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

(11) Publication number: **0 072 062**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **82200945.2**

(22) Date of filing: **23.07.82**

(51) Int. Cl.³: **E 06 B 9/264**, E 06 B 3/66

(30) Priority: **04.08.81 IT 2335981**

(43) Date of publication of application: **16.02.83**
Bulletin 83/7

(84) Designated Contracting States: **AT BE CH DE FR GB IT LI LU NL SE**

(71) Applicant: **Nardini, Gian Vieri, Via della Chioccioia 44, I-22060 Carimate (Como) (IT)**

(72) Inventor: **Nardini, Gian Vieri, Via della Chioccioia 44, I-22060 Carimate (Como) (IT)**

(74) Representative: **Dragotti, Gianfranco, SAIC BREVETTI S.a.s. di Ing. G. Dragotti & C. Via Spontini, 1, I-20131 Milano (IT)**

(54) Externally actuated light shielding curtains housed in the sealed space of double glazings.

(57) A curtain for shielding light is made from a thin sheet of an easily deformable material, which is totally or partially opaque according to the requirements; it is contained in the sealed space of a double glazing and can be operated at will by means of the reciprocal magnetic attraction existing between two mobile parts, the first one being also contained in said sealed space and mechanically connected with said douser, while the second mobile part is outside said sealed space and can be moved by an operator.

In an alternative embodiment, the said curtain is operated by means of electrostatic instead of magnetic attraction, and said electrostatic attraction takes place between two electric plates being carried respectively by said curtain, in the form of a metallic or metallized layer, and by the inner face of one of the two glass plates, making up the double glazing, in the form of a layer of a conductive or semiconductive, but in any case at least partly transparent material deposited thereupon.

A previously impressed tension or deformation will help the said douser to recoil in an orderly manner whenever its extension is less than maximum.

EP 0 072 062 A2

The object of this invention is a curtain for light, that can be operated at will and is intended for being totally contained within the inner space of a double glazing, of the sealed variety.

Double glazing is a component of windows: it is obtained by joining two glass plates along their rims.

A constant distance between said plates is maintained by placing between them a length of a hollow metallic spacer along each side; said spacer is then made to adhere to both plates by means of an appropriate sealing compound, and in the end there is formed between said plates a hermetically sealed space having a constant thickness of a few millimeters (usually 6 to 12 millimeters). Sealed double glazing as a substitute for single glazing is being increasingly used thanks to its superior insulating properties.

Also thanks to their improved thermal insulation, doubly glazed windows do not necessarily require outside shutters. However, some protection from excessive solar radiation is often required, and this is afforded by single curtains at least, or by more elaborate systems such as the multiple blade curtains called "Venetian blinds" or eventually by still other mobile systems, all of which are expensive and place consuming, and require maintenance and cleaning care; in any case, it would be preferable if said systems could be dispensed with.

Mobile curtains are also known that are similar to Venetian blinds, and, being installed in the space between two glass plates, are mechanically operated by means of handles, shafts and gear transmission. Curtains of the latter type are indeed less easily soiled than totally exposed Venetian blinds, however they do require some expensive maintenance, and their structure it also more expensive than ordinary Venetian blinds. As a result, in spite of being no longer novel, said systems still cover only a very limited market share.

It is obvious, however, that a shielding system that could be installed within the double glazing without increasing the plate spacing while ensuring trouble-free operation, and being very light and possibly cheap, would certainly offer a

considerable advantage over the present systems.

In the search for a system that would fill this specification, Venetian blinds have been discarded on the ground that they involve the co-operation of a large number of parts with relatively small and heavily solicited junctions.Out of statistical reasons, this is a potentially important source of trouble, although the vast market presently covered by Venetian blinds has made it possible to develop suitable and very reliable automatic machinery for their production. However, in the application envisaged here, it would be necessary to miniaturize the single blades making up a Venetian blind by a factor of at least five with respect to present standards, in order to let them fit into the available spacing of a standard sealed double glazing. This would involve a fivefold increase in the number of elements and the ensuing probability of malfunctions, and this is highly undesirable, since any malfunctioning curtain would be exposed to the immediate sight of everybody, while being enclosed in a cavity that should remain materially inaccessible over a time span of at least ten, but possibly fifty years or even longer. A single, continuous sheet of a suitable material has been found to be much preferable indeed.

Provided the double glazing can be kept effectively sealed, it will afford a high degree of environmental protection to the material contained in its cavity; a very thin sheet or foil will do the job, as it is wholly shielded from the wind, from damage by accidental contact or even dust deposition. On the other hand, said curtain has to be very thin in order to occupy as little space as possible whenever shielding is not wanted.

