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(54) **Title**: AUTOMATIC RELEASE CONTROL SYSTEM FOR CONTROLLING THE CONNECTION BETWEEN TWO ELEMENTS

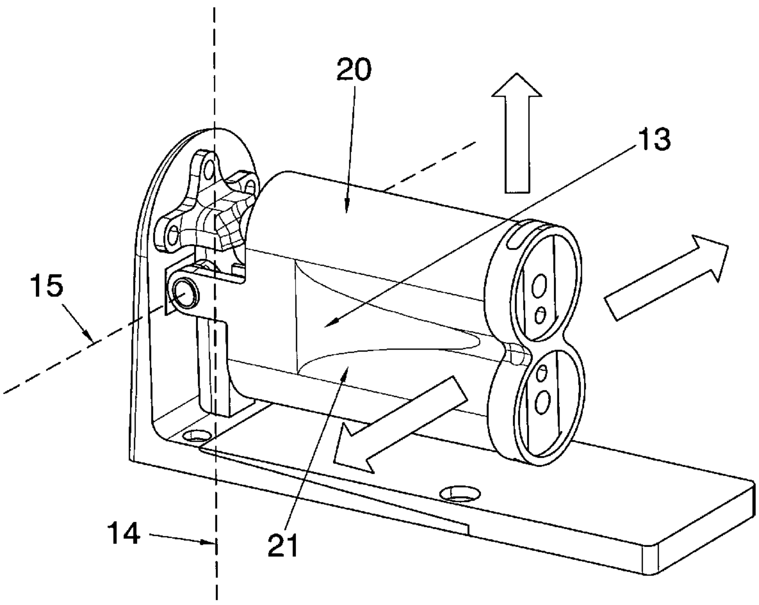

FIG. 5

(57) **Abstract**: The automatic release control system for controlling the connection between two elements, refers to a system for efficiently controlling the connection between two elements, preferably between a user and an apparatus, such as a ski or snowboard, on which the user's leg or foot is retained. The mechanism ensures that whatever the direction, application point and strength of the resultant of the forces transmitted by the apparatus to the leg, the releasable retaining system will release under the action of a potentially injurious force and remain in retaining state if no injurious forces are involved.

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AUTOMATIC RELEASE CONTROL SYSTEM FOR CONTROLLING THE CONNECTION BETWEEN TWO ELEMENTS

OBJECT OF THE INVENTION

A system for efficiently controlling the connection between two elements, preferably between a user and an apparatus, such as a ski or snowboard, on which the user's leg or foot is retained. The mechanism ensures that whatever the direction, application point and strength of the resultant of the forces transmitted by the apparatus to the leg, the releasable retaining system will release under the action of a potentially injurious force and remain in retaining state if no injurious forces are involved.

CROSS – REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 61/323,085, filed on April 12, 2010, the disclosure of which is incorporated herein in its entirety by reference.

FIELD OF THE INVENTION.

The invention relates to a system for controlling the relative motion between two elements. In particular this system is applicable for controlling the connection between a user's leg, and specifically a boot, and an apparatus. The invention also relates to a device for controlling the relative motion between two elements, in particular the connection between a user's leg and an apparatus. It also relates to a method for controlling the relative motion between two elements.

BACKGROUND

The development of some activities requires the use of an apparatus connected to the body. This is the case, for example, in snow sports that require the use of skis, snowboards, etc. connected through the boot to the leg and/or foot of the user or skier. These apparatuses can act as levers that apply forces or resistances to certain parts of the body that exceed the strength the body can support, thereby causing injuries. In the example of skiing, the forces generated by the ski frequently cause broken leg bones or severe knee injuries. In particular, it is very common in the skier's community to suffer severe knee injuries frequently involving ligaments injuries. The extended use of high performance boots that are very stiff in the ankle area prevent ankle injuries, however, the boot's stiffness results in direct transmission of the generated forces or loads on the apparatus to the knee. This is a main cause of knee injuries.

