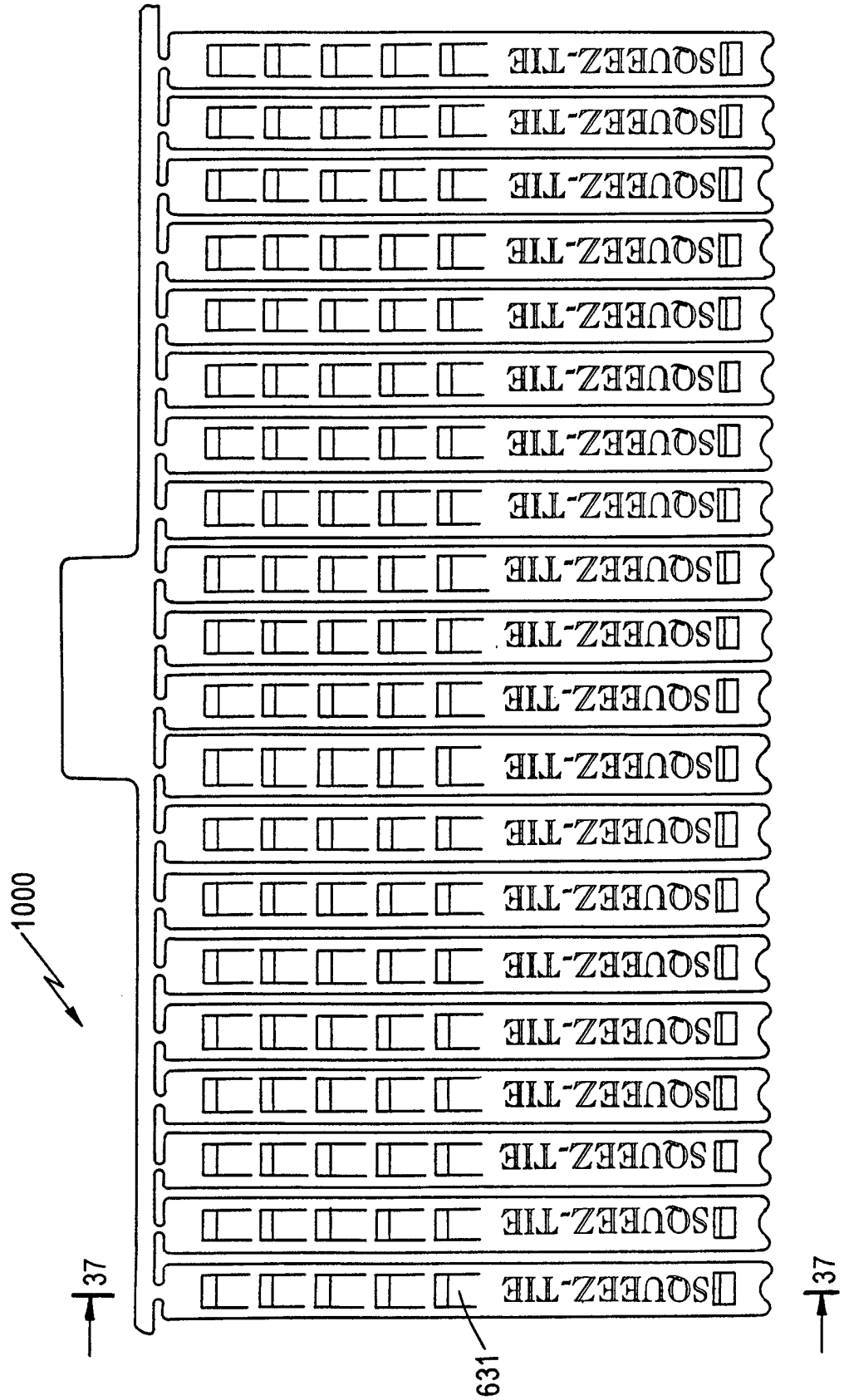


FIG. 36

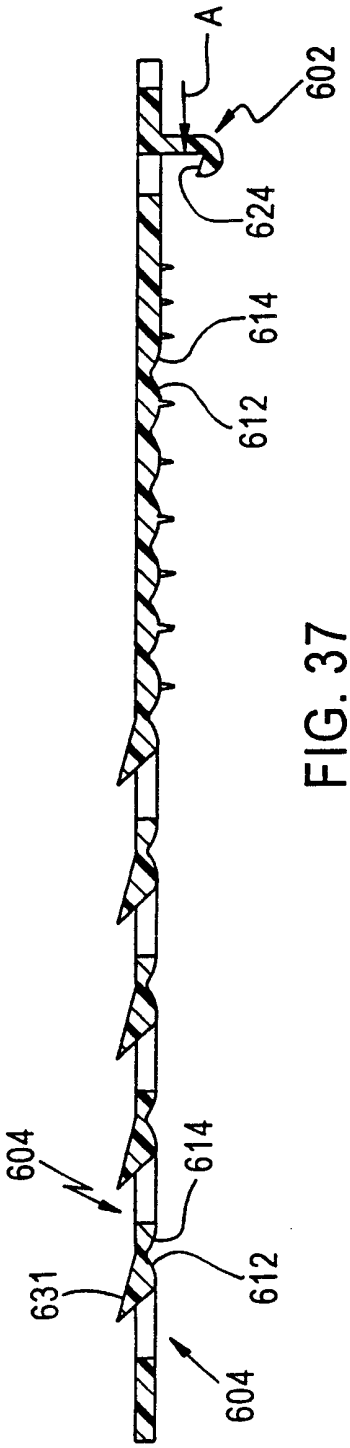


FIG. 37

FIG. 37A