According to the present invention there is provided a curtain to be housed in the sealed space of a double glazing characterized in that the curtain is formed by a single, thin and opaque sheet, movable between a non shielding position, in which the light is allowed to pass through the glass plates forming the double glazing, and a shielding position actuating means being provided for the displacement of said sheet between said two positions, said actuating means being selected amongst magnetic means and electrostatic means.

Shortly stated, according to the invention the means to operate said curtain from outside a double glazing without affecting its air-tight quality have been obtained by using either of two distinct physical principles, namely magnetic (not necessarily

electromagnetic) means on the one hand, and electrostatic means on the other hand.

According to the first embodiment of the invention a magnetic principle is adopted for transmitting motion id est by using a mobile and/or deformable curtain, entirely contained in the inner space of a sealed double glazing, and by driving and/or supporting the operation of said curtain by means of a first mobile member also contained within said inner space, said first mobile member being connected by means of magnetic attraction with a second mobile member placed outside said inner space, said second mobile member being moved at will by an operator.

It has been found advantageous to use ferromagnetic materials in the shape of bars as the above said mobile members, respectively first and second mobile members, one of which at least should be permanently magnetized.

Other features that have been found advantageous are the following: one at least of said two bars should have both ends bent at right angles for a certain length, in the same plane, so that said bar is indeed shaped as a letter U, with a rather long middle span; also one at least of said two mobile members, and preferably the second mobile member being outside the inner space of the double glazing should be controlled by such known means that will keep it parallel to itself, while moving along the outside surface of the glazing and adjacent said surface.

According to another embodiment of the invention an electrostatic principle has been found to be equally effective in order to drive a mobile or deformable curtain, entirely being contained in the inner space of a sealed double glazing, onto the inner surface of one of the plates of the said double glazing, and thus to stop or greatly reduce the incident light. To this end , said curtain will contain at least one elctrically conductive layer, that will co-operate with another electrically conductive or at least semiconductive layer coating the surface of said glass plate, in order to form a variable condenser. The latter should moreover include a dielectric layer, and this can either be built in said curtain, or be deposited on top of said conductive or semicondutive layer on said glass plate. The capacity of the condenser thus formed will vary according to its instantaneous configuration, and conversely an electric voltage willingly applied between its plates will cause it to modify its configuration in the desired sense. Whereas the conductive layer on said

curtain should be substantially opaque, and vacuum-deposited metallic layers can easily fulfill this requirement, the conductive or semiconductive layer to be deposited on said glass plate should be substantially transparent, at least for visible light. Several processes are known, including multi-layer deposition in vacuum and doped metallic-oxide deposition at substantially atmospheric pressure that will yield transparent conductive layers on glass surfaces, exhibiting a specific surface resistance substantially lower than 1000 Ohms per square. The latter has been found to be about the maximum acceptable value of specific surface resistance for the present purpose.

Lastly, it will become clear from the following examples and enclosed figures, that curtains according to the invention are most advantageously made from very thin flexible foils of tough, homogeneous synthetic materials, weighing only a few grams or at most a few dozen grams per square meter. Said foils are in any case sufficiently tough for them to get and retain any kind of color or coating, even metallic ones, impressions, decorations, and any other treatment required in order to obtain a wide range of transparence or opaqueness and other desirable optical and/or decorative effects.

A remarkable problem has been faced concerning a method for causing the curtain to recoil in an orderly way whenever it is desired to operate it towards reducing the extension of the surface covered by it.

Two convenient solutions have been found for said problem; the first solution is obtained by impressing in the curtain material, previously to its being assembled, such a permanent mechanical tension or deformation as to become apparent whenever the amount of stretch imposed on said curtain undergoes a reduction; according to the materials used for said curtain said deformation can take either the form of a plurality of pleats, as a result of which said curtain will recoil like a bellows or of a continuous bending, that will cause said curtain to roll up like a croll or still otherwise.

The second solution that has been found in order to cause said curtain to recoil in an orderly way consists in winding it up around a mobile cylindrical core proceeding within the sealed space of the double glazing, and actually rolling along an inner wall of said double glazing. It is also possible to combine both said solutions,

inasmuch as said curtain, that will wind up around said mobile cylindrical core, has already been endowed, previously to assembling, with a self-winding trend. In the embodiments based on the magnetic principle, said mobile cylindrical core is also endowed with magnetic properties and works as the first mobile member mentioned in the above description.