To help in the prevention of such accidents, it is common to use retaining elements or bindings based on spring retention that release the skiers boot from the ski when the force exerted from the boot on the binding exceeds the force of the spring. The vast majority of those bindings include two units: a "toe unit" that retains the toe part of the boot and a "heel unit" that holds the heel part of the boot.

The toe unit mechanism in a great number of current bindings is such that they only release the toe end of the boot when it moves in the "horizontal plane," that is, the plane of the ski. The heel unit in the vast majority of the current ski bindings is such, that it only releases the heel end of the boot when it moves in the "vertical plane" that is a plane perpendicular to the plane of the ski.

Both units, toe unit and heel unit, have a mobile/dynamic part and a static part. In current bindings the springs are usually in the static part. This means that the static part has to be long enough to house the spring or springs. On the other hand, the mobile or dynamic part has to be long enough to move along with the boot in its movement from a retaining to a releasing position, absorbing as much energy as possible. The previous configuration forces the designers using state of the art bindings principles to choose between either too big bindings or bindings with poor energy absorption, as it will be explained herein.

Such bindings yield acceptable results in some particular cases. However, as injury statistics clearly show, those retaining elements or bindings do not provide adequate protection in many other cases and every year many skiers throughout the world suffer severe injuries.

Therefore, retaining elements or bindings commercially available, do not give an adequate level of protection, because they only work properly in very few cases compared to the many types of incidents that frequently happen during skiing. Many of these incidents involve severe injuries due to the mentioned poor binding performance. The state of the art bindings have different limitations as detailed below.

In first place, most of the bindings of the state of the art do not release in backward falls. Current ski boots are very stiff and very high, creating a solid block that extends from the foot to half way between the foot and the knee. Current bindings do not have a releasing mechanism to release the boot under the action of a vertical force induced by the toe end of the boot on the binding. In backward falls the boot prevents the ankle from flexing and the binding prevents the boot from moving to accomplish the leg movement, so the weight of the body falling backwards applies an enormous load on the knee, which frequently causes ligament breakage.

Secondly, actual bindings do not release under lateral forces applied to the ski on the projection of the tibial axis ("lateral forces"). The vast majority of these bindings do not have a releasing mechanism to release the heel part of the boot under lateral forces. This induces two types of incidents. A first incident when the knee is flexed, as the ski can apply high torques on the femur through the tibia acting as a lever, thus inducing high loads into the knee joint that frequently result in severe injuries.

A second incident when the ski rotates around the tibial axis, and the release action depends entirely on the releasing mechanism close to the toe end of the boot. Consequently, the torsion force or torque needed to make the mechanism release depends on the point of application of the resultant of the forces acting on the boot. The binding settings, thus, can be either too loose or too firm. If they are too loose the binding will release when it should remain in the retaining state if the point of application is closer to the toe end of the boot. If they are too firm the binding will not release when it should if the point of application is close to the heel end of the boot. For example, United States patent number 7,318,598 and United States published patent application number 20080179862 describe a ski binding heel unit that includes lateral release cams and a vector decoupler mechanism that provides lateral shear release of the heel of a ski boot from a ski.

According to the previous documents, the bindings described therein solve the problem of releasing under lateral forces, but in fact fails to accomplish this adequately. In the first place, the binding only releases under forces applied on one side of the ski, not on both sides.

On the other hand, the present invention provides for optimization of the process of switching from a retaining state to a releasing state in all the possible directions of the force applied and keeps constant the force required to release: a) all along the path of the releasable retaining system from the retaining position to the releasing position, and b) no matter the direction and point of application of the force.

In third place, in the vast majority of current bindings, when there is a combination of forces in different planes (vertical and horizontal), that are diagonal forces applied on the ski (see Fig. 2), the retention force exerted by the binding is the vector sum of both components, vertical and horizontal, plus another considerable force corresponding to friction. In practice, this means that the force needed to switch from the retaining state to the releasing state is higher than the optimal. This makes it impossible for one to find a proper setting to prevent injuries because: (a) if the binding is adjusted to release in the case of combined (diagonal) forces, it will be too "loose" (that is, it will release when it should not) in the case of simple (horizontal or vertical) forces and vice versa; and (b) if the binding is adjusted to remain in the retaining state under the action of weak, non injuring horizontal or vertical forces, it will be set too tight, requiring too strong a diagonal force to release and consequently putting the leg and knee at risk in such circumstances.

