(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 558 154 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **93200555.6**

(51) Int. Cl.[5] : **E06B 9/262**

(22) Date of filing : **26.02.93**

(30) Priority : **28.02.92 JP 93955/92**

(43) Date of publication of application :
01.09.93 Bulletin 93/35

(84) Designated Contracting States :
AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL PT SE

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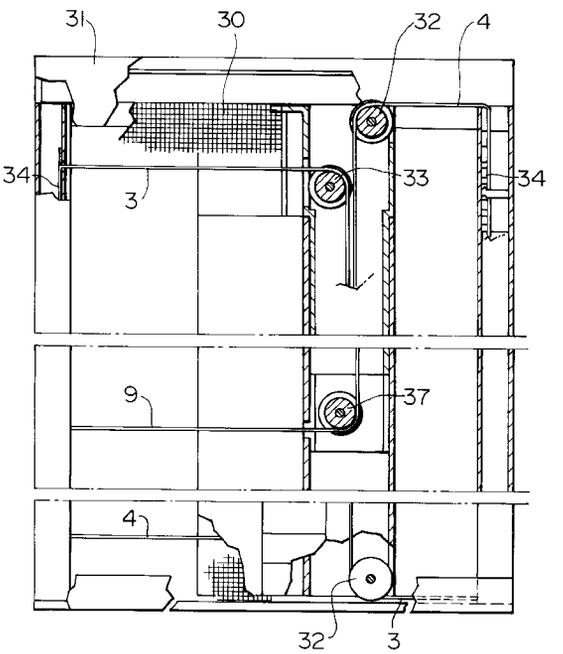
(54) Cord controlled window shades.

(57) A wire pierce screen apparatus capable of being installed and used as an opening/closing member of an open part and a partition by expanding and contracting an expandable/contractible pleat fabric. An expandable/contractible pleat fabric 1 is disposed in an opening/closing zone ABCD. Paired wires 3, 4 pierce this pleat fabric 1 astride of respective crest-trough plaits. The wires 3, 4 are led via both edges of the opening/closing zone ABCD and arranged in parallel bars 2 connected to opening/closing ends of the pleat fabric 1. The wires 3, 4 are stretched between both end portions of the opening/closing zone ABCD. When moving the parallel bars 2, lengths of crossovers in the parallel bars 2 are kept constant. Further, a pierce part and a fixed part are relatively changed while keeping constant a total length of these two parts, thus moving the parallel bars 2 in parallel.

FIG. 21



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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a wire pierce screen apparatus suitable for an installation and use in the form of an opening/closing member in an open part such as a window and a partition in the architecture by expanding and contracting a pleat fabric such as an expandable/contractible pleat screen.

Related Background Art

A conventional pleat screen apparatus has a screen member. The screen member assumes a substantially angular undulatory shape in section, wherein pleats, i.e., crest or trough plaits, are alternately arranged. The screen member is expanded by extending it or contracted by folding it. For instance, a window is opened and closed by this type of screen member disposed in the window part. As disclosed in, e.g., Japanese Utility Model Laid-Open Publicatlon No.2-99194, the screen member is opened and closed based on the following construction. A code pierces the screen member in the opening/closing direction and is simultaneously, connectively inserted in a base bar corrected to, the end portion of the screen member. The code is so arranged as to suspend from the upper part in a space where the screen member is installed. The screen member is opened and closed by pulling or releasing the code.

As stated in the specifications of U.S. Patent Nos.4,733,710, 4,842,034, 4,825,929, 4,850,414 and 4,852,627, the code piercing the pleat screen member is inserted in a slide bar connected to the end portion of the screen member. The code is cross-stretched between both end portions of an opening/closing space. The code is thus arranged and fixed. Then, the screen member can be held in a tense state due to a tension produced in the code itself. Opening and closing degrees can be also freely adjusted.

This type of conventional pleat screen apparatus, however, presents the following drawbacks. Japanese Utility Model Laid-Open Publication No.2-99194 discloses a pleat screen apparatus in which the code piercing the pleat screen member is simply connected to the base bar. A free stoppage in an arbitrary position in the opening/closing space is obtained only by fixing a code for an external operation. For this reason, this requires a special stopping means, and handling is troublesome.

Further, U.S. Patent No.4,733,710 discloses a pleat screen apparatus wherein the code piercing the pleat screen member is cross-arranged. The code is complicatedly arranged. The code arrangement involves the troublesomeness. Besides, when the opening/closing space such as a window or the like is largely opened by contracting the pleat screen member, the wire arranged is directly exposed. The open part is not completely opened. Further, the bars do not surely move in parallel. The bars are increasingly tilted every time the operation is repeated (see U.S. Patent Nos.4,733710, 4,842,034 and 4,925,929). In addition, the opening/closing operation code is arranged outside, and hence the operation involves troublesomeness. The appearance is unfavorable (see U.S. Patent No.4,484,2034). Moreover, the code remains arranged on the opening side. The core therefore becomes an obstacle but is not fine in its appearance (see U.S. Patent Nos.4,850,414 and 4,852,627).

SUMMARY OF THE INVENTION

Accordingly, It is a primary object of the present invention, which has been devised under the above-mentioned circumstances existing in the prior arts, to provide a wire pierce screen apparatus capable of being employed as, e.g., a screen for opening and closing a window or the like in the architecture or a room partition in the architecture. The wire pierce screen apparatus is constructed in the following manner. Paired wires are stretch-arranged between both end portions of an opening/closing zone in the opening/closing directions. The wires pierce an interior of a pleat fabric installed in the opening/closing zone. The pleat fabric can be opened and closed in the opening/closing zone by expanding and contracting the pleat fabric by the action of stretching the wires.

It is another object of the present invention to provide a wire pierce screen apparatus capable of opening and closing the pleat fabric with a pleat configuration remaining stable by setting an angle based on a balance of tensions and staggering turn members like pulleys for turning the wires arranged in the pleat fabric in the opening/closing direction so as to form fixed parts, pierce parts that pierce the interior of the pleat fabric and crossovers intersecting one another at an arbitrary angle or right angle to the opening/closing directions within the pleat fabric.

It is still another object of the present invention to provide a wire pierce screen apparatus capable of fixing a position of the pleat fabric and stabilizing a configuration of the pleat fabric against the reaction when ex-

panded and contracted by setting a braking force corresponding to the tension with a hysteresis resistance and a frictional resistance or a compound resistance in the positions of the wire turn members.

It is a further object of the present invention to provide a wire pierce screen apparatus capable of completely opening the open part and largely opening this open part without exposing and distributing the wires therein in accordance with an asymmetrical mode of wires which seize the opening/closing ends of the pleat fabric between stretch-retaining parts of the wires.

It is a still further object of the present invention to provide a typical system of an opening/closing means in the open part in which the pleat fabric can be installed and developed by stretching in a free placement while allowing a bias and a tilt without requiring the support in the positions of central line and gravity of the pleat fabric itself by surely holding the pleat fabric in a tense state held previously by the stretched wires themselves.

To accomplish the objects described above, a wire pierce screen apparatus of this invention has a pleat fabric and wires as basic components. The pleat fabric is expandable and contractible when stretched and folded. The pleat fabric is also disposed in an opening/closing zone. The wires pierce this pleat fabric astride of folded portions thereof. The wires are led via both edges of the opening/closing zone, then turned and intersect one another in the pleat fabric or do not intersect. The wires are stretched and pair-arranged between the both end portions in the opening/closing zone. The wires are distributed in a mode of asymmetrical arrangement on the closing/opening sides of the pleat fabric with respect to the opening/closing ends in the pleat fabric.

Further, the pleat fabric can be constructed so that the pleat fabric is supported within a frame structure for defining the opening/closing zone or between the guide rails laid at both ends of the opening/closing zone or only by the wires stretched between the both end portions of the opening/closing zone and piercing It. The pleat fabric can be also constructed to hold a configuration of the end portions by the parallel bars connected to the end portions of the pleat fabric.

The wires can be constructed as follows. The wires are arranged in the opening/closing directions and fixed at the end portions in the opening/closing directions. The wires intersect one another at an arbitrary angle or substantially right angle to the opening/closing directions. The crossovers are thereby formed to adequate lengths substantially in mid-positions of the wires in the pleat fabric.

According to one aspect of the invention, there is provided a wire pierce screen apparatus comprising: a pleat fabric disposed within an opening/closing zone, expanded and contracted in opening/closing directions; and wires stretched in a state where proper tensions are imparted to the wires between both end portions of the opening/closing zone in the opening/closing directions, pierce-arranged in the pleat fabric on a closing side where the pleat fabric is expanded and arranged in both side edges of the opening/closing zone on an opening side where the pleat fabric is opened, wherein the wires are led via the side edges thereof from the opening-side end portion of the opening/closing zone, turned around, inserted in a parallel bar connected to opening end portion of the pleat fabric, turned from the parallel bar, made to pierce the pleat fabric, reach the closing-side end portion of the opening/closing zone and thus pair-arranged. Simultaneously the paired wires intersect one another within the parallel bar or do not intersect. Further, the wires with the intersection or no intersection are properly arranged in combination.

According to another aspect of the invention, there is provided a wire pierce screen apparatus similarly comprising: a pleat fabric; and wires, wherein the wires are led via the closing-side end portion from the opening-side end portion of the opening/closing zone, turned, made to pierce the pleat fabric, reach a parallel bar connected to the opening end portion of the pleat fabric and thus pair-arranged. Simultaneously, the paired wires intersect one another in a position of the closing-side end portion of the pleat fabric or do not intersect. Further, the wires with the intersection or no intersection are properly arranged in combination.

According to still another aspect of the invention, there is provided a wire pierce screen apparatus similarly comprising: a pleat fabric; and wires, wherein parallel bars connected to respective end portions of the pleat fabric are slidably disposed within the opening/closing zone between guide rails laid at both side edges of the pleat fabric, and the wires fired to the end portions of the guide rails are inserted in the parallel bars, made to pierce the pleat fabric and thus pair-arranged.

According to a further aspect of the invention, there is provided a wire pierce screen apparatus similarly comprising: a pleat fabric; and wires, wherein the closing-side end portion of the pleat fabric is properly fixed, the opening-side end portion of the pleat fabric is connected to a parallel bar, and the wires inserted in the parallel bar and piercing the pleat fabric are pair-arranged between the both end portions of the opening/closing zone.

According to a still further aspect of the invention, there is provided a wire pierce screen apparatus similarly comprising: a pleat fabric; and wires, wherein the opening/closing zone in which the pleat fabric is opened and closed is defined by a frame structure, and the wires retaining side edges of the pleat fabric, turned at the end portions of the side edges of the pleat fabric and piercing the both end portions of the pleat fabric are thus pair-arranged.

According to a yet further aspect of the invention, there is provided a wire pierce screen apparatus similarly comprising: a pleat fabric; and wires, wherein the wires are led via the both edge portions of the opening/closing zone, turned at the end portions of parallel bars, inserted in the parallel bars, turned from the parallel bars and made to pierce the pleat fabric. The wires are thus pair-arranged in the parallel bars connected to the both end portions of the pleat fabric between the both end portions of the opening/closing zone.

According to an additional aspect of the invention, there is provided a wire pierce screen apparatus similarly comprising: a pleat fabric; and wires, wherein the wires retaining the side edges of the pleat fabric between both end portions of guide rails laid at the both side edges of the pleat fabric, turned at the end portions of the side edges of the pleat fabric and piercing the both end portions of the pleat fabric. The wires are thus pair-arranged.

Further, the pleat fabric can be composed of an expandable/contractible pleated membrane formed with continuous folded sections having crest-trough plaits alternately arranged or composed of a continuum of arrayed hollow members capable of flat-contraction and swell-expansion or formed in such a hollow configuration that the pleat fabric is contracted with plaits in a flat shape in the opening/closing directions.

The wires have pierce parts piercing the pleat fabric in the opening/closing directions of the pleat fabric, crossovers along the end portions of the pleat fabric in such a direction as to be substantially orthogonal to the opening/closing directions or intersect one another at an arbitrary angle and fixed parts fixed to the opening- or closing-side end portion in the opening/closing zone, and the pierce and fixed parts relatively change while keeping a total length constant with a crossover length fixed concomitantly with the expansion and contraction of the pleat fabric.

A wiring direction is turned at a turn member like a rotatable pulley or a glide having a circular arc surface between the fixed part, the crossover and the pierce part of the wire, and the turn member is attached to any one of the frame structure, the guide rail and the parallel bar.

The wire pierce screen apparatus further comprises a proper number of intermediate wires piercing the pleat fabric in arbitrary positions in the opening/closing direction of the pleat fabric, turned inwardly of the parallel bar at the opening-side end portion of the pleat fabric and arranged along the side edges in the opening/closing zone.

The wire is turned at the frame structure for partitioning the opening/closing zone, a pulley unit sliding inwardly of the guide rail, or a pulley supported inwardly of the parallel bar.

Furthermore, the wire is turned at the frame structure for partitioning the opening/closing zone, a glide unit sliding inwardly the guide rail or a glide pulley disposed inwardly of the parallel bar and having a curved surface.

Moreover, a braking force corresponding to a tension is set depending on a hysteresis resistance and a frictional resistance of the wire themselves or a composite resistance thereof in a turning position of the wire.

Additionally, the wires themselves that are stretch-retained between the both ends in the opening/closing zone pierces the pleat fabric on the side of the pleat fabric and arranged in an asymmetry at the both side edges of the opening/closing zone on the opening side at boundaries defined by the opening/closing ends of the parallel bars connected to the end portions of the pleat fabric.

A fundamental concept of the present invention will herein be explained with reference to FIG. 1 schematically illustrating a basic structure in the wire pierce screen apparatus according to the present invention.

A parallelogram opening/closing zone ABCD in which a pleat fabric is expanded and contracted is partitioned into a closing area D_1 (shown as a discontinuous oblique line area in the Figure, and this is the same hereinbelow. Note that FIG. 1 is an enlarged view fully illustrating the pleat fabric 1 having a typical plaiting structure and pierced with a wire w_1) and an opening area D_2 with a rigid parallel bar 2 serving as a boundary therebetween. The pleat fabric 1 is developed in the closing area D_1 but is not developed in the opening area D_2. Paired wires w_1, w_2 fixed to fixing points P_{13}, P_{23} on the AB-side of one end portion of the opening/closing zone pierce the pleat fabric 1 in the closing area D_1. The wires w_1, w_2 intersect each other in the parallel bar 2 after being bent and turned at turning points P_{12}, P_{22} within the parallel bar 2. These wires are further bent and turned at turning points P_{11}, P_{21} within the parallel bar 2 and thereafter fixed respectively to fixing points P_{10}, P_{20} on the CD-side of the other end portion of the opening/closing zone along the edge of the opening area D_2.

That is, the wires w_1, w_2 stretched between the fixing between the fixing points P_{10}, P_{13} and between points P_{20}, P_{23} are distributively arranged along parallel lines L_1, L_3, L_2, L_4 by tensions S_1, S_2. Then, when the tensions S_1, S_2 are combined, the central line of the turning points P_{12}, P_{22}, P_{11}, P_{21} or the parallel bar 2 is stabilized while keeping angles α, β with respect to the parallel lines L_1, L_3. L_2, L_4. The central line thereof or the parallel bar 2 moves in parallel in the longitudinal direction of the parallel lines L_1, L_3, L_2, L_4.

At this time, the moments M_1, M_2 along lengths of crossovers of the wires w_1, w_2 are given as follows:

$$M_1 = S_1 T_1$$

$M_2 = S_2 T_2$

where T_1, T_2 are the lengths of the crossovers, defined as insertion lengths, of the wires w_1, w_2 in the parallel bar 2.

The vectors V_1, V_2 are given such as:

$V_1 = 2S_1 \cos \alpha/2$

$V_2 = 2S_2 \cos \beta/2$

$V_1 = V_2$

where α and β are the refraction angles of the wires w_1, w_2.

Then, a relationship between the angles α, β and the tensions S_1, S_2 is given in the following equation:

[Equation 1]
$$\frac{S_1 T_1}{S_2 T_2} = \frac{\cos\frac{\beta}{2}}{\cos\frac{\alpha}{2}} = \frac{\cos\frac{\pi-\alpha}{2}}{\cos\frac{\alpha}{2}} = \frac{\sin\frac{\alpha}{2}}{\cos\frac{\alpha}{2}} = \tan\frac{\alpha}{2}$$

where $\alpha \leqq \beta$.

A half-angle cosine ratio of the refraction angle or the crossover angle is a reciprocal ratio of the moments M_1, M_2 along the wires w_1, w_2. For this reason, the tension system exhibits such a property as to readily stabilize in a $\alpha \rightarrow \beta$ direction, i.e., toward an angle given such as $\alpha = \beta = \pi/2$. Hence, this parallel driving system is capable of setting arbitrary angles α, β with setting of the tensions S_1, S_2. If the opening/closing zone ABCD is formed as an arbitrary parallelogram, the pleat fabric 1 flexible enough to deform and pierce-stretched in the closing area D_1 is freely expandable and contractible by freely folding and stretching within this closing area D_1. Originally, when the opening/closing zone ABCD is rectangular, the tension system thereof is stabilized.

Further, if flexures (extension rate) of the wires w_1, w_2 are large, the longer wires w_1, w_2 have larger flexure quantities correspondingly and are easy to loosen. Therefore, the wires w_1, w_2 are combined to have such an arrangement and configuration that the lengths of the wires w_1, w_2 and the crossover lengths are equal. A more stabilized state in terms of function is obtained as the refraction angles α, β approximate to the right angle.

Similarly, pairs of wires w_1, w_2, w_3, w_4 ... wi,.. wj are compounded in a parallel mode with respect to the pleat fabric expanded and contracted in the opening/closing zone ABCD shown in FIG. 2 and a wire driving device including the parallel bars moving in parallel, wherein the refraction angle is determined by an unequal tension and an equal vector. In this case, an equation (2) of the equal vector is given as below.

[Equation 2]
$$\frac{S_2 T_2 + S_4 T_4 + \cdots\cdots + S_i T_i}{S_1 T_1 + S_3 T_3 + \ldots\ldots + S_j T_j} = \tan\frac{\alpha}{2}$$

where S_1, S_2, S_3, S_4, ... Si, ...Sj are the tensions of the wires w_1, w_2, w_3, w_4, ... wi, ... wj, and T_1, T_2, T_3, T_4, ... Ti, ... Tj are the crossover lengths of the respective wires w_1, w_2, w_3, w_4, ... wi, ...wj. However, $|\, i - j \,| > 1$.

The above-described equation generally implies that the plural pairs of wires can be compounded with the sets of crossover lengths.

Further, vector coordination units each consisting of a combination of the wires and the pleat fabric described above can be compounded in an in-line mode. More specifically, a plurality of parallel bars are disposed in series in the lengthwise direction of the paired parallel lines. The vector coordination units are compounded in series. Given based on the following structure in this case is a continuum in which open spatial planes and planes on which the pleat fabrics are expanded and contracted are arranged in a checkered configuration (Scherpinsky ribbon) on such a continuous plane that the number of the parallel bars is $b \geqq 2$, and the number of the areas in the open part is $D \geqq 3$. It is herein assumed that b is the number of the parallel bars 2, n is the number of torsions of the tension surfaces made by vector couple wire circuits (note that n = 1/2 in a complete/simple unit), m is the number of the pleat fabrics, U is the simple unit (or U_1, U_2, U_3 ...), and U* (or U_1*, U_2*, U_3*, ...) is the vector couple constituting a pseudo circuit unit.

Note that the pseudo circuit unit forms a Hoff space in which vector kinematic pair circuits consisting of the paired wires pass in series through the plurality of parallel bars, and the tension surface shaped by the wire circuit has the torsion number of n = 1, or a Zaifert space in which n > 1 + 1/2. Then, generally the parallel bar has two degrees of freedom, i.e., a freedom degree 1 of translation with respect to the parallel motion and a freedom degree 1 of rotation (there are the same direction and directions reversed for every other one). In the motion while undergoing an external force, a posture of the parallel bar is not stabilized and therefore remains tilted.

As illustrated in FIG. 3(A), when $D \geqq 3$ and $b \geqq 2$, there is only one in-line composition formed of only the complete/simple units U. FIG. 3(A) shows a case where b = 2, n = 1/2 + 1/2, m = 2 and $U = (U_1 + U_2) = 2$. The wires w_1, w_2 pierce and intersect one another in the parallel bar b_1 in the simple unit U_1. The wires w_3, w_4 pierce and intersect one another in the parallel bar b_2 in the simple unit U_2.

Further, as shown in FIG. 3(B), a method of dividing the pseudo circuit unit U* expressed such as $D \geqq 3$ and $d \geqq 2$ into simple units U is limited to only one case. FIG. 3(B) shows a case where b = 2, (n = 1) $\rightarrow$ (n =

1/2 + 1/2), m = 2, (D = 3) → (D = 4), and (U* = U_1* = 1) → (U = (U_1 + U_2) = 2).

There exists only one dividing method of regulating the degree of freedom of rotation of the parallel bar but allowing only the translation/parallel motion of the freedom degree 1. This is applied to a case where the pseudo circuit unit is the one when n = 1; and at least one point P_1 on the wire in the open space is fixed on the frame structure. The open area D_2 is provided between the closing areas D_1, D_2 disposed at both ends. The wires w_1, w_2 are inserted and intersect one another in the parallel bars b_1, b_2 in the pseudo circuit unit U_1*.

Paying attention to the parallel motion of the parallel bar b_1 when the point P_1 is fixed, a fixing point group and a turning point group including the point P_1 on the side of the parallel bar b_2 are combined to form one steady point. Hence, this exhibits the same function as that when a symmetrical point $P_1\tilde{}$ of the point P_1 is set on the opposite line. Similarly, the attention is paid to the motion of the parallel bar b_2, and one steady point consists of fixing point group and the turning point group on the side of the parallel bar b_1. Therefore, this pseudo circuit unit U_1* is divided into two simple units with (P_1 P_1~) serving as a motion boundary.

Generally when D ≧ 3, the in-line compound is constructed of an overlap of at least a pair of pseudo circuit units U_1* and the complete/simple unit (non-pierce type) U (or U_1, U_2, U_3, ...). To be specific, as illustrated in FIG. 4, this is the case where D >3, b > 2, and m ≧ D/2. The combination is attained by sequential compounds in the following way. For instance, the wires w_1, w_2 in the pseudo circuit unit U_1* are inserted and intersect one another respectively in the parallel bars b_1, b_2 for partitioning the areas D_1, D_2,.... The wires w_3, w_4 in the complete/simple unit U_1 are inserted and intersect one another in the parallel bar b_2. The wires w_5, w_6 in the complete/simple unit U_2 are inserted and intersect one another in the parallel bar b_4. At this time, when compounding in line the non-pierce type complete/simple unit (vector couple) U in a relationship of U* = 1, the number of simple units to be compounded is expressed such as U ≧ b/2.

The in-line compound based on the overlap of only the pseudo circuit units is special in terms of conditions for restricting the degree of freedom of rotation of the parallel bar. The parallel motion is therefore easy to become unstable. in general, this is not established. Further, this pseudo circuit unit is, as shown in FIG. 5, classified into three patterns, i.e., an intersect type (see FIG. 5(A)), a non-intersect type (see FIG. 5(B)), a mixed type (see FIG. 5(C)). The wires w_1, w_2 in the pseudo circuit unit U_1* are inserted in the parallel bars b_1, b_2 having a length B and acting to partition the closing areas D_1, D_3, D_5 ... and the opening areas D_2, D_4, D_6 ... .

A balance of vectors relative to the tension and the crossover length satisfies the above-mentioned equation (2). The parallel bars take angular displacements (rotary angles) of $\phi 1$, $\phi 2$, $\phi 3$ ... when exerting an external force P on one arbitrary point of the parallel bar on the assumption that e is the extension rate of the wire, R is the radial hysteresis resistance, and L is the length of the circuit. The turning and refracting points are sufficiently lubricated. If so, in the intersect and non-intersect types, a relationship is established, wherein $\phi 1 = \phi 2 = \phi 3$ ... After eliminating the external force P, a residual displacement angle τ is stabilized and fixed ($\tau < \phi$) in a position where an in system hysteresis frictional resistance R balances with a tension corresponding to an extension λ of the wire. In these two types, if a length B of the parallel bar is fired, the displacement angle and the residual displacement angle are considerably large. A parallel posture of the parallel bars is lost largely. In the mixed type, when applying the external force P on one point, the displacement angles are inverted each other, and ($\phi 1 = \phi 3 = \phi 5$ ...) is equal to $|\ \phi 2 = \phi 4 = \phi 6$ ... $|$, or one is larger than the other.

Hence, if an accurate placement is performed for a distribution of tensions, there is constructed a circuit in which an intersect type pseudo circuit unit is overlapped double with a mixed type over the entire area, and a non-intersect type pseudo circuit unit is overlapped double with the mixed type over the entire area. Then, the degrees of rotation offset each other, thereby making it possible to design the vector coordination of the freedom degree (translation) 1.

Further, in the wiring circuit of the wires in this vector coordination unit, the respective fixing ends of the wires within one unit are overlapped to form a ring in the space. In this case, the vector kinematic pair with the number of parallel bars being N = 1 is of such a system that the tension plane thereof forms a Möbius ring, and the parallel motion thereof is restricted to the freedom degree 1. Namely, with the vector kinematic pair, an in-phase wire circuit is provided at a boundary of the Möbius ring having a torsion of n = 1/2. Thus, the parallel motion system of the freedom degree 1 is established. Then, the pseudo circuit unit is formed in association with the mode of arranging the in-phase wires at the boundary of a Zaifert curved surface of n > 1 + 1/2 and a Hoff band with the number of parallel bars being N = 2, wherein the tension plane thereof has a twist of 2π (360°) when n = one torsion. Then, the parallel motion of the freedom degree 2 takes place. The freedom degree 1 of rotation is added to the motion of the parallel bar, thereby making unstable the translation parallel motion of the parallel bar. The system compound involves a simple combination or continuation of the simple unit of the vector kinematic pairs. Further, as illustrated in FIG. 6(A), if constructed so that the wires w_1, w_2 along the boundary of the Möbius ring intersect in the parallel bar 2 located at the torsion part of the Möbius ring, this is referred to as a relative motion type. Further, as shown in FIG. 6(B), if constructed so that the wires w_1, w_2

along the boundary of the Möbius ring are fixed inwardly of the parallel bar located at a non-torsion part of the Möbius ring, this is called an absolute motion type.

The following is an explanation of the relative motion type. As depicted in FIG. 7, it is assumed that virtual parallel lines exist in the opening/closing directions. A fixed end point P_{20} is set at one point of one of a pair of parallel lines L_1, L_3, or L_2, L_4 among two pairs of parallel lines parallel to each other. The wire w_2 piercing the pleat fabric 1 that forms the closing area D_1 passes through turning points P_{21}, P_{22} provided on the line thereof and reaches a fixing point P_{23} set at the other point on the opposite line in the opening area D_2, thus connecting the fixed end point P_{20} to one fixing point P_{23}. Similarly, a fixing point P_{10} is provided on one of the other pair of parallel lines L_2, L_4 or L_1, L_3. The wire w_1 extends via turning points P_{11}, P_{12} to a fixing point P_{13}, thus connecting the fixing point P_{10} to the fixing point P_{13}. A group of the turning points P_{21}, P_{22}, P_{11}, P_{12}, provided on the lines traversing the parallel lines are fixedly disposed on a length of rigid parallel bar 2. In this case, the parallel line and the transverse line are balanced at such an angle that vectors determined by the tensions S_1, S_2 are equalized, where S_1 is the tension of the wire w_1, and S_2 is the tension of the wire w_2.

At this time, upon applying the external force along the parallel line on one point of the parallel bar 2 provided with the group of the turning points P_{11}, P_{12}, P_{21}, P_{22}, the parallel bar 2 always moves in parallel with respect to the initial position. Then, the wires w_1, w_2 existing in one closing area D_1 with the parallel bar 2 serving as a boundary pierce the pleat fabric 1. When the pleat fabric 1 is repeatedly alternately folded in and stretched out, there exists a relative velocity between the pleat fabric 1 and the wires w_1, w_2.

Then, FIG. 7(A) illustrates an intersect type where the wires w_1, w_2 intersect in the parallel bar 2. FIG. 7(B) shows a non-intersect type where the wires w_1, w_2 do not intersect in the parallel bar 2. FIG. 7(C) illustrates a compound type where a proper number of intersect types are compounded. At this time, the parallel lines L_1, L_4, L_2, L_5, L_3, L_6 are respectively paired. The wires w_1, w_2, w_3, w_4 are arranged. Originally, the compound type involves compounding the intersect and non-intersect types and compounding a proper number of non-intersect types.

Note that the angular stability depends on crossover lengths T_1, T_2, T_3, T_4. Hence, the intersect type is more stable than the non-intersect type, and the compound type is more stable than the intersect type.

