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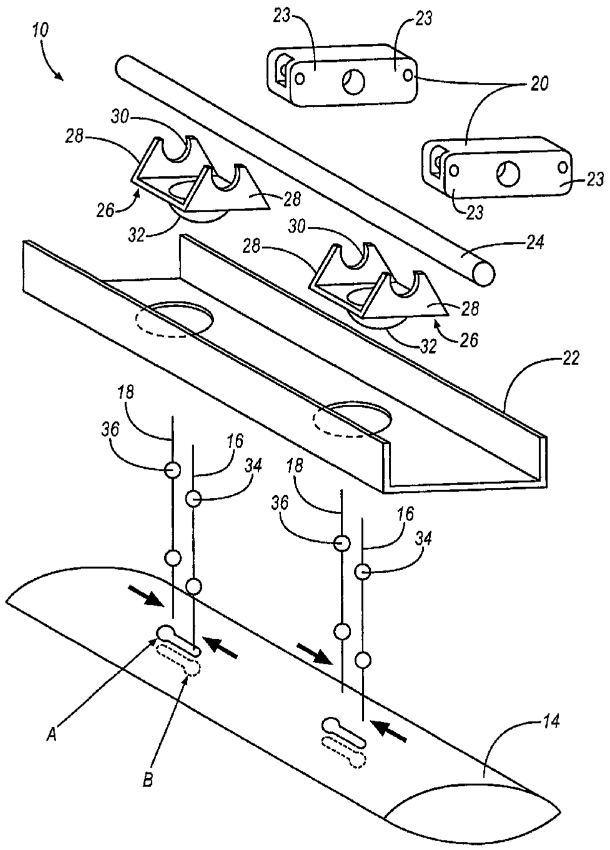
(54) **Title:** ACTUATOR DEVICE AND METHOD OF MANUFUCATURING CELLS FOR VIEW THROUGH WINDOW COVERING



(57) Abstract: An actuator device is provided for use in a view-through window covering having a plurality of cells. The actuator device includes at least one cooperating pair of control members including a first control member that engages an upper portion of each cell and a second control member that engages a lower portion of each cell. The cooperating pair of control members are engaged with the cells along a plane parallel to the plane of the window covering, whereby relative movement of the control members modifies the size of the space between the cells. A cell and method of manufacturing a cell for a multi-cell window covering is also disclosed. The method includes the steps of providing a flexible material, stiffening a portion of the flexible material, and creating at least one control engagement formation and at least one control clearance formation in axially extending sections of the stiffened flexible material that will become an upper portion and a lower portion of the cell. The method is further defined by folding the flexible material to create a closed element and securing the flexible material to itself to maintain the shape of the closed element.

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ACTUATOR DEVICE AND METHOD FOR MANUFACTURING A VIEW THROUGH WINDOW COVERING

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention generally relates to window coverings and treatments. More specifically, the present invention relates to an actuator device suitable for use with an adjustable view-through cellular shade or window covering, the cells of a multi-cell window covering and a method for manufacturing the cells of a multi-cell window covering.

Description of the Related Art

[0002] Partly in response to the limitations inherent in traditional window coverings like venetian blinds, fresh window coverings and treatments, such as multi-cellular shades, were developed and welcomed by consumers. In the broad sense, a cellular shade is a pleated window covering having a plurality of cells arranged adjacent to one another. The adjacent cells are bonded at their edges to form a complete sheet for the window covering. These multi-cellular shades provide significant insulating value, uniform light diffusion and a desirable aesthetic presentation, but they typically have no view-through capability. Unlike traditional venetian blinds, which provide easy modulatable view-through and light control by simply adjusting the orientation of the horizontally disposed slats or vanes, traditional multi-cellular shades are not capable of separating the plurality of cells, thus preventing a view-through option. Therefore, in order for a person to see through a window that is outfitted with a traditional multi-cellular shade, it is necessary to collectively raise and gather the plurality of cells, i.e., raise the entire window covering. However, raising the whole cellular window shade is laborious and time consuming.

[0003] In light of the advantages of venetian blind and multi-cellular window shades, a hybrid window covering was developed that provides the characteristics of both a venetian blind and a multi-cellular window covering. This hybrid window covering includes a plurality of cells arranged parallel to one another. Each cell has at least one side, and a joint unites adjacent sides of each cell. The adjacent sides are pivotable about the joint such that each cell is variably adjustable between a collapsed position and an expanded position. By collapsing and expanding the cells, the window covering can achieve adjustable light-control, modulatable view-through, light diffusion, and excellent insulation value, all in an aesthetically pleasing design.

[0004] Included in this hybrid window covering is a means for variably adjusting the cells between the collapsed position, where adjacent cells are separated, and the expanded positioned, where adjacent cells contact one another. The adjustment means typically includes a pair of cords that engage and actuate the cells between the collapsed and expanded positions. Due to the structure of the cells, the relative position of the cords in each pair is not fore-and-aft (i.e., perpendicular to the plane of the window covering), as in a conventional venetian blind, but rather is parallel to the plane of the window covering for central, balanced lifting and lowering of the upper and lower portions of each cell. A series of beads or other suitable attachment elements are secured to the cords and are engaged with one or more surfaces of the cells during manufacture.

[0005] One limitation to positioning the cords along a common plane with the width of the cells is that the cords generally do not function properly with conventional head-rail mounted adjustment mechanisms. More specifically, twisting the cords from the fore-and-aft spacing in a conventional head-rail to a position substantially parallel with the window covering plane creates an uneven motion between the cords during adjustment. This uneven motion causes the cells' weight to be lifted or dropped during adjustment of the cells. Thus, the cells tend to jump away from the adjustment mechanism as the cells collapse and strongly resist or load the adjustment mechanism as the cells expand.

[0006] Figure 1 of the drawings illustrates an exemplary window treatment employing the cell and cord arrangement described above. Note that in location "A," the upper surface of the cell includes a relatively small bead-engaging aperture aligned vertically with a larger cord clearance aperture on the lower surface of the cell. Alternatively, at location "B," the relatively small bead-engaging aperture is located on the lower surface of the cell and the larger cord-clearance aperture is located on the upper surface of the cell. Manufacturing alternating apertures on the upper and lower surfaces of a pre-manufactured, multi-surface cell is generally impractical, as it would require a separate manufacturing operation on the upper and lower surfaces of the cell. The difference in aperture size alone, regardless of the orientation between dissimilar apertures, renders their formation difficult with conventional punch tooling. In such a manufacturing operation, custom tooling is required to make a two-stage cut in the cell. Additionally, the scrap material from the punched upper aperture is likely to be retained in the cell, having no sufficiently sized hole in the lower surface of the cell to drop through.

SUMMARY OF THE INVENTION

[0007] An actuator device is provided for use in a view-through window covering having a plurality of cells. The actuator device includes at least one cooperating pair of control members including a first control member that supports an upper portion of each cell and a second control member that supports a lower portion of each cell. The cooperating pair of control members support the cells along a plane parallel to the plane of the window covering. Relative movement of the control members modifies the size of the space between the cells.

[0008] The actuator device may also include an actuator mechanism selectively operable to create opposite movement of the first and second control members. A guide member may also be provided between the actuator mechanism and the control members to transition the control members from being aligned substantially perpendicular to the window covering plane to being aligned substantially parallel with the window covering plane.

[0009] A cell and method of manufacturing a cell for a multi-cell window covering is also disclosed. The method begins with the step of providing a flexible material defined as an elongated member having axial and transverse directions. A portion of the flexible material is then stiffened to create at least one axially extending flexible junction. At least one control engagement formation and at least one control clearance formation are then created in axially extending sections of the stiffened flexible material that will become an upper portion and a lower portion of the cell. The flexible material is then folded to create a closed element and the flexible material is secured to itself to maintain the shape of the closed element.

[0010] The method of the present invention enables the manufacture of expandable and collapsible cells for a window covering, using common raw materials. The proposed method uses relatively inexpensive tooling to produce cells having distinct features in the upper and lower surfaces of the cells. The ability to create distinct features in the top and bottom surfaces of the cells enables the use of cords that selectively engage either the upper or lower portions of the cells at predetermined locations.