In the fourth place, the retention force varies along the movement of the binding from the retaining position to the releasing position. As long as the binding moves to release the boot, the retention force is different in the different positions of the binding.

In the fifth place, the movement range between the retaining position and the releasing position is short.

Additionally, the two last mentioned features cause poor energy absorption that in practice results in undesirable release of the binding due to short impacts that would not have caused injury if the binding had absorbed the resultant energy without releasing. This is explained below.

The graph in Fig. 9 shows in the x-axis the distance T traveled by a binding from its retaining (RT) position to its releasing (RL) position and in the y-axis the force needed to release the binding F (that is equivalent in value to the retention force). The dotted line shows the retention force in a conventional binding in each position all along this path. The area contained between this dotted line and the axis (integral of the force over the displacement) represents the work, and the amount of energy needed to do the work of releasing a conventional binding.

An incident during ski practice produces a certain amount of energy. The amount of work needed to release a binding is, using other words, the amount of energy produced in the ski incident and this is, as previously explained, a function of the force F and the distance T. On the other hand, the potential injury has no relation with the distance T, it is only related with the exerted force F. It is important to prevent inadvertent releases that the binding can absorb as much energy as possible because this will prevent small incidents (with no risk of injury because the applied force F is under injury levels) derived from releasing the binding. In other words, the binding can travel a distance T as far as possible while applying a constant retention force F, that is, maintaining the retention just under the injury level but traveling as far as possible. Figure 9 shows, in first place, that the amount of energy needed to release the conventional binding is very limited. In second place, this figure shows that the force needed to release a conventional binding is variable all along the path of the binding from the retaining to the releasing position. This means a "rolling" binding, which produces uncomfortable and unsafe skiing. Unsafe because the binding can have peaks of "retention force" thus remaining in retaining state when it should release, and valleys in which it releases upon demand of a force clearly lower than the set one.

In view of the state of the art, a device is needed to effectively control the connection between a user's leg and an apparatus, such as a board, a snowboard, a ski, or any other device that by its features prevents the critical situations in which the user runs a risk of an injury, such as those described above.

SUMMARY OF THE INVENTION

To achieve a device that effectively controls the connection between a user's leg and an apparatus has been a big challenge in view of the existing bindings concepts that have not been introduced into the market, because they failed to provide significant and practical solutions to the problems addressed. However, the present invention not only solves the existing problems of prior bindings, but it does so by being complete, compact, mechanical, non expensive, simple and easy to manufacture. The present invention can be extensively configured not only in with respect to its retention force, but all its behavior to new and different demands, such as for special individuals or communities with different physiologic structures, according to new discoveries, racers with specific demands, etc. Therefore the invention's application can be customized. The present invention is not required to have any type of electronic devices and will work well in aggressive, outdoor environments.

The present invention has been conceived and designed with one objective: to help in controlling the connection between a skier and a ski. However, it can be used in many other fields that require an efficient mode of regulating connections between two parts, one or both parts susceptible to being affected negatively by the application of forces on the other. We refer herein to the "user's leg" and "apparatus" or "boot" and "ski" as only exemplary embodiment, but the present invention also can be used with different apparatuses and even with no user's leg involved, but anything that might be damaged by the action of forces applied to another element connected to it. The present invention is, using an electrical analogy, like the most efficient "fuse" in a circuit to prevent damages when the load is too high and exceeds predetermined values.