On the other hand, the absolute motion type will be explained. As illustrated in FIG. 8, it is assumed that virtual parallel lines are provided in the opening/closing direction in the opening/closing zone. One firing point P_{10} is a point of intersection between a line segment $P_{10}P_{20}$ which transversely intersects a set of, i.e., two pairs of parallel lines parallel to each other and the parallel lines L_1, L_2 or L_3, L_4. A fixing point P_{14} is a point of intersection between one line segment on a pair of parallel lines L_1, L_3 or L_2, L_4 and a crossover line (transverse line). A turning point P_{13}, is set in a position apart therefrom on the same line. The wire w_1 is arranged in such a way that the wire extends across an auxiliary turning point P_{12} to the turning point P_{13}, on the other parallel line and then pierces the pleat fabric 1; and the other fixing point P_{14} is a point of intersection between the other line and the transverse line. Similarly, the wire w_2 is arranged with respect to the other pair of parallel lines L_2, L_4 or L_1, L_4 in such a manner that the wire passes through a route from the fixing point P_{20} across three turning points P_{23}, P_{22} (at least two or more points) to the other fixing point P_{24}. A group of the fixing points P_{10}, P_{14}, P_{20}, P_{24} on the transverse line are fixedly disposed on the one rigid parallel bar 2. It is assumed in this case that S_1, S_2 are the tensions of the wires w_1, w_2. The parallel line and the transverse line-viz.,the parallel bar 2-are stabilized to keep such an angle that the vectors determined by a balance of the tensions S_1, S_2 are equalized.

At this time, when applying the external force along the parallel line on one arbitrary point on the parallel bars provided with the group of the fixing end points P_{10}, P_{14}, P_{20}, P_{24}, the parallel bar 2 always moves in parallel with respect to the initial position. Then, the wires w_1, w_2 existing in one closing area D_1 with the parallel bar 2 serving as the boundary pierce the interior of the pleat fabric 1 and are repeatedly alternately folded in and stretched out with the parallel motion of the parallel bar 2. At this time, the pleat fabric 1 and the wires w_1, w_2 always make motions at the equal speed in the equal direction. Hence, contact points of the wires w_1, w_2 with the pleat fabric 1 undergo no frictional force.

Then, FIG. 8(A) illustrates an intersect type Where the wires w_1, w_2 intersect one another. FIG. 8(B) shows a non-intersect type where the wires w_1, w_2 d_o not intersect. FIG. 8(C) illustrates a compound type where a proper number of intersect types are compounded. At this time, the parallel lines L_1, L_4, L_2, L_5, L_3, L_6 are respectively paired. The wires w_1, w_2, w_3, w_4 are arranged. Originally, the compound type involves compounding the intersect and non-intersect types and compounding a proper number of non-intersect types.

Note that the stability of an angle made by the transverse line and the parallel line similarly depends on crossover lengths T_1, T_2. Hence, in this absolute motion type also, the intersect type is more stable than the non-intersect type, and the compound type is more stable than the intersect type as in the relative motion type.

Further, in a stretching mode of these wires w_1 ..., the wires are allowed to be arranged in proper locations in the vertical, horizontal and oblique directions. It is possible to form a quadric surface assuming a curvili-

nearity in the stretching direction thereof. A quadric refracting surface provided with a torsion can be also formed.

Contemplated herein are the frictional force and the hysteresis resistance produced in the wires in the positions of the turn members, i.e., the pulleys shown in FIG. 9(A). The wire w having a line diameter d_0 is wound on a pulley r_0 having a sufficiently lubricated bearing. Equal tensions S are given to both ends thereof. If a curvature radius r of the wire w is not so large for the line diameter d_0, an additional tension is imparted to one end of the wire w. When increased gradually, the tension of one end reaches S + Si. Hereupon, the wire starts moving.

A bending moment and a recovery moment of the wire w at the deformation point P_1, P_2 are expressed in the following equations.

$$[\text{ Equation 3 }] \qquad M_1 = \frac{E * I(1 + \rho)}{r}$$

$$M_2 = - \frac{E * I(1 - \rho)}{r}$$

where $r = r_1 + d_0/2$.

The wire w_1 undergoes a bending stress at the point P_1 and is recovered at the point P_2. If the wire is made of a completely elastic material. The deformations at the points P_1, P_2 are equal but opposite to each other in terms of direction. Hence, the tension Si may be capable of moving the wire w along the pulley surface without causing no resistance when satisfying a condition of $Si > 0$.

The actual material, however, has a thermal loss (hysteresis loss) caused with an internal friction. When deforming the wire in accordance with a small curvature, the resistance (hysteresis resistance) based on this hysteresis is present conspicuously. This hysteresis resistance R is expressed in the following equation.

$$[\text{Equation 4}] \qquad R = S\,i = \frac{M_1 + M_2}{r} = \frac{2E * I\rho}{r^2}$$

where 2ρ is the hysteresis loss rate, and E* is the apparent Young's modulus of the wire under the pretension S. A definition is given in the following equation.

$$[\text{Equation 5}] \qquad 2\rho = \frac{S\,i}{S + S\,i}$$

Strictly, the definition is given in the following equation.

$$[\text{Equation 6}] \qquad 2\rho = \frac{\int f_1(\varepsilon) - \int f_2(\varepsilon)}{\int f_1(\varepsilon)}$$

$$= \frac{(1 + \rho)\int f(\varepsilon) - (1 - \rho)\int f(\varepsilon)}{\int f(\varepsilon)}$$

where $f_1(\in)$ is the outward curve of the hysteresis curve, $f_2(\in)$ is the recovery curve, and $f(\in)$ is the complete elastic curve.

Then, the apparent Young's modulus is expressed in the following equation.

$$[\text{Equation 7}] \qquad E^* = \frac{\sigma_\beta + \sigma^*}{\sigma_\beta} E$$

$$\sigma^* = S/A$$

where S is the tension, A is the effective sectional area of the wire, and $\sigma\beta$ is the rupture stress.

Note that a performance of the wire changes in many ways depending on how to combine a material, a diameter of element wire, a core material, a strand fabric, the number of strands and a filler. It is therefore theoretically difficult to obtain values of E and I. Empirically, however, these values are obtainable.

Further, when the pulley bearing is a simple journal, the following equation is given:

$$[\text{Equation 8}] \qquad R = \frac{2E * I\rho}{r^2} + \frac{2\cos\frac{\phi}{2} S\,\mu r_2}{r}$$

On the other hand, a wire or rope capable of ignoring a bending strength is similarly wound on a circular arc surface of the glide or the surface of a circular cylinder shown in FIG. 9(B). The equal tensions S are applied to both ends of the wire. An additional tension is gradually applied to one end. Just when reaching ΔS, the wire starts sliding. Based on this assumption, a distribution of tensions of the respective parts of the wire is expressed in the following equation. A radial component of force acting on the wire is given such as:

$$[\text{Equation 9}] \qquad S\sin\frac{\Delta\theta}{2} + (S + \Delta S)\sin\frac{\Delta\theta}{2} = F\theta\Delta\theta$$

$$- S\cos\frac{\Delta\theta}{2} + (S + \Delta S)\cos\frac{\Delta\theta}{2} = F_f\,\theta\,\Delta\,\theta$$

where F is the resistance of the surface of the circular cylinder per unit length with a wire balance between the a limit. The limit is given by:

[Equation 10] $S = \theta F$

$$\frac{ds}{d\theta} = \theta F_f$$

and,

[Equation 11] $$\frac{d s}{d \theta} = \theta F_f = \theta \mu F = \mu S$$

$$\int \mu S = \mu \log S = \mu\theta + C$$

$$S = e^c e^{\mu\theta}$$

where μ is the static friction coefficient between the circular cylinder and the wire.

$S = S$ and $C = O$ with respect to $\theta = O$,

and hence,

[Equation 12] $S + \Delta S = Se^{\mu\theta}$

$$\Delta S = S (e^{\mu\theta} - 1)$$

Therefore, the resistance R when the wire having the bending strength moves in a deformable manner while sliding on the surface of the glide is expressed in the following equation.

[Equation 13] $$R = \Delta Si = \frac{2E * I\rho}{r^2} + S (e^{\mu\theta} - 1)$$

where ΔSi is the force for weighing.

Besides, the wire passing through staggered insertion gaps (labyrinth) undergoes the frictional resistance and the hysteresis resistance. Since non-continuous points of action are arranged in series, the hysteresis resistance is expressed in the following equation.

[Equation 14] $$R_1 = \frac{2E I\rho}{r^2} = S_1$$

$$S_n = \sum_{n=1}^{n} S1 \quad (1+\rho)^n = S_1 \quad \frac{(1+\rho)^n - 1}{(1+\rho) - 1}$$

where n is the number of staggered steps, r ($r = r_0 + d_0/2$) is the radius of curvature when the wire is deformed, θ is the central angle of a contact portion, μ is the static friction coefficient between substances, S1 is the pull-out force of the first step, and Sn is the pull-out force of the n-th step.

However,

[Equation 15] $$S_1 = \frac{2EI\rho}{r^2} \qquad r = r_0 + d_0/2$$

Similarly, the frictional part is continuous from the central angle. The tension on one side is given in the following equation in relation to the hysteresis resistance and the first-step resistance.

[Equation 16] $$S_n \tilde{} \tilde{} = S_1 (e^{\mu\theta} - 1) = \frac{2 E I \rho}{r^2} (e^{n\mu\theta} - 1)$$

Hence, from the hysteresis resistance and the frictional resistance, the pull-out resistance Sn of the n-th step is given by: $Sn = Sn\tilde{} + Sn\tilde{\tilde{}}$. The pull-out resistance Sn is expressed in the following equation.

[Equation 17] $$S_n = \frac{2 E I \rho}{r^2} \{\frac{(1+\rho)^n - 1}{(1+\rho) - 1} + (e^{n\mu\theta} - 1)\}$$

Incidentally, if there is a fixing means having such a variable number that n is the number of refracting points undergoing a compressive force, the compressive force P is applied, and hence the following equation is given:

[Equation 18] $$S_n = (R + \frac{2EI\rho}{r^2}) \{\frac{(1+\rho)^n - 1}{(1+\rho) - 1} + (e^{n\mu\theta} - 1)\}$$

$$R = \frac{(1+\rho)^n - 1}{(1+\rho) - 1} P$$

Then, as illustrated in FIG. 10, a proper number of intermediate wires $w\tilde{}$ are arranged between the pair-arranged wires w_1, w_2. The intermediate wires $w\tilde{}$ pierce the pleat fabric 1 in arbitrary positions in the opening/closing directions thereof and are turned within the parallel bar 2 at the opening-side end portion of the pleat fabric 1. The intermediate wires $w\tilde{}$ are then arranged along the side edges of the opening/closing zone ABCD. At this time, the following equation is established:

[Equation 19] $$\frac{S_1 T_1 + T\tilde{} S\tilde{}}{S_2 T_2} = \tan \frac{\alpha}{2}$$

where S_1, S_2, $S^{\sim}$ are the tensions of the wires w_1, w_2 and the intermediate wire $w^{\sim}$, and T_1, T_2, $T^{\sim}$ are the crossover lengths.

Further, the apparatus according to this invention can be developed in a three-dimensional cylindrical space, a polygonal rod space and three-dimensional spaces assuming other polygons on the plane as well as being expanded and contracted within the plane because of the pleat fabric being developed in the plane. The pleat fabric itself is constructed to form the areas which surround the three-dimensional space. That is, in the relative motion type, the parallel bars including the group of turning points are extended out on the plane ZX within the space XYZ. In the absolute motion type, the parallel bars including the group of fixing points are extended out on the plane ZX within the space XYZ. The apparatus is phase-deformed into a circular ring, a disk, a polygonal ring, a polygonal plate or sphere and a polygon. Thus, the apparatus is three-dimensionally formed in the three-dimensional space. At this time, the parallel bar takes a shape of a parallel plate such as a disk, a doughnut-like panel. The parallel bar has a circular wire-arranged path on the planar surface formed along the outer periphery thereof. The pleat fabric itself assumes a configuration like bellows.

FIG. 11(A) schematically illustrates the apparatus of the relative motion type according to the present invention. The plane type shown in FIG. 11(A) is, as illustrated in FIG. 11(B), subjected to a phase conversion in a mode where this is expanded out into a cylindrical surface type even on the minimum incomplete unit. The symbols S_1, S_2 represent the tensions of the wires w_1, w_2, and the symbols L_1, L_2, L_3, L_4 denote the parallel lines along which the wires w_1, w_2 are arranged.

Then, in the cylindrical surface type, a set of parallel lines L_3, L_4 at the right and left ends thereof are overlapped with each other after turning around the surface of the cylinder. The plane type and the cylindrical surface type therefore have an equal value in terms of phase and exhibit the same function. For this reason, the group of turning points or fixing points existing on the ellipse or circle in section of the circular cylinder make a parallel motion with respect to the initial position.

FIG. 12 is a representation of the cylindrical surface type on the surface of the circular cylinder. Referring to FIG. 12(A), a disk-like parallel plate B1 makes a parallel motion. Referring to FIG. 12(B), a circular ring parallel plate B2 makes a parallel motion. The movements of the parallel plates B1, B2 work to expand and contract the pleat fabric 1 assuming a circular cylindrical shape that is pierced with the wires w_1, w_2, w_3 ... arranged along the parallel lines L_1, L_2, L_3, L_4 ... The pleat fabric 1 is formed in a shape like bellows.

Further, in accordance with the mode of arranging the wires on the surface of the circular cylinder or the polygonal surface, the wires can be extended by compounding the units thereof as in the same way with the plane type. Movable parts of the wires between the fixing points and the turning/refracting points pierce the pleat fabric and are therefore expandable and contractible with the parallel motion. This is established with a set of three wires when set in the mode of arrangement on the surface of the circular cylinder on the minimum complete unit. As illustrated in FIG. 13(B), a multiplicity of wires may be arranged, According to the mode of arranging these compounded wires w_1, w_2, w_3 ... along the parallel lines L_1, L_2, L_3, L_4 ..., if the groups of fixing/turning end points on the closing side contractibly closed by developing the pleat fabric are dispersed with no deviation, the group of wires w_1, w_2, w_3 ... on the opening side with parallel plate sandwiched therebetween can be converged into at least one or two wires.

Further, in a mode where the wires are continuously arranged in the line direction, when the continuous number is n, n-pieces of parallel plates are provided.

On the other hand, FIGS. 14(A) and 14(B) show a concept of mode of arranging the wires when the apparatus of the absolute motion type is expanded out. Referring to the same Figures, the parallel lines L_1, L_2, L_3 are coincident on the surface of the circular cylinder. Formed are vector kinematic pairs (three vector pairs are present in a side by side relationship to form a set of vector pairs) on the surface of the circular cylinder wherein the wiring structure on one unit consisting of three wires w_1, w_2, w_3 is stabilized most. Further, a kinematic pair based on a pair of wires w_1, w_2 is also established. The stability is incomplete unless the wires w_1, w_2 ... simultaneously pierce the pleat fabric.

FIG. 15 shows a mode of phase conversion into the surface of the circular cylinder in the absolute motion type. To be specific, there is a wiring structure of vector kinematic pairs formed on the surface of the circular cylinder by use of a plurality of wires w_1, w_2, w_3, w_4 ... Referring to FIG. 15(A), the parallel plate B1 assuming a disk-like shape is adjusted in the up-and-down directions, thereby establishing a relationship of equation between a counter for weighting and an in-system resistance. The parallel plate B1 in this instance is, e.g., a seat plate of a chair or a no-inertial-quantity piston in a reciprocating engine. Besides, in FIG. 15(B), similarly the parallel plate B2 taking a doughnut-like shape is, e.g., an elevator raised and lowered outwardly of the circular rod. If this parallel plate B2 is constructed in the form of a ruff structure exhibiting a high contractibility, the circular rod is also deformable in terms of phase into a sphere.

Additionally, in these circular cylinder surface modes, the pleat fabric pierced with the wires has a contractibility in the widthwise direction. In this case, the surface thereof converges on a hyperboloid of revolution.

It is feasible to attain a development of three-dimensional configuration into, e.g., a hand drum shape, a drum shape, a conical shape, a doughnut-like shape, etc..

Furthermore, the following construction may suffice for the wire pierce screen apparatus according to the present invention. As illustrated in FIGS. 16 to 20, the wires 3, 4 are fixed and turned in the opening/closing zone. Further, the edges of the pleat fabric 1 in the opening/closing direction move in parallel while keeping a state of intersecting at an arbitrary angle or substantially at a right angle to the opening/closing direction. For this reason, a minimum design type may be adopted depending on the mode of arrangement thereof. The minimum design type may involve omissions of the frame structure (stile) 5 for defining the opening/closing zone, the guide rails 6 for guiding the side edges of the pleat fabric 1 and the parallel bars for regulating the edges of the pleat fabric 1. Further, this minimum design type is classified into a first group with an omission of any one of the frame structure 5, the guide rail and the parallel bar 2, and a second group with omissions of both the frame structure 5 and the guide rail 6 or both of the frame structure 5 and the parallel bar 2.

Namely, FIG. 16 shows the first group with the omission of the frame structure 5. The fixing ends of the wires 3, 4 are set to both ends of the paired guide rails fixedly laid on both sides in the opening/closing directions. The wires 3, 4 are cross-inserted in the parallel bars 2 connected to the edges of the pleat fabric 1. Besides, the wires 3, 4 pierce the pleat fabric 1.

FIG. 17 shows the first group with the omission of the guide rails 6. For instance, the pleat fabric 1 is raised and lowered in the vertical directions. The fixing ends of the wires 3, 4 are set to upper and lower frame members of the frame structure 5 fixed to the upper and lower ends in the opening/closing directions. The wires 3, 4 pierce the interior of the pleat fabric 1 and are also inserted in the parallel bars.

FIG. 18 illustrates the first group with the omission of the parallel bars 2. The fixing ends of the wires 3, 4 are set to the stretch-directional end portions of the frame structure 5 for defining the overall opening/closing zone. Similarly, the wires 3, 4 in the guide rails 6 corresponding to the side edges in the stretching direction pierce the side edges of the pleat fabric 1 while being held (piercing) by pierce rings 7. On the other hand, the wires 3, 4 are arranged through turn members 8 serving as turning points that travel within the guide rails 6 while being positioned at the edges of the pleat fabric 1.

Further, FIG. 19 shows the second group with the omissions of the fame structure 5 and the guide rails 6. The fixing ends of two pairs of wires 3, $3^{\sim}$, 4, $4^{\sim}$ are set to the respective end portions of the opening/closing zone. The wires 3, $3^{\sim}$, 4, $4^{\sim}$ are inserted in the parallel bars 2 connected to the front and rear ends of the pleat fabric 1 that correspond to the front and the rear in the opening/closing directions. The inserted wires 3, $3^{\sim}$, 4, $4^{\sim}$ pierce the interior of the pleat fabric 1. In this mode of wire arrangement, the above-mentioned pseudo circuit unit U is compounded with the simple unit U. The wires 3, 4 in the pseudo circuit unit U* are cross-inserted in the respective parallel bars 2 connected to both ends of the pleat fabric 1. The wires $3^{\sim}$, $4^{\sim}$ are cross-inserted in only one parallel bar 2.

FIG. 20 illustrates the second group with the omissions of the frame structure 5 and the parallel bars 2. The fixing ends of the wires 3, 4 (or two pairs of wires 3, $3^{\sim}$, 4, $4^{\sim}$) are set to both ends of the paired guide rails 6 fixedly disposed along the both side edges of the opening/closing zone. Similarly, the wires 3, 4 (or wires 3, $4^{\sim}$, 4, $4^{\sim}$) within the guide rails 6 corresponding to the side edges in the opening/closing directions pierce the side edges of the pleat fabric 1 while being held (piercing) by the pierce rings 7. On the other hand, the wires 3, 4 (or wires 3, $3^{\sim}$, 4, $4^{\sim}$) are arranged through the turn members 8 traveling within the guide rails 6 while being positioned at the edges of the pleat fabric 1.

However, the wires 3, 4 (or wires 3, $3^{\sim}$, 4, $4^{\sim}$) themselves pierce the pleat fabric 1 between the both end portions of the opening/closing zone. Further, the wires are stretched to have the crossovers along the edges of this pleat fabric 1. It is therefore sufficient that the wires retain the pleat fabric 1 with an adequate tension. The wire may include the one compounded by giving a torsion to, e.g., a metal wire as an element wire, the one having a plastic or metal core material at the center, the one having its surface covered with a plastic material, the one adapted to float the element wire into the overall plastic by means of a high-pressure extruder and a plastic monofilament or a plastic rod, etc..

In the wire pierce screen apparatus according to the present invention, the proper tensions are given to the wires stretched between the both end portions of the opening/closing zone. The wires pierce the interior of the pleat fabric. The pleat fabric installed in the opening/closing zone is held by the crossovers set substantially in the mid-positions of the wires. This pleat fabric is expanded and contracted in the opening/closing directions.

When the pleat fabric is expanded and contracted, the lengths of the crossovers in this pleat fabric remain fixed. Besides, a total length of the pierce part and fixed part also remains fixed. Both changes relatively, and therefore the opening/closing directional end portions of the pleat fabric itself are slid substantially in parallel in the opening/closing directions. The parallel bars connected to the opening/closing ends of the pleat fabric maintain a uniform tension between the intra parallel bar crossovers of the wires turned in th positions of the

end portions or the middles of the parallel bars themselves, the pierce parts piercing the interior of the pleat fabric and the fixed parts to the end portions of the opening/closing zone. The parallel bar themselves stop in arbitrary positions in the open part by the braking action produced in the turning positions.

The pair-arranged wires are balanced by the torsions given to the wires themselves between the both side edges of the pleat fabric in the opening/closing directions. The pleat fabric is thus stabilized when opened and closed. Further, the closing area is, when expanded, completely covered. Whereas when contracted, the opening area of the opening/closing zone is largely opened.

The frame structure for defining the opening/closing zone supports the frames when the pleat fabric is expanded. The guide rails disposed at the both edges of the opening/closing zone also maintain the configuration of the pleat fabric in such a direction as to intersect at an arbitrary angle or substantially right angle to the opening/closing directions. Furthermore, the pleat fabric pierced with the wires is also supported by the wires themselves that are stretched between the both end portions of the opening/closing zone.

The wires are led via the side edge from the open-side end portion of the opening/closing zone, then turned and inserted in the parallel bar connected to the open end portion of the pleat fabric. The wires turned from the parallel bar pierce the pleat fabric and reach the closing-side end portion of the opening/closing zone. In this pair-arranged mode, when the parallel bar itself slides, a relative velocity is caused between the pleat fabric and the wires.

The wires are led via the closing-side end portion from the open-side end portion of the opening/closing zone, then turned and pierce the interior of the pleat fabric. The wires reach the parallel bar connected to the open end portion of the pleat fabric. In this pair-arranged mode, when the parallel bar itself slides, the pleat and the wires always move at the equal velocity in the same direction. The contact points therebetween undergo no frictional force.

The wires provided with the proper tensions hold the pleat fabric. The pleat fabric can be installed in a large variety of states such as a vertical state where the opening/closing direction coincide with the direction of gravity, a horizontal state where the opening/closing direction is substantially orthogonal to the direction of gravity, a tilt state where the opening/closing direction is tilted and others. No constraint is given to the installation mode.

A proper number of intermediate wires piercing the intermediate portion other than the side edges of the pleat fabric itself prevent the flexure easily caused in the pleat fabric itself when the pleat fabric is expanded and contracted.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will become apparent during the following discussion in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic view of assistance in explaining a fundamental concept of the present invention, fully showing some portions in enlargement;

FIG. 2 is a schematic view showing one example where plural pairs of wires are stretched;

FIGS. 3(A) and 3(B) are schematic views each illustrating an in-line compound mode of vector coordination units;

FIG. 4 is a schematic view showing a typical placement mode in the in-line compound mode;

FIGS. 5(A), 5(B) and 5(C) are schematic views each showing a placement mode in a pseudo circuit unit, FIG. 5(A) illustrating a intersect type, FIG. 5(B) illustrating a non-intersect type, and FIG. 5(C) illustrating a mixed type;

FIG. 6 is a view showing how a Möbius ring is formed based on a relationship between the wires and a parallel bar;

FIGS. 7(A), 7(B) and 7(C) are schematic views illustrating types of a relative motion, FIG. 7(A) showing an intersect type, FIG. 7(B) showing a non-intersect type, and FIG. 7(C) showing a compound type;

FIGS. 8(A), 8(B) and 8(C) are schematic views illustrating types of absolute motion, FIG. 8(A) showing an intersect type, FIG. 8(B) showing a non-intersect type, and FIG. 8(C) showing a compound type;

FIGS. 9(A) and 9(B) are views of assistance in explaining a resistance generated between the wire and the turn member, FIG. 9(A) showing a hysteresis resistance, and FIG. 9(B) showing a frictional resistance;

FIG. 10 is a schematic view illustrating a case where intermediate wires are arranged;

FIGS. 11(A) and 11(B) are views of assistance in explaining an apparatus of the relative motion type according to the present invention in a case where the apparatus is three-dimensionally constructed, FIG. 11(A) showing a plane type, and FIG. 11(B) showing a circular cylinder surface type;

FIGS. 12(A) and 12(B) are schematic views of assistance in explaining the fundamental concept similarly in the case where the apparatus is three-dimensionally constructed, FIG. 12(A) showing a moving mode

of a disk-like parallel plate, and FIG. 12(B) showing a moving mode of a doughnut-like parallel plate;
FIGS. 13(A) and 13(B) are views of assistance in explaining a compound arrangement, FIG. 13(A) showing the arrangement on a minimum complete unit, and FIG. 13(B) showing the arrangement of combination of an arbitrary number of wires;
FIGS. 14(A) and 14(B) are views of assistance in explaining a wire arrangement mode in a state where the wires are extended on the plane when the apparatus of the absolute motion type according to the present invention is three-dimensionally constructed, FIG. 14(A) showing a case where the wires are directly stretched at both ends of an opening/closing zone, and FIG. 14(B) similarly showing a case where the wire are stretched to form crossovers;
FIGS. 15(A) and 15(B) are schematic views of assistance in explaining the fundamental concept in which the apparatus is similarly three-dimensionally constructed, FIG. 15(A) showing a moving mode of the disk-like parallel plate, and FIG. 15(B) showing a moving mode of the doughnut-like parallel plate;
FIG. 16 is a schematic view illustrating a minimum design type with an omission of a frame structure;
FIG. 17 is a schematic view illustrating the minimum design type with an omission of guide rails;
FIG. 18 is a schematic view showing the minimum design type with an omission of the parallel bars;
FIG. 19 is a schematic view illustrating the minimum design type with omissions of the frame structure and the guide rails;
FIG. 20 is a schematic view showing the minimum design type with omissions of the frame structure and the parallel bars;
FIG. 21 is a front view with some portions omitted in an embodiment when constructed as a pleat screen;
FIG. 22 is similarly a side view with some portions;
FIG. 23 is a front view in an embodiment when constructed as an air bag wall;
FIG. 24 is similarly a principal sectional view with some portions omitted;
FIG. 25 is a sectional view of a pleat fabric based on a tube structure;
FIGS. 26(A), 26(B) and 26(C) are principal sectional views when the wires are arranged in parallel in the pleat fabric, FIG. 26(A) showing a formation by use of a flexible sheet material, FIG. 26(B) showing a formation by sue of a crest sheet material assuming a V-shape in section, and FIG. 26(C) showing a formation by use of a crest sheet material assuming a U-shape in section;
FIGS. 27(A) and 27(B) are sectional views each illustrating the pleat fabric by use of a pleat sheet material;
FIG. 28 is a schematic plan view showing a construction of a polygonal type on the plane by using junction poles;
FIG. 29 is similarly a schematic front view;
FIGS. 30(A) and 30(B) are sectional views each showing an eyelet seal member when piercing a flexible screen member with the wires, FIG. 30(A) showing a using state of single type based on a cylindrical body structure, and FIG. 30(B) similarly showing a using state of double type;
FIGS. 31(A) and 31(B) are sectional views each showing the eyelet seal member in another embodiment, FIG. 31(A) Illustrating a using state of the single type based on a ring structure, and FIG. 31(B) similarly showing a using state of the double type;
FIG. 32 is a principal front view showing one example of configuration to close a gap between the frame structure and the pleat structure;
FIG. 33 is a front view showing a case where a limiter means is added;
FIG. 34 is a plan view showing a state of joining the pleat fabric assuming a polygonal shape in plane;
FIGS. 35(A) and 35(B) each illustrating a counter balance means, FIG. 35(A) showing a single parallel bar structure, and FIG. 35(B) showing a double parallel bar structure;
FIGS. 36(A) and 36(B) each illustrating a case where end pulleys are constructed in the form of wheels; FIG. 36(A) is a front sectional view; and FIG. 36(B) is a side sectional view;
FIG. 37 is a sectional view illustrating a wire separator;
FIGS. 38(A), 38(B) and 38(C) each illustrate a fixing means at the end of wire; FIG. 38(A) is a plan view; FIG. 38(B) is a front view; and FIG. 38(C) is a side sectional view;
FIGS. 39(A) and 39(B) each similarly show other fixing means; FIG. 39(A) is a front view; and FIG. 39(B) is a side sectional view;
FIG. 40 is a schematic front view showing a case in which a flexure adjusting means is incorporated;
FIG. 41 is a front sectional view illustrating a pulley block as a turn member;
FIG. 42 is a front sectional view illustrating a glide block as a turn member;
FIG. 43 is a front sectional view of other glide block as a turn member;
FIGS. 44(A), 44(B) and 44(C) each show a come-off preventive means; FIG. 44(A) is a side view; FIG. 44(B) is a principal cross-sectional view; and FIG. 44(C) is a principal vertical sectional view;
FIGS. 45(A) and 45(B) each illustrate a sealing member; FIG. 45(A) is a side sectional view with some

portions omitted when closing a gap with respect to the inner surface of an upper frame of the frame structure; and FIG. 45(B) is a cross-sectional view with some portions omitted when closing gaps with respect to right and left frames of the frame structure;

FIGS. 46(A), 46(B), 46(C) and 46(D) show one example of configuration in which the wires are connected to frame structure and the parallel bars; FIG. 46(A) is a plan view with some portions omitted; FIG. 46(B) is a principal perspective view of the frame structure or the parallel bar; FIG. 46(C) is a sectional view in a state where the wires are connected to the frame structure in other example; and FIG. 46(D) is a sectional view when mounting a joint bracket in the parallel bar in other example;

FIGS. 47 (A) and 47(B) each show a simply structured pulley block; FIG. 47(A) is a front sectional view; and FIG. 47(B) is a side view;

FIGS. 48(A) and 48(B) each illustrate a simply structured glide block; FIG. 48(A) is a front sectional view; and FIG. 48(B) is a side view;

FIGS. 49(A) and 49(B) each show a cylindrical part at the edge of the pleat fabric; FIG. 49(A) is a principal sectional view of the pleat fabric based on plaiting structure; and FIG. 49(B) is a principal sectional view of the pleat fabric exhibiting a flexibility;

FIGS. 50(A), 50(B) and 50(C) illustrate other structural example of the glide block; FIG. 50(A) is a sectional view when fitted in the parallel bar; FIG. 50(B) is a sectional view when fitted outwardly of the end portion of the wire separator; and FIG. 50(C) is a sectional view when fitted in the parallel bar on the basis of a split structure;

FIG. 51 is a sectional view illustrating an intermediate glide;

FIGS. 52(A) and 52(B) each show an example when installed and used in the minimum design type; FIG. 52(A) is a front view; and FIG. 52(B) is a plan view;

FIG. 53 is a schematic view similarly illustrating an example where the wires are arranged;

FIGS. 54(A), 54(B), 54(C) and 54(D) each show a terminal bracket at the end of wire; FIG. 54(A) is a sectional view of one example when structured as a stand; FIG. 54(B) is similarly a sectional view in another example; FIG. 54(C) is a front view of one example of a plate-like configuration; and FIG. 54(D) is similarly a front view of another example thereof;

FIGS. 55(A) and 55(B) are views each showing examples when installing and using other structures of the minimum design type;

FIGS. 56(A) and 56(B) are similarly schematic views each illustrating an example where the wires are arranged;

FIG. 57 is a schematic front view showing a case where other pleat fabric is disposed in composition within the pleat fabric; and

FIGS. 58(A) and 58(B) are side views each showing a case where the pleat fabrics are disposed in combination in a skylight, FIG. 58(A) showing a parallel placement, and FIG. 58(B) showing a in-line placement.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Concrete embodiments of the present invention will hereafter be described with reference to FIGS. 21 through 58.