In the enclosed drawings:

Fig. 1 is a partial cross-section view of a curtain according to a first embodiment of the invention.

Fig. 2 is a view similar to fig. 1 of another embodiment of a curtain of the invention;

Fig. 3 is a cross-section view of a third embodiment of a curtain according to the invention;

Fig. 4 is a front view of the curtain of fig. 3;

Fig. 5 is a cross-section view of a fourth embodiment of curtain according to the invention and

Fig. 6 is a cross-section view, on enlarged scale, of a detail shown in fig. 5 by reference 70.

The enclosed figures 1 and 2 show, as sectioned with vertical planes normally to their own surfaces, two examples double glazing equipped with two different curtains according to the invention.

While typical, both said examples should not be considered as limiting in any way, many other material solutions being easily envisaged by anybody experienced in the art of windows and glazing.

In figure 1, curtain (1) is a polyvinyl chloride (PVC) sheet, either colored or superficially metallized with an aluminium layer thinner than one-half micrometer; ferromagnetic bars (2) and (3) are respectively located within and without the inner space (10) of the double glazing, the latter consisting of two glass sheets (8) and (9), plus spacer (12) and being sealed by sealant (13). Curtain (1) is 40 micrometers thick and is pleated with alternative pleats (4) and (5), following one another with a regular spacing of 5 millimeters; said curtain (1) is also secured at its extreme borders, being connected, respectively, with spacer (12) by means of connection (6) and with ferromagnetic bar (2) by means of connection (7).

Ferromagnetic bar (3) is bent downwards at both ends (16) so that its middle span is shown in the drawing as section (14), while its bent arms (16) glide along vertical guides (17), each of which is adjacent either side border of the double glazing and carries a flange (18) that will keep ferromagnetic bar (3) close to the outer surface of glass sheet (9).

Whenever an operator displaces mobile member (3) either upwards or downwards, guides (17), that are of aluminium or of any other non-magnetic material, will cause it to remain parallel to itself,id est, both ends (16) will stay level. A magnetic flux, symbolized by the lines of force (15), joins the ends (16) of the ferromagnetic bar (3), and the ferromanetic bar (2), and causes the latter (2) to follow, within the sealed space (10), the motion given by the operator to the former (3). As a result, the amount of stretch of curtain (1) and the area covered by the same will be increased (if the motion is directed downwards), or decreased (if upwards).

In any intermediate position between those of maximum and minimum stretch, a part (19) of curtain (1) will adopt an extended configuration, and its weight will be carried mostly by the upper connection (6), while the complementary part (20), being in a recoiled configuration, will rest on the lower connection (7); upward motion will cause more of the curtain (1) to change from the extended configuration to the recoiled one; downward motion will cause the reverse, which will modify the relative shares of parts (19) and (20). According to the arrangement of fig. 1 the upper part of the window closed by the double glazing undergoes shielding with priority over its lower part. The opposite effect may be sometimes desired: this is easily obtained, inasmuch as curtain (1) is hung on the mobile member (2) by means of connection (6), while its lower border (7) is connected with the lower side of the spacer frame(12).

Figure 2 shows another embodiment of the invention: numbered references keep in Fig. 2 the same meanings as in fig. 1; curtain (11) is a polyester sheet, two and one-half micrometers thick and metallized with an aluminium layer thinner than one-half micrometer; the bar (22) of ferromagnetic material is cylindrical and its diameter is five and one-half millimeters; it will follow the motion of mobile member (3) while remaining horizontal and while rolling along the inner surface of

glass sheet (9) thus causing curtain (11) to wind up around said bar (22) in the case of downward motion, or to unwind itself, in the opposite case of upward motion. In this example like in the previous one, an arrangement contrary to that shown is of course possible as well, id est curtain (11) can be connected with the upper side of spacer frame (12) instead of its lower side, and in this case curtain (11) will wind up when mobile member (22) moves upward, and it will unwind when the latter moves downward.

Figures 3 and 4 shows a third embodiment of the curtain according to the invention. It differs from the preceding ones because its second, or outer, mobile member (3) has a different arrangement of magnets and a different driving device. In fact, the curtain itself (1) and said first, or inner, mobile member (2), as shown by figure 3, are identical with those of the first embodiment, as shown by figure 1.

Alternatively, curtain (11) and first mobile member (22), as shown by figure 2, could equally well be used in connection with second mobile member (3), the latter being embodied as shown by figures 3 and 4. Figure 3 is again a cross-section through a double glazing containing a curtain (1) and through the accompanying mobile members (2) and (3), while fig. 4 is, on a smaller scale, a front view of the same double glazing.