An object of the present invention is to solve the until now unsolved problem of bringing full protection against injuries when a user's leg is connected to an apparatus such that the induced forces applied to the user's leg might induce severe injuries in the user's leg. The present invention achieves this objective, because it disconnects the user's leg from the apparatus when any potentially injurious force is applied to the user's leg through the apparatus, no matter the direction or point of application of the force.
Another object of the present invention is to provide better performance by keeping the apparatus effectively connected to the user's leg in any circumstance in which there is no risk of injury. This prevents the apparatus from disconnecting when it should remain connected and consequently prevents the user from injuries induced by accidents caused by the loss of an apparatus, such as a ski.
An aspect of the present invention provides a coupling system that controls the connection between a user's leg, preferably a foot or boot, and an apparatus to which the user is bound by using at least a three dimensional cam and follower-type system.
A further aspect of the invention is a device that controls the connection between a user's leg and an apparatus to which the user is bound by a releasable retaining mechanism or system that has two states: a retaining state and a releasing state.
An aspect of the present invention involves the connection of a user's leg and an apparatus that is composed by two units, a first one holding the user's boot at the toe end (toe unit) and a second one holding the user's boot at the heel end (heel unit). Each of these units has two mechanisms (as shown, for example, in Fig. 1): the manual release or releasable retaining mechanism (16) to hold the boot ends and an automatic release or releasable retaining mechanism or "Automatic Release Control Mechanism" (17) to control the way the connection behaves when external forces are applied to the ski, efficiently regulating the connection between the user's leg and the apparatus.
The manual releasable retaining mechanism (16), which is the one that holds the boot at its ends, is manually switchable from a retaining state to a releasing state. It serves to manually connect the user's boot to the apparatus and to manually disconnect the user's boot from the apparatus.
The second mechanism, or Automatic Release Control Mechanism (17), that is part of the binding or releasable retaining system, regulates the force exerted by the releasable retaining system (binding) against the force applied on the apparatus (ski) in the most efficient mode meaning that: a) it will switch from the retaining state to the releasing state when any force from any direction applying to the apparatus at any

point exceeds a certain threshold value that might be injurious to the user's leg, and b) forces applying to the apparatus that are not potentially injurious will not switch the system from the retaining state to the releasing state.

Both mechanisms, the manual releasable retaining mechanism (16) and the automatic release control mechanism (17) are connected together by conventional and adequate means. The manual releasable retaining mechanism 16 and the Automatic Release Control Mechanism 17 together form each unit, toe unit and heel unit. Both mechanisms, the manual and the automatic, can be joined by different means. In some preferred embodiments they are bolted, in other they share a common part.

The Automatic Releasable Retaining Mechanism is conceived, designed and developed in such a way that the behavior of the overall releasable retaining system or binding is optimal in all the cases including those not covered by the bindings currently in the market. For a better understanding of some of the advantages of this invention, a list of some cases or incidences not covered by the bindings currently in the market but that can be covered by a binding using this invention follows:

1. A releasable retaining system in accordance with the present invention switches from the retaining state to the releasing state at any time when a potentially injurious force is applied to the ski, including backward falls, no matter the exit direction. Bindings currently on the market do not switch from the retaining state to the releasing state in backward falls, which is a cause of frequent ACL (Anterior Cruciate Ligament) breakage as explained above.

   A releasable retaining system in accordance with the present invention switches from the retaining state to the releasing state at any time when a potentially injurious force is applied to the ski, including when lateral forces are applied to the ski on the projection of the tibial axis (the most extreme case of "lateral force"), regardless of which side of the ski the force is applied, making it possible to get a setting that releases adequately under "lateral forces" while retaining adequately under "ski rotation induced forces". Current bindings also do not permit a setting that releases the binding adequately under "lateral forces" while retaining adequately under "ski rotation induced forces," nor do they permit adjusting the binding to switch from the retaining state to the releasing state when a lateral force is applied to the ski on the projection of the tibial axis. The present invention optimizes the process of switching from the retaining state to the releasing state in all the possible directions and keeps uniform/ constant the force required to release: 1) all along the path of the releasable retaining system from the retaining position to the releasing position, and 2) no matter the point of application of horizontal forces.