FIGS. 21 and 22 show an embodiment to form a pleat screen. To be specific, an open part frame 31 constituting a substantially rectangular frame structure includes parallel bars 2 disposed between upper and lower frame members thereof and slidable along the right-and-left directions of the open part frame 31.

An expandable/contractible pleat screen 30 is constructed of continuous folded sections formed by alternately arranging crest-trough plaits. The pleat screen 30 is disposed between the parallel bars and any one of the right and left frame members. End pulleys 32 and pierce pulleys 33 are rotatably supported in an interior defined by the parallel bars 2. The end pulleys 32 are located in the vicinities of the upper and lower portions of the parallel bars 2 on the side of the screen 30. The end pulleys 32 are also located respectively at the upper and lower ends of the parallel bars 2 on the opposite side to the screen 30. The pierce pulleys 33 are located in the vicinities of the upper and lower ends of the parallel bars 2. One or plural pairs of wires 3, 4 have one ends fixed through fixing means 36 on the side of the screen 30, this side being defined as one of the right and left frame members. The wires 3, 4 respectively pierce the folded sections of the screen 30. The wires 3, 4 intersect one another in the interior of the parallel bars 2 after turning at the pierce pulleys 33. The wires 3, 4 turn at the end pulleys 32, and thereafter the other ends thereof are fixed through fixing means 34 to the other of the right and left frame members along the inner surfaces of the upper and lower frame members of the open part frame 31. Further, the numeral 9 in the Figures designates an intermediate wire, and 37 represents a midway pulley at which the intermediate wire 9 turns in the parallel bars 2.

A lower edge of a ceiling panel 36 is, as illustrated in FIG. 22, always contact with an upper edge of the

screen 30. The ceiling panel 36 engages with engagement rails 35 provided inwardly of the upper frame member of the open part frame 31 and makes a free fall. A gap between the upper edge of the screen 30 and the upper frame member is thus closed.

Note that the wires 3, 4 piece meshes formed in the screen 30 with an omission of special pierce holes.

FIGS. 23 and 24 show an embodiment to form an air bag wall. Specifically, the parallel bars 2 slidable in the right-and-left directions of an open part frame 41 are disposed between the upper and lower frame members of the open part frame 41. A expandable/contractible hollow air bag 40 is contractibly pleated in a flat state in the opening/closing directions. The air bag 40 is disposed between the parallel pars 2 and any one of the right and left frame members of the open part frame 41. One or plural pairs of the same wires 3, 4 as those in the preceding embodiment are arranged between the parallel bars 2 and the right and left frame members of the open part frame 41 through the end pulleys 42 and the pierce pulleys 43. The wires 3, 4 penetrate a joint braid unit 44 for regulatively connecting the internal and external surfaces of the air bag 40 to each other with a predetermined breadth (see FIG. 24) so as to regulate a spacing between the internal and external surfaces thereof. Note that this joint braid unit 44 is of an assembly type. Pierce members 45 hermetically pierce the internal and external surfaces of the air bag 40. A connecting member 46 permits the wire 3 or 4 to penetrate the central part thereof. Joint legs 47 are disposed on both side of the connecting member 46. These members are sequentially connectively engaged with each other through engaging means 48 so that arrow-head male parts forcibly engage them with each other. Then, an air blow fan 51 is provided inwardly of the parallel bars 2. The air blow fan supplies the interior of the air bag 40 with the air for expansion when expanding the air bag 40 with slide travelling of the parallel bars 2. An exhaust fan 52, an air cleaner 53 and deodorizing/perfume dispenser 54 are respectively provided in an interior of one of the right and left frame members on the side of the air bag 40 in the open part frame 41. The exhaust fan 52 exhausts the expansion air from within the air bag 40 when contracting the air bag 40.

FIG. 25 illustrates an embodiment to constitute a folding door and a partition. Hollow members 55 for attaining a flat contraction and an expansion are continuously arrayed. A multiplicity of hollowed parts 56 substantially orthogonal to the opening/closing directions are arrayed. A expandable/contractible tube structure 57 is thus constructed, wherein its internal and external surfaces are undulated. The tube structure 57 is obtained by, e.g., a high foaming resin form molding method. Rigid shape retentive frames 58 are connected to both ends of this tube structure 57. Further, the wires 3, 4 pierce the tube structure 57 as in the foregoing embodiment.

FIG. 26 illustrates parallel wiring geometries of the wires 3, 4 in the pleat fabric 1. FIG. 26(A) shows a folding door having no lazy tong. The wires 3, 4 are led and turned at turn members 8 provided inwardly of the parallel bars 2. The wires 3, 4 then penetrate pierce rings 60 attached to the insides of the internal and external surfaces of flexible sheet materials 61 assuming undulations. The insertion rings 60 regulate spacings of foldings and draperies of the internal and external surfaces and prevent them from being more expanded than required. incidentally, when making uniform the undulate pleats of the pleat fabric 1, the pierce rings 60 are each doubled. The wire pierces an engaged portion. FIG. 26(B) illustrates a combination of crested sheet materials each formed in a V-shape in section to assume the same exteriority as a hexagon honeycomb structure. The sheet portions are partially bonded to each other. Further, FIG. 26(C) shows a combination of crested sheet materials 62 formed in a U-shape in section. The pierce rings 60 are attached to the troughs thereof. The wires 3, 4, pierce the rings 60. The pleat fabric 1 exhibits a facility of contractible closing owing to resilience of the troughs.

FIG. 27 illustrates an embodiment of the pleat fabric 1 constructed in the following manner. Pleat sheet materials 63 each assuming a configuration of continuous crested undulations are provided on the internal and external surfaces. The insides of the crests (see FIG. 27(A)) or the troughs (see FIG. 27(B)) of the pleat sheet materials 63 on the internal and external surfaces are connected to each other through band-like connecting pieces 64. The pleat fabric 1 is thus constructed. The wires 3, 4 pierce the connecting pieces 64.

FIGS. 28 and 29 illustrates an embodiment to provide a arrangement of stretching through a plurality of junction poles to assume a polygonal shape in plane. The junction poles 65 are rotatable through pivots taper pulleys and compression springs between the ceiling and the floor and between the upper and lower frame parts. The junction poles 65 are arranged in bending positions thereof. On the other hand, the wires 3, 4 are positioned at the tops of the crested plaits on the bending side as viewed in plane. The wires 3, 4 are thus made to pierce and arranged along the outline of the junction poles 65. Others are the same as those in the embodiments discussed above. The wires 3, 4 turn at end pulleys 66 and pierce pulleys 67, thus piercing the pleat structure 1. The numeral 68 in the Figure indicates an operation braid connected to the upper end of the parallel bars 2.

Further, though the illustration is omitted, the expandable/contractible pleat fabric 1 can be constructed to have fluctuations. This involves such arrangements that pierce spacings for penetration of the wires 3, 4 are made ununiform, or the plurality of wires 3, 4 penetrate in unparallel to each other, and simultaneously the

pleat fabric 1 is made of an elastic material.

Moreover, a plural pieces of segments split in the opening/closing directions have their joining edges formed in Monrow curve. A series of wires 3, 4 pierce these segments, thereby giving a large distortion to each joining edge. It is possible to obtain a Monrow curtain having a sheet surface formed with flares, creases and folding lines.

In the pleat fabric 1, random tucks may get together, or cuttings (Montana) may be formed.

Further, though the illustration is omitted, the parallel bars 2 are formed with undulations in the vertical and horizontal directions. On the other hand, a possible configuration is that the pleat structure 1 has inphase helical curves.

The pleat fabric 1 is not, however, limited to the continuum formed with the continuous folded sections shaped by alternately arranging the crest-trough plaits. The pleat fabric 1 includes a discrete structure as seen in a distribution and an aggregation of linear materials, braid materials and tabular materials. Further, the-continuum may be conceived identical with those having an infinite folded structure as in the case of a random walk trace of gas molecules, Peano curve and a vortex line and having the same spatial internal structure as a spatial characteristic including a percolation (phase transition) pattern and a boundary of a fractal graphic. The simplest structures among the pleat fabrics in the form of the continuum described above are known as gathers, corrugates, ripples, flares, drapery, honeycomb waves and plaiting. Further, the pleat fabric 1 may involve the use of a lath net, wherein the pleat fabric 1 is expanded and contracted through loosely joined meshes.

Additionally, FIGS. 30 and 31 each illustrate an eyelet seal member 70. Where the wires 3, 4 pierce a planar screen member 71 as the pleat fabric 1 in the form of a flexible sheet and cloth, the eyelet seal members 70 having a large axial length and attached to the pierce portions thereof are constructed to make the wires 3, 4 substantially orthogonal to the screen member 71.

More specifically, the eyelet seal member 70 shown in FIG. 30 is constructed as follows. A doughnut-like disk 73 is fixedly contact with the peripheral edge of a pierce hole 72 bored in the screen member 71. A pierce cylinder 74 adjacent to the pierce-hole 72 is located connectively to the disk 73. Torus springs 76 are fitted to the outer periphery of the pierce cylinder 74 pierced with the wire 3 or 4 along the inner surfaces of engaging flanges 75 formed at both ends of the open part of the pierce cylinder 74. FIG. 30(A) illustrates a single type. FIG. 30(B) shows a double type in which the screen member 71 is sandwiched in between the disk 73 and a doughnut-like seal washer 77.

On the other hand, the eyelet seal member 71 shown in FIG. 31 is constructed as below. A disk 81 is fixedly contact with the peripheral edge of the pierce hole 72 bored in the screen member 71. The disk 81 is formed with ring-like pierce parts 82 contact with the outer periphery of the wire 3 or 4. As shown in FIG. 31(A), the pierce parts 82 configured as a single type are brought into contact with the screen member 71 from the internal and external surfaces thereof. Alternatively, as shown in FIG. 31(B), the pierce parts 82 are configured as a double type. The screen member 71 is sandwiched in between the pierce parts 82 together with the doughnut-like washer 77 from the internal and external surfaces thereof.

Any type of eyelet seal member 70 itself is made of plastic rubber. A bonding means having a lower melting point is formed on the internal surfaces of the disk 73 and thermally welded to the screen member 71.

When this eyelet seal member 70 has an adequate axial length, a pierce angle with respect to the screen member 71 can be set properly large by setting bending rigidities of the surface of the disk 73, the pierce cylinder 74 and the pierce part 82 with respect to the axial line. A seal function necessary for preventing water and air leakages in the pleat fabric 1 is thereby obtained. Simultaneously, the plaiting can be also structured.

If the pleat fabric 1 has a large breadth, the parallel bars 2 for expanding and contracting this pleat fabric 1 may be constructed in the form of pretension bars formed to previously adding flexures. These flexures acting in an opposite direction to resist flexures caused depending on a turning point (8) group and a fixing point group relative to the wires 3, 4.

The pleat fabric 1 may be, when expanded horizontally with the pleat fabric 1 itself being substantially vertical, demanded of a sealing property between the upper edge thereof and the upper inner surface of an opening/closing zone. For this reason, as illustrated in FIG. 32, the pleat fabric 1 itself is divided into a plurality of sections in the direction substantially orthogonal to the opening/closing direction. Slots aligned with each other are bored respectively in edges of pieces of thus divided sections. The wire 3 pierces these slots 85, thereby connectively nesting the sections. On the other hand, the upper or lower edges of the uppermost and lowermost parts of the sections are brought into contact with the inner surfaces of the upper and lower ends of a frame structure 5. For instance, the sealing property can be maintained by a retainment with another wire 4 piercing and positioned in the vicinity of the frame structure 5. Note that the numeral 86 in the Figure denotes an end pulley bearing the parallel bar 2, and 87 similarly represents a pierce pulley. With the maintenance of this sealing property, a shielding body for shielding, e.g., radiant rays and visible rays may incorporate shut-

out and black-out functions as an air filter and an insect screen.

Referring to FIG. 33, the pleat fabric 1 is disposed between a pair of parallel bars slidably arranged in parallel to each other in the opening/closing directions (double parallel bar structure). Provided in this case is a limiter means 90 for maintaining a pleat configuration with a flexure allowance required by the pleat fabric 1 itself by regulating the maximum stretching width between the parallel bars 2. This limiter means 90 includes a wire reel 91 capable of adjusting an extension length to set an expansion length of the plaiting between the parallel bars 2. The wire reel 91 is fixed to one of the parallel bars 2. A limiter wire 92 extending therefrom is fixed to the other parallel bar 2 on one hand, and a fixed wire 93 consisting of a wire or ribbon piercing the pleat fabric 1 to a predetermined length is connected between the parallel bars 2 on the other hand.

Turning to FIG. 34, there is shown a structure of partial polygonal faces and a polygonal bar with a pierce line of the wire 3 or 4 serving as a ridge line. A multiplicity of pleat fabrics 1 are connected at a predetermined angle θ. For this purpose, the pleat fabrics 1 are overlapped at their edges, and the wires 3, 4 pierce the overlapped portions in common. The connection of the multiplicity of pleat fabrics 1 is not restricted to the structure such as the polygonal bar and partial polygonal faces. The pleat fabrics 1 can be connectively arranged by piercing respective overlapped portions of the divided sections with the wires 3, 4 in common to prevent buckling or the like caused in the pleat fabrics 1 depending on pierce spacings of the wires 3, 4, a pleat width and tensions of the wires 3, 4. More specifically, the divided sections are connected with this pierce line serving as the joint center, thus constructing the continuous pleat fabrics 1 bent along a polygon volt or at right-angled corners or acute-angled corners. The pleat fabric 1 can be freely expanded and contracted. Exhibited in this case are visually exciting effects of these overlapped lines or silhouette of the overlaps. In combination with this, a rhythmical configuration of the overlapped junctions may include other adequate shapes such as a semi-circular shape, a crest-cut shape, an oblique-cut shape and an undulation-cut shape.

The pierce positions of the wires 3, 4 into the pleat fabric 1 at this moment are the centers in section of the overlaps of the respective folded sections of the undulate pleat fabric 1 in which the crest-trough plaits are alternately arranged. Further, the pierce positions are the vertexes of the plaits. An edge cutting configuration is given depending on each of these cases. Exemplified are, e.g., a circular arc shape, V- and W-shapes, a slash-like shape and others. Further, where the pleat fabric 1 itself takes a parallel tube configuration and a honeycomb configuration, an adequate edge cutting configuration is similarly provided.

FIG. 35 illustrates a counter balance means 100. When the pleat fabric 1 is installed in the opening/closing directions along the vertical directions, the apparatus as a whole undergoes a force downward in the gravitational direction. Hence, a magnitude of hysteresis resistance value of the wires 3, 4 set in the apparatus has to be equal to or greater than a tare weight to prevent a slip-down thereof. For this reason, a proper weight 103 is connected via a pulley 102 supported on the upper part of the installing location to a balancer wire 101 connected to any one of the ends of the parallel bars 2. FIG. 35(A) shows a single parallel bar structure. FIG. 35(B) illustrates a double parallel bar structure.

FIG. 36 shows how end pulleys 111 incorporating a turning-point function and supported on the parallel bars 2 work as wheels simultaneously when impinging on the inner surfaces of guide rails 6. More specifically, the grooved end pulleys 111 wound with the wires 3, 4 are so supported on the parallel bars 2 as to protrude outwardly of the both ends thereof. When the end pulleys 111 roll along the guide rails 6, the traveling direction of the parallel bars 2 coincides with the rotating direction of the end pulleys 111. The end pulleys 111 work as the wheels. Therefore, this stabilizes the slide-traveling performance of the parallel bars 2. Provided further is a rugged engagement structure between the outer periphery of the end pulley 111 and the inner surface of the guide rail 6. As shown in FIGS. 36(A) and 36(B), the end pulleys 111 travel after being set in guide grooves 112 cut in the guide rails 6. The traveling stability can be thereby further improved. Note that this is the same with pierce pulleys 113 for turning the wires 3, 4 to pierce the pleat fabric 1. The pierce pulleys 113 can be also supported even in positions of both ends of the parallel bars 2. The numeral 114 in the Figures designates an auxiliary wheel.

FIG. 37 illustrates a wire separator 115 for preventing an entanglement of a plurality of two through three or more wires 3, 4 penetrating inwardly of the parallel bars. This wire separator 115 is constructed such that an interior of a cylindrical body 116 is partitioned by a proper number of partitioning walls 117 into a plurality of pierce chambers 118. The wire separator 115 Itself is disposed inwardly of the parallel bars 2 by adequately fixing both ends of the separator in the parallel bars 2.

Note that the parallel bars 2 themselves can be slide-traveled directly by a manual operation and also forcibly slide-traveled by a drive of a motor such as a geared motor. a reversible motor, etc.. Additionally, a linear motor can be installed in the guide rials 6; or it is possible to perform remote control by means of a manual crank, a geared crank, a worm gear, etc.. in any case, slide-traveling can be attained irrespective of a manual or automatic operation and a direct or indirect operation.

FIGS. 38 and 39 illustrate some concrete embodiments of a fixing means 120 for fixing the terminals of

the wires 3, 4. The fixing means 120 shown in FIG. 38 is constructed in such a way that crushable grooved swollen extrusions 122 with pierce gaps formed to and fro are provided at proper intervals on a rectangular fixed panel 121. Then, after piercing the pierce extrusions 122 with the wires 3, 4, the pierce extrusions 122 are press-crushed, thereby inducing a hysteresis resistance by bending at a smaller curvature. A pressure set when this resistance is present is exerted on the wires 3, 4. On this assumption, the wires 3, 4 can be fixed with a frictional resistance according to the number of secondary deformation points. For this reason, a large pull-out resistance force can be obtained by minimizing partial damages of the wires 3, 4 without imparting a large external force. Incidentally, the numeral 123 in the Figures represents a screw fastening hole, and 124 denotes a swollen turn guide part.

Further, the fixing means illustrated in FIG. 39 consists of a fixed panel 125, a press disk 127 and a fixing screw 129. The fixed panel 125 is formed with radially arranged stoppage protrusions 126. The press disk 127 is similarly formed with radially arranged engaging protrusions 128 to have phase-shifts with respect to the stoppage protrusions 126. The fixing screw 129 fastens the press disk 127 to the fixed panel 125. Then, the wires 3, 4 are so inserted between the press disk 127 and the fixed panel 125 as to be wound therein, the panel 125 and the disk 127 being disposed so that the stoppage protrusions 126 confront the engaging protrusions 128. The panel 125 and the disk 127 are press-fastened to each other with the fixing screw 129, whereby even a plurality of wires 3, 4 can be fixed.

Note that the wires 3, 4 piercing between paired press members having their inner surface formed, though the illustration is omitted, with undulatory protrusions can be similarly fixed by crushing the press members or fastening them with screws.

As depicted in FIG. 40, springs intervene in the wires 3, 4 to be expanded, thus forming flexure adjusting means 130. A respondency to a deformation and distortion of the apparatus is thereby enhanced. The is enables the functionality to expand. For example, the illustrated flexure adjusting means 130 consisting of the spring has a lemon-like contractible closed line. The flexure adjusting means 130 is allowed to function within a range of small limit flexure width, in which this is expanded. Further, in the case of an extremely large flexure quantity of a coil spring or the like having a long extension of element wire, limiter-oriented rods and sleeves are employed in combination to prevent the pretension of the wires 3, 4 from disappearing when expanded up doe to an overload.

Moreover, though the illustrating is omitted, one ends of the paired wires 3, 4 can be connected to each other by means of a tension adjuster having a spring. At this time, the tensions of the respective wires 3, 4 are equalized and then stabilized. The tensions are thus adjusted to bring the parallel bars 2 into a parallel state.

FIGS. 41 to 43 show examples of a compact configuration of the turn member 8 such as a pulley, a glide, etc. supported inwardly of the parallel bars 2.

A compact pulley unit 140 shown in FIG. 41 includes an end pulley 141 and a pierce pulley 142. One end of one wire 3 is so arranged in the parallel bars 2 as to be positioned on the closing side of the pleat fabric 1. The other end thereof is arranged along the inner surface of the guide frame 6 on which the parallel bar 2 slides. The end pulley 141 wound with the wire 3 is supported on the end portion of the parallel bar 2. One end of the other wire 4 is so arranged in the parallel bars 2 as to be positioned on the opening side thereof. The other end thereof is so arranged as to pierce the pleat fabric 1. The pierce pulley 142 wound with the wire 4 is supported in the vicinity of the end portion of the parallel bar 2. Then, when the parallel bars 2 themselves slidably travel, the pull-out direction of each of the wires 3, 4 is identical with the rotating direction of each of the pulleys 141, 142. Hence, the end pulley 141 and the pierce pulley are each disposed on the same axis along the turn-piercing direction of the wires 3, 4 arranged within the parallel bars 2. The parallel bars 2 themselves can be thereby constructed with a narrow width in the expanding direction, wherein the pulley unit 140 is installed.

A compact glide unit 150 depicted in FIG. 42 includes a quadrant end glide 151 and a quadrant pierce pulley 152. One end of one wire 3 is so arranged inwardly of the parallel bars 2 as to be positioned on the closing slide of the pleat fabric 1. The other end thereof is arranged along the inner surface of the guide frame 6 on which the parallel bars 2 travel. The end glide 152 wound with the wire 3 is disposed at the end portion of the parallel bar 2 so that a circular arc slide portion is located on the closing side of the pleat fabric 1. One end of the other wire 4 is so arranged within the parallel bars 2 as to be positioned on the opening side thereof. The other end thereof is so arranged as to pierce the pleat fabric 1. The pierce glide 152 wound with the wire 4 is disposed in the vicinity of the end portion of the parallel bar 2 so that the circular arc slide portion is located on the opening side. Then, the rectilinear side of the pierce glide 152 merely permits a passage of the wire 3 wound and slid on the end glide 151. Hence, the terminal of the circular arc slide portion of the end glide 151 and the rectilinear side of the pierce glide 152 are disposed on the same line in the direction of the wire 3 or 4 arranged inwardly of the parallel bars 2. The parallel bars 2 themselves can be thereby constructed with a

narrow width in the expanding direction, wherein the glide unit 150 is installed.

FIG. 43 shows an example of structure of still another compact glide unit 155 in combination with the wires 3, 4 sharing the same point. That is, the glide unit 155 includes a semicircular end glide 156 and a semicircular glide 157. The end glide 156 is disposed at the end portion of the parallel bar 2 traveling along the guide frame 6 so that a circular arc slide portion is located on the closing side. The pierce glide 157 is disposed in the vicinity of the end portion of the parallel bar so that a circular arc slide portion is located on the opening side. The end glide 156 and the pierce glide 157 are staggered in the direction of the wires 3, 4 arranged within the parallel bars 2. The pierce glide 157 has a holed or grooved pierce part 158 undergoing a penetration of the wire 3 slid along the end glide 156.

FIG. 44 illustrates a come-off preventive means 160 for the parallel bar 2 slidably traveling along a shallow guide groove 162 cut in the upper surface of a lower guide 161 in the opening/closing zone. That is, the come-off preventive means 160 is constructed as follows. Engaging panels 164 falling by their tare weights are attached to the two side surfaces of the lower end portion of the parallel bar 2 through engaging parts 163 (see FIG. 44(B)) each assuming a slidably engaged state in the vertical direction, e.g., a configuration of dovetail groove in section. Then, a regulating protrusion 165 protruding from the inner surface of this engaging panel 164 engages with a regulating recess 166 recessed in the outer surface of the parallel bar 2. A slide width depending on the fall of the engaging panel 164 Itself by its tare weight is thus regulated. An unnecessary downward extrusion is thereby prevented (see FIG. 44(C)).

FIG. 45 illustrates a sealing member 170 for closing a gap between the side edge of the pleat fabric 1 and the inner surface of the opening/closing zone. This sealing member 170 includes engaging pieces at opening edge. The engaging pieces 172 engage in a possible-of-disengagement manner with the inner surface of an engaging rail 171 provided on the inner surface of the frame structure 5 framed to partition the opening/closing zone. The sealing member 170 has a such section that the outer surface of the bottom thereof is brought into contact with the side edge of the pleat fabric 1. The sealing member 170 is grooved to have a fan-shaped open part. Then, a breadth of this sealing member 170 is not smaller than a breath of each opening/closing section of the pleat fabric 1. FIG. 45(A) shows an arrangement to close a gap produced between the upper part of the pleat fabric 1 and the inner surface of the upper part of the opening/closing zone when the pleat fabric 1 itself standing substantially in a vertical state is developed to open and close in the horizontal directions. FIG. 45(B) shows an arrangement to close gaps produced between the right and left sides of the pleat fabric 1 and the inner surfaces of the right and left parts of the opening/closing zone when the pleat fabric 1 itself standing substantially in the vertical state is raised and lowered to open and close in the up-and-down directions. The sealing member 170 itself is resiliently biased inward by a rubber spring member 173 made of a high foaming resin and stuck to the inner surface of the frame structure 5 of the opening/closing zone. The sealing member 170 is thereby impinged on the side edge of the pleat fabric 1 through a slide member 174.

FIG. 46 illustrates a structure of connecting the parallel bar 2 in the pleat fabric 1 to the guide rail 6 in the opening/closing zone. Referring to FIGS. 46(A) and 46(B), if the pleat fabric 1 is of a corner circumscription type or the like, the wires 3, 4 are positioned to pierce the vertexes of the crest plaits of the pleat fabric 1 or the bottoms of the trough plaits. The wires 3, 4 fixed in a stoppage groove 181 can be pulled out via a pull-out port 182 notched in a portio of the stoppage groove 181 in the guide rail 6 or the parallel bar 2.

Turning to FIG. 46(C), the above-mentioned fixing means 120 and the flexure adjusting means 130 of the wires 3, 4 are fitted in a grooved fitting part 183 formed in rear of the stoppage groove 181 in the guide rail 6 or the parallel bar 2.

Referring to FIG. 46(D), there is shown a structure of the parallel bars 2 in the case of the apparatus of the absolute motion type. When the fixed ends of the wires 3, 4 in this absolute motion type apparatus are fixed onto the parallel bars 2, the final tensions of the wires 3, 4 can be set after mounting the guide rail of the opening/closing zone in which the turn members 8 such as the glides or the pulleys are incorporated. For this reason, a separately prepared joint bracket 184 for mounting is fixedly formed on the parallel bar 2.

FIGS. 47 through 49 show a pulley block 190 of a minimum design type and applied especially in the second group, an edge cylindrical part 198 of the pleat fabric 1 and a glide block 195 for the parallel bar 2. In this minimum design type (see FIGS. 16 to 20), any one of the frame structure 5, the guide rail 6 and the parallel bar 2 is omitted.