[0011] Various additional aspects of this invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiments, when read in light of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is an exploded perspective view showing an actuator device according to the principles of the present invention;

[0013] FIG. 2 is a side view of a window covering employing an actuator device according to an embodiment of the present invention, wherein a plurality of cells are arranged in an open (collapsed) position;

[0014] FIG. 3 is a side view of the window covering of FIG. 2, wherein the cells are arranged in a closed (expanded) position;

[0015] FIG. 4 is a cross-sectional view of a cord element and cord for use in expanding and collapsing the cells of the window covering of FIGS. 2 and 3;

[0016] FIG. 5 is perspective view showing the cord element of FIG. 4 relative to an opening in a cell;

[0017] FIG. 6 is a top view of a cradle and guide according to the present invention;

[0018] FIG. 7 is a side view of a window covering employing another embodiment of the actuator device of the present invention, wherein a plurality of cells are arranged in an open (collapsed) position;

[0019] FIG. 8 is a side view of the window covering of FIG. 7, wherein the cells are arranged in a closed (expanded) position;

[0020] FIG. 9 is a side view of a window covering employing another embodiment of the actuator device of the present invention, wherein a plurality of cells are arranged in an open (collapsed) position;

[0021] FIG. 10 is a cross-sectional view of a sliding cord element, fixed cord element and cord for use in expanding and collapsing the cells of the window covering of FIG. 9;

[0022] FIG. 11 is a side view of a window covering employing another embodiment of the actuator device of the present invention, wherein a plurality of cells are arranged in a closed (expanded) position;

[0023] FIG. 12 is a side view of a window covering employing another embodiment of the actuator device of the present invention, wherein a plurality of cells are arranged in a closed (expanded) position;

[0024] FIG. 13 is a plan view of a laminate prior to folding the laminate into a cell;

[0025] FIG. 14 is a side view of the laminate of FIG. 13 after folding the laminate into a cell; and

[0026] FIG. 15 is a simplified perspective view of an exemplary manufacturing line for manufacturing the cells of FIGS. 13 and 14.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] Referring now to the drawings, various embodiments of the present invention are described in detail. Referring to FIG. 2, an exemplary window covering 10 is shown within which an actuator device 12 according to the principles of the present invention may be advantageously employed. Window covering 10 may include a plurality of horizontally disposed elongated cells 14, all of which are preferably arranged parallel to one another. Each cell 14 is adapted to be expanded and collapsed so as to provide variable light control and see-through capability for window covering 10. FIG. 3 depicts cells 14 in the expanded position, wherein adjacent cells 14 are in contact with one another, while FIG. 2 depicts cells 14 in a partly collapsed position, wherein adjacent cells 14 are separated from one another. The design and configuration of window covering 10 is by way of example only and is not intended to limit the scope of the invention as claimed. Accordingly, the components of the exemplary window covering 10, more particularly cells 14, can be arranged and designed in a wide variety of different configurations.

[0028] In order to achieve the collapsibility and expandability of cells 14, actuation device 12 employs at least one cooperating pair of control members that are engaged with cells 14 along a plane parallel to the plane of the window covering. In the embodiment illustrated in FIGS. 1-3, the control members include a cooperating pair of cords, *i.e.*, a first cord 16 and a second cord 18. As illustrated in FIG. 1, it is contemplated that a plurality of cord pairs could be disposed along the length of cells 14, the number of pairs employed generally depending on the width of window covering 10. At their upper extreme, cords 16 and 18 are secured to an actuator mechanism that is housed in a head-rail 22. In the embodiment illustrated in FIGS. 1-3, the actuator mechanism is a rotatable member 20 that preferably includes a pair of integrally formed arms 23 to which cords 16, 18 are attached, but is not intended to be limited thereto. As will be described in further detail below, rotatable member 20 can be rotated in a direction that causes first cord 16 to move upward and second cord 18 to simultaneously move downward, and vice versa.

[0029] Actuator device 12 may include a plurality of rotatable members 20 corresponding in number to the number of cord pairs positioned along the width of window covering 10. Each rotatable member 20 is mounted on an axle 24, which in turn is supported by a plurality of cradles 26 that are positioned along the length of axle 24 proximate each rotatable member 20. As illustrated in FIG. 1, each cradle 26 is preferably a U-shaped structure defining a pair of spaced apart arms 28 each having a notch 30 that is sized to receive axle 24. Once assembled, each rotatable member 20 is disposed on axle 24 substantially between arms 28. Alternatively, rotatable member 20 may be provided to one side (i.e., cantilevered) relative to the two arms 28, or only one arm 28 may be employed per cradle 26, with the plurality of cradles 26 providing the required stability of axle 24.

[0030] Referring still to FIG. 1, each cradle 26 preferably includes a guide member or portion 32 that is disposed in an opening in head-rail 22. As will be described in detail below, guide portion 32 functions to re-position cords 16 and 18 from the fore-and-aft spacing at the connection with rotatable member 20 to a side-by-side spacing substantially parallel with the plane of window covering 10.

[0031] It will be appreciated that the means of moving cords 16, 18 is not limited to rotatable members 20 and that other actuator mechanisms may be employed in head-rail 22, such as those described in U.S. Patent No. 3,269,453, U.S. Patent No. 5,778,956 and GB 1,032,124 (the disclosures of which are incorporated herein in their entirety). For example, the actuator mechanism may include a cylindrical drum upon which cords 16, 18 are collected. In another example, the actuator mechanism may include pair of push rods within head-rail 22 to which cords 16, 18 are connected. The push rods are moveable along the length of head-rail 22 to move cords 16, 18 in opposing directions. A conventional rack-and-pinion arrangement could be provided to regulate movement of the push rods and a rotatable wand or control rod could be employed to rotate the pinion. In yet another example, rotatable members 20 may be mounted in head-rail 22 parallel with cells 14 such that no twisting of cords 16, 18 is necessary between cells 14 and rotatable member 20. A multi-axle drive mechanism would be required to drive rotation of the rotatable members 20 since, in this embodiment, rotatable members 20 would not share a common pivot axis.

[0032] Referring again to FIGS. 2 and 3, in order to adjust the shape of each cell 14, first cord 16 is adapted to support the lower portion 14A of each cell 14 and second cord 18 is adapted to support the upper portion 14B of each cell 14. By raising and lowering first cord 16 and second cord 18, each cell 14 can be expanded (see FIG. 3) or collapsed (see FIG. 2).

[0033] To support the lower portion 14A of each cell 14, first cord 16 includes a plurality of beads or cell engaging elements 34 positioned along its length. Elements 34 are preferably spaced equally apart, such as in a bead chain, and each element 34 is adapted to abut an outer surface of the lower portion 14A of a corresponding cell 14. When first cord 16 is raised, each element 34 presses upwardly against and "lifts" the lower portion 14A of its associated cell 14. This lifting action results in the collapsing of each cell 14, as illustrated in FIG. 2. Collapse of each cell 14 is further facilitated by the lowering of cord 18 (as described below), which occurs simultaneously with the raising of cord 16 due to the pivotal movement of rotatable member 20. In the fully expanded condition of each cell 14 (as shown in FIG. 3), elements 34 drop through an enlarged aperture in the next lower cell, so as not to interfere with the desired face-to-face contact between adjacent cells 14 in the fully closed or view-blocking condition of cells 14.

[0034] Similarly, second cord 18 includes a plurality of beads or cell engaging elements 36 positioned along its length. Each element 36 serves the function of providing support to the upper portion 14B of a corresponding cell 14. As illustrated in FIGS. 4 and 5, elements 36 are preferably formed like small spools having a slot 38 that is slightly larger than the wall thickness of a mating cell 14 and is preferably horizontally annular about each element 36. The upper and lower outer surfaces 37, 39 of elements 36 are preferably conical to facilitate entry into an opening 40 in cell 14. The above-described structure of element 36 is not intended to be limited thereto, but may include other configurations such as clips, knots, loops and the like.

[0035] Referring to FIG. 5, opening 40 includes a first portion 42 that is large enough for elements 36 to be inserted into, and a second smaller portion 43 separated from first portion 42 by a tapered channel 44. Connecting elements 36 to cells 14 is accomplished by inserting element 36 into first portion 42 of opening 40 and subsequently sliding element 36 into second portion 43. Although not required, connecting elements 36 with the upper portion 14B of each cell 14 at portions 43 advantageously reduces the tendency of cells 14 to flutter when collapsed or nearly collapsed.