2. A releasable retaining system in accordance with the present invention switches from the retaining state to the releasing state at any time when a potentially injurious force is applied to the ski including combination of forces. For any combination of forces, including a combination of forces (see Fig. 2) in the vertical plane and the horizontal plane (that is, diagonal forces), it is possible to make the diagonal retention force (continuous line arrows in Fig. 2) lower than the vector sum of the vertical and horizontal components, as well as diminish considerably the force that results from the friction. This is not possible in the bindings of the state of the art in which the retention force (continuous plus dotted line arrows in Fig. 2) exerted by the binding is the sum of both components vertical and horizontal, plus another considerable force corresponding to friction (projected dotted line arrows in axis x and y in Fig. 2). The foregoing makes it impossible to find a proper setting to prevent injuries, because if the binding is adjusted to release in the case of combined (diagonal) forces, it will be too "loose" (that is, it will release when it should not) in the case of simple (horizontal or vertical) forces and vice versa; and if the binding is adjusted to remain in the retaining state under the action of weak, non-injuring horizontal or vertical forces, it will be set too tight, thus, requiring too great a diagonal force to release and consequently putting the leg and knee at risk in such circumstances.
3. A releasable retaining system or binding in accordance with the present invention ensures that the retention force in binding using the Automatic Releasable Control mechanism (F, continuous line in Fig. 9) is constant (continuous line in the x-y graph in Fig. 9) all along the path travelled (T, Fig. 9) by the binding from the retaining position (RT, Fig. 9) to the releasing position (RL, Fig. 9). This is not the case in the bindings of the state of the art, in which the retention force (F, dotted line in the x-y graph in Fig. 9) varies along the movement (T, Fig. 9) of the binding from the retaining position (RT, Fig. 9) to the releasing position (RL, Fig. 9).

   The challenge for an ideal binding is to be as close as possible to a flat displacement / retention curve for each direction of releasing and for every setting (retention force value). This is possible using the present invention for a particular setting. For example, a binding can be "preset" to give the same retention force (for example, 6 DIN) no matter the releasing direction all along the different points of the path from the retaining position to the releasing position, that is, a flat curve in all the possible directions. However, if a user wants to customize that preset bindings looser or stronger (for example, 4 or 7 DIN), the bindings will not have a perfect flat retention curve.

In the rest of all the possible settings the retention curve would not be 100% flat, but very close to such value. We can ensure that it will be over 90% or very close to that. To say 90% flat means that the area of the retention force in a graph showing distance traveled by the binding in the x-axis (T in Fig. 9) and retention force in the y-axis (F in Fig. 9), the area delimited between the curve and axis is in the worse case, close to 90% of the area corresponding to a 100% flat curve.

For simplicity, we will refer to a 100% flat curve hereafter to mean 100% for one setting in all releasing directions and 100% in one direction and more than 90% in the rest for the rest of the possible settings.

4. The movement range between the retaining position (RT in Fig. 9) and the releasing position (RL in Fig. 9) is much longer than in the current bindings.
5. The above-mentioned two features 4 and 5 allow a greater energy absorption and, therefore, in practice short impacts do not release the boot from the binding because the binding absorbs the impact energy without transmitting excessive forces to the leg. This is important, because it prevents what is called "inadvertent releases", or cases in which the binding switches from the retaining to the releasing position when it should remain in retaining position without causing any injury. Those inadvertent releases, very common in state of the art bindings, frequently cause skier falls and produce injuries as a consequence.

As explained previously, the graph in Fig. 9 shows in the x-axis the distance T traveled by a binding from its retaining position to its releasing position and in the Y-axis the retention force F. The dotted line shows the retention force in a conventional binding in each position all along this path. The area contained between this dotted line and the x and y axes (integral of the force over the displacement = work) represents the work, and the limited amount of energy needed to do the work of releasing a conventional binding.

The continuous line in the x-y graph in Fig. 9, shows instead the retention force in the binding object of the invention at any point along the path from the retaining to the releasing position. The area between the continuous line and the x and y axes (integral of the force over the displacement = work) represents the work, and the amount of energy needed to release the binding. Its easy to see how the binding gives full advantage in energy absorption and a better and safer skiing because of this flat curve that means that the retention force remains constant all along the path of the binding from the retaining to the releasing position.