Fig. 3 is viewed as by an observer placed at the left side of fig. 4, and fig. 4 is viewed as by an observer placed at the right side of fig. 3. In the embodiment shown by figures 3 and 4, mobile member (3) comprises the following parts: a flat bar, made of ferromagnetic material (31), a number of permanent magnets (32), two pivots (33,34) secured to said bar (31) each carrying one of two wheels (35,36) both free to turn around their axes, two cords (37,38) made of metal wire or of any other flexible but inextensible material, a cover (39) preferably made of non-magnetic material. The functions of said parts will be better understood by looking at fig. 4. This shows the area of double glazing temporarily being shaded by curtain (1), as a result of the position given to mobile member (3), and the assembly of parts making up the latter is made visible on fig. 4, by removing cover (39). For the sake of clarity, cord (38), is shown as a dashed line, in order to better distinguish it from cord (37) , that is represented by a solid line. Both cords (37)and (38)are mounted in the shape of a letter "Z" symmetrically to each other. Each cord

is held taut by fixing it at both ends on the window frame holding the double glazing (shown on fig. 4 only): cord (37) is fixed on the lower side (40) of said window frame by means of turnbuckle (41), and on the upperside (45) of said window frame by turnbuckle (43) while cord (38) is fixed by turnbuckle (42) on said lower side (40) and by turnbuckle (44) on said upper side (45). By bending about one-fourth of a circle around each of wheels (35) and (36) , cord (37) will prevent mobile member (3) from slanting clockwise, while cord (38) will prevent it from slanting anticlockwise. Neither cord will prevent mobile member (3) from moving upwards or downwards, thanks to the free-wheeling condition of both wheels (35) and (36) and the overall result is that mobile member (3) can be easily moved by hand in a vertical direction, while keeping rigorously parallel to itself.

Fig. 4 also shows magnets (32) as four dashed circles; in this embodiment, said magnets are indeed cylindrical slugs, being magnetized along their axes. They are applied on bar (31) and stick to it owing to their magnetic attraction. It is preferable to use an even number of magnets (32), spaced at approximately equal intervals along the length of bar (31), making sure that their directions of magnetization are alternatively opposite to each other, so that, of each subsequent pair of magnets (32,32'), one (32) will touch bar (31) with its North face and the following one (32') will touch it with its South face, or vice-versa: this arrangement will provide for the maximum effect of magnetic attraction between mobile members (2) and (3).

Figures 5 and 6 show a fourth embodiment of the curtain according to the invention, being driven by an electrostatic effect. Figure 5 is again a cross-section through a double glazing contaning a curtain (51), while fig. 6 is a magnified cross-section of the detail identified in fig. 5 by reference (70). Looking at fig. 6, the structure of curtain (51) is seen to include three different layers, of which two outer layers (74) and (75) are made of dielectric materials, while the inner layer (72) is electrically conductive. Such a structure can be obtained by laminating to each other two sheets of the same or different plastic materials, either of which sheets has been previously vacuum-metallized with a layer of aluminium or any other metal. Still on fig. 6, references (73) shows the conductive or semiconductive surface layer having been deposited on the surface (54) of glass plate (59).

Turning now to figure 5, two concentric dashed circles (52) show the resting configuration that curtain (51) will assume when no electric voltage is applied between plates (72) and (73), i.e. when these are short-circuited by means of the external conducting leads (57) and (58). Said resting configuration (52) is characterized by the following features: its shape is that of a scroll, and its position is the lowest possible withing the inner splace of the double glazing. The latter feature is obviously due to gravity, said lowest position being defined by stop (50), that is preferably made from an electrically insulating material. The former feature should be the result of an especially controlled laminating process and/or subsequent thermal treatment.

It is indeed possible to induce a self-winding trend in the composite sheet or curtain (51), provided that slightly different and carefully controlled mechanical tensions are exercised on the component sheets (74) and (75) during the laminating process. Alternatively, one can laminate together sheets (74) and (75) made of two different materials that will shrink differently as a result of thermal treatment, thus yielding a self-winding composite sheet (51). However produced, a self-winding sheet (51) will tend to acquire at rest a scroll-like configuration (52) that is characterized by a precisely defined inner diameter (55). An electric voltage, when applied between layers (72) and (73) by means of leads (57) and (58) respectively, will cause scroll (52) to start upwards, thus unwinding curtain (51) that will then adhere onto the inner surface (54) of glass plate (59). At any intermediate position part of curtain (51) having unwound already, the part of it that still remains wound-up will still form an, albeit thinner, scroll (53). In its final position curtain (51) will have unwound completely, its full length (60) having been developed, and its upper border (56) will no longer form a scroll.