[0036] As illustrated in FIG. 2, each element 36 is used to support each cell 14 from the upper portion 14B thereof. Therefore, when second cord 18 is raised along its longitudinal axis, each engaged element 36 supports each cell 14 from the upper portion 14B thereof, wherein each cell 14 tends to "hang" from its engaged element 36. By raising cord 18, each cell 14 is suspended from its upper portion, while the simultaneous lowering of cord 16 and associated elements 34 allows the lower portion to move downwardly, resulting in the expansion of cells 14.

[0037] Because the operative plane of cooperating cords 16 and 18 is substantially parallel with the plane of window covering 10, the expansion of cells 14 is effected by the relative raising of second cord 18 and lowering of first cord 16 without significant fore-and-aft rotation or tilting of any cell 14 (as opposed to the case of intended tilting in conventional venetian blinds). In achieving the collapsibility and expandability of cells 14, it is particularly preferred that the ratio of the stiffness of each cell juncture to the weight of each cell 14 be selected so as to facilitate cell expandability and collapsibility. More specifically, the stiffness to weight ratio should be such that when the cells are supported from the upper portion, the weight of each cell 14 is sufficient to facilitate the opening of the cell, and when cells 14 are supported from the lower portion, the stiffness of each cell is low enough to facilitate the collapsing of the cell. Accordingly, expansion of cells 14 is gravity-driven, requiring that cord 16 regulate the expansion of cells 14, not force it.

[0038] Referring to FIG. 6, guide portion 32 of cradle 26 preferably includes a pair of passages 46, each having a first region 48 large enough to allow passage of elements 34, 36 and a second region 50 that allows passage of cords 16 and 18, but not elements 34, 36. Second regions 50 are aligned in the operative plane of cords 16, 18 so that cords 16, 18 remain aligned in their operating location. Cords 16 and 18 extend up though guide portion 32 and are twisted from a plane substantially parallel with the plane of window covering 10 to a relative position substantially perpendicular to the window covering plane, wherein cords 16, 18 are attached to rotatable member 20. The attachment of cords 16, 18 to the ends of rotatable member 20 can be made in any of several known manners, including but not limited to, tying and crimping cords 16, 18 to a pair of posts 51 on rotatable member 20.

[0039] The upper and lower surfaces of each cell 14 remain substantially equidistantly spaced from the cell's central plane A-A with equal and opposite movement of cords 16 and 18. However, unequal movement of cords 16, 18 undesirably causes the cells to lift and fall as a whole rather than a balanced expansion or collapse of each cell 14. Unequal movement of cords 16, 18 is typically due to a relatively large change in the angle of cords 16, 18 relative to guide portion 32 as rotatable member 20 rotates.

[0040] To limit the angular change of cords 16, 18 relative to guide portion 32, the distance between posts 51 on rotatable member 20 is preferably not less than about twice the distance between elements 34 and 36 in a single cell 14 when cells 14 are collapsed. In the embodiment of FIG. 2, the suggested distance restricts the rotation angle of rotatable member 20 to less than about thirty degrees above and below horizontal for full actuation of cells 14 between the expanded and collapsed positions. Additionally, the axis of rotatable member 20 should be raised above guide portion 32 not less than approximately one-half the distance between posts 51 or approximately the distance between elements 34 and 36 in a single cell 14 when cells 14 are collapsed. Such a restriction limits the angular change of cords 16, 18 relative to guide portion 32 as rotatable member 20 rotates.

[0041] Any conventional means may be employed to rotate axle 24, *e.g.*, a vertically rotatable wand or control rod, a slide stick or an electric motor (none shown). Additionally, as desirable in most window covering applications, a means of raising and lowering window covering 10 may be employed. One means of raising and lowering window covering 10 utilizes lift cords, which are separate from cords 16 and 18, to lift a bottom rail (neither shown) and cells 14 therebetween. The lift cords pass up through cells 14 and into head-rail 22 where they are wound around a turning guide that brings the lift cords into alignment within the head-rail. The lift cords pass through a cord lock in the head-rail and are tied together at a pull handle that is selectively operated to raise the bottom rail and cells 14.

[0042] Alternatively, the lift cords may be accumulated on and paid-out from axle 24 by fitting each rotatable member 20 with a slip clutch. In this embodiment, rotation of axle 24 in either direction initially rotates each rotatable member 20 to its limit. Thereafter, continued rotation of axle 24 causes each clutch to slip allowing the lift cord to be accumulated on or paid-out from axle 24 while rotatable member 20 is prevented from further rotation. This embodiment allows actuator device 10 and the means for raising and lowering window covering 10 to be controlled by a single user interface, such as a loop cord, rotatable wand and the like.

[0043] Referring to FIGS. 7 and 8, another embodiment of the present invention is shown in detail. In this embodiment, a window covering 110 is disclosed that is substantially similar to window covering 10 with at least one exception, namely, elements 36 are not connected with cells 14. Instead, elements 36 abut the upper portion of cells 14 from underneath similar to the manner in which elements 34 abut the lower portion of cells 14. Supporting the upper portion of cell 14 in this manner eliminates the need to individually connect elements 36 with cells 14 during manufacture. In another embodiment of the present invention (not illustrated), elements 34 and 36 are both connected to the lower and upper portions of cells 14, respectively, in a manner substantially similar to that described above.

[0044] Referring to FIG. 9, another embodiment of the present invention is shown in detail. In this embodiment, a window covering 210 is disclosed that is substantially similar to window covering 10 with at least one exception, namely, first cord 16 includes two elements per cell 14 instead of the one element 34 described above. More specifically, for each cell 14, first cord 16 includes a fixed element 60 and a sliding element 62. As illustrated in FIG. 10, sliding element 62, which is substantially similar in structure to element 36 described above, includes an interior channel 64 that is slightly larger in diameter than the diameter of cord 16. Interior channel 64 allows sliding element 62 to slide freely on cord 16, while remaining aligned with the orientation of cord 16.

[0045] Sliding element 62 may be made by separately manufacturing two discrete halves and attaching the halves together around cord 16. Alternatively, sliding element 62 may be molded onto cord 16 at the same time fixed elements 60 are molded around cord 16. In this manner, a thin tubular member (not shown) is temporarily inserted between cord 16 and sliding member 62 during the molding operation. The tubular member is removed after sliding member 62 is molded around cord 16 to create interior channel 64.

[0046] Like element 36 described above with respect to cord 18, sliding element 62 is connected to its mating cell 14. In contrast, fixed element 60 is affixed to cord 16 and supports sliding element 62, which rests on top of fixed element 60 unless otherwise disturbed. In this manner, the lower portion 14A of each cell 14 is indirectly supported and laterally guided, but not vertically positioned by fixed element 60 during closure. While sliding elements 62 provide no vertical positioning of cells 14, each sliding element 62 functions to resist tilt and flutter of its mating cell 14. Thus, a third cord (not illustrated) may be used to guide sliding elements 62, instead of using cord 16 to guide both sliding elements 62 and move fixed elements 60. The upper portion 14B of each cell 14 preferably remains fully engaged with element 36, to provide uniform cell spacing and flutter resistance.

[0047] Referring to FIG. 11, another embodiment of the present invention is shown in detail. In this embodiment, the axis of rotatable member 20 is raised above guide portion 32 a distance significantly greater than the spacing between elements 34 and 36 in a single cell 14 when cells 14 are collapsed. In this embodiment, the angle of cords 16 and 18 relative to guide portion 32 is reduced as compared to the embodiment illustrated in FIGS. 2 and 3, resulting in a smaller angular change in cords 16, 18 relative to guide portion 32 as rotatable member 20 rotates.

[0048] Referring to FIG. 12, another embodiment of the present invention is shown in detail. In this embodiment, rotatable member 20 includes a pair of arc-shaped cam members 52. Cam members 52 arc about the center of rotation of rotatable member 20 so that rotation of rotatable member 20 does not substantially change the angle of cords 16, 18 relative to guide portion 32.