Fig. 9 thus shows that this binding keeps constant the retention force (F in Fig. 9) all along the movement of the binding from the retaining (RT in Fig. 9) position to the releasing (RL in Fig. 9) position. This point is important in the behavior of a binding: a bone or a ligament does not break because of the accumulated work, that is, the fact that a determined force is applied for a period of time. Rather, the bone or ligament break because a force peak takes place. The binding in accordance with the present invention can guarantee that neither force peaks higher than the set values happen, nor force valleys (inadvertent releases).

The foregoing are just some advantages of the present invention over the state of the art bindings. However, there are many other advantages in this invention, some of which are noted below.

The invention allows the adjustment of a maximum retention force for each different release direction. Even in diagonal (combined) forces it is possible to adjust or customize different retention forces for different release directions. The invention can therefore be configured or customized, that is, its functioning can be extensively adapted not only with respect to its retention force but all its behavior to new and different demands, like for special individuals or communities with different physiologic structures, according to new discoveries, racers with specific demands, etc.... Every adaptation can be made just by changing two small pieces, without the need of electronic devices and robust to work in a harsh, outdoor environment.

Due to the design of the invention and the fact that it keeps independent mechanisms for independent functions (a mechanism to retain - release manually and a mechanism to automatically release in case of potential injury), it allows a ski binding using the present invention to be manually connected or disconnected to the boot either by the toe end or the heel end of the boot.

All the bindings currently on the market have one static part and one mobile part. Our system shares these features. The springs in a conventional binding are in the static part of the binding. This means that the static part has to be long enough to house the spring or springs. On the other hand, the mobile part has to be long enough to go along with the boot in its movement from retaining to releasing position absorbing as much energy as possible. That configuration forces designers using current bindings principles to choose between either too big bindings or bindings with poor energy absorption, as we will explain hereto. A binding using the present invention instead, can have the pressure exerting element or pressure device (elastic elements as springs, pneumatic element as pistons, magnetic elements), if desired, in the mobile part. This permits a binding incorporating the mechanism of the present invention to offer a longer path from a retaining position to a releasing position as well as a better "retention curve" and energy absorption as explained above. The different elements of the mechanism can be placed either in the mobile part of in a static or fixed part, depending on the design features of each binding.

A device that solves many problems existing in the prior art, as well as other problems, is described and claimed in the co-pending U.S. patent application No. 12/103196 titled "EXOSKELETON", filed on April 15, 2008, and U.S. patent application No. 12/103410 titled "SAFETY AND CONTROL EXOSKELETON FOR SNOW SKIING," filed on April 15, 2008, for new exoskeletons invented by the same inventors of the present invention. These co-pending applications are incorporated herein in their entirety by reference. The present invention provides additional features that can be used in combination with aspects of the exoskeleton described in these co-pending applications.

BRIEF DESCRIPTION OF DRAWINGS

The invention will be better understood from the following description with reference to the annexed drawings.

Fig. 1 shows a side view of a ski boot connected to a ski 40 through a ski binding having two units, a toe unit and a heel unit, each unit having two mechanisms, a manually releasable mechanism 16, and an automatic release control mechanism 17.

Fig. 2 shows a perspective view of an automatic releasable retaining mechanism performance with respect to diagonal forces R, a binding equipped with an automatic releasable retaining mechanism of the present invention shown using continuous line and a conventional binding performance shown using a dotted line.

Fig. 3 shows a perspective view of a connecting element with the carved surface of the connecting cam from the connecting sliding cam.

Fig. 4 shows a perspective view of the connecting element on the supporting element including the supporting piece with the carved surface of the supporting cam from the supporting sliding cam.

Fig. 5 shows a perspective view of an automatic releasable retaining mechanism.

Fig. 6 shows a perspective view of an automatic releasable retaining mechanism showing some of its internal components.

Fig. 7 shows a perspective view of an automatic releasable retaining mechanism showing the possibilities of displacement of the point B respect to the point A limited by a limited part of a theoretical sphere.

Fig. 8 shows three different positions of an automatic releasable retaining mechanism.

Fig. 9 shows a energy absorption graphic in a binding using the automatic releasable retaining mechanism (continuous line) compared with a conventional binding (dotted line) as well as an upper view of two skis.