The parallel bars do not exist, whereas the guide rail 6 is provided. In this case, the pulley block 190 is assumed to travel in the guide rails 6. Turned at the edge portions of the pleat fabric 1 located at the guide rails 6 are, as illustrated in FIGS. 47 and 16, the wire 3, 4 fixed to the ends of the guide rails 6 or piercing the pleat fabric 1 and the wires 3, 4 piercing the edges of the pleat fabric 1. for this purpose, a pair of pulleys 192 rollably traveling within the guide rails 6 are rotatably supported back and forth in a slide member 191 assuming substantially groove-like shape in section and traveling within the guide rails 76. Then, A guide protrusion 193 having a curved surface along the outline of pulley 192 is protrusively located on the inner surface of the bottom

of the slide member 191 between the front and rear pulleys 192. This arrangement facilitates piercing of the wires 3, 4 but hinders them from coming off.

Further, as shown in FIG. 48, there is formed a glide block 195 having curved surfaces for respectively turn-sliding the wires 3, 4 piercing in the back-and-forth directions to provide the slide traveling within the guide rails 6 or the parallel bars 2. The glide block 195 includes pierce grooves 196 confronting each other and cut in the piercing direction in the parallel bar 2.

Moreover, the wires 3, 4 in this minimum design, as depicted in FIG. 49, pierce the edge cylindrical parts (piping) 198 each formed by bending the edge itself of the pleat fabric 1. FIG. 49(A) illustrates a case where the pleat fabric 1 is formed with plaits. FIG. 49(B) shows a case where the pleat fabric 1 is flexible and is therefore formed with no plait.

Hence, as previously illustrated in FIG. 18, for instance, the wires 3, 4 are fixed to the both side edges of the frame structure 5 in the opening/closing directions in the opening/closing zone. The side edges of the pleat fabric 1 are held (pierced) by the wires 3, 4 in the side edges through pierce rings 7. On the other hand, the wires 3, 4 piercing the edge cylindrical parts 198 formed at the edges of the pleat fabric 1 are arranged through the pulley block 190 or the glide block 195 serving as a turn point for traveling within the side edges while being positioned at the side edges of the pleat fabric 1. Adequate tensions are given to these wires. With this arrangement, in the case of sliding the edges of the pleat fabric 1 that correspond to virtual positions of the parallel bars 2, it follows that the wires 3, 4 are slid in the opposite directions when passing each other within the edge cylindrical parts 198 though not observed from outside. The pleat fabric 1 can be thereby slid to and fro.

FIG. 50 shows a glide block 200 for the parallel bar 2. The glide block 200 is so formed as to be connectable to, e.g., the end of the above-mentioned wire separator 115 or the body of the cyclindrical parallel bar 2. The glide block 200 cooperates with these components to constitute the parallel bar 2. The glide block 200 has a pair of front and rear curved surfaces for turning and sliding the lead-in wires 3, 4 by inserting the wires in the back-and-forth directions. The glide block 200 is fundamentally formed in the cylindrical shape, wherein pierce grooves cut in the piercing direction in the wire separator 115 confront each other. Then, the glide block 200 may be fitted in the end portion of the parallel bar body (see FIG. 50(A) or fitted outwardly of the end portion of the wire separator 115 (see FIG. 50(B). The glide block 200 may also be constructed as follows. Half-split blocks 203 takes a bisymmetrical structure, wherein a pierce surface for the wires 3, 4 is formed at the end portion thereof, and pierce ports for the wires 3, 4 are formed substantially mid-positions. The half-split blocks 203 assuming a half-split shape, basically substantially a grooved shape in section are butt-joined to each other. A cylindrical member 204 is fitted therein after being butt-joined (see FIG. 50(C)).

Further, FIG. 51 illustrates an intermediate glide 205 suitable for an application to a location where the wires 3, 4 and further an intermediate wire 9 pierce the pleat fabric 1. This intermediate glide 205 is constructed as below. Half-split blocks 207 take a bisymmetrical structure wherein wire pierce ports 206 are formed substantially in midpositions. The half-split blocks 207 assuming a half-split shape, basically substantially a grooved shape are butt-joined to each other.

Further, FIGS. 52 to 54 show terminal brackets 210 applied even to the minimum design type of any one of the first and second groups. These terminal brackets 210 serve to fix the ends of the wires 3, 4 to the end portions of the opening/closing zone in the case of the following construction. As illustrated in FIG. 52, when installed in, e.g., a window frame, the frame structure 5 is omitted. The wires 3, 4 piercing the pleat fabric 1 provided in the opening/closing zone are inserted in the parallel bars 2 connected to the end portions of the pleat fabric 1. Note that decorative ball members 211 are attached to the respective end portions thereof.

In the screen apparatus of this minimum design type, as shown in FIG. 53, the wires W_1, W_2 in the pseudo circuit unit U* described above and the wires W_3, W_4 in the simple unit U are complexly arranged. The wires are connected to the terminal brackets 210 defined as fixing ends and each turned at both ends of the parallel bars 2 or at the middles of the parallel bars to pierce the pleat fabric 1.

The terminal bracket 210 shown in FIGS. 52 and 54(A) includes a stand-like fixed base 213, a wire joint 216 and a cylindrical wire clamper 217. The fixed base 212 having an insertion bore 212 bored in the central part of the upper surface thereof is fixed in a predetermined position. The wire joint 216 has a spherical grip 214 and a split insertion pin 215 protruding from the grip 214 and forcibly inserted into the insertion bore 212. The wire clamper 217 is inserted into the insertion pin 215 together with the wires 3, 4 led in the interior of the clamper itself. Further, the fixed base 213 is formed to screw-fasten the stand portion to the base plate 218 fixed in the fixing position with a screw or by bonding (see FIG. 54(A)). Alternatively the fixed base 213 is structured as, e.g., an adsorption panel so that the base itself can be fixed directly in the fixing position (see FIG. 54(B)).

The terminal bracket 210 shown in FIG. 54(C) is formed in a plate-like configuration. For attaching both to the ceiling and the wall, a substantially L-shaped base body 222 in profile , wherein screw fastening holes

221 are holed in the horizontal part and in a leg part. The upper portion of the base body 222 is formed with a pierce hole 223 for receiving the wires 3, 4. A proper number of crushable grooved swollen pierce extrusions 224 with pierce gaps formed to and fro are provided in the lower portion of the base body 222.

The terminal bracket 210 illustrated in FIG. 54(D) is attached to the end of, e.g., the guide rail 6. A plate-like base body 225 contact with the end surface of the guide rail 6 is formed with screw fastening holes 227 for screw-fastening to cylindrical portions of reinforcing pieces 226 formed inwardly of the guide rail 6. An adequate number of crushable grooved swollen pierce extrusions 229 with pierce gaps formed back and forth are provided on a terminal piece 228 formed in continuation from the base body 225.

Besides, FIGS. 55 and 56 illustrate small-sized and simple screen apparatuses suitable for installation in, e.g., a small window having a relatively small opening/closing zone. That is, the screen apparatus comprises: parallel bar members 231 like hinged band plates between which the edges of the pleat fabric 1 in the opening/closing directions are sandwiched from the external and internal surfaces thereof; the wires 3, 4 piercing the pleat fabric 1 to keep a kinematic pair relationship of a cross arrangement and positioned in the vicinity of the ends of the parallel bar members 231 to pierce wire pierce holes formed therein; and terminal brackets 233 for fixing the ends of the wire 3, 4. Attached then to the wire pierce holes 232 are eyelet slide guides 234 for reinforcing the peripheral edges of the wire pierce hoes 232, smoothing the slide of the wires 3, 4 and simultaneously connecting the parallel bar members 231 on the internal and external surfaces. The terminal bracket 233 is a disk having its internal surfaces to which a peelable adhesive tape is adhered. The terminal bracket 233 includes a proper number of crushable grooved swollen pierce extrusions 235 with pierce gaps formed back and forth. This terminal bracket 233 is, if necessary, covered with a cover 236.

In this small-sized simple screen apparatus, as illustrated in FIG. 56(A), the wires W_1, W_2 in the pseudo circuit unit U* described above and the wires W_3, W_4 in the simple unit U are complexly arranged. Further, as shown in FIG. 56(B), the wires W_1, W_2 in the above-described simple unit U_1 and the wires W_3, W_4 in the simple unit U_2 are complexly arranged. Then, these wires W_1 W_2, W_3, W_4 are connected to the terminal brackets 233 defined as fixing ends. The wires are each turned through the wire pierce holes 232 of the parallel bar members 231 to pierce the pleat fabric 1.

In this type of the apparatus, if made contact with the window frame in a state where the pleat fabric 1 is sufficiently expanded, the pleat fabric 1 is usable as a screen. At this time, the wires 3, 4 piercing the pleat fabric 1 are desirably positioned at the plaits on the side of the window surface.

FIG. 57 illustrates a construction in which another pleat fabric 11 is disposed in combination within the pleat fabric 1. The pleat fabric 11 is expandable and contractible in the moving range of the parallel bars 2 in the pleat fabric 1. More specifically, the wires 3, 4 piercing the pleat fabric 1 are turned through the end and pierce turn members 8 within the parallel bar 2 to provide crossovers. The wires 3, 4 are then stretched in the opening/closing directions between the both end portions of the opening/closing zone. On the other hand, the wires are turned through end and pierce turn members 18 within parallel bar 12 to provide the crossovers in another pleat fabric 11 located and arranged within the pleat fabric 1. Wires 13, 14 piercing the pleat fabric 11 are turned through the turn members 18 within the parallel bar 2 and thus stretched between the both end portions of the opening/closing zone. Then, one end of the parallel bar 12 is wound with an operation wire 17 turned through an operation turn pulley 16 supported within the parallel bar 2 between operation pulleys 15 supported respectively at the both end portions of the opening/closing zone. Note that the tensions of the wires 13, 14 for moving the parallel bar 12 can, if required, be balanced by imparting tensions to those on the opposite side.

In this mode where the pleat fabrics 1, 11 are disposed in combination, another pleat fabric 121 can be installed irrespective of the interior or exterior of the pleat fabric 11. Besides, the pleat fabric 1 and another pleat fabric 11 are separately operable and each expandable and contractible separately.

FIG. 58 illustrates a construction in which a plurality of pleat fabrics 1 each assuming a different color such as, e.g., white, black, etc. are installed in combination within a skylight 240. These pleat fabrics can be opened and closed in an overlapped configuration; or the pleat fabrics can be complexly combined in a variety of forms so that the pleat fabrics are separately opened and closed.

Referring to FIG. 58(A), the plurality of pleat fabrics 1, 11 are disposed in side-by-side relationship so that the pleat fabrics can be separately operated at predetermined spacings in the upper and lower parts of the skylight 240. The first pleat fabric 1 is connected to the parallel bar 2 thereof. An operation wire 241 stretched over to the front and rear portions of the skylight 240 is pulled from outside of the skylight 240 through the operation pulley 242 supported by the side of the skylight 240. Similarly, another one, i.e., the second pleat fabric 11 disposed downwardly of the first pleat fabric 1 is connected to the parallel bar 12 thereof. An operation wire 243 stretched over to the front and rear portions of the skylight 240 is pulled from outside of the skylight 240 through an operation pulley 244 supported by the side of the skylight 240.

Referring to FIG. 58(B), the plurality of pleat fabrics 1, 11 are disposed in series so that the pleat fabrics

can be separately operated in the horizontal directions of the skylight 240. Another second pleat fabric 11 is connected to the first parallel bar 2 of the first pleat fabric 1. The second operation wire 243 for opening and closing the second pleat fabric 11 is connected to the second parallel bar 12 thereof and arranged over to the front and rear portions of the skylight 240. On the other hand, the first operation wire 241 for opening and closing the first pleat fabric 1 is connected to the first parallel bar 2 and arranged to one external side of the skylight 240. With this arrangement, the pleat fabrics 1, 11 can be separately opened and closed by pulling a small number of operation wires 241, 243.

Incidentally, in accordance with the mode of combined placement, the pleat fabrics can be opened and closed by driving of a motor. The pleat fabrics can be opened and closed by use of two loops, 2-system racks and pinions or by driving of a single motor with a provision of a switching means such as an electromagnetic clutch. Opening/closing positions are detected by a microswitch, etc. and thus controlled.

An additional mode is that a plurality of pleat fabrics 1 are so disposed as to be overlapped in the back-and-forth directions in the opening/closing zone. In this case, the pleat fabrics are singly separately operated to expand and contract. A large variety of displays are thereby expressed in the opening/closing zone. For instance, the colors, materials and others can be combined in many ways.

The present invention has the constructions described above. Therefore, the turn members can be staggered within the parallel bars. The angle is set based on the balance of tensions of the wires stretched between the both end portions of the opening/closing zone. The pleat fabric can be thereby expanded and contacted within the opening/closing zone with the pleat configuration remaining stable.

Further, the braking force corresponding to the tension is set within the apparatus due to the hysteresis resistance and frictional resistance of the wire Itself or a composite resistance thereof in the positions of the turn members disposed in the frame structure, the guide rails and the parallel bars, respectively. Made are attempts to stabilize the configuration and fix the position against the reaction in the expansion and contraction of the pleat fabric. The parallel bars can be halted in arbitrary positions. It is possible to freely set a size of open part in the opening/closing zone.

At this moment, the wires themselves take an asymmetrical shape wherein the wires pierce the pleat fabric on the side of the pleat fabric and arranged in the both side edges of the opening/closing zone on the opening side, with the boundaries defined by the opening/closing ends of the parallel bars connected to the edges of the pleat fabric between the portions where the wires are stretched and supported. The open part can be therefore opened completely. No wire is exposed and distributed in the open part, whereby the open part is rendered open largely.

Besides, the pleat fabric is surely held in a tense state where the proper tensions are imparted beforehand to the wires themselves. There is no necessity for supporting the pleat fabric both in the position of the central line and at the center of gravity of the pleat fabric itself. The pleat fabric can be stretched and expanded in a free mode of placement in the gravitational, horizontal and oblique directions while allowing a bias and inclination thereof. The opening/closing means in the open part exhibits a general usability. The application extends to an extremely wide range.

In addition, the wires pierce the pleat fabric, wherein the proper tensions are given to the wires themselves that are stretched between the both end portions in the opening/closing zone. The crossovers are formed substantially in the middles of the wires. In combination with this, the pleat fabric is surely held within the opening/closing zone and easily expandable and contractible in the opening/closing directions.

That is, when the pleat fabric is expanded and contracted, the lengths of the crossovers of the wires in this pleat fabric are kept fixed. On the other hand, the pierce parts and fixed parts are each relatively altered, with a total length fixed. Hence, the opening/closing edges of the pleat fabric can be slid substantially in parallel in the opening/closing directions. Further, the tensions of the pair-arranged wires work to balance the pleat fabric in the opening/closing directions, thereby stabilizing the actions to open and close the pleat fabric.

The frame structure for defining the opening/closing zone supports the frames when the pleat fabric is expanded and contracted. Further, the guide rails are laid along the both edges in the opening/closing zone, thereby maintaining the configuration of the pleat fabric in such a direction as to intersect at an arbitrary angle or substantially right angle to the opening/closing directions.

Moreover, the wires are led via the side edge from the end portion of the opening/closing zone on the opening side, then turned and inserted in the parallel bar. The wires are further turned from the parallel bar to pierce-the pleat fabric itself. In the relative motion type that presents the pair-arranged wire mode described above, when parallel bar itself slides, a relative velocity is produced between the pleat fabric and the wire. The parallel bar is surely stopped under the adequate braking action.

On the other hand, the wires are led via the end portion on the closing side from the end portion on the opening side in the opening/closing zone, then turned, inserted in the pleat fabric and reach the parallel bar. In the absolute motion type that presents a pair-arranged wire mode described above, when the parallel bar

itself slides, the pleat fabric and the wires always move at an equal velocity in the same direction. The contact points thereof undergo no frictional force, thereby attaining the smooth opening/closing operations.

Further, the pleat fabric composed of a pleated membrane is usable in the form of a shield membrane, a shielding/decorative curtain, a simple partition and others. Moreover, the hollow pleat fabric is usable in the form of fittings such as a door, etc., an architect structural body such as a wall, etc. and others.

A proper number of intermediate wires are inserted in the pleat fabric Itself in the middle positions other than the side edges thereof. With this arrangement, when the pleat fabric is expanded and contracted, the mid-portion of the pleat fabric itself in the piercing position is held. It is thus possible to prevent a flexure that is easy to occur in the pleat fabric itself.

In addition, the apparatus according to the present invention is constructed applicably to, e.g., a venetian blind, a pleat screen, a folding door, a folding screen, a duet, French curtain, a gather curtain, a Roman shade, an Austrian curtain, a drapery, a tent, an awning, a sash, a bran, a pneumatic membrane structure, a membrane structure opening/closing system, a greenhouse, a partition, a movable wall body, a movable ceiling, a movable roof, a fence, a movable net fabric, a thick curtain, an exterior wall structure (carbon fiber, ceramic fiber), a poster pictorial hanger, a rack structure, an air filter and others.

Furthermore, the apparatus is applicable to an air cleaner, an air bag, a writing system, a soft shutter, an opening/closing type window glass structure, an opening/closing type glass roof, a solar cell power generation roof, a water gate, an advertisement tower, an ad. panel, an ad. wall, an ad. window with a sensor to human body, a printer, a high-speed shutter, an imagination net, a smoke-proof shutter, a crane, a jack system, a drawer system, a paper feed system, a telescope system, an axial flow valve system, a piston system, a metal pleat, a metal sheet pleat and a metal roof.

It is apparent that, in this invention, a wide range of different working modes can be formed based on the invention without deviating from the spirit and scope of the invention. This invention is not restricted by its specific working modes except being limited by the appended claims.

Claims

1. A wire pierce screen apparatus comprising:
   a pleat fabric disposed within an opening/closing zone, expanded and contracted in opening/closing directions; and
   wires stretched in a state where proper tensions are imparted to said wires between both end portions of said opening/cloning zone in the opening/closing directions, pierce-arranged in said pleat fabric on a cloning side where said pleat fabric is expanded and arranged in both side edges of said opening/closing zone on an opening side where said pleat fabric is opened,
   wherein said wires are led via the side edges thereof from the opening-side end portion of said opening/closing zone, then turned, inserted in a parallel bar connected to opening end portion of said pleat fabric, turned from said parallel bar, made to pierce said pleat fabric, reach the closing-side end portion of said opening/closing zone and thus pair-arranged, and simultaneously said paired wires intersect one another within said parallel bar.

2. A wire pierce screen apparatus comprising:
   a pleat fabric disposed within an opening/closing zone, expanded and contracted in opening/cloning directions; and
   wires stretched in a state where proper tensions are imparted to said wires between both end portions of said opening/closing zone in the opening/closing directions, pierce-arranged in said pleat fabric on a closing side where said pleat fabric is expanded and arranged in both side edges of said opening/closing zone on an opening side where said pleat fabric is opened,
   wherein said wires are led via the side edge thereof from the opening-side end portion of said opening/closing zone, then turned, inserted in a parallel bar connected to opening end portion of said pleat fabric, turned from said parallel bar, made to pierce said pleat fabric, reach the closing-side end portion of said opening/closing zone and thus pair-arranged, and simultaneously said paired wires do not intersect one another within said parallel bar.

3. A wire pierce screen apparatus comprising:
   a combination of said wire pierce screen apparatuses according to claim 1 or 2.

4. A wire pierce screen apparatus comprising:

a pleat fabric disposed within an opening/closing zone, expanded and contracted in opening/closing directions; and

wires stretched in a state where proper tensions are imparted to said wires between both end portions of said opening/closing zone in the opening/closing directions, pierce-arranged in said pleat fabric on a closing side where said pleat fabric is expanded and arranged in both side edges of said opening/closing zone on an opening side where said pleat fabric is opened,

wherein said wires are led via the closing-side end portion from the opening-side end portion of said opening/closing zone, then turned, made to pierce said pleat fabric, reach a parallel bar connected to the opening end portion of said pleat fabric and thus pair-arranged, and simultaneously said paired wires intersect one another in a position of the closing-side end portion of said pleat fabric.

5. A wire pierce screen apparatus comprising:

a pleat fabric disposed within an opening/closing zone, expanded and contracted in opening/closing directions; and

wires stretched in a state where proper tensions are imparted to said wires between both end portions of said opening/cloning zone in the opening/cloning directions, pierce-arranged in said pleat fabric on a closing side where said pleat fabric in expanded and arranged in both side edges of said opening/closing zone on an opening side where said pleat fabric is opened,

wherein said wires are led via the closing-side end portion from the opening-side end portion of said opening/cloning zone, then turned, made to pierce said pleat fabric, reach a parallel bar connected to the opening end portion of said pleat fabric and thus pair-arranged, and simultaneously said paired wires do not intersect one another in a position of the closing-side end portion of said pleat fabric.

6. A wire pierce screen apparatus comprising:

a combination of said wire pierce screen apparatuses according to claim 4 or 5.

7. A wire pierce screen apparatus comprising:

a pleat fabric disposed within an opening/closing zone, expanded and contracted in opening/cloning directions; and

wires stretched in a state where proper tensions are imparted to said wires between both end portions of said opening/closing zone in the opening/closing directions, pierce-arranged in said pleat fabric on a closing side where said pleat fabric is expanded and arranged in both side edges of said opening/closing zone on an opening side where said pleat fabric is opened,

wherein parallel bars connected to respective end portions of said pleat fabric are slidably disposed within said opening/closing zone between guide rails laid at both side edges of said pleat fabric, and said wires fixed to the end portions of said guide rails are inserted in said parallel bars, made to pierce said pleat fabric and thus pair-arranged.

8. A wire pierce screen apparatus comprising:

a pleat fabric disposed within an opening/closing zone, expanded and contracted in opening/closing directions; and

wires stretched in a state where proper tensions are imparted to said wires between both end portions of said opening/closing zone in the opening/closing directions, pierce-arranged in said pleat fabric on a closing side where said pleat fabric is expanded and arranged in both side edges of said opening/cloning zone on an opening side where said pleat fabric is opened,

wherein the closing-side end portion of said pleat fabric is properly fixed, the opening-side end portion of said pleat fabric is connected to a parallel bar, and said wires inserted in said parallel bar and piercing said pleat fabric are pair-arranged between the both end portions of said opening/closing zone.

9. A wire pierce screen apparatus comprising:

a pleat fabric disposed within an opening/closing zone, expanded and contracted in opening/closing directions; and

wires stretched in a state where proper tensions are imparted to said wires between both end portions of said opening/closing zone in the opening/closing directions, pierce-arranged in said pleat fabric on a closing side where said pleat fabric is expanded and arranged in both side edges of said opening/closing zone on an opening side where said pleat fabric is opened,

wherein said opening/closing zone in which said pleat fabric is opened and closed is defined by a frame structure, and said wires retaining side edges of said pleat fabric, turned at the end portions of the

side edges of said pleat fabric and piercing the both end portions of said pleat fabric are thus pair-arranged.

10. A wire pierce screen apparatus comprising:

a pleat fabric disposed within an opening/closing zone, expanded and contracted in opening/cloning directions; and

wires stretched in a state where proper tensions are imparted to said wires between both end portions of said opening/cloning zone in the opening/cloning directions, pierce-arranged in said pleat fabric on a closing side where said pleat fabric is expanded and arranged in both side edges of said opening/closing zone on an opening side where said pleat fabric is opened,

wherein said wires are led via the both edge portions of said opening/closing zone, turned at the end portions of parallel bars, inserted in said parallel bars, turned from said parallel bars and made to pierce said pleat fabric, and said wires are thus pair-arranged in said parallel bars connected to the both end portions of said pleat fabric between the both end portions of said opening/closing zone.

11. A wire pierce screen apparatus comprising:

a pleat fabric disposed within an opening/closing zone, expanded and contracted in opening/closing directions; and

wires stretched in a state where proper tensions are imparted to said wires between both end portions of said opening/closing zone in the opening/cloning directions, pierce-arranged in said pleat fabric on a closing side where said pleat fabric is expanded and arranged in both side edges of said opening/closing zone on an opening side where said pleat fabric is opened,

wherein said wires retaining the side edges of said pleat fabric between both end portions of guide rails laid at the both side edges of said pleat fabric, turned at the end portions of the side edges of said pleat fabric and piercing the both end portions of said pleat fabric, and said wires are thus pair-arranged.

12. The wire pierce screen apparatus according to any of claims 1 through 11, wherein said pleat fabric is composed of an expandable/contractible pleated membrane formed with continuous folded sections having crest-trough plaits alternately arranged.

13. The wire pierce screen apparatus according to any one of claims 1 through 11, wherein said pleat fabric is composed of a continuum of arrayed hollow members capable of flat-contraction and swell-expansion.

14. The wire pierce screen apparatus according to any one of claims 1 through 11, wherein said pleat fabric is formed in such a hollow configuration that said pleat fabric is contracted with plaits in a flat shape in the opening/closing directions.

15. The wire pierce screen apparatus according to any one of claims 1 through 14, wherein said wires have pierce parts piercing said pleat fabric in the opening/closing directions of said pleat fabric, crossovers along the end portions of said pleat fabric in such a direction as to be substantially orthogonal to the opening/closing directions or intersect one another at an arbitrary angle and fixed parts fixed to the opening- or closing-side end portion in said opening/closing zone, and said pierce and fixed parts relatively change while keeping a total length constant with a crossover length fixed concomitantly with the expansion and contraction of said pleat fabric.

16. The wire pierce screen apparatus according to any one of claims 1 through 15, wherein a wiring direction is turned at a turn member of a rotatable pulley or a glide having a circular arc surface between said fixed part, said crossover and said pierce part of said wire, and said turn member is attached to any one of said frame structure, said guide rail and said parallel bar.

17. The wire pierce screen apparatus according to any one of claims 1 through 16, further comprising a proper number of intermediate wires piercing said pleat fabric in arbitrary positions in the opening/closing direction of said pleat fabric, turned inwardly of said parallel bar at the opening-side end portion of said pleat fabric and arranged along the side edges in said opening/closing zone.

18. The wire pierce screen apparatus according to any one of claims 1 through 16, wherein said wire is turned at said frame structure for partitioning said opening/closing zone, a pulley unit sliding inwardly said guide rail, or a pulley supported inwardly of said parallel bar.

19. The wire pierce screen apparatus according to any one of claims 1 through 16, wherein said wire is turned at said frame structure for partitioning said opening/closing zone, a glide unit sliding inwardly said guide rail or a glide pulley disposed inwardly of said parallel bar and having a curved surface.

20. The wire pierce screen apparatus according to any one of claims 1 through 19, wherein a braking force corresponding to a tension in net depending on a hysteresis resistance and a frictional resistance of said wire themselves or a composite resistance thereof in a turning position of said wire.

21. The wire pierce screen apparatus according to any one of claims 1 through 20, wherein said wires themselves that are stretch-retained between the both ends in said opening/closing zone pierces said pleat fabric on the side of said pleat fabric and arranged in an asymmetry at the both side edges in said opening/closing zone on the opening side at boundaries defined by the opening/closing ends of said parallel bars connected to the end portions of said pleat fabric.