In one particular embodiment as illustrated by figures 5 and 6, layer (74) is a sheet of polyvinylidene difluoride, ten micrometers thick, previously vacuum-metallized with aluminium (72) to a thickness of one half micrometer; layer (75) is a sheet of polypropylene, 12 micrometers thick, and the composite sheet or curtain (51) tends to wind up in the form of a scroll with an inner diameter (55) of 9 millimeters. An electric voltage of about 500 Volts is required in order to start scroll (52) upwards from its resting position, and thus to effectively unwind curtain (1).

CLAIMS

1. Light shielding curtain comprising a mobile and/or deformable shielding curtain, entirely contained in the sealed hollow space formed by two glass plates or double glazing, characterized in that said shielding curtain is a continuous plane sheet, mobile between an unshielding position, in which light is allowed to pass through the said two glass plates, and a shielding position in which the light is prevented from passing through said two glass plates for a desired and willingly variable extension, and actuating means for the displacement of the said curtain between said two positions, said actuating means being operated by a magnetic or electrostatic force.

2. Light shielding curtain according to claim 1, characterized in that said actuating means comprise a first actuating member at least partially formed by magnetic or magnetizable material, said first member being mechanically connected to said curtain, whereby the displacement of said first actuating member within said hollow space corresponds to the displacement of said curtain between said two positions, and a second actuating member, positioned outside of said hollow spalce and movable along the outer surface of one of said glass plates, said second actuating member being at least partially formed by magnetic or magnetizable material, whereby a magnetic dragging force is generated between said first and second actuating members, means being provided for the guiding of at least one of said first and second actuating members, so as to keep it always parallel to the initial position thereof.

3. Light shielding curtain according to claim 2, characterized in that said curtain is a continuous sheet foldable like a bellows, having a first end fastened to one end of the double glazing and the other end fastened to said first actuating member.

4. Light shieleding curtain according to claim 2, characterized in that said curtain consists of a continuous sheet having one end fastened to one end of the double glazing and the other end fastened to said first actuating member, the latter being a roller freely rotatable around its axis, the said sheet being wound and unwound with respect to said roller.

5. Light shielding curtain according to claim 2, characterized in that said guiding means consist of two parallel guides for the sliding motion of said first actuating

member.

6. Light shielding curtain according to claim 2, characterized in that said first and second actuating members are of ferromagnetic material, at least one of said two actuating members being permanent magnetized.

7. Light shielding curtain according to claim 2, characterized in that a number of cylinder shaped slugs adhere to said second actuating member, said slugs being magnetized along their axes and protruding towards the adjacent surface of the double glazing, said slugs being alternated, with alternatingly opposite magnetizing directions.

8. Light shielding curtain according to claim 2, characterized in that two double race sheaves are fastened to said second actuating member, said sheavy being freely rotatable around their axes and symmetrically mounted at the two ends of said member, either race of each sheave being engaged by either two cords, having their ends fastened to the upper end and to the lower end of the double glazing respectively, each cord thus forming with the length engaged with said sheaves a Z shaped configuration, whereby whatever displacement of said second actuating member from the parallel condition with respect to the initial position is automatically compensated and corrected.

9. Light shielding curtain according to claim 1, characterized in that said actuating means comprise electric plates respectively carried by said curtain and the inner face of one of said two glass plates, said electric plate carried by said glass plate being at least partly light transparent the two said plates forming a variable electric condenser, and means for varying the capacity of said condenser.

10. Light shielding curtain according to claim 9, characterized in that said electric plate carried by said curtain is a metallic or metallized layer and a dielectric layer is provided between said electric plates.

11. Light shielding curtain according to claim 9, characterized in that said electric plate carried by said glass plate is an electrically conductive or at least semiconductive layer coating the surface of said glass plate.

12. Light shielding curtain according to claims 10 and 11, characterized in that said dielectric layer is built in said curtain or deposited on top of said conductive or semiconductive coating of said glass plate.

13. Light shielding curtain according to claim 10, characterized in that said curtain comprises three different layers, the outer ones being of dielectric materials and the intermediate layer being of electrically conductive material.

14. Light shielding curtain according to claim 9, characterized in that said two electric plates are each electrically connected to an electric lead, means being provided to establish a desired voltage between the ends of said two electric leads.