Fig. 10 shows a perspective view of automatic releasable retaining mechanism showing the plungers.

Fig. 11 shows a schematic longitudinal section of a side view of a preferred embodiment in which there is a single spring and a single cam and follower system.

Fig. 12 shows a schematic longitudinal section of a side view of a preferred embodiment in which there is an alternative device interposed between the cam and the follower.

Fig. 13 shows a side view and a top view of a manual releasable retaining system.

Fig. 14 shows a schematic longitudinal section of a side view of a preferred embodiment using a ball and socket type mechanism.

Fig. 15 shows a longitudinal section of top view of the embodiment in figure 14.

Fig. 16 shows a longitudinal section of a side view of an optional arrangement of the ball and socket mechanism of figures 12 and 14.

Fig. 17 shows a longitudinal section of a top view of the preferred embodiment shown in Fig. 12.

DETAILED DESCRIPTION OF PREFFERED EMBODIMENTS OF THE INVENTION

Figure 1 shows a ski boot connected to a ski (40) through a releasable retaining system or binding (16, 17, 16', 17' in Fig. 1). The system has bindings made up by at least two units: a toe unit, which is the unit holding the toe part of the boot (16, 17) and a heel unit, which is the unit holding the heel part of the boot (16', 17'). These units are of the releasable type, which means that they can release the boot when a force exceeding a threshold level is applied to the boot or manually when the user wants to get disconnected from the ski. Each unit has two mechanisms: one mechanism (16), which is a manual release mechanism, for contacting the boot to hold the boot end; and a second mechanism (17), which is an automatic release mechanism connected to the ski, to control the way the connection behaves when external forces are applied to the ski.

The automatic release mechanism (17) is the primary mechanism that controls the connection between the boot and the ski (40). It has two main states, a retaining state in which the boot is retained to the ski, and a releasing state in which the boot is released by disconnecting the boot from the ski when any potentially injurious force is applied to the user's leg trough the ski and the boot. This release is independent of the direction or point of application of the force that is exerted. When there is no risk of injury, the same element assures that the boot remains connected to the ski flexibly and firmly, thus preventing any inadvertent release of the boot.

Further, the binding and, in particular, the automatic release mechanism (17, 17') can comprise a connecting element (1 in Fig. 3) that is configured to connect the automatic release mechanism to the ski in a manner that allows the automatic release mechanism to turn about at least one of at least two perpendicular axes, but preferable about both axes (14 and 15 in Fig. 3). An example of such a connecting element is a universal joint type cross as shown in the figures.

The connecting element (1) is connected to at least one support element (3 in Fig. 4) that can be extended through an extension element (12 in Fig. 6) and that is fixed to the ski. The support element (3) can be configured to support the connecting element (1), allowing the connecting element to turn around an axis, for example a vertical axis (14 in Fig. 4).

The automatic release mechanism (17, 17') also includes at least one housing element (13 in Fig. 5) connected to the connecting element (1) in such a way that the housing element (13) can turn around an axis (15 in Fig. 5) that is different from the other axis (14 in Fig. 5) around which the connecting element can turn, for example a horizontal axis.

The housing element (13) has at least one pressure exerting element or pressure device, usually a compression or an elastic device (6, 8 in Fig. 6), preferably a preloaded compression spring or similar device which is housed in the housing element

(13). Alternatively, this pressure device or pressure exerting element can be a pneumatic device or a magnetic device. For simplicity, we will refer to this element as a spring, although as mentioned, any other device or element that provides similar features could be used.

At least one sliding or control system is included which is formed by at least two pieces defining control surfaces that can slide one with respect to the other converting rotary motion into linear motion, of the cam and follower type, for example. In one preferred embodiment of this invention, there are two independent cam (2, 4) and follower (7, 5) systems, one connecting sliding or control system (2-7 in Fig. 6) joined to the connecting element (1 in Fig. 6) and a supporting sliding or control system (4-5 in Fig. 6) joined to the support element (3 in Fig. 5). In this non-limiting embodiment the connecting sliding or control system (2 – 7 in Fig. 6) is a bi-dimensional cam and follower system that is, a cam and a follower configured to allow relative two dimensional movement between the cam and the follower (the follower can move in a plane), and the supporting sliding or control system (4 – 5 in Fig. 6) is a three dimensional cam and follower system that is, a cam and a follower configured to allow relative three dimensional movement between the cam and the follower (the follower can move in a volume).