FIG. 1

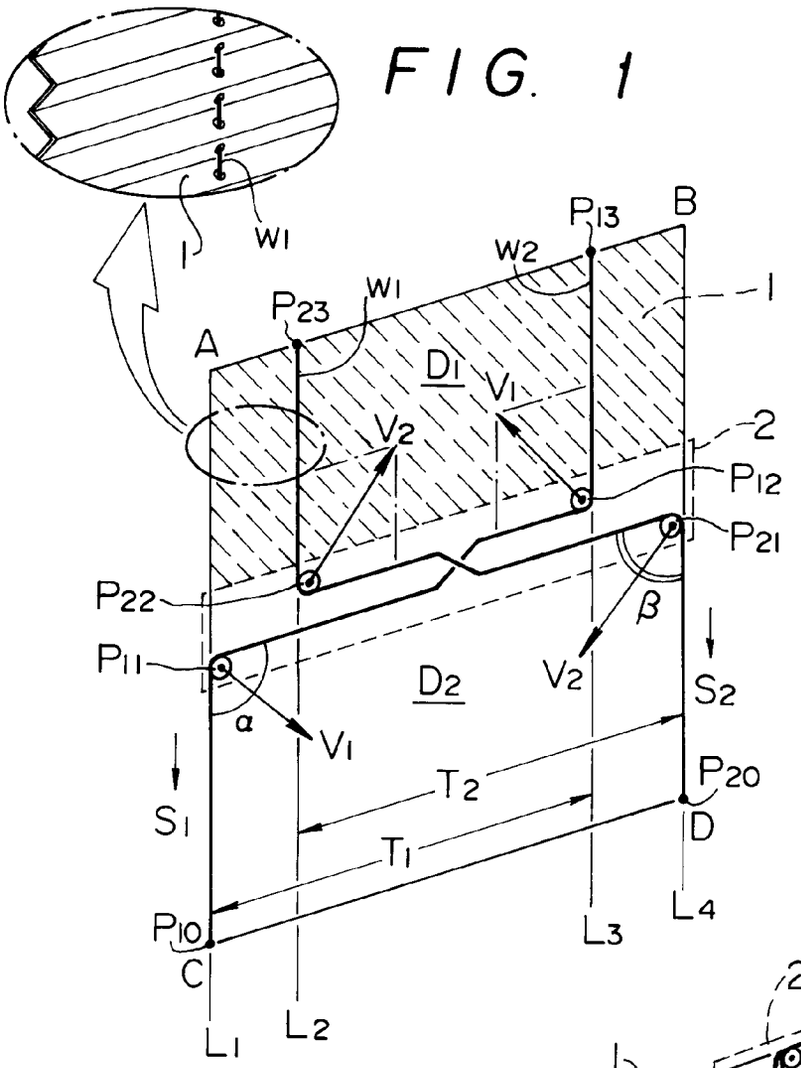
W1
1
P13
B
W2
W1
P23
A
D1
V1
V2
2
P12
P21
P22
β
P11
D2
V2
S2
α
V1
S1
T2
P20
T1
D
P10
L4
L3
C
L1
L2

FIG. 2

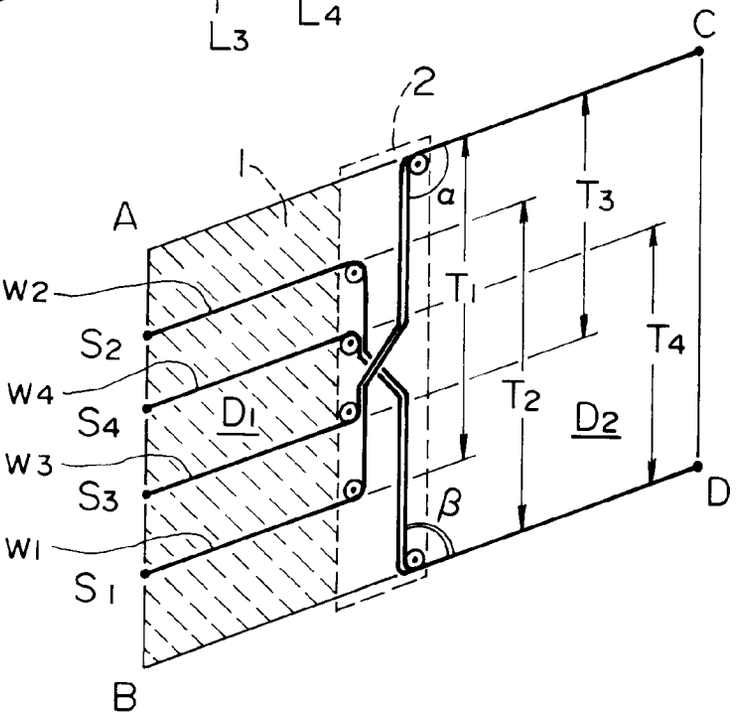
C
2
1
α
A
T3
W2
T1
S2
T4
W4
T2
S4
D1
D2
W3
S3
β
D
W1
S1
B

FIG. 3
(A)

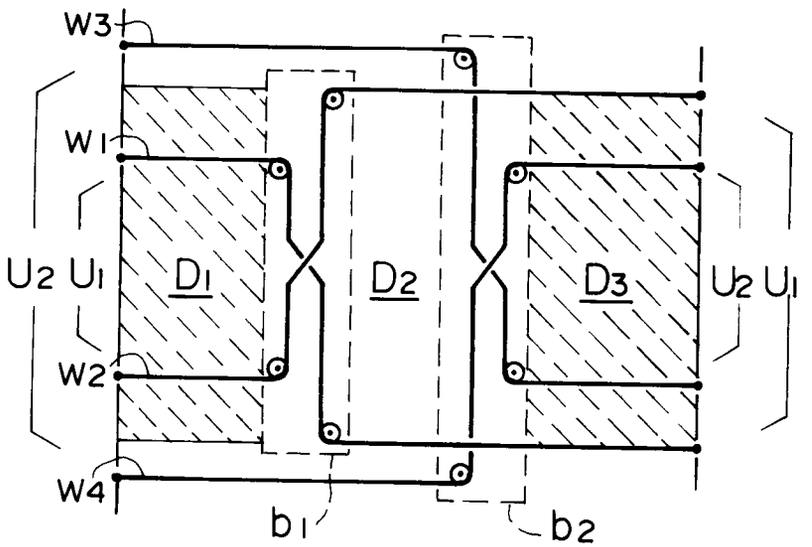
W3
W1
U2 U1
D1
D2
D3
U2 U1
W2
W4
b1
b2

FIG. 3
(B)

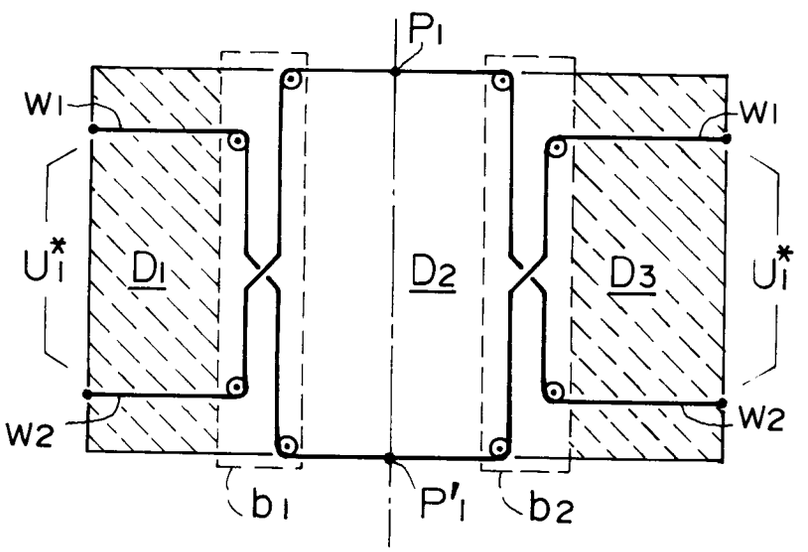
P1
W1
W1
U1*
D1
D2
D3
U1*
W2
W2
b1
P'1
b2

FIG. 4

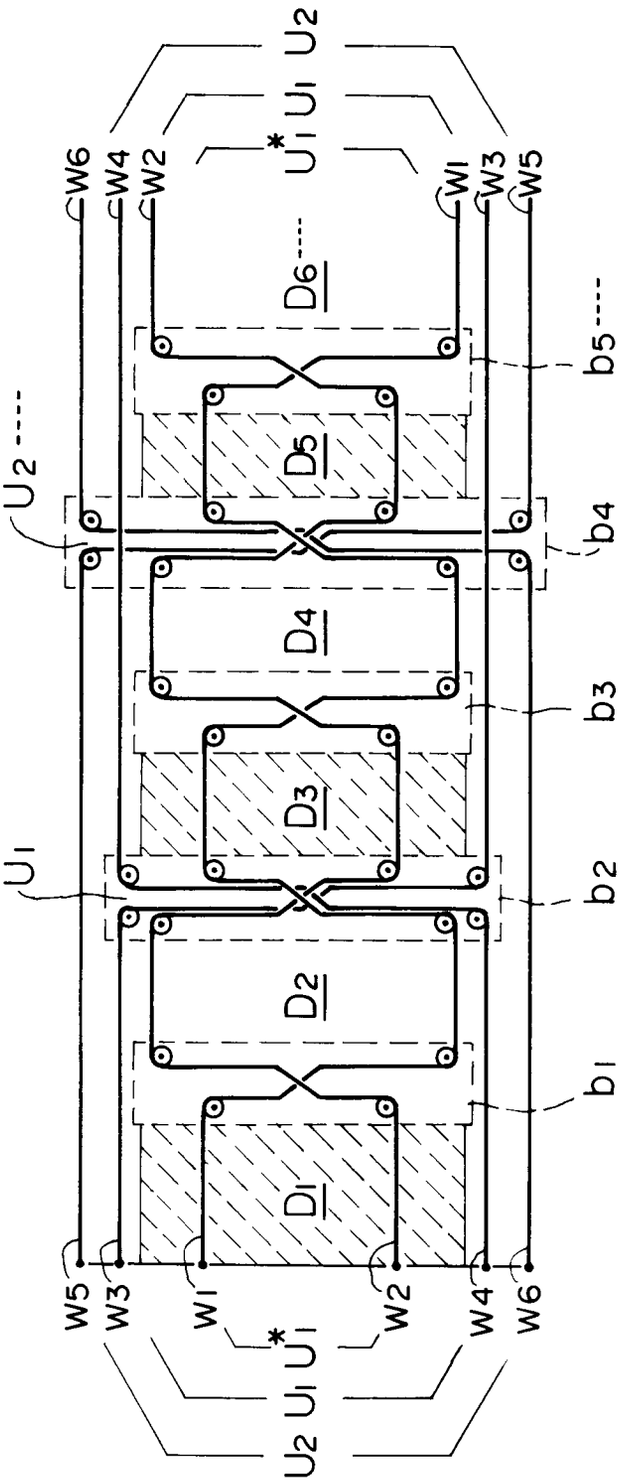
U2 U1 U1 U2
W6 W4 W2 W1 W3 W5
D6
D5
D4
D3
D2
D1
b5
b4
b3
b2
b1
U2
U1
W5 W3 W1 W2 W4 W6
U2 U1 U1 U2

FIG. 5
(A)

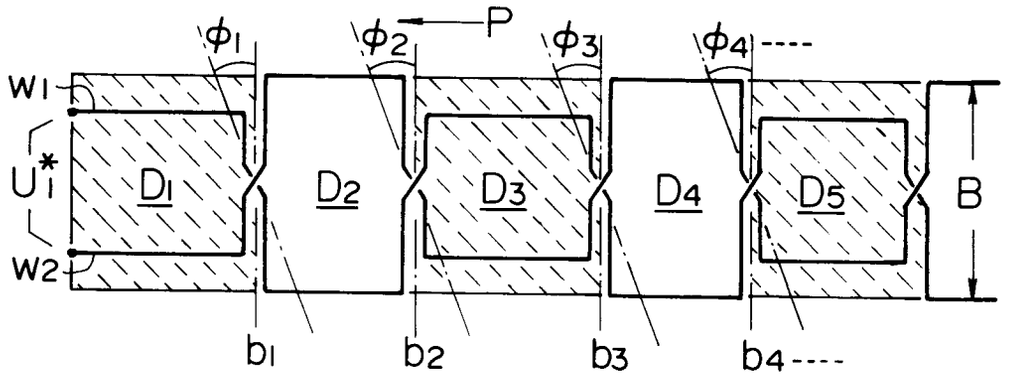

FIG. 5
(B)

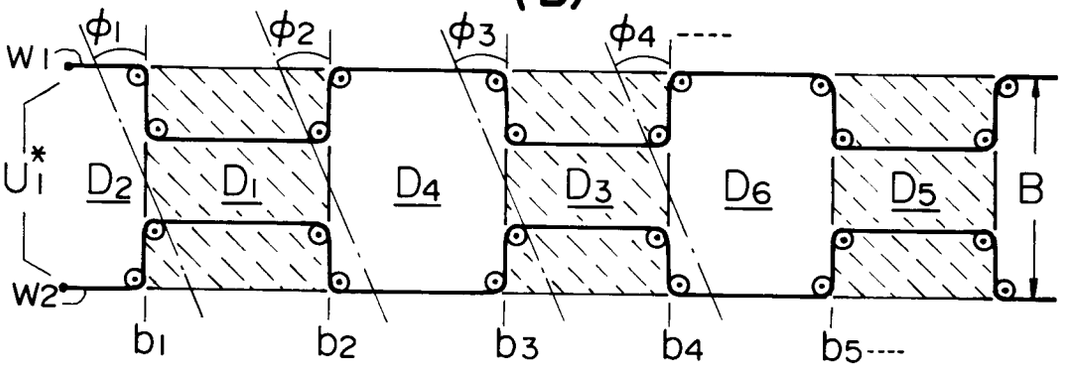

FIG. 5
(C)

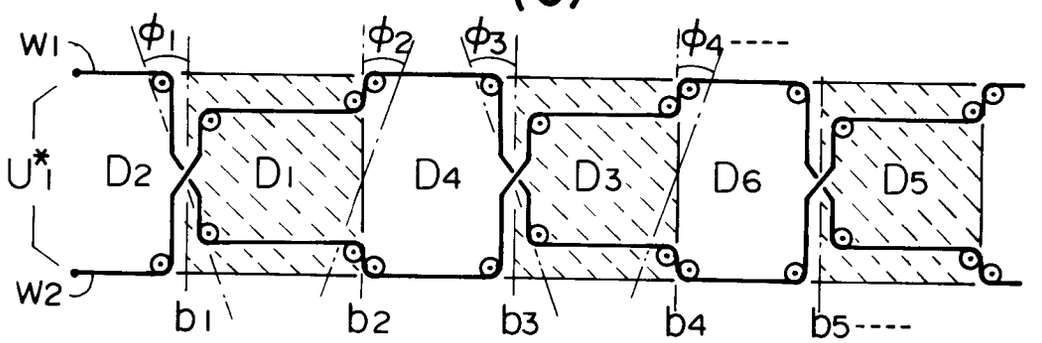

FIG. 6
(A)

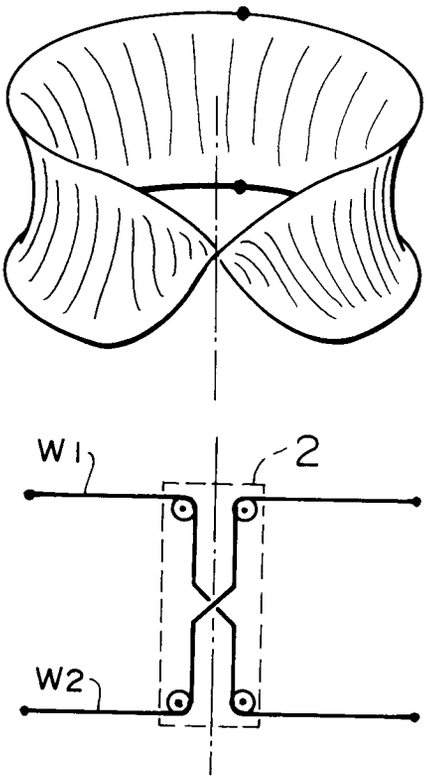

FIG. 6
(B)

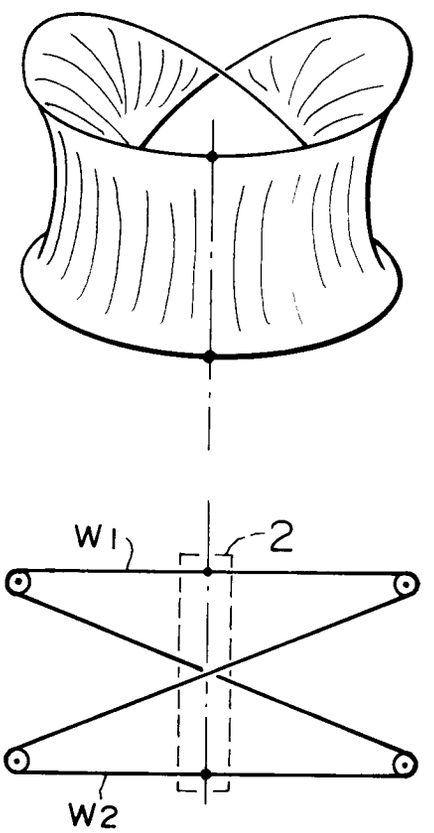

FIG. 7(A)

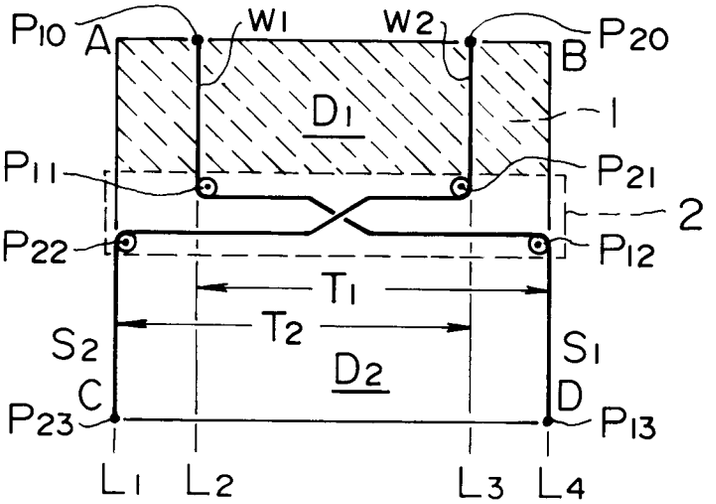

FIG. 7(B)

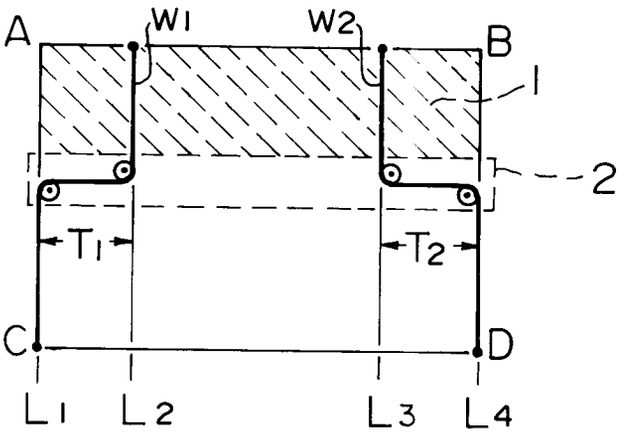

FIG. 7(C)

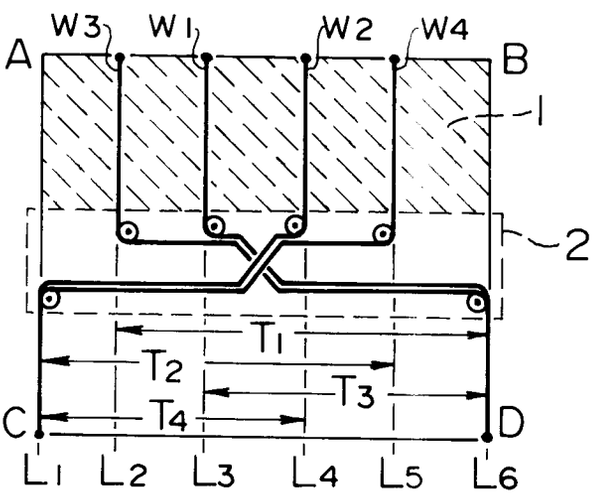

FIG. 8 (A)

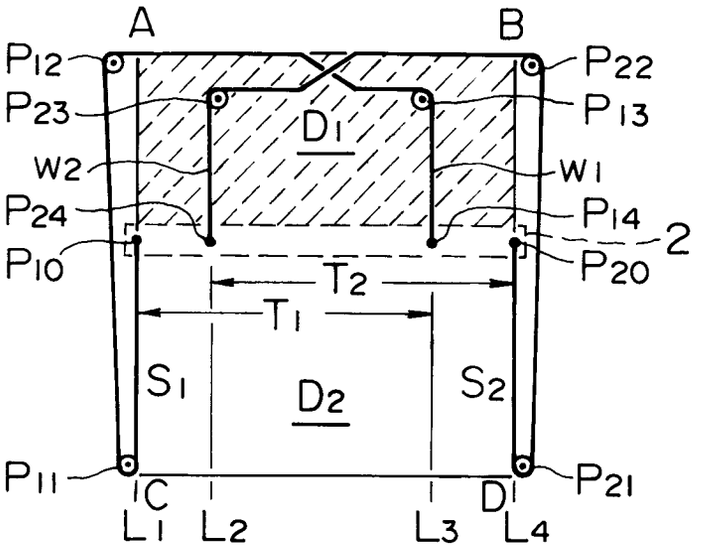

FIG. 8 (B)

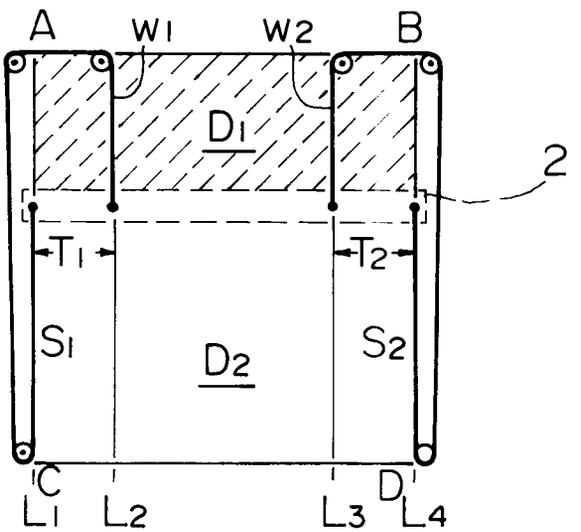

FIG. 8 (C)

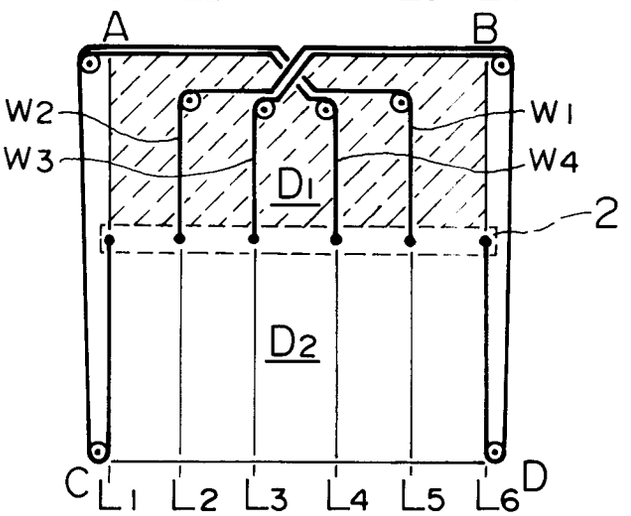

FIG. 9
(A)

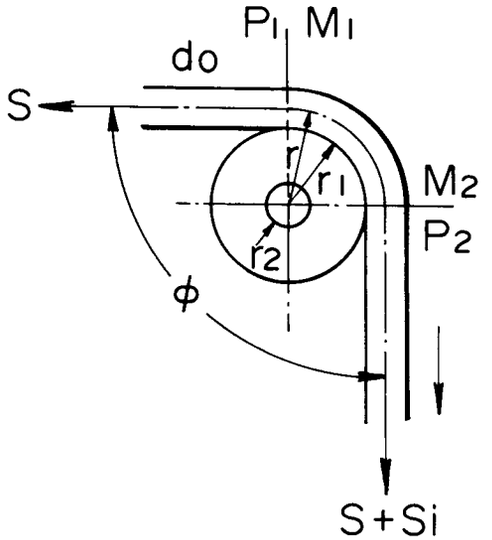

FIG. 9
(B)

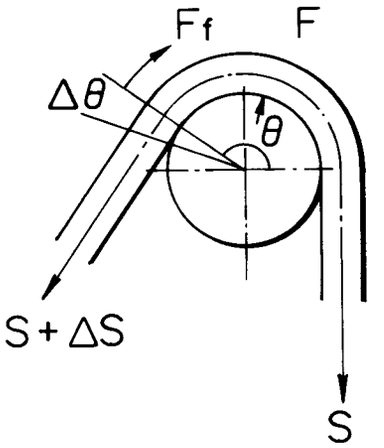

FIG. 10

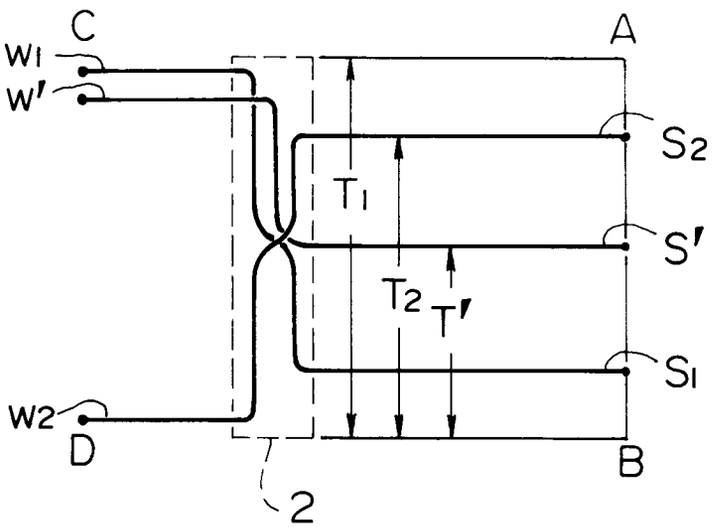

FIG. 11
(A)

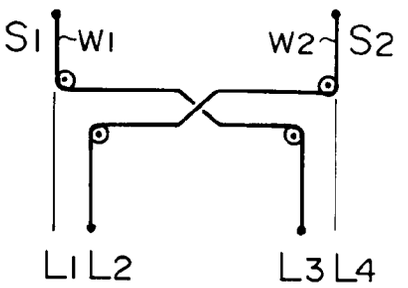

FIG. 11
(B)

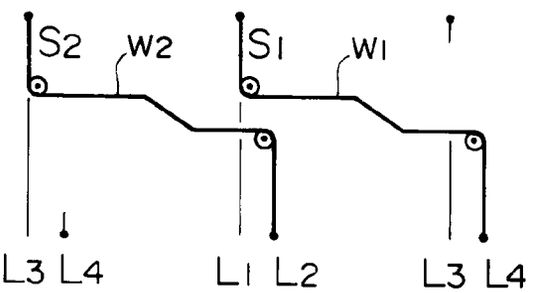

FIG. 12
(A)

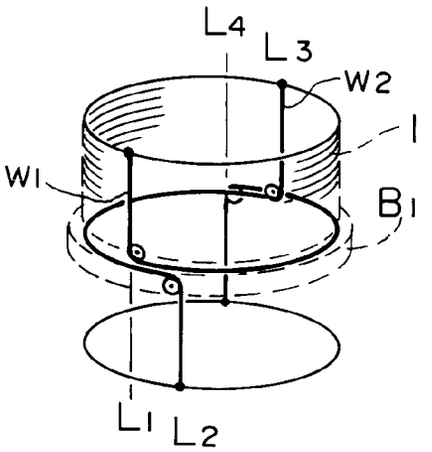

FIG. 12
(B)

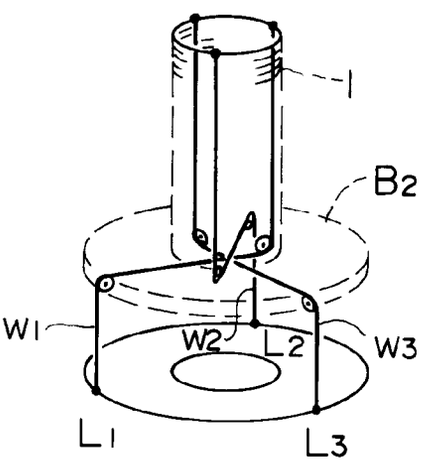

FIG. 13
(A)

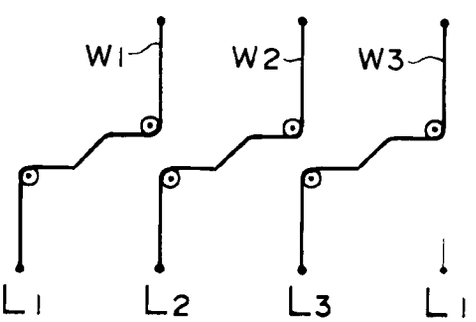

FIG. 13
(B)

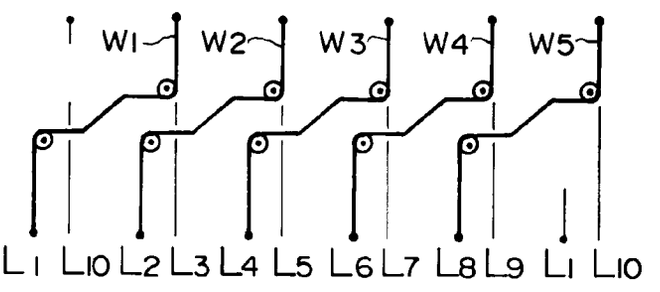

FIG. 14
(A)

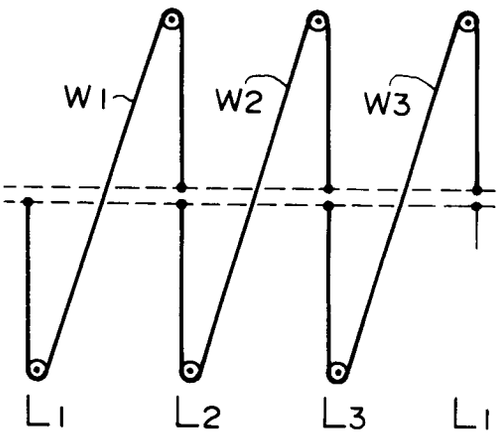

FIG. 14
(B)

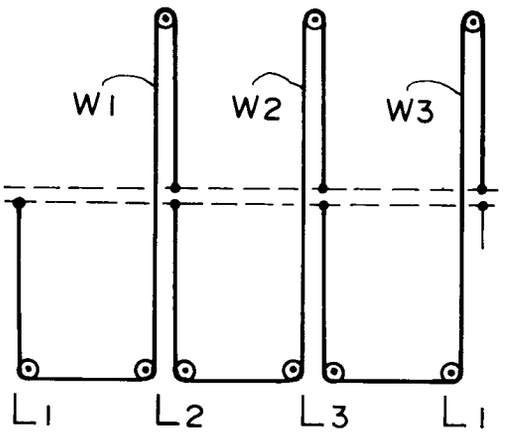

FIG. 15
(A)