[0049] As illustrated in FIG. 13, a single cell 14, according to an embodiment of the present invention, is fabricated from a strip of a flexible material 76, such as a woven fabric. In a first manufacturing step, flexible material 76 is stiffened, such as by applying a curable stiffening compound to flexible material 76, or by laminating flexible material 76 with at least one stiffening member 78, such as, for example, a narrow strip of plastic film, stiffened fabric or metal ribbon.

[0050] In an exemplary embodiment of the present invention, flexible material 76 is laminated with at least two stiffening members 78, each spaced a predetermined distance apart, to form a laminate 80. Optionally, for aesthetic reasons, at least one of stiffening members 78 may be colored prior to laminating flexible material 76. The colored stiffening member(s) 78 is secured to flexible material 76 in an area that will be visible from within a room where the window covering is extended. Because the flexible material

76 selected may be translucent, the colored stiffening member(s) is visible through the material, permitting cells 14 of the window covering to match the décor of the room.

[0051] Preferably, for reasons that will be explained below, the stiffening members that help form the upper and lower portions of cells 14, depicted as stiffening members 79 in FIG. 13, are a substantially rigid, yet formable material, such as metal. The gaps 82 provided between stiffening members 78, 79 permit flexible material 76 to act as a living hinge, allowing laminate 80 to be folded into a multi-sided tubular element 84. A closure seal 86, such as an adhesive or double sided tape, is provided between opposing edges 88, 90 of laminate 80 to retain tubular element 84 in tubular form. The joint between edges 88, 90 may be created as an overlapping joint, as illustrated in FIG. 14 or, alternatively, a butt-type joint (not shown).

[0052] In the process of manufacturing tubular element 84, it is desirable to maximize the longitudinal bending stiffness of laminate 80 to minimize the number of pairs of support cords 16, 18 needed to support cells 14 in window covering 10. Referring to FIG. 15, to increase the bending stiffness of laminate 80, stiffening members 79 are roll-formed or otherwise processed by a forming device 89 to give stiffening members 79 a curved, transverse cross-sectional shape (not illustrated). Forming the metal stiffening members 79 in this manner increases their effective section modulus, thereby increasing the longitudinal bending stiffness of laminate 80 as a whole. Alternatively, stiffening members 79 may be formed with a slight curve prior to laminating flexible material 76, particularly when stiffening members 79 are made from materials other than metal.

[0053] Prior to closing cell 14, stiffening members 79 are punched with a series of openings 40 by a punching tool 91. The spacing between openings 40 is generally a function of the bending stiffness of cells 14 and the relative vertical position of cords 16, 18. Because the portions of laminate 80 that will later become aligned at each location in top and bottom arrangement are, at this step, side-by-side transverse to the length of laminate 80, the punching operation can be accomplished simultaneously with one tool for both top and bottom openings 40. Alternatively, openings 40 may be created in laminate 80 by slitting, stitching or otherwise forming an engagement feature in laminate 80 for receiving elements 34, 36 or allowing passage of cords 16, 18. In addition, punching of adjacent openings 40 can also be achieved either simultaneously or in timed sequence with multiple punching tools, instead of the single punching tool described above.

[0054] The punched laminate 80 is then moved over a series of guides 92 that fold laminate 80 along at least two predetermined hinge lines, bringing the upper and lower surfaces of laminate 80 into an over-and-under position, as shown in FIG. 15. Closure seal 86 is then adhered to opposite edges of laminate 80, in an overlapping manner, to form the closed element 84. The cross-sectional profile of closed element 84 and finished cells 14 are not limited to the profile shown in FIGS. 2 and 3. It will be appreciated that the method of the present invention may be used to manufacture cells having different cross-sectional profiles, including, but not limited to, the cells disclosed in U.S. Patent No. 5,680,891 to Kendall Prince.

[0055] Referring still to FIG. 15, each closed element 84 is then directed through a shearing machine 94, which is continuously timed by a measurement of the position of laminate 80, so as to be in register with the position of the punched openings 40. The position of laminate 80 may be continuously determined, for example, by a conventional encoder on pulling rolls 96, which act to pull laminate 80 through the manufacturing line, or by other means known in the art. This shearing operation generates a plurality of cells 14 with regularly spaced openings 40, symmetrically located between the sheared ends of cells 14. Cells 14 may then be strung together with cords 16 and 18, as described above, and attached to the actuator mechanism in head-rail 22 to form window covering 10. Alternatively, closed element 84 may be sheared into discrete cells before punching, such as by using a set of substantially identical punches on a self-spacing pantograph linkage (none illustrated), to provide for substantially equal spacing of the punches between sheared ends.

[0056] The disclosed method enables the manufacture of expandable and collapsible cells for a window covering, using common raw materials. The proposed method uses relatively inexpensive and ordinary tooling to produce cells having distinct features in the upper and lower surfaces of the cells. The ability to create distinct features in the top and bottom surfaces of the cells enables the use of cords that selectively engage either the upper or lower portions of the cells at predetermined locations. Such selective engagement permits independent, but coordinated, control of the expansion and collapse of the cells in a cellular window covering.

[0057] Although certain preferred embodiments of the present invention have been described, the invention is not limited to the illustrations described and shown herein, which are deemed to be merely illustrative of the best modes of carrying out the invention. A person of ordinary skill in the art will realize that certain modifications and variations will come within the teachings of this invention and that such variations and modifications are within its spirit and the scope as defined by the claims.

CLAIMS

What is claimed is:

1. An actuator device for a window covering having a plurality of cells, comprising:

at least one cooperating pair of control members including a first control member that engages an upper portion of each cell and a second control member that engages a lower portion of each cell, the cooperating pair of control members being engaged with the cells along a plane substantially parallel to a plane of the window covering, whereby relative movement of the control members modifies the size of the space between the cells.

2. The actuator device of claim 1, wherein the first and second control members each comprise a cord having a plurality of cell-engaging elements spaced along their length.

3. The actuator device of claim 2, wherein one of the cell-engaging elements is positioned below a lower portion of each cell to selectively lift the lower portion of the cell to a collapsed position.

4. The actuator device of claim 3, wherein the cell-engaging element directly engages the lower portion of the cell.

5. The actuator device of claim 3, wherein the cell-engaging element positioned below the lower portion of each cell engages and lifts a mating element connected to the lower portion of the cell.

6. The actuator device of claim 2, wherein one of the cell-engaging elements is positioned immediately below an upper portion of each cell to abut the inner surface thereof to selectively lift the upper portion to an expanded position.

7. The actuator device of claim 2, wherein one of the cell-engaging elements is connected to the upper portion of each cell to selectively lift the upper portion to an expanded position.

8. The actuator device of claim 2, wherein one of the cell-engaging elements is connected to the lower portion of each cell to selectively push the lower portion to an expanded position.

9. The actuator device of claim 2, wherein at least one of the cell-engaging elements comprises a bead having opposing conical surfaces and a slot for receiving a portion of the cell.

10. The actuator device of claim 1, further including an actuator mechanism that is selectively operable to create substantially opposite movement in the vertical direction of the first and second control members.

11. The actuator device of claim 10, wherein the first and second control members are connected to the actuator mechanism in a plane substantially perpendicular to the window covering plane.

12. The actuator device of claim 10, wherein the actuator mechanism is configured to minimize unequal opposite movement of the control members.

13. The actuator device of claim 1, further including a guide member positioned to transition the first and second control members from being aligned substantially perpendicular to the window covering plane to being aligned substantially parallel with the window covering plane.

14. An actuator device for a window covering having a plurality of cells, comprising:

at least one cooperating pair of control members including a first control member that engages an upper portion of each cell and a second control member that engages a lower portion of each cell, the cooperating pair of control members being engaged with the cells along a plane substantially parallel to the plane of the window covering, whereby relative movement of the control members modifies the size of the space between the cells;

an actuator mechanism that is selectively operable to create substantially opposite movement of the first and second control members; and a guide member positioned to transition the first and second control members from being aligned substantially perpendicular to the window covering plane to being aligned substantially parallel with the window covering plane.

15. A method of manufacturing a cell for use in a multi-cell window covering comprising the steps of:

providing a flexible material defined as an elongated member having axial and transverse directions;

stiffening a portion of the flexible material to create at least one axially extending flexible junction;

creating at least one control engagement formation and at least one control clearance formation in axially extending sections of the stiffened flexible material that will become an upper portion and a lower portion of the cell;

folding the flexible material to create a closed element; and

securing the flexible material to itself to maintain the shape of the closed element.