0072062

FIG. 2

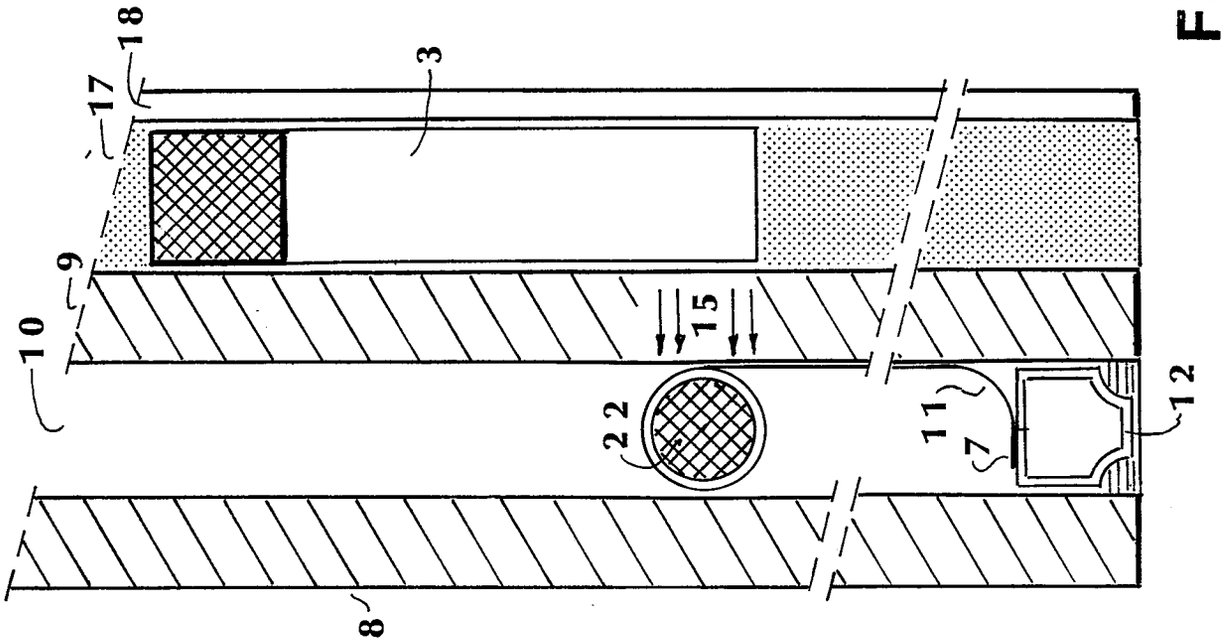
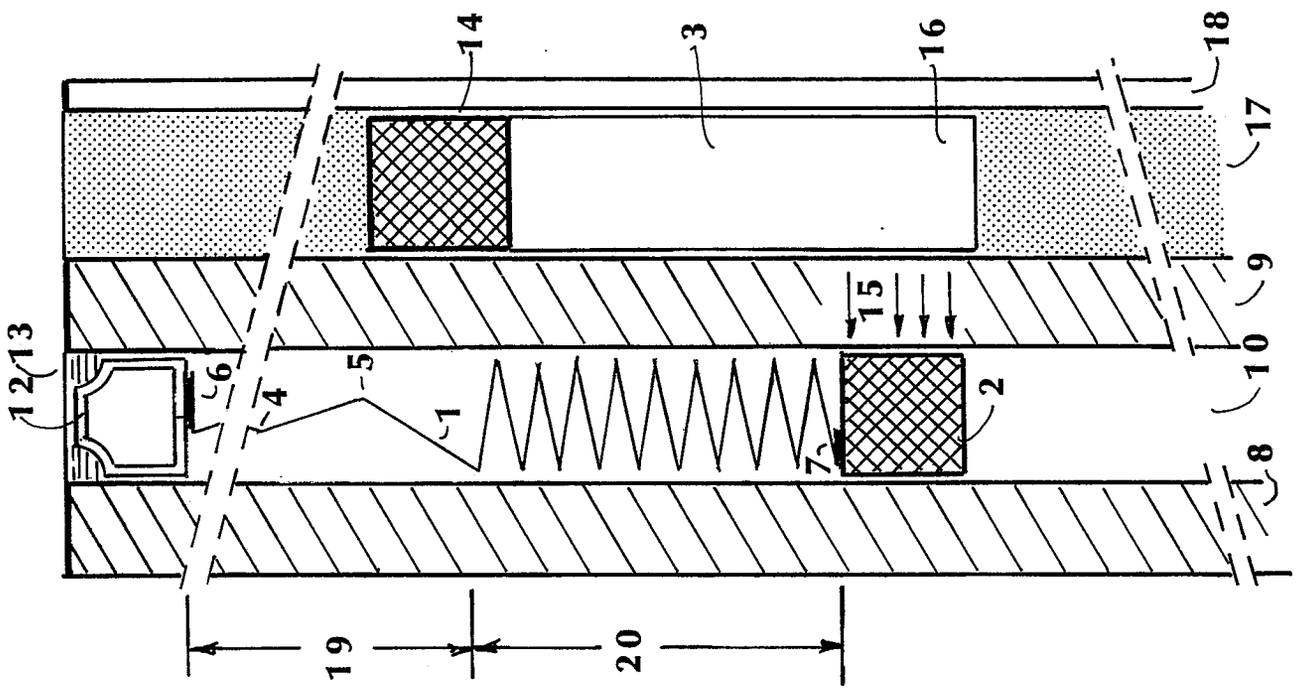