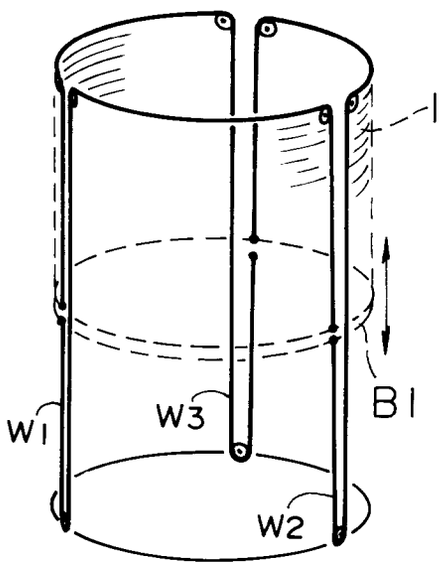

FIG. 15
(B)

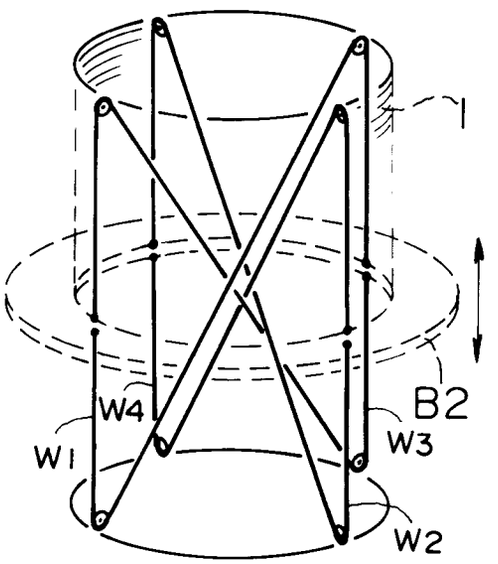

FIG. 16

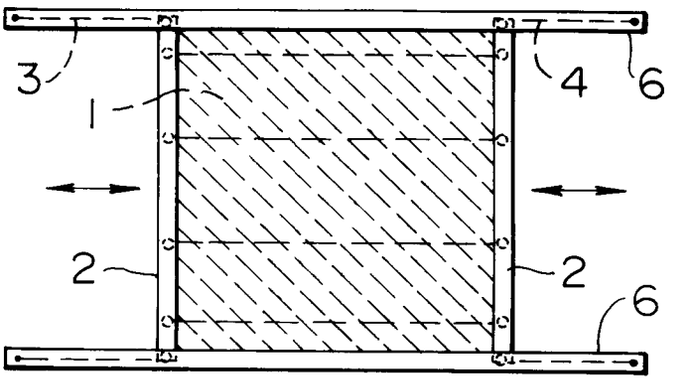

FIG. 17

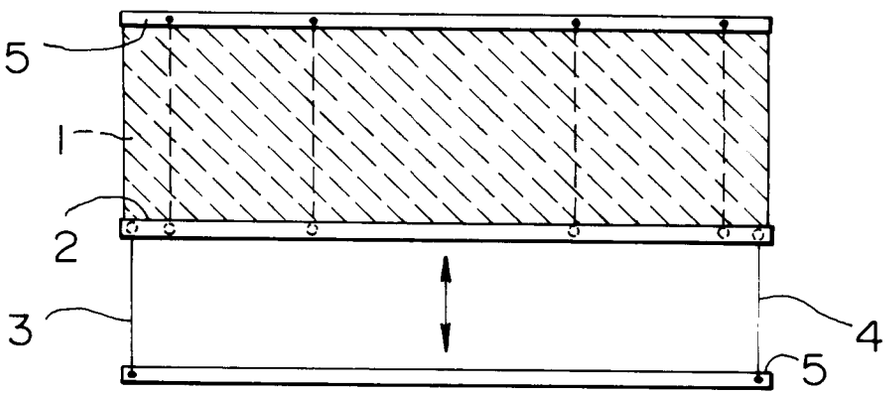

FIG. 18

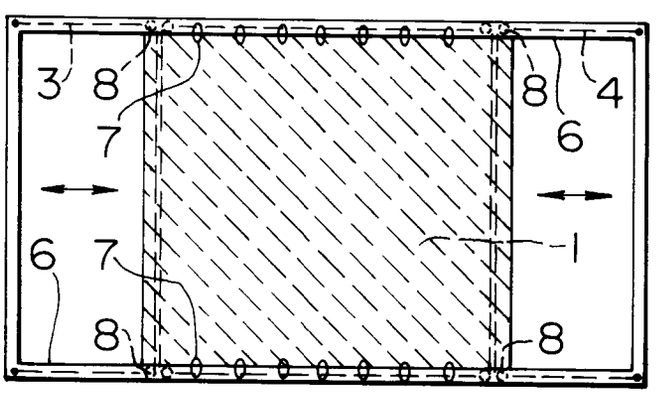

FIG. 19

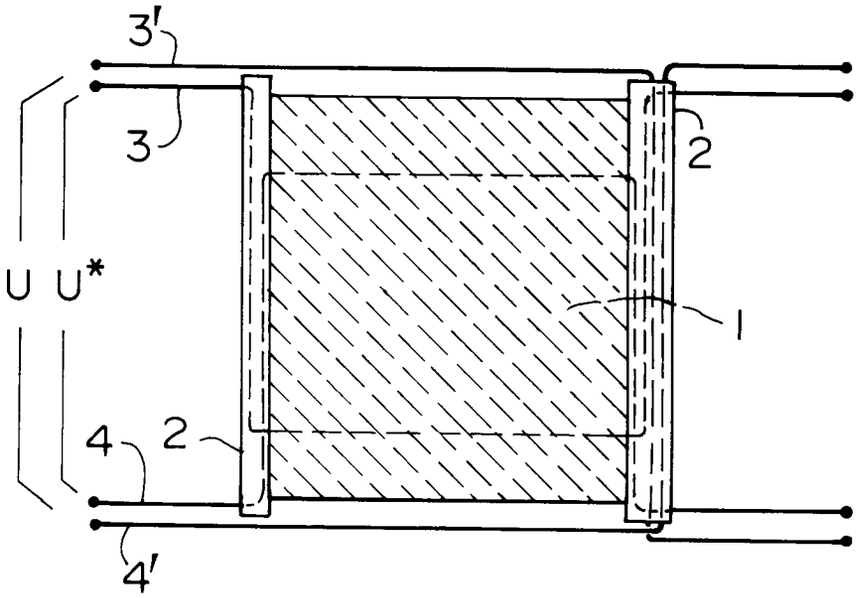

FIG. 20

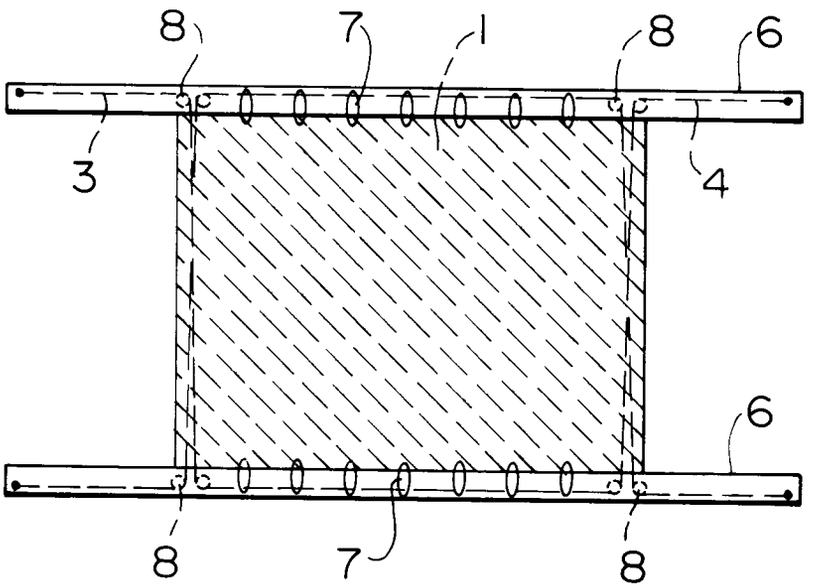

FIG. 21

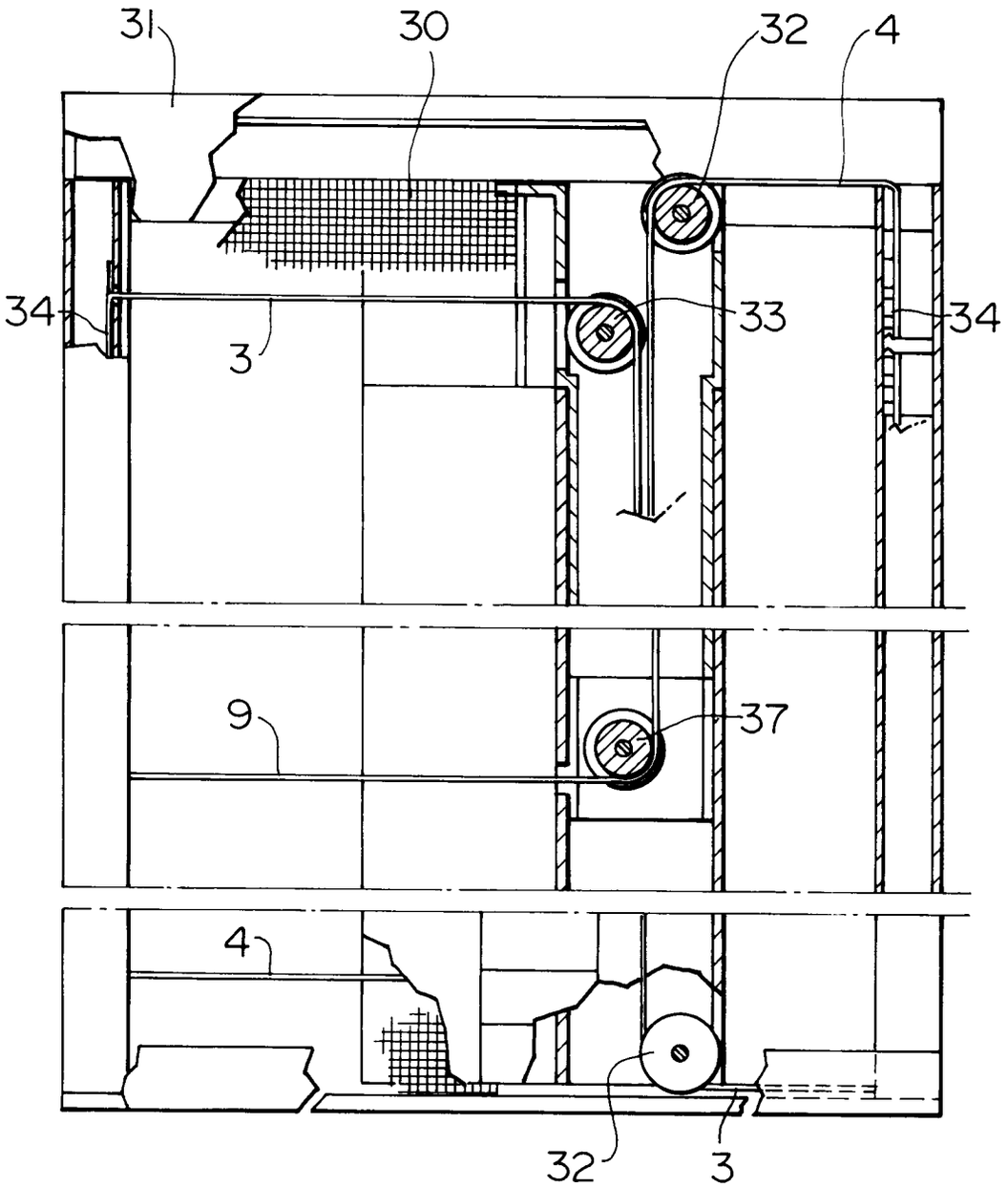

FIG. 22

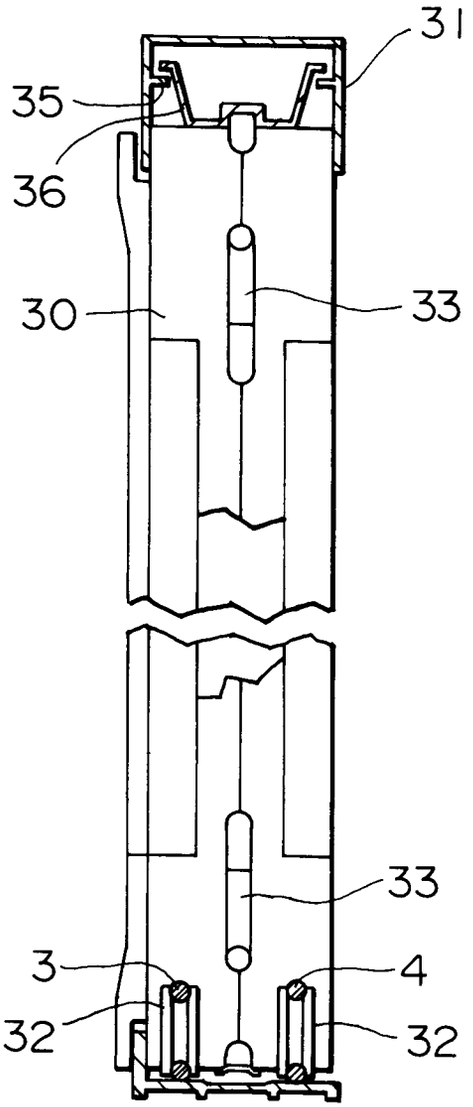

FIG. 24

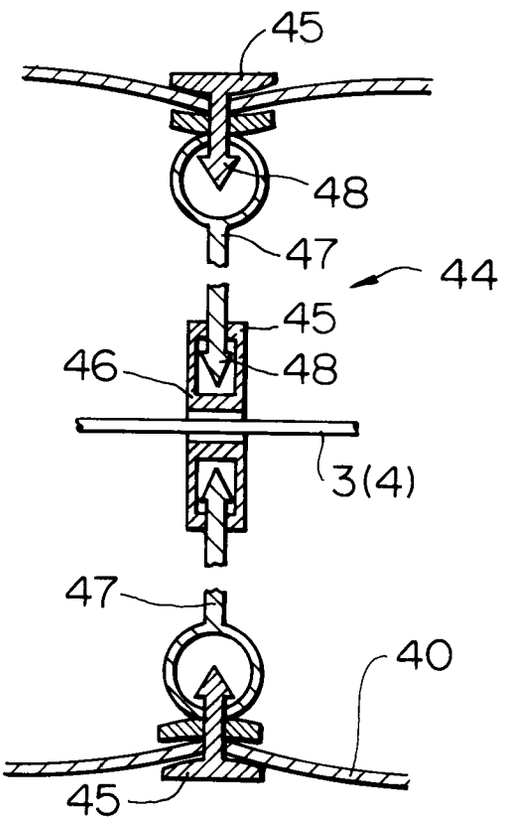

FIG. 25

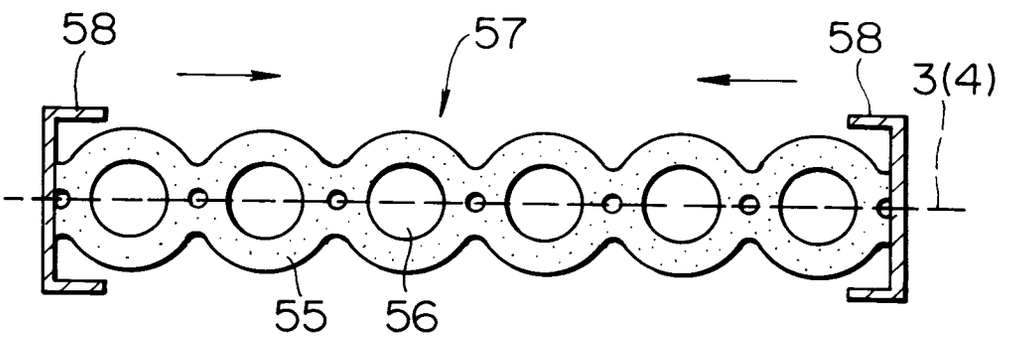

FIG. 23

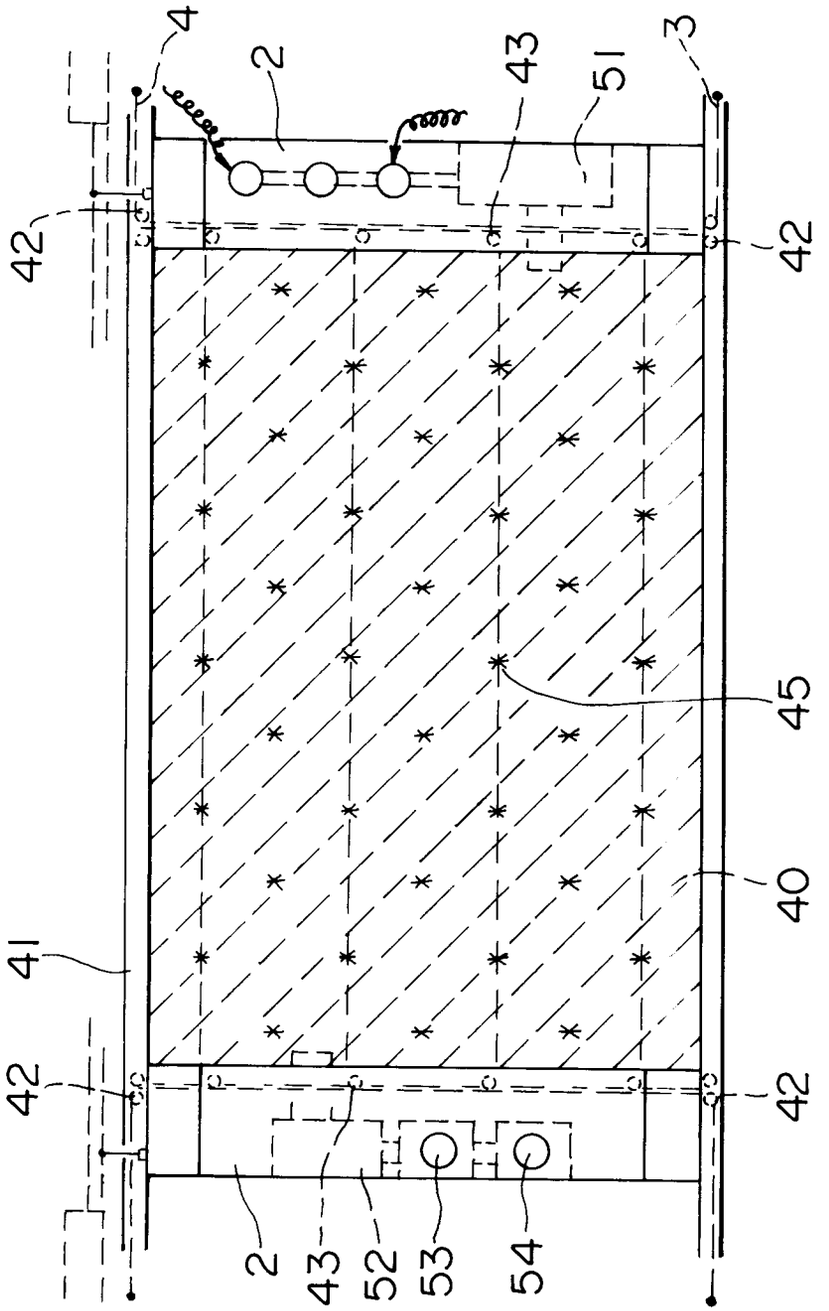

FIG. 26
(A)

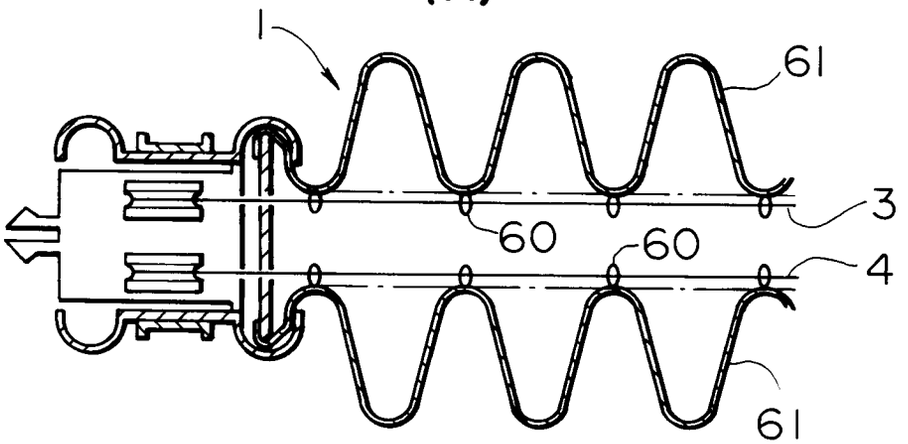

FIG. 26
(B)

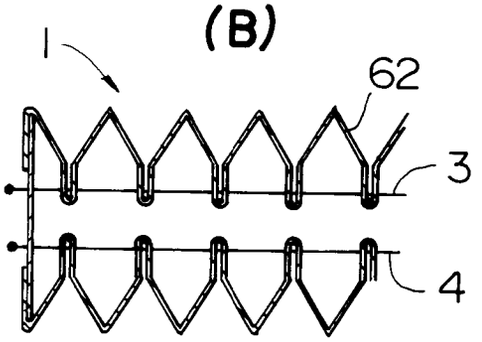

FIG. 26
(C)

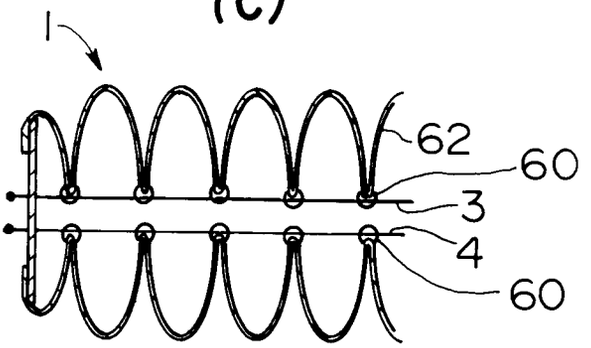

FIG. 27
(A)

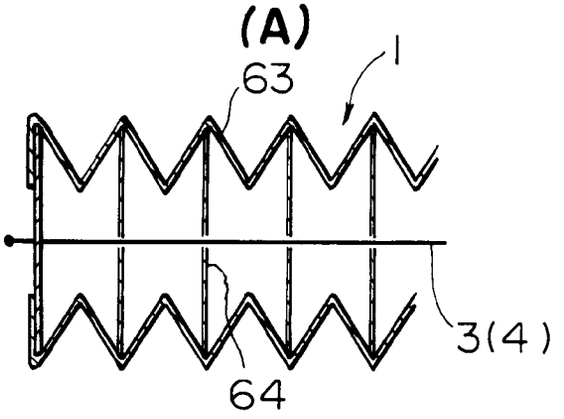

FIG. 27
(B)

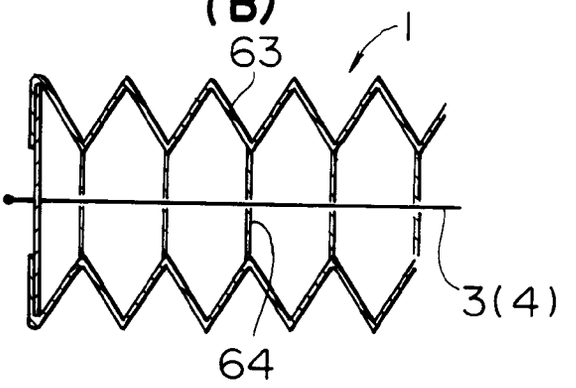

FIG. 28

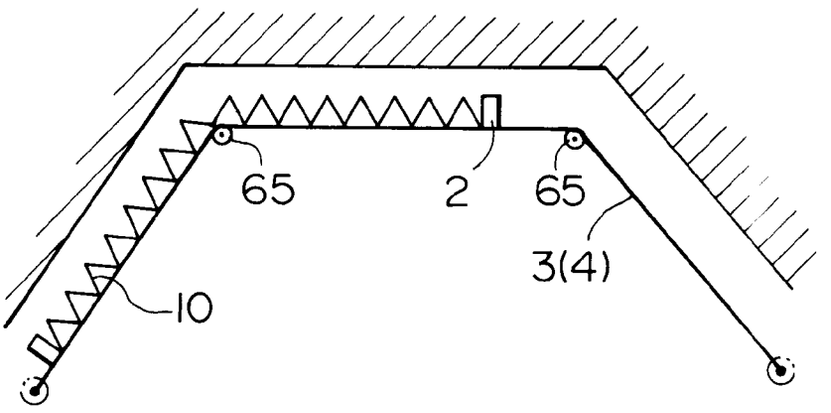

FIG. 29

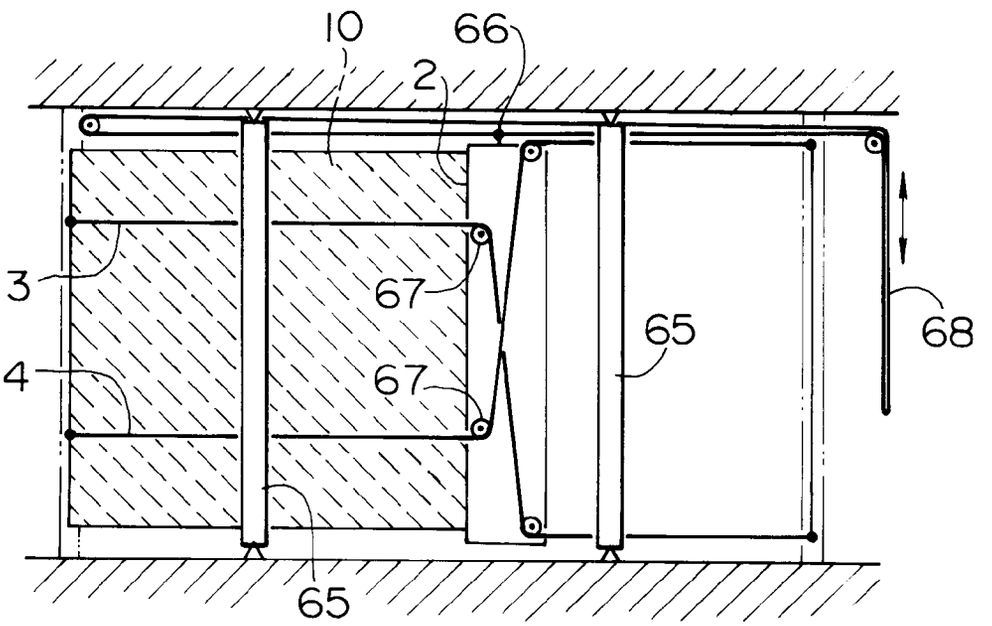

FIG. 30
(A)

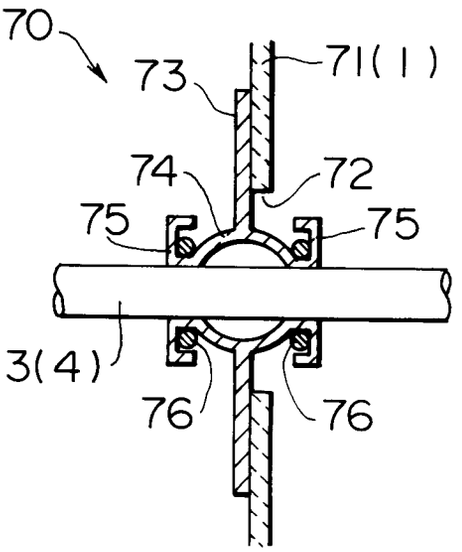

FIG. 30
(B)

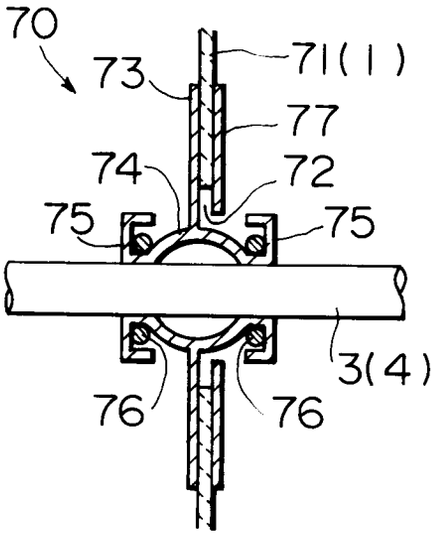

FIG. 31
(A)

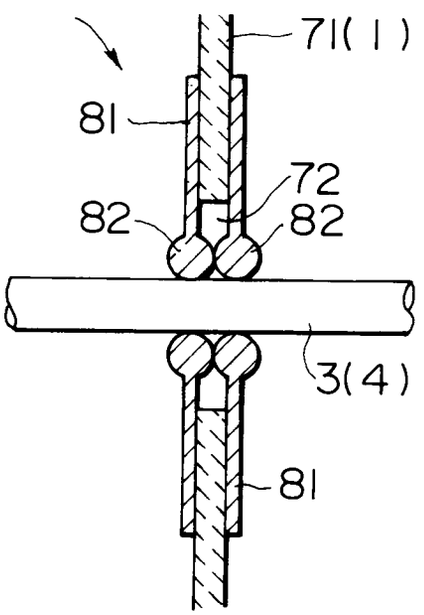

FIG. 31
(B)