16. The method of claim 15, wherein the stiffening step is further defined by applying a stiffening compound to the flexible material.

17. The method of claim 15, wherein the stiffening step is further defined by laminating at least one stiffening member to the flexible material.

18. The method of claim 17, wherein the stiffening member comprises one of a plastic film, a stiffened fabric and a metal ribbon.

19. The method of claim 17, wherein the flexible material is translucent and the stiffening member is colored prior to laminating the stiffening member to the flexible material.

20. The method of claim 15, wherein the step of securing the flexible material to itself is further defined by adhering a first edge of the flexible material to a second edge of the flexible material.

21. The method of claim 15, further including the step of cutting the closed element into cells of discrete length.

22. A cell for use in a multi-cell window covering comprising:

a flexible material defined as an elongated member having axial and transverse directions, a portion of the flexible material being stiffened to create at least one axially extending flexible junction, the flexible material having transversely opposed edges that are fixed together to form a closed element; and

at least one control engagement formation and at least one control clearance formation disposed in axially extending sections of the stiffened flexible material that will become an upper portion and a lower portion of the cell.

23. The cell of claim 22, wherein the flexible material is stiffened with a stiffening compound.

24. The cell of claim 22, wherein the flexible material is stiffened by laminating the flexible material with a stiffening member.

25. The cell of claim 25, wherein the stiffening member comprises one of a plastic film, a stiffened fabric and a metal ribbon.

26. The cell of claim 25, wherein the flexible material is translucent and the stiffening member is colored.

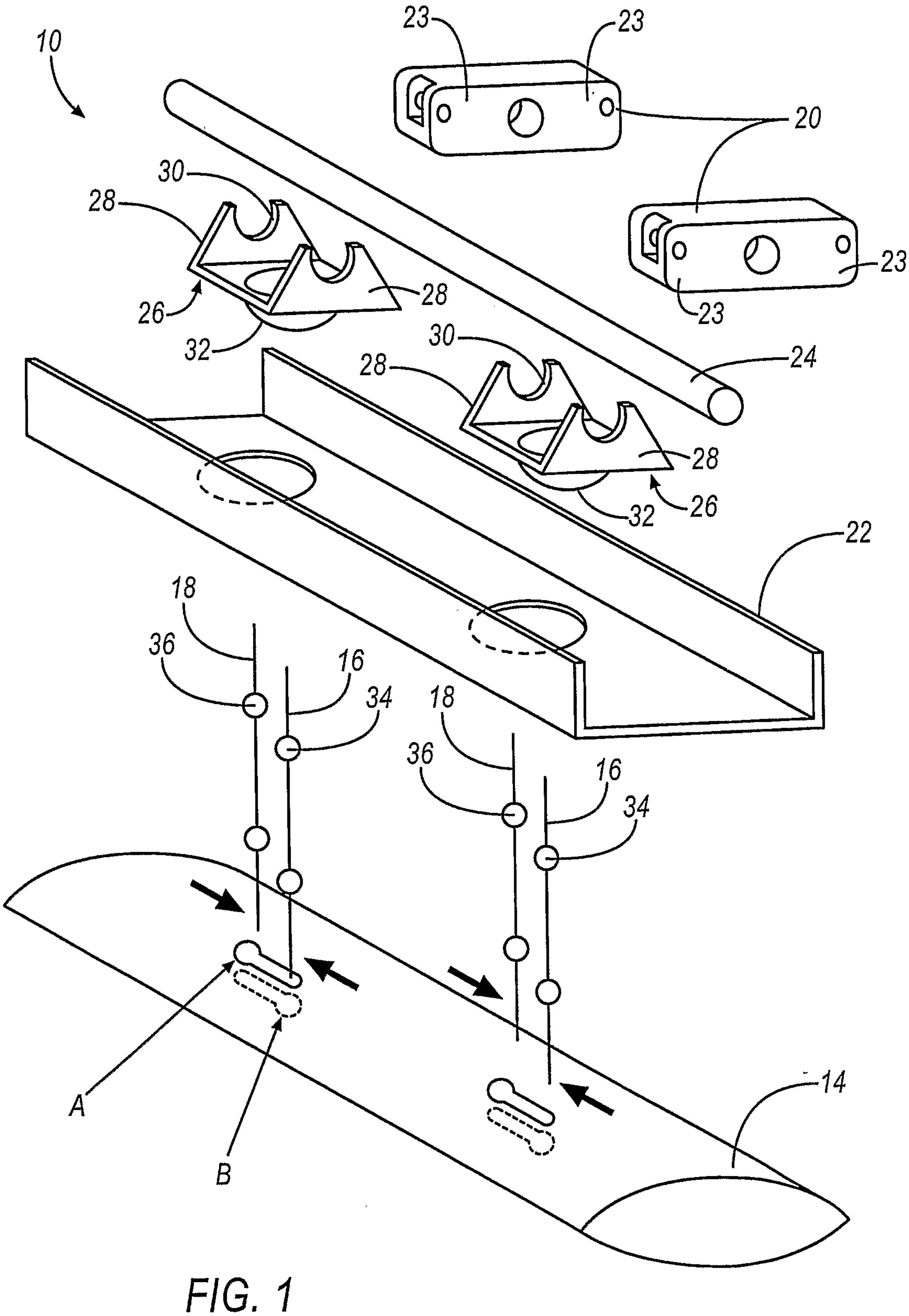
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FIG. 1

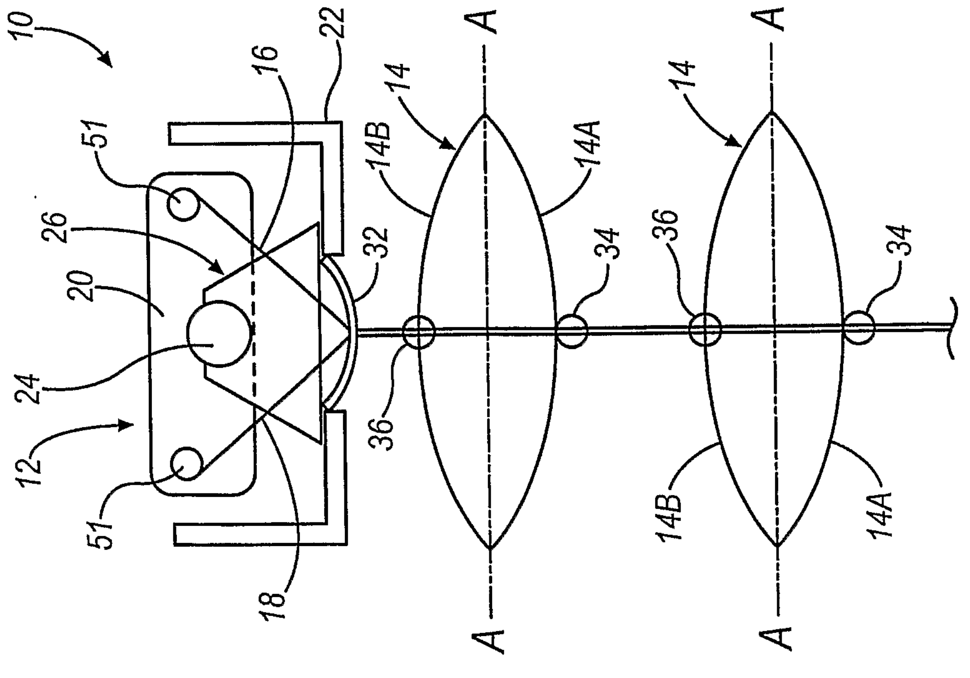
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FIG. 2