FIG. 1



0072062

FIG.3

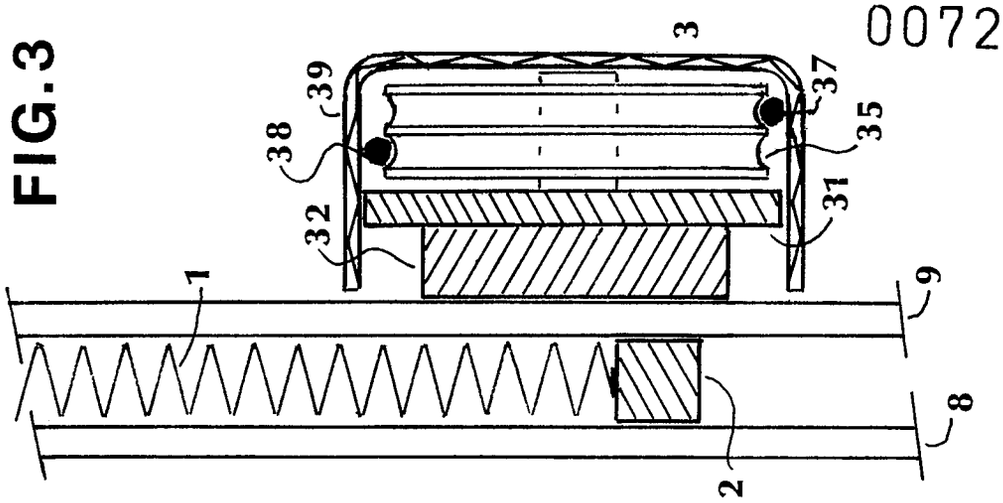
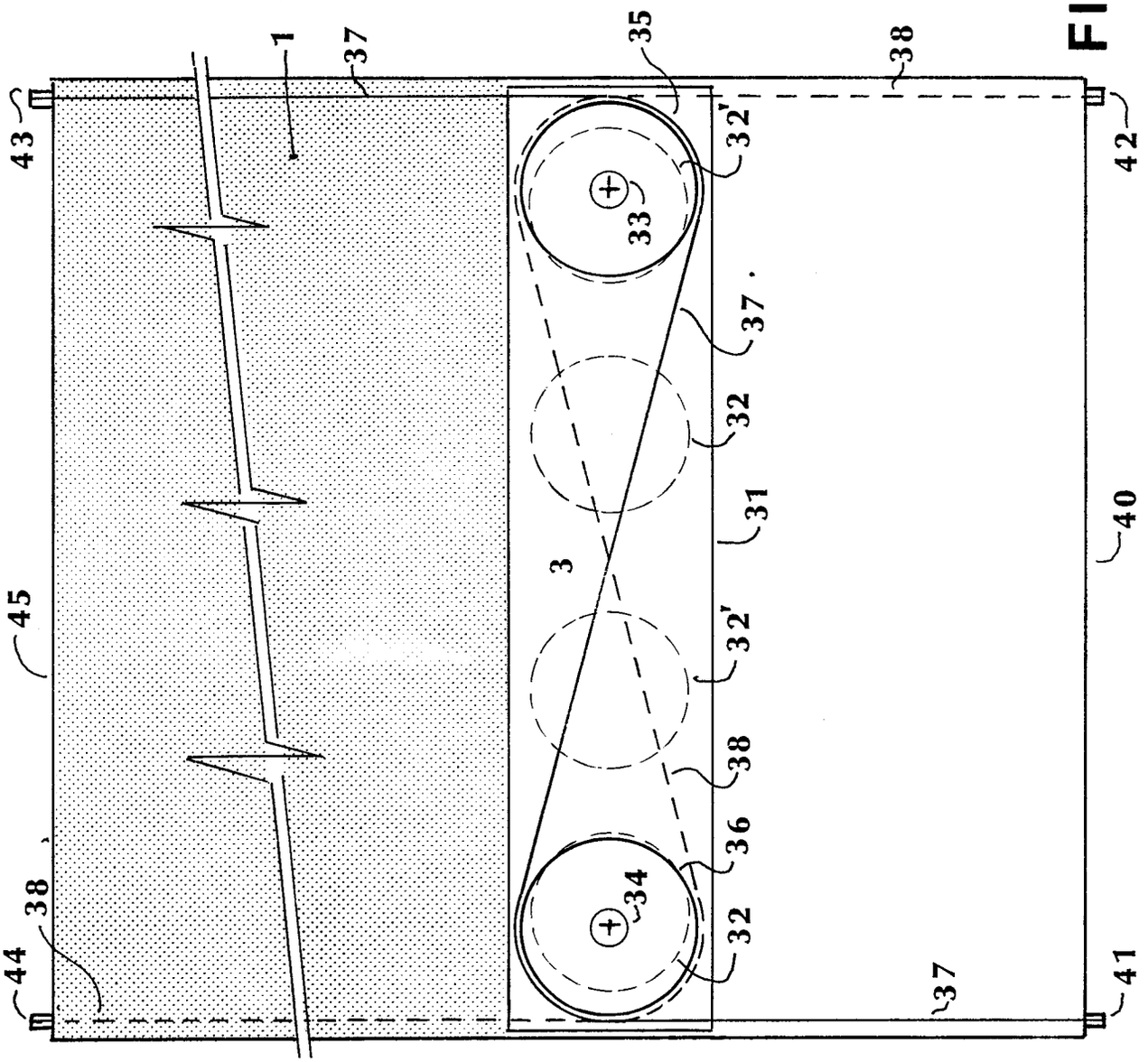