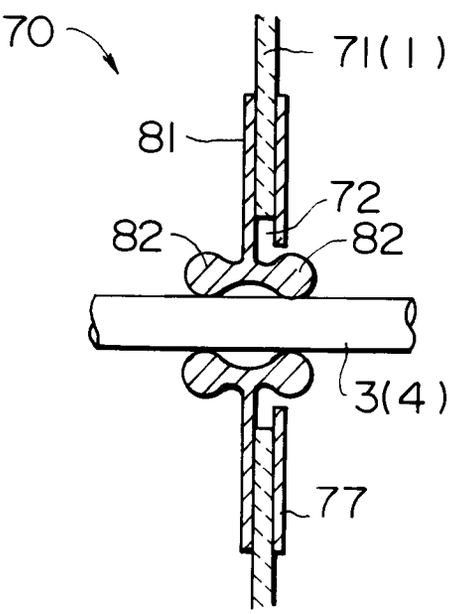

FIG. 32

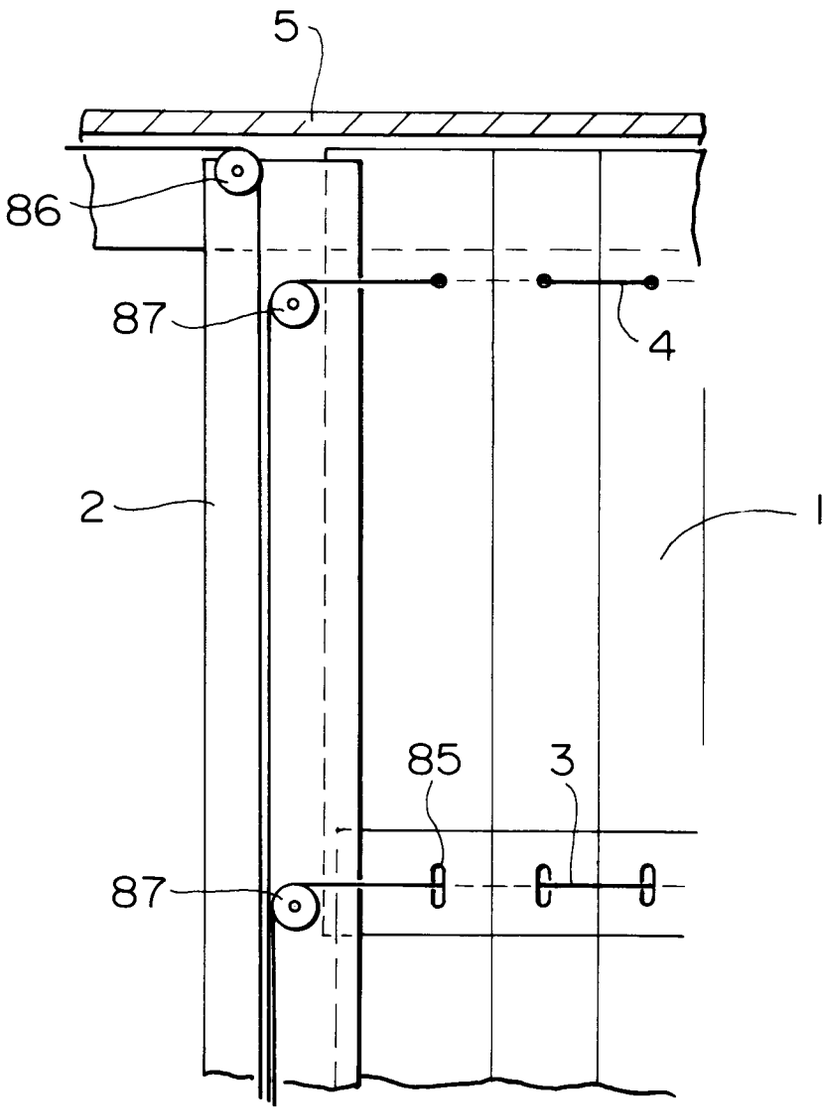

FIG. 33

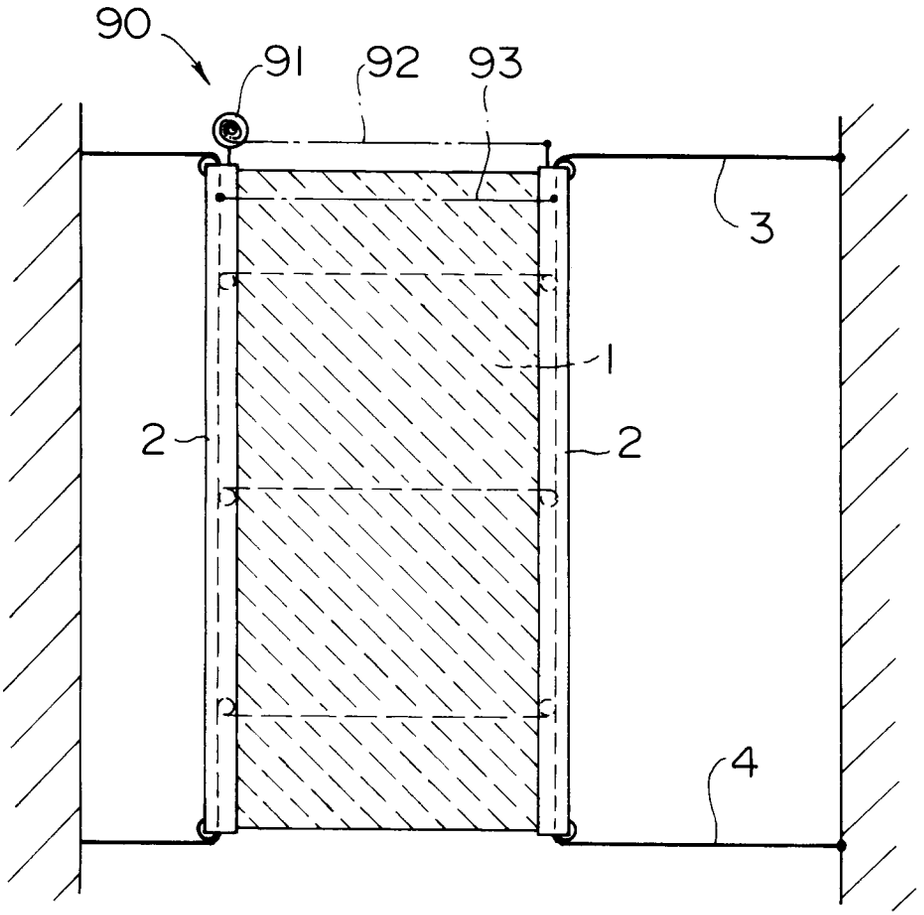

FIG. 34

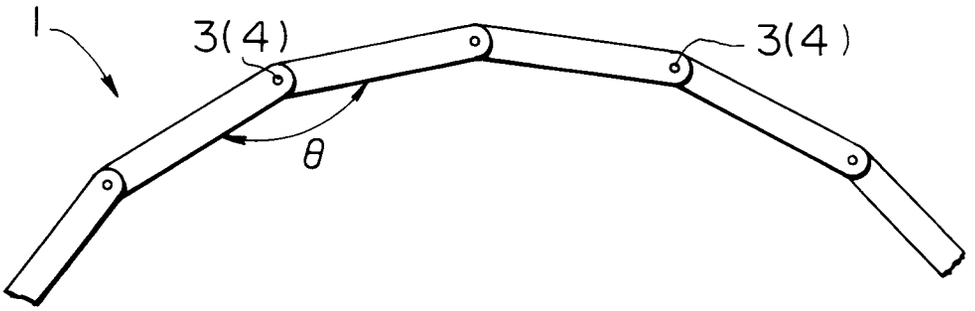

FIG. 35 (A)

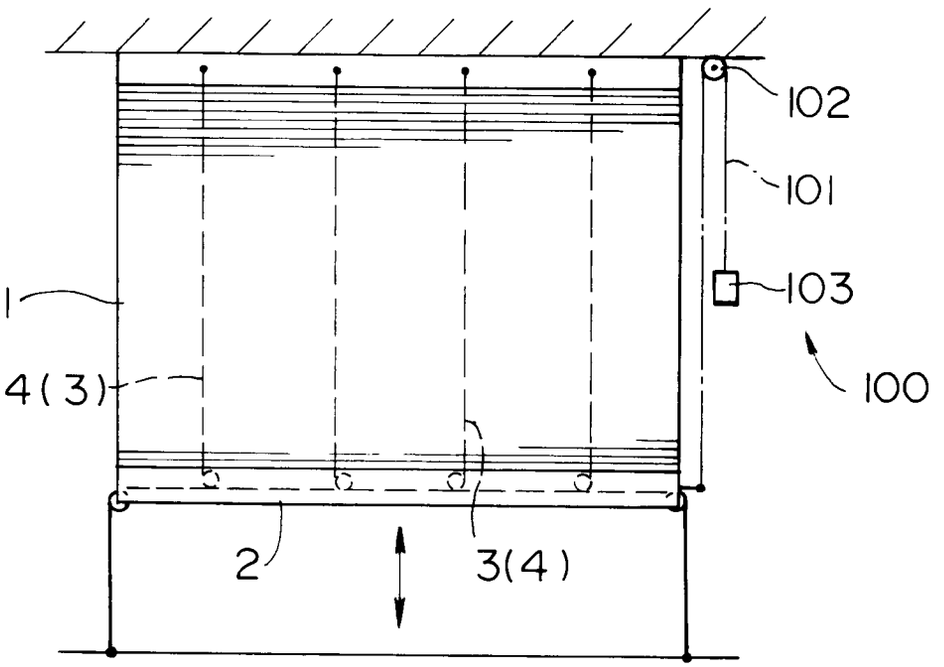

FIG. 35 (B)

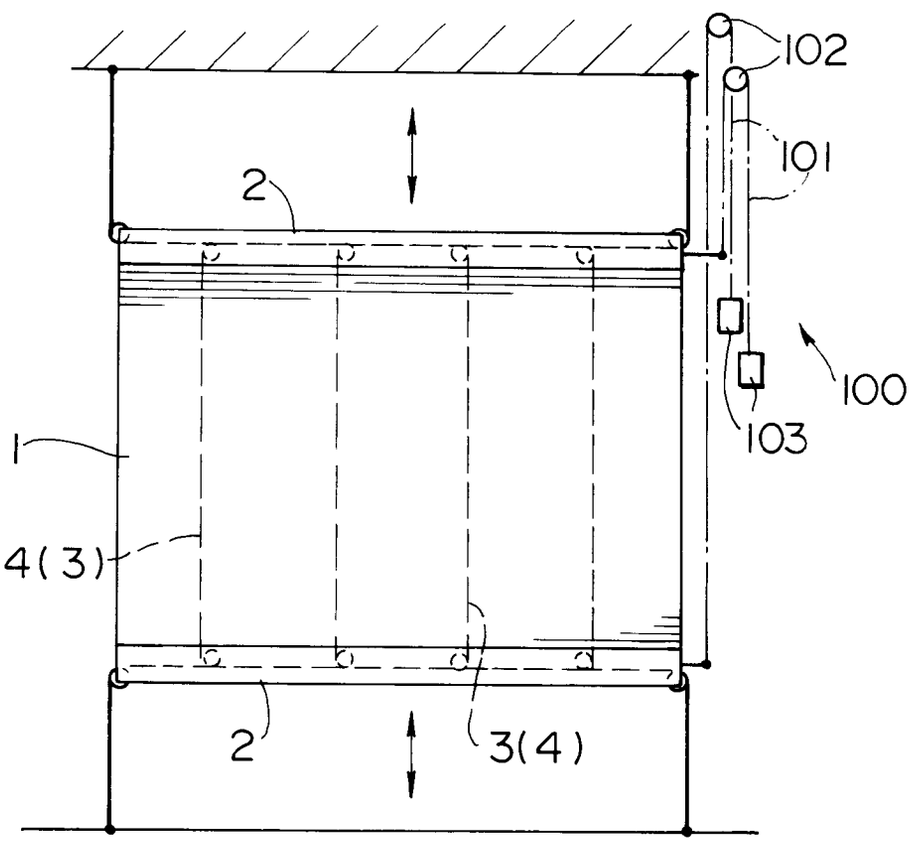

FIG. 36
(A)

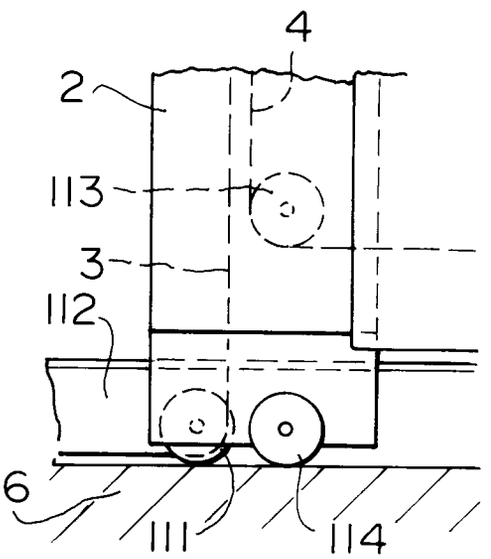

FIG. 36
(B)

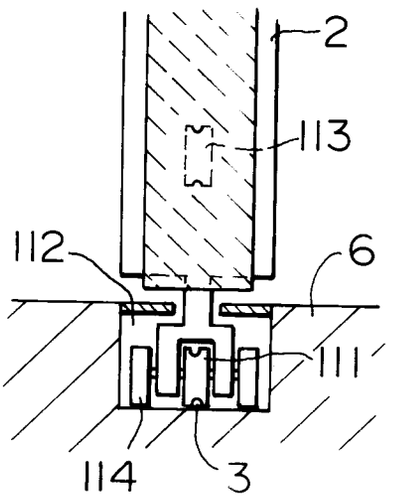

FIG. 37

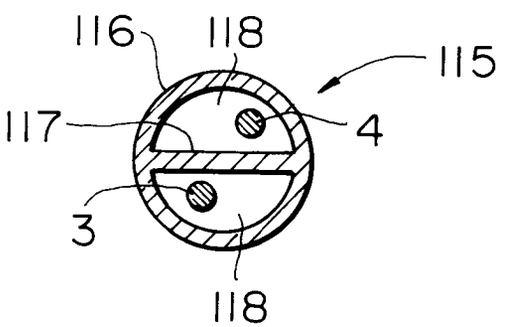

FIG. 38
(A)

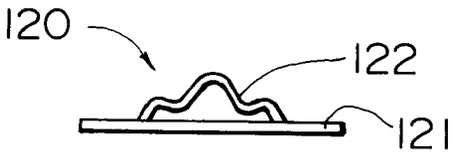

FIG. 38
(B)

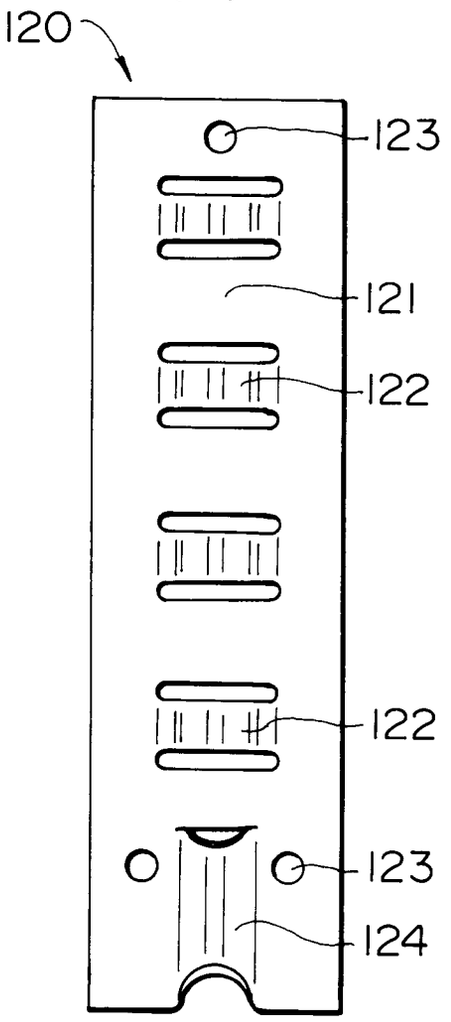

FIG. 38
(C)

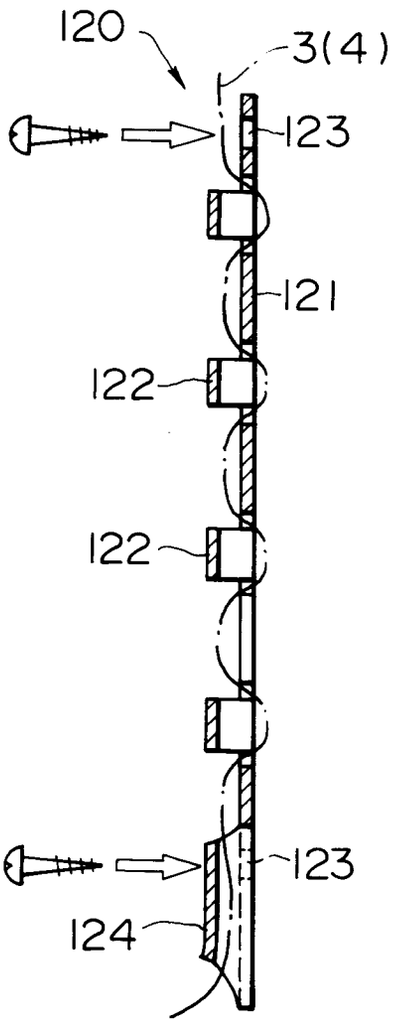

FIG. 39
(A)

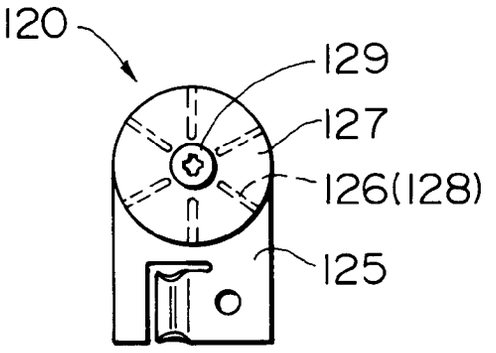

FIG. 39
(B)

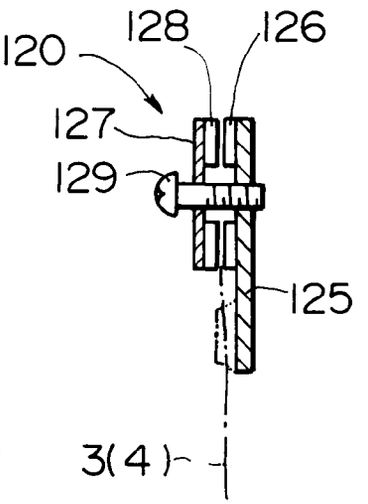

FIG. 40

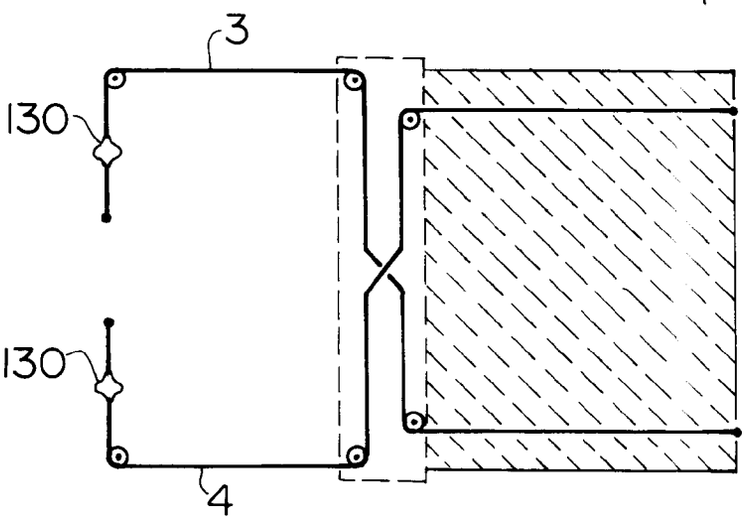

FIG. 41

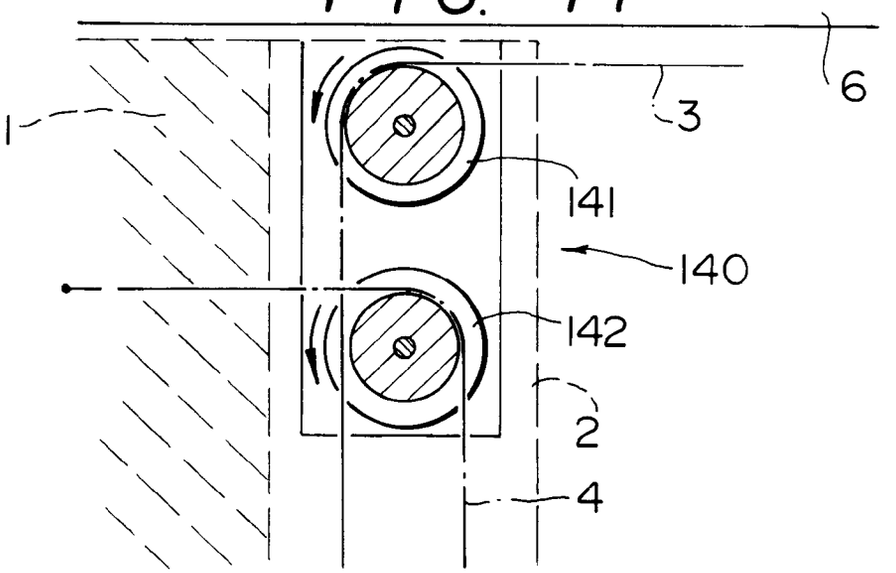

FIG. 42

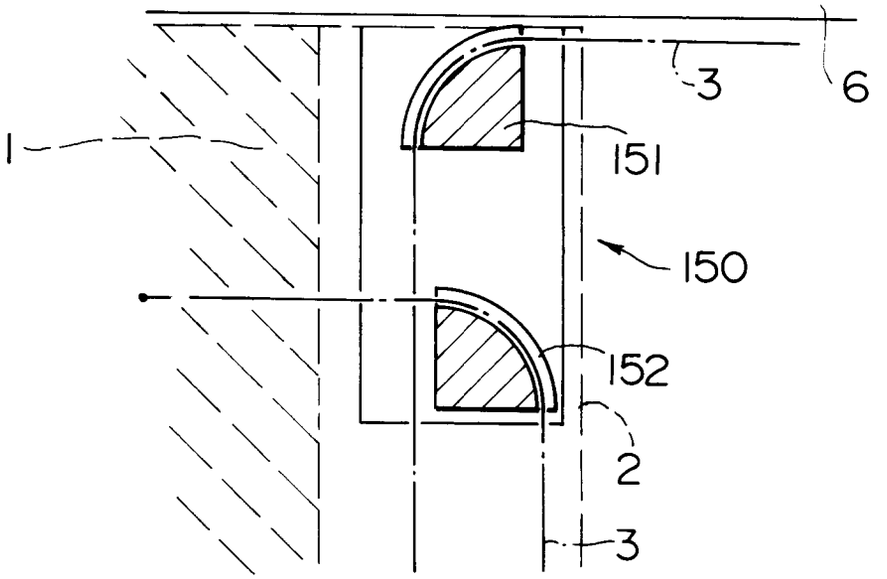

FIG. 43

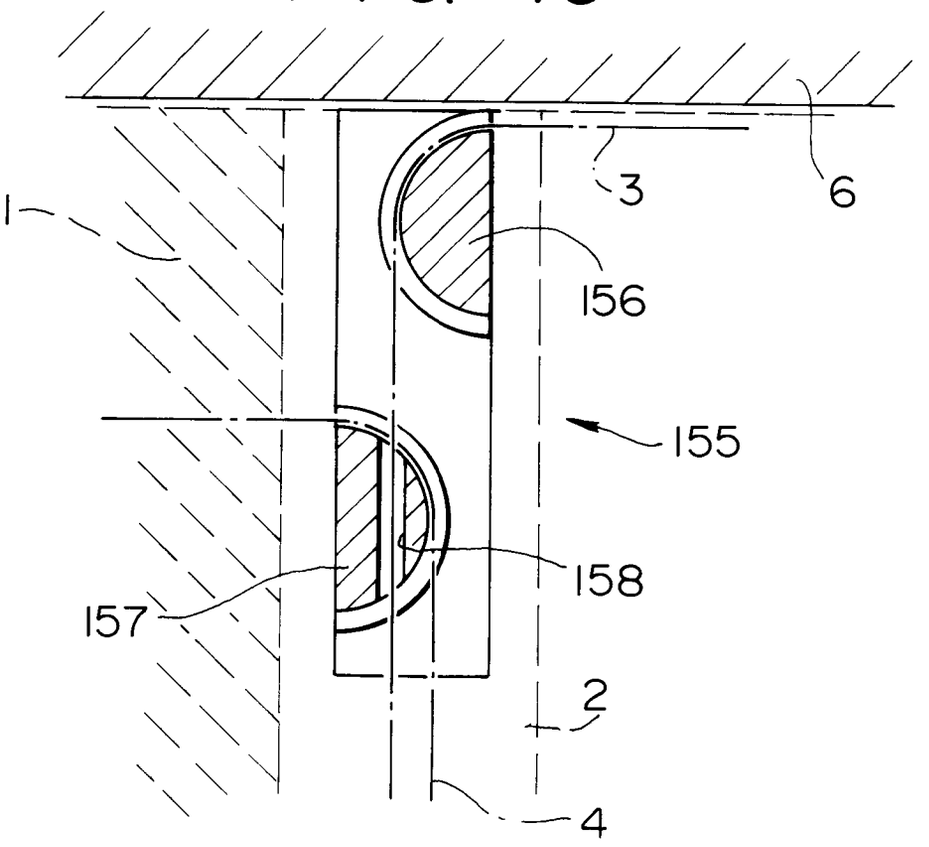

FIG. 44
(A)

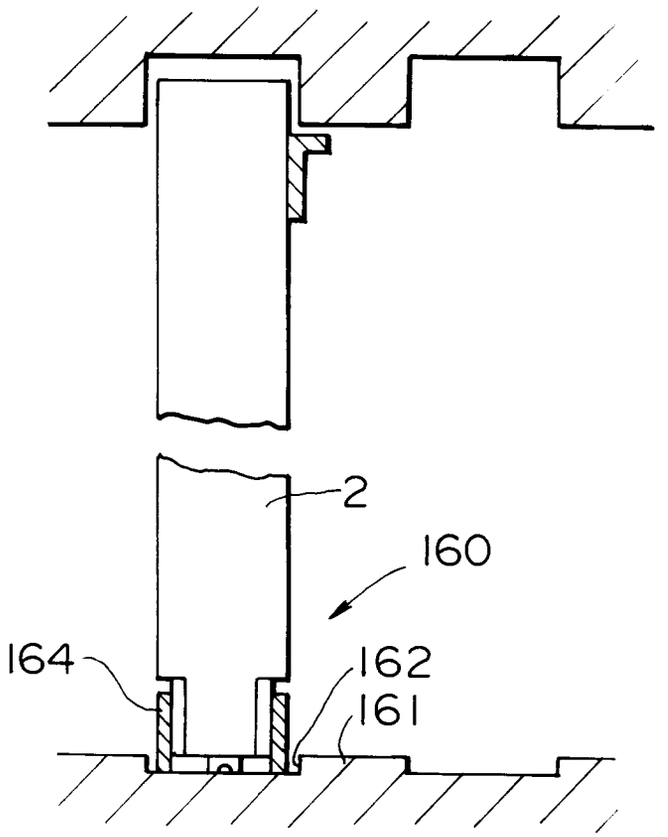

FIG. 44
(B)

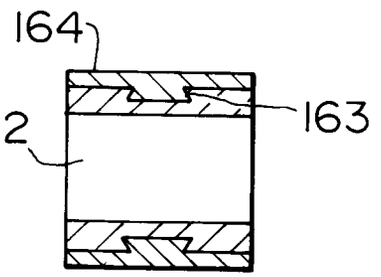

FIG. 44
(C)

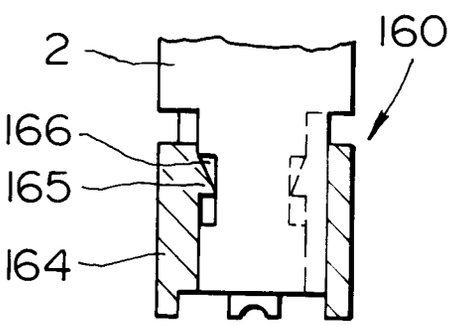

FIG. 46
(A)

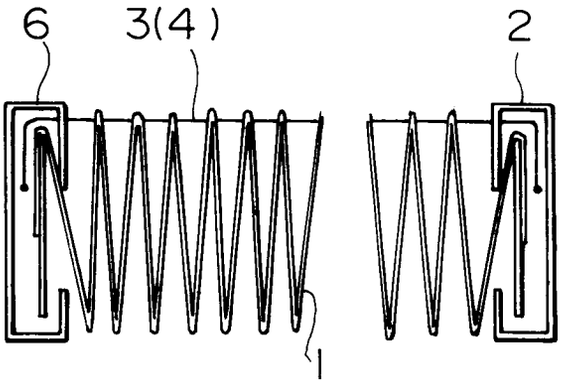

FIG. 46
(B)