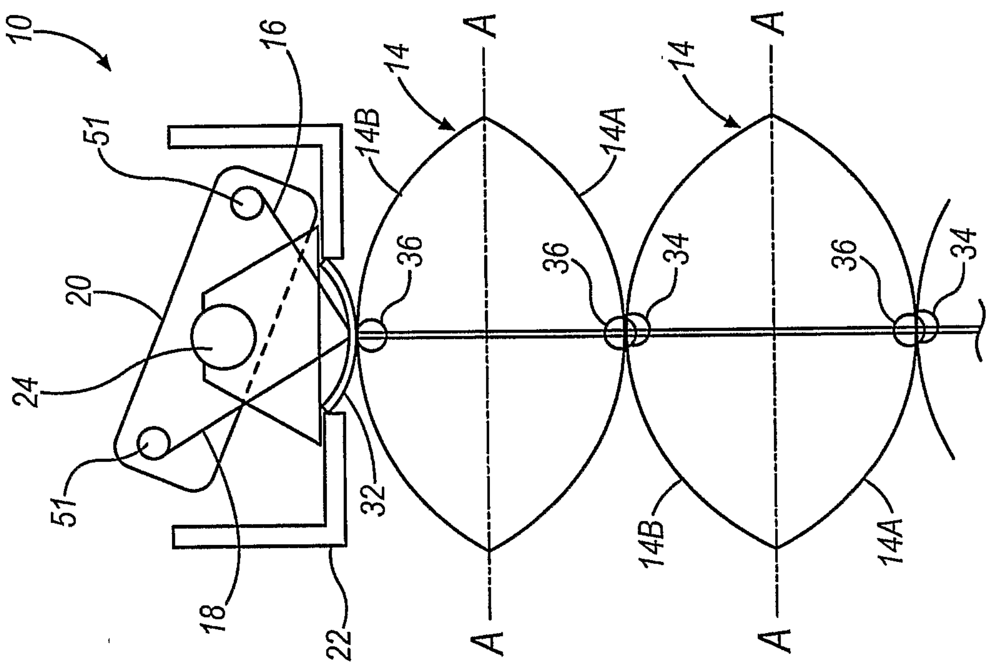
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FIG. 3