FIG.4



0072062

FIG.5

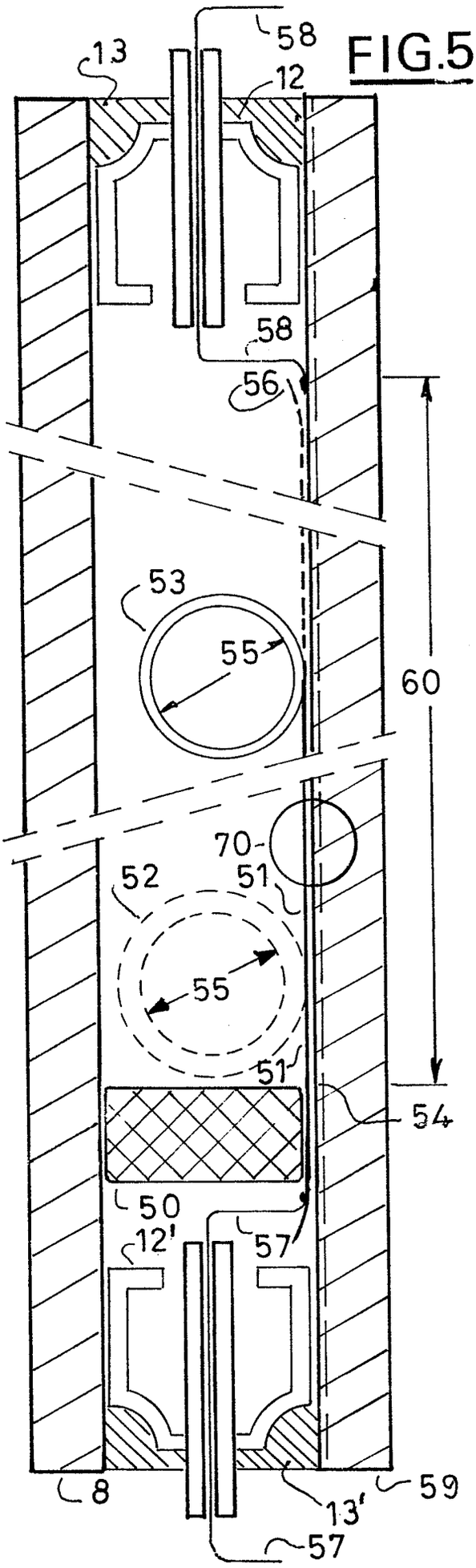


FIG.6