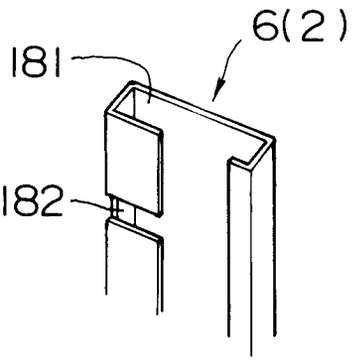

FIG. 46
(C)

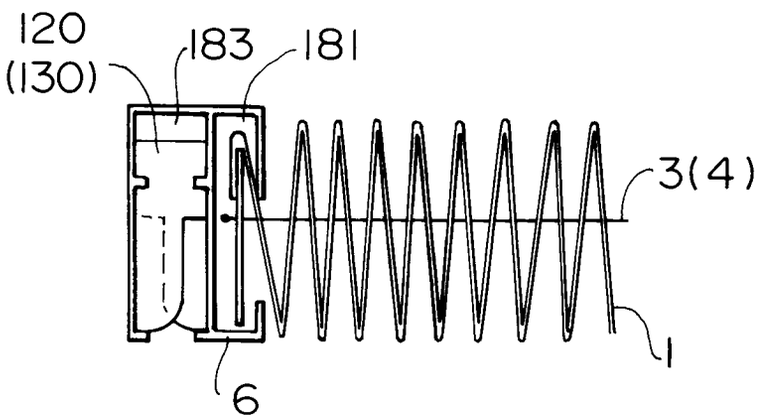

FIG. 46
(D)

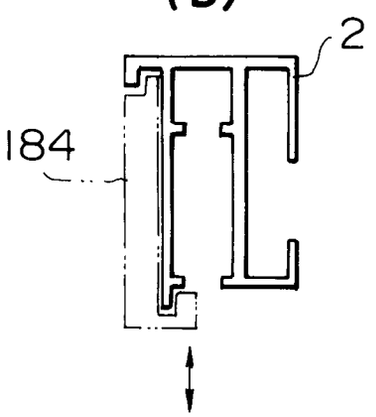

FIG. 45
(A)

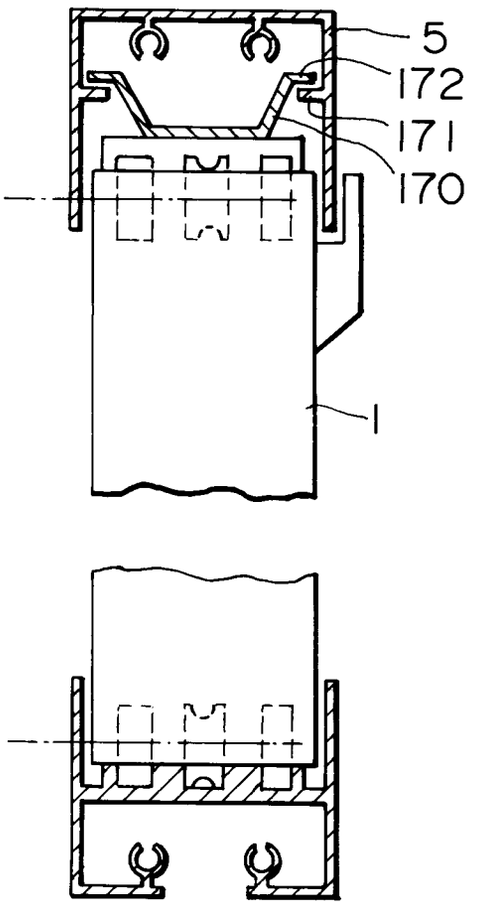

FIG. 45
(B)

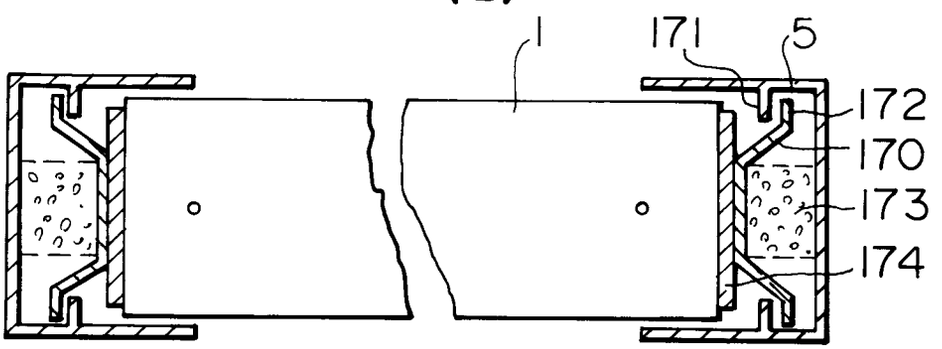

FIG. 47
(A)

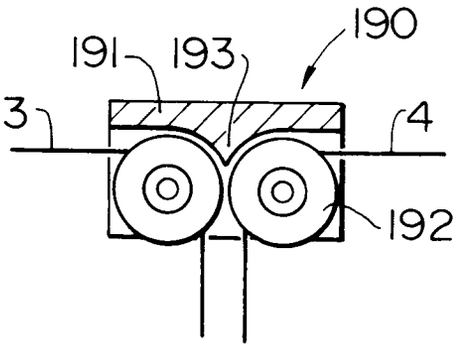

FIG. 47
(B)

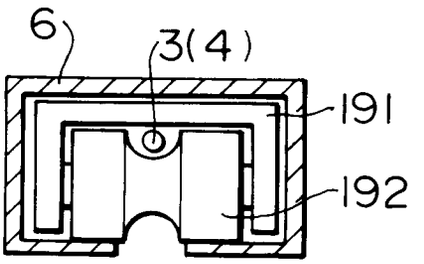

FIG. 48
(A)

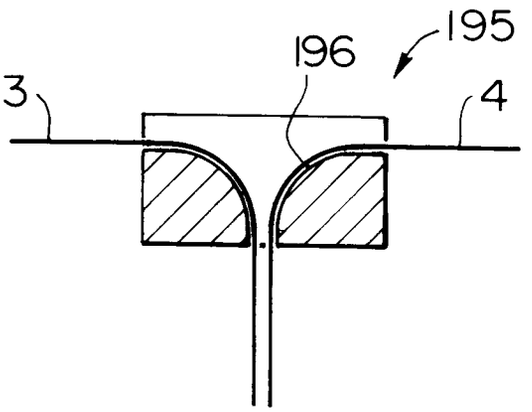

FIG. 48
(B)

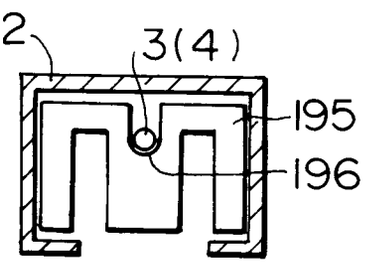

FIG. 49
(A)

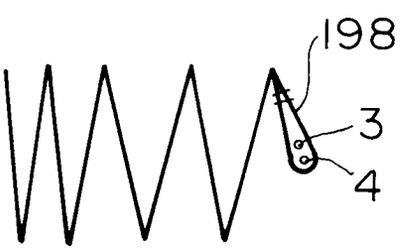

FIG. 49
(B)

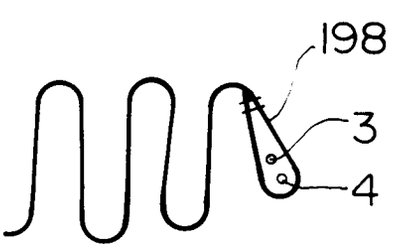

FIG. 50 (A)

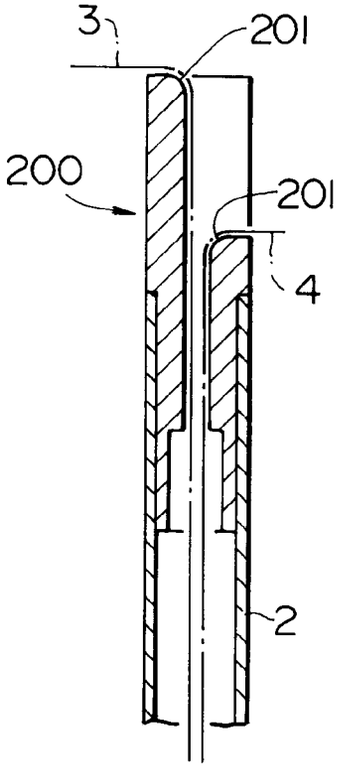

FIG. 50 (B)

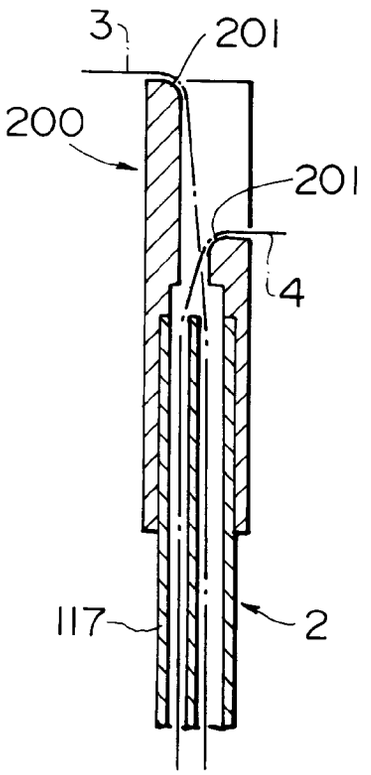

FIG. 50 (C)

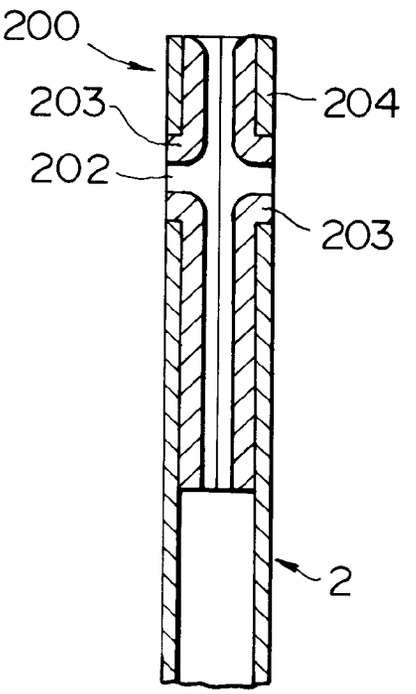

FIG. 51

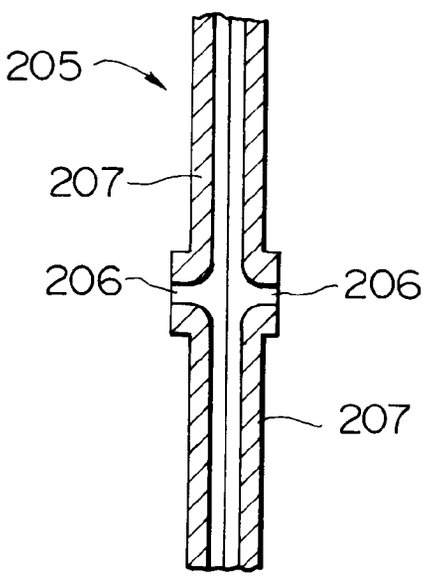

FIG. 52
(A)

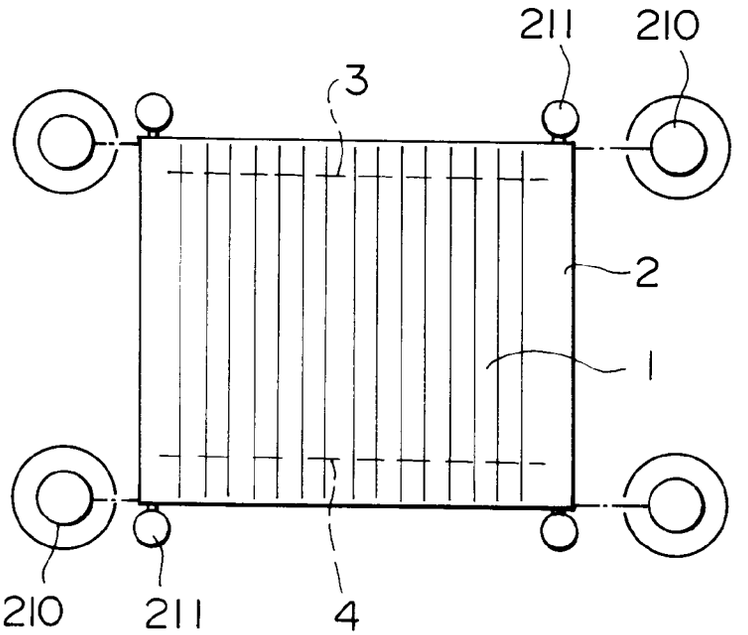

FIG. 52
(B)

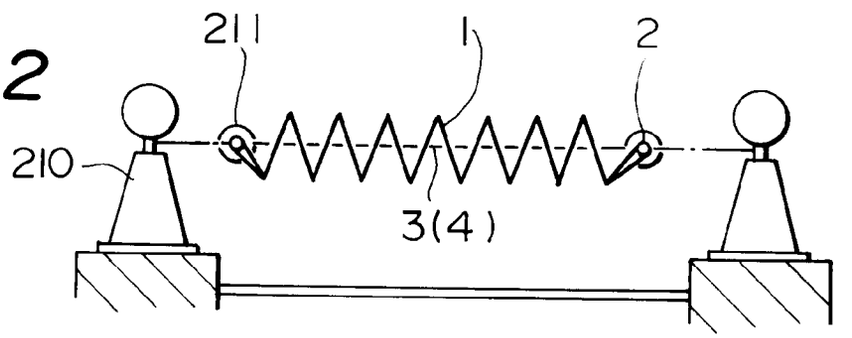

FIG. 53

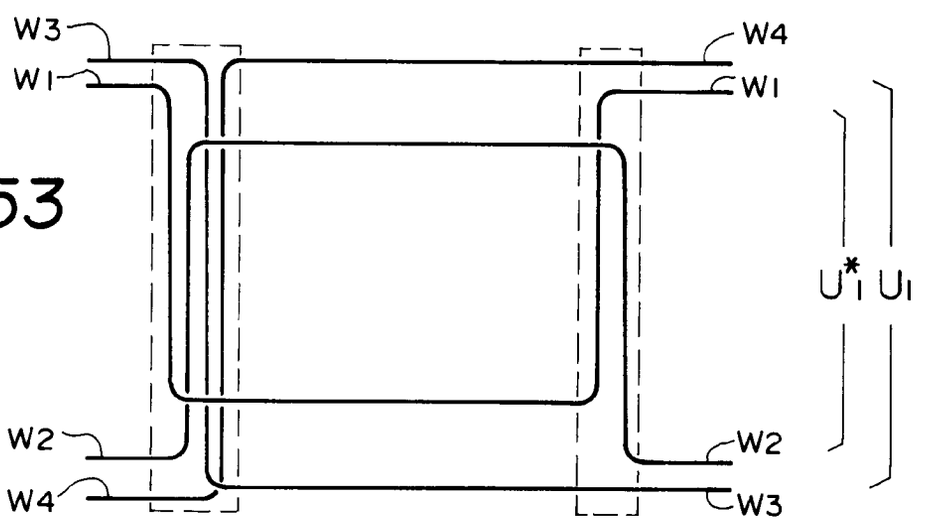

FIG. 54
(A)

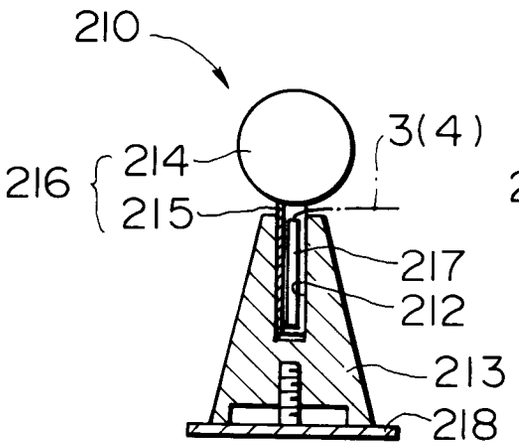

FIG. 54
(B)

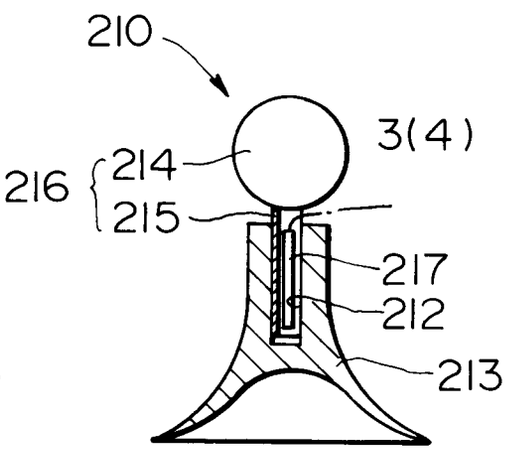

FIG. 54
(C)

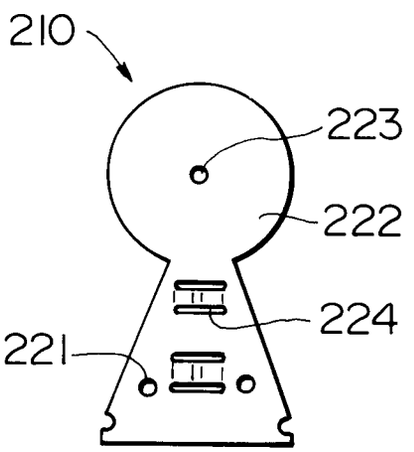

FIG. 54
(D)

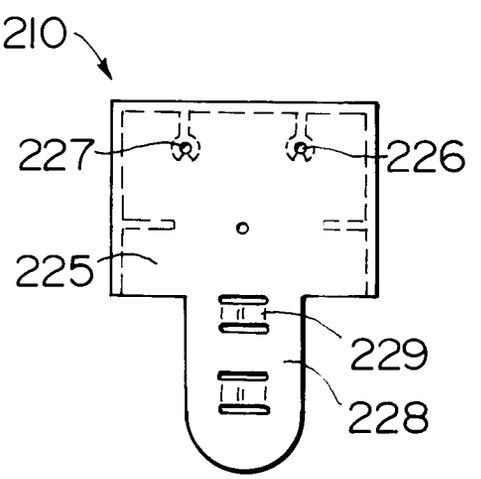

FIG. 55
(A)

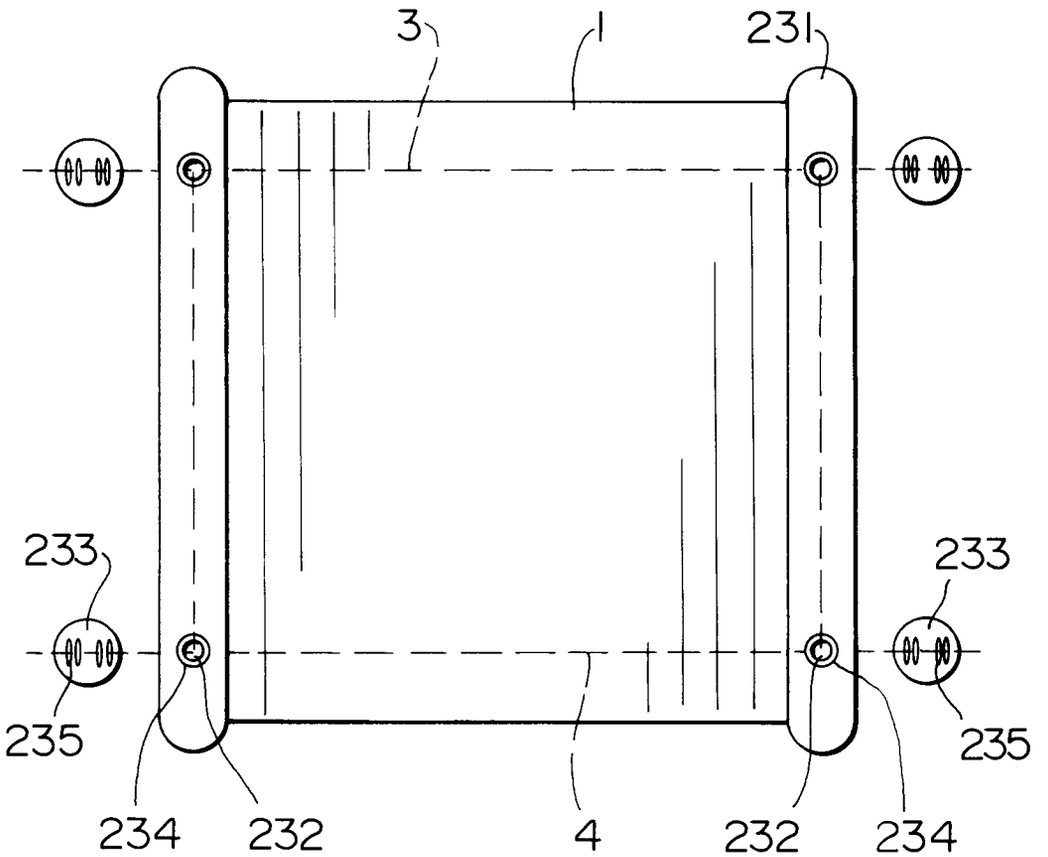

FIG. 55
(B)

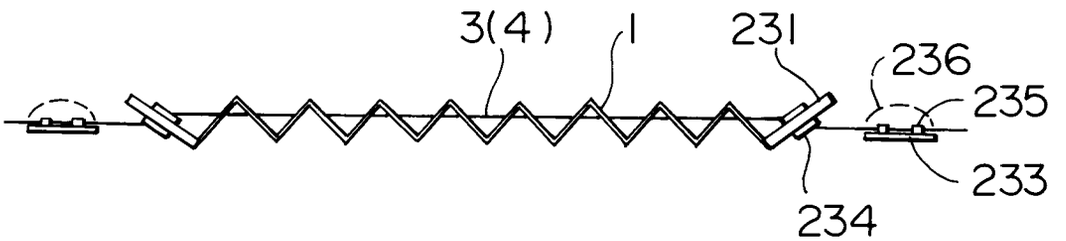

FIG. 56
(A)

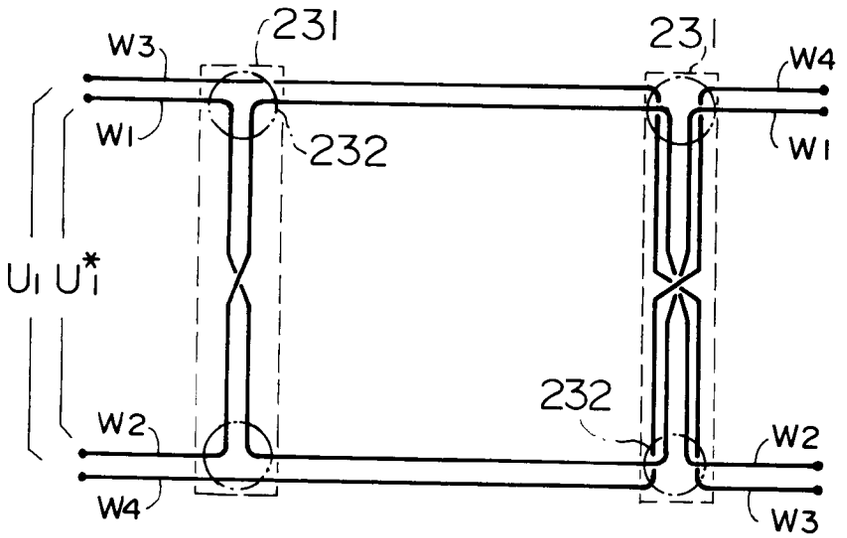

FIG. 56
(B)

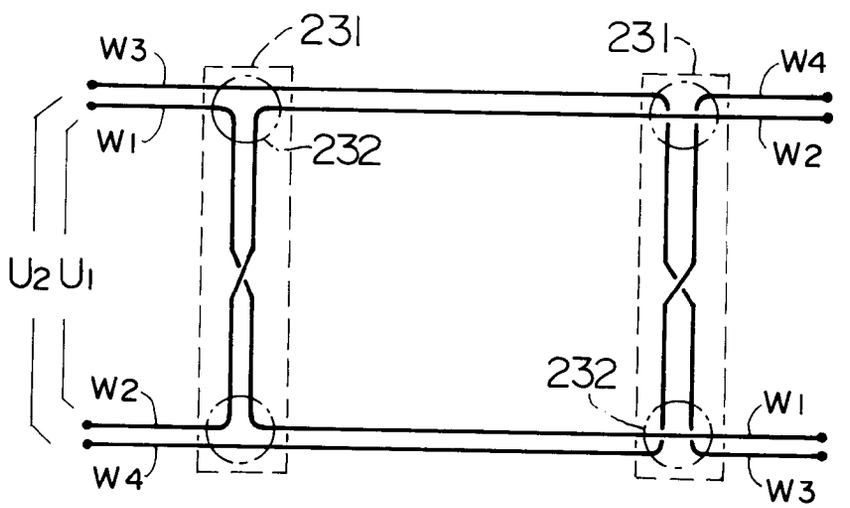

FIG. 57

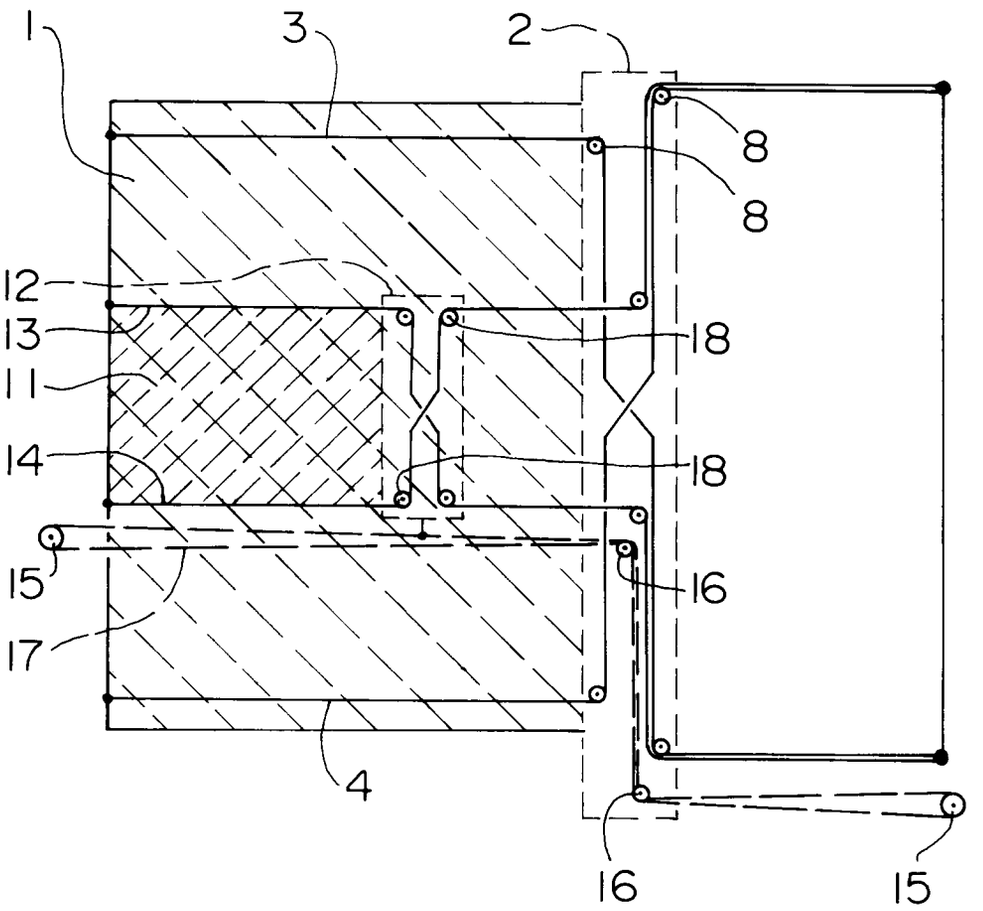

FIG. 58
(A)

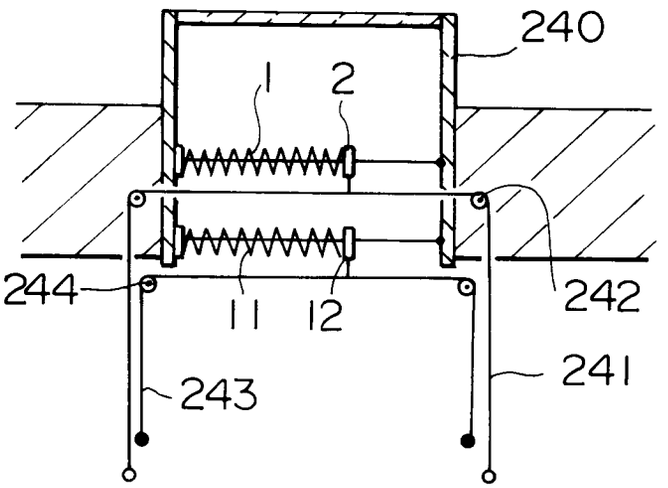

FIG. 58
(B)