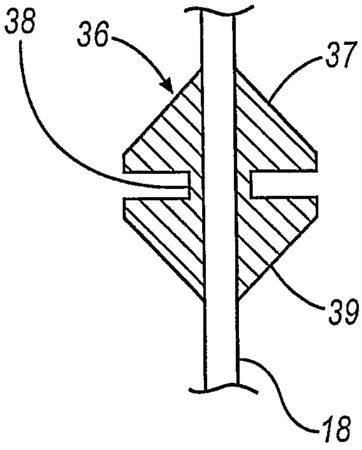

FIG. 4

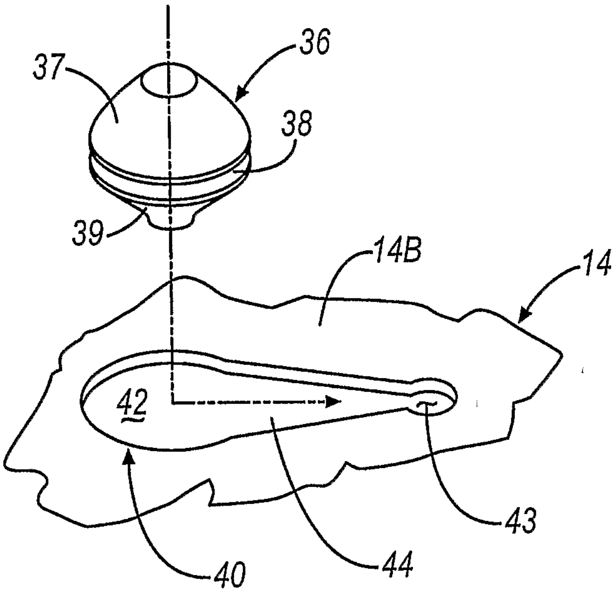

FIG. 5

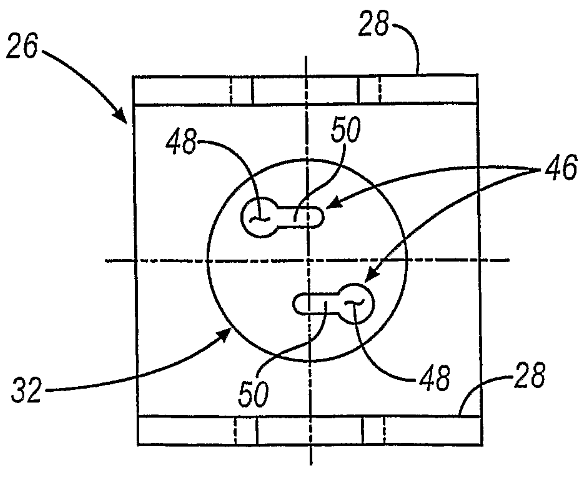

FIG. 6

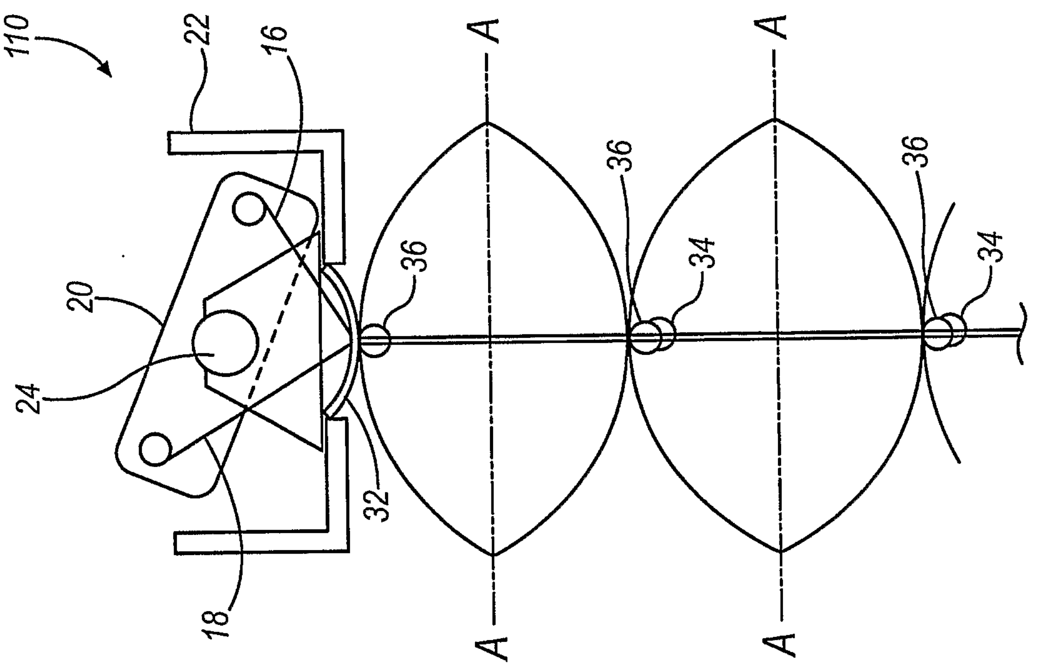

FIG. 8

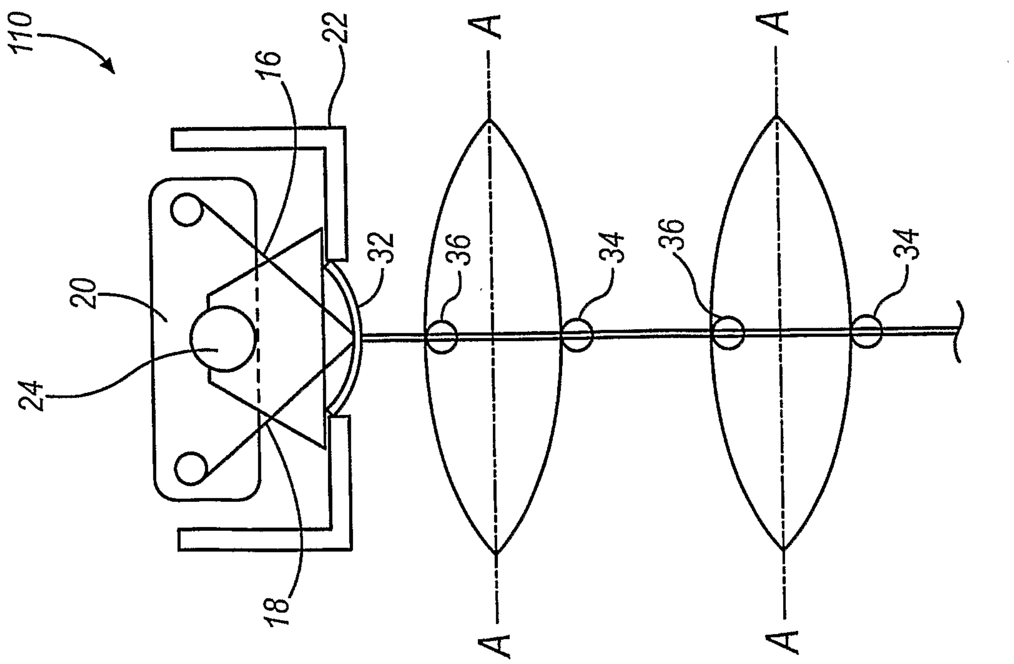

FIG. 7

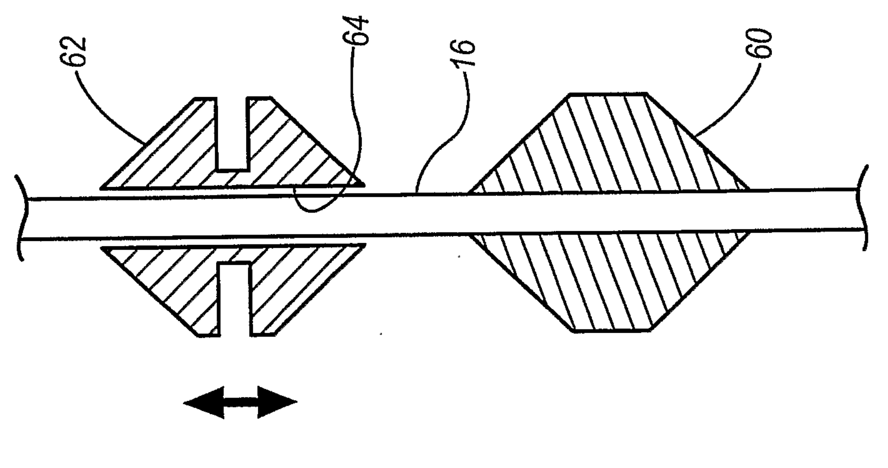

FIG. 10

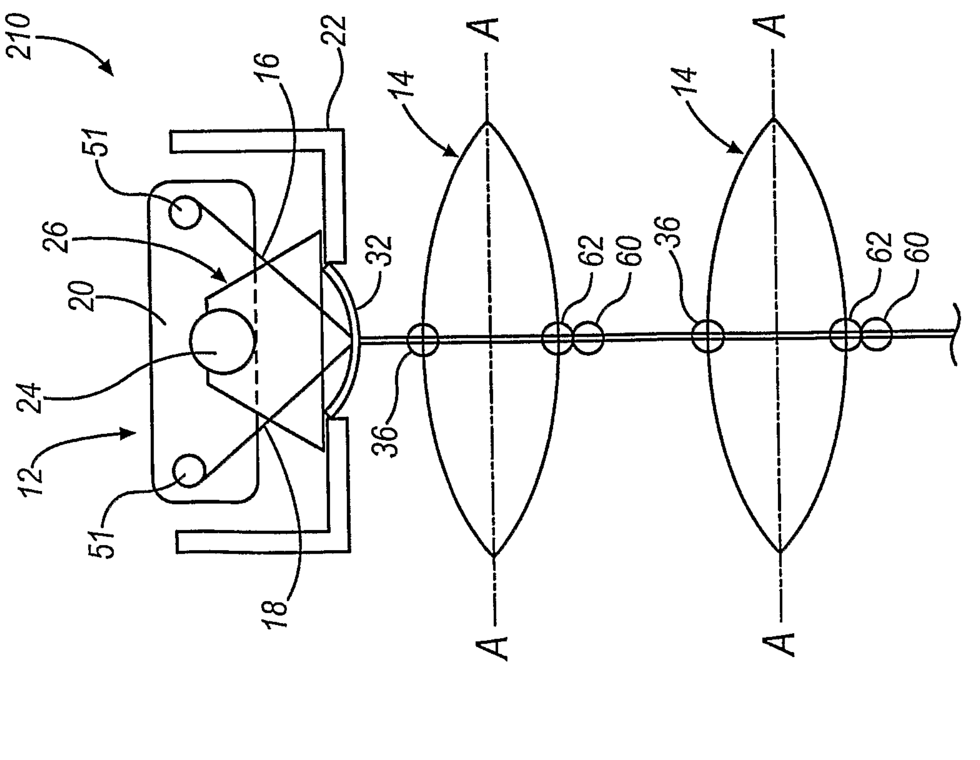

FIG. 9

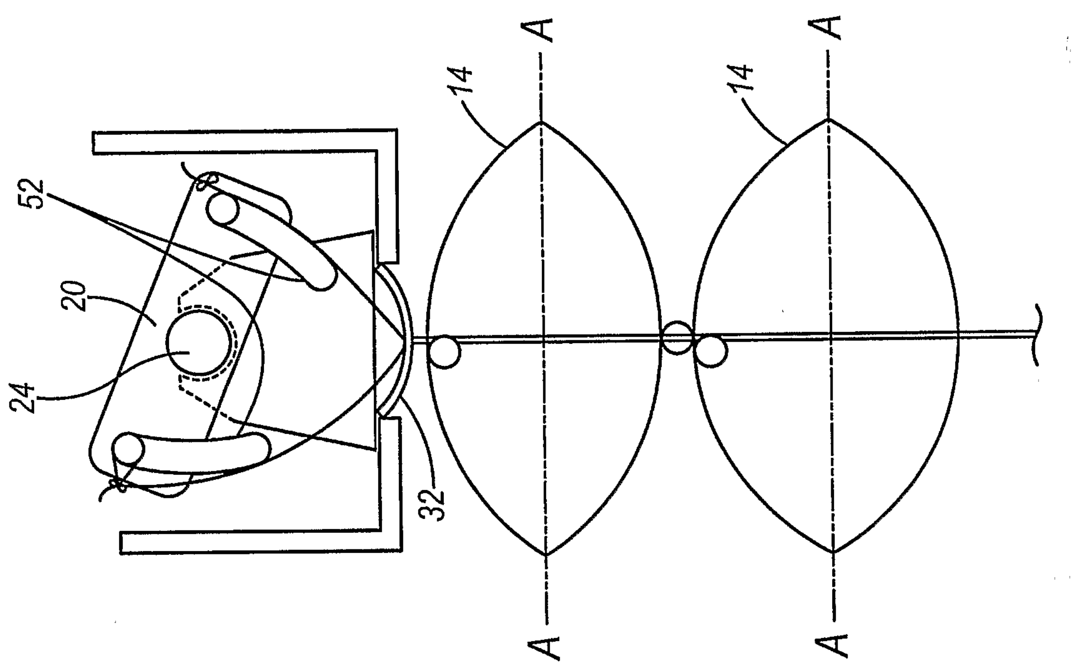

FIG. 12

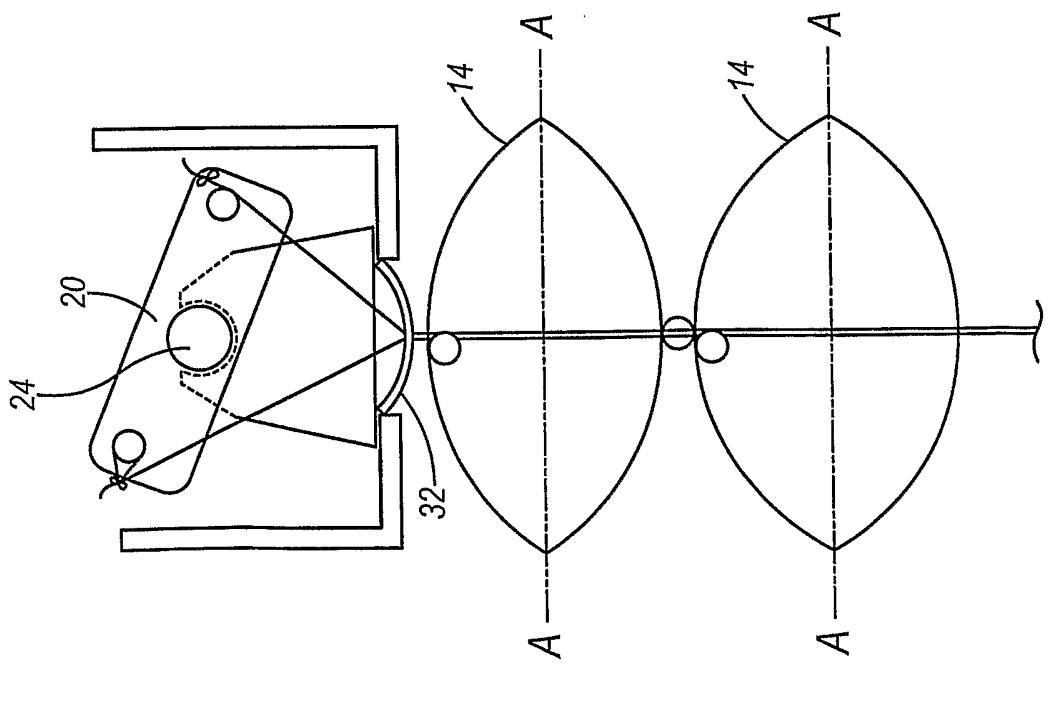

FIG. 11

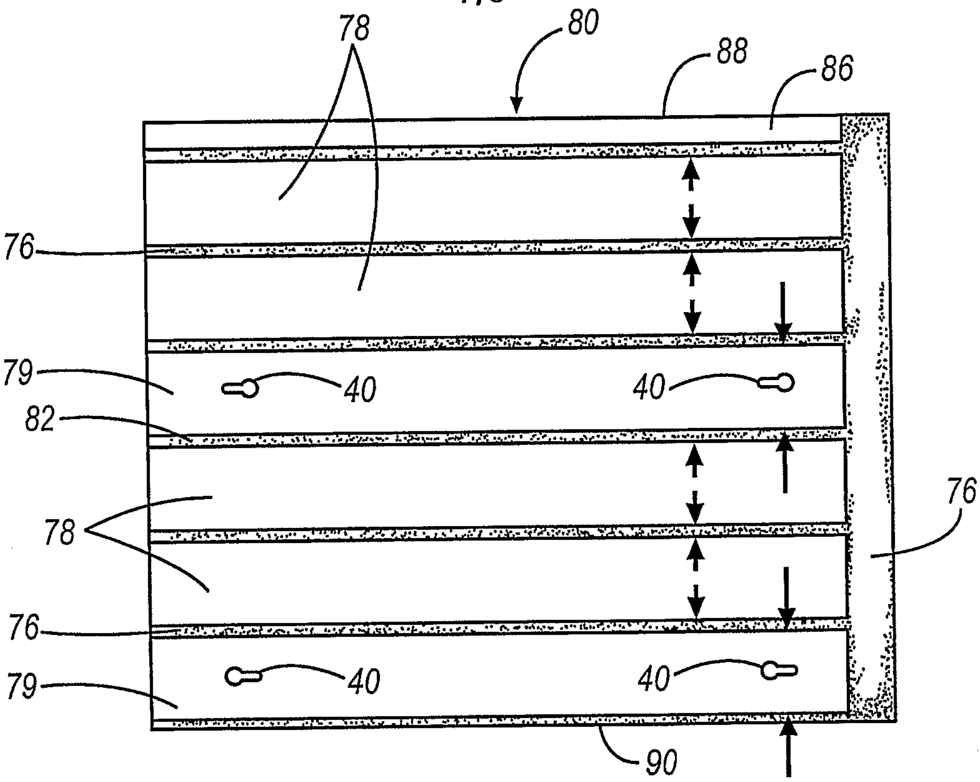

FIG. 13

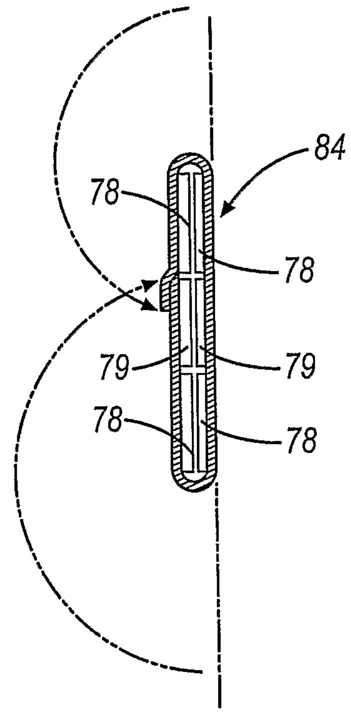

FIG. 14

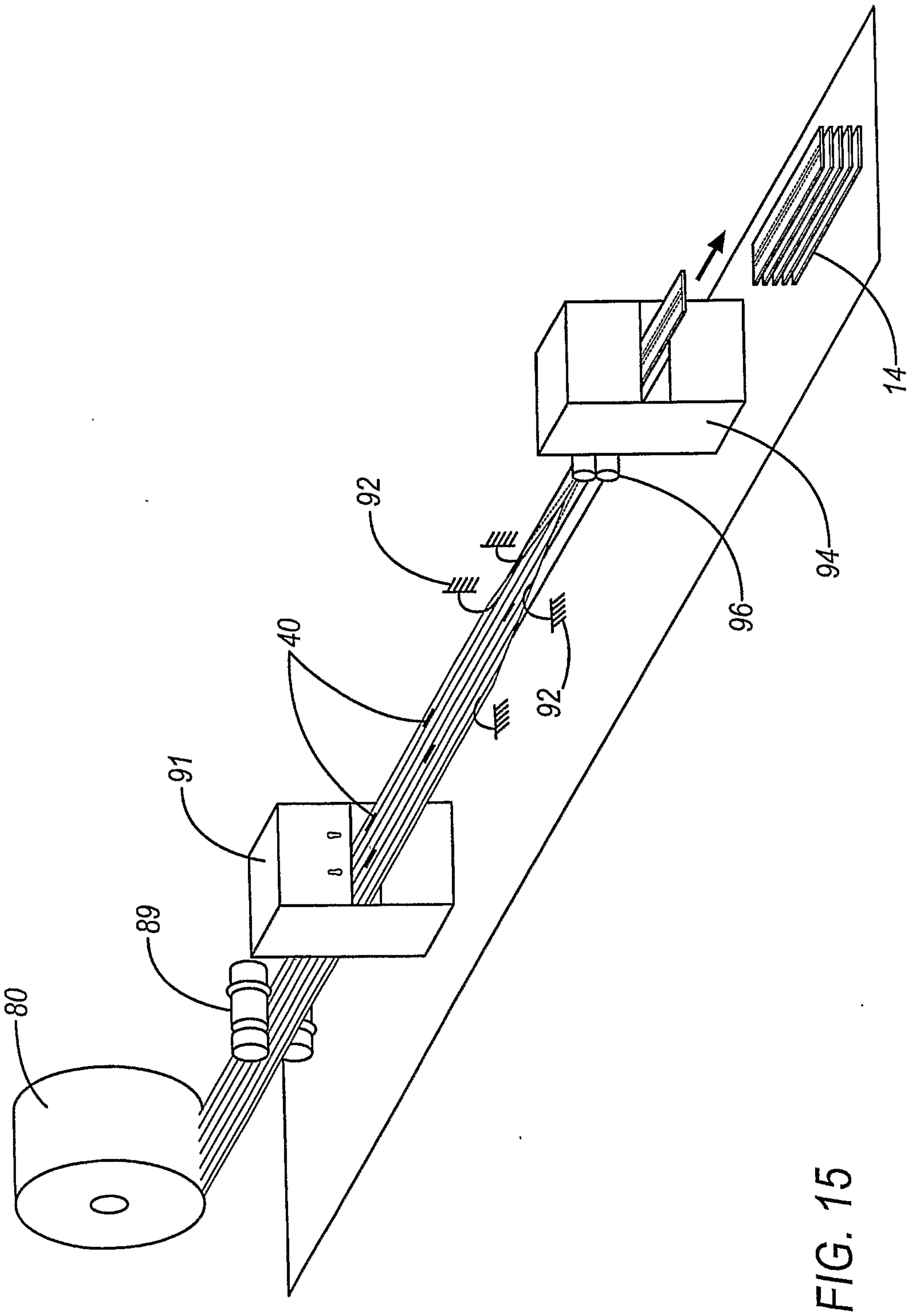

FIG. 15