Either the "cam" or the "follower" of the at least one sliding or control system are linked to the at least one spring.

In order to pre-load the elastic element or spring, at least one pre-load adjustment system (9-10) is included to adjust the load exerted by the compression spring between both parts, the cam (2, 4) and the follower (7, 5).

The releasing control system is designed in a way that provides one, several or all of the following advantages. It allows the manual releasable retaining mechanism (16), that is, the mechanism or device holding a boot end, to be positioned at any point on a surface that is a delimited space of a theoretical sphere (Fig. 7) with its center placed in a point close to the first connecting element (1), preferably in the point where the horizontal axis (15) and vertical axis (14) cross, or point A. In other words, in the first preferred embodiment it allows a point B to be positioned at any point that is delimited by the space of a theoretical sphere with its center in A which is the point where the vertical and the horizontal axis of the connecting element cross (1). This theoretical sphere has a radius equal to the distance between the point A, which is the center of the theoretical sphere, and the point B, which is placed in the surface of the theoretical sphere (Fig. 7).

On an opposite retention unit to the previous one, with a manual releasable mechanism (16') and an automatic releasable retention mechanism (17') too, further points A′ and B′ exist. The previous unit could be the toe unit and, therefore, this one would be the heel unit or vice versa. As a consequence, a distance D (Fig. 1) between B and B', being B′ the point on the surface of a second theoretical sphere with center at A′, increases as long as the automatic releasing control mechanism (17) allows the movement in any direction with the limitation of the point B (Fig. 7) to move restricted to the theoretical sphere with radius AB (fig. 7) and the point B′ to move restricted to the theoretical sphere with radius A′B′. This makes the boot to be released due to a geometric effect that is, because the manual releasable retaining mechanism (16), separates from the boot end.

As stated below the automatic releasing control mechanism (17) should have at least one cam and follower system or sliding system or control system. When this mechanism (17) has more than one cam and follower system, and one of them, the connecting sliding or control system (2-7 in Fig. 6) is joined to the connecting element (1 in Fig. 6) while the other, the supporting sliding system (4-5 in Fig. 6) is connected to the supporting element (3 in Fig. 6), it forces the connecting sliding system (2-7 Fig. 6) to always work only in a vertical plane. That is, it only increases spring (6) compression when the housing element (13 in Fig. 5) moves vertically (Fig. 8), and does not work. In other words, it does not induce spring compression when the housing element (13) moves laterally. The supporting sliding or control system (4-5 in Fig. 6) instead, which is joined to the supporting element (3 in Fig. 6), always works. That is, it always increases spring (8) retention no matter the housing element (13) displacement direction, vertical, horizontal or a combination of both. This allows the adjustment of the binding to a maximum retention force a) independently of any different direction and b) with this retention force being constant all along the path of the binding from the retaining position to the releasing position.

This is an advantageous disposition, because the required vertical retention force is around four times the required horizontal retention force. With this design, one spring (6) is fully dedicated to retain in vertical position while the other spring (8) works both in vertical and horizontal position, making possible the 4/1 ratio or any other. The 4/1 ratio means that when the device is subjected to a vertical movement, both springs react, while if the device is subjected to a horizontal movement only one of the springs reacts. Due to the springs action, the binding defines a stable position of the point B (Fig. 7) with respect to the point A (Fig. 7), as well obviously of the point B′ with respect to the point A′. Further, and due to the springs action too, the binding applies a resistance torque towards the stable position or initial position when forces tangential to the theoretical spherical surface are applied on B (Fig. 7).

The values of the resistance force in any position of B (Fig. 7) from any direction of movement can be configured or customized by the designer by changing the shape of the cams (2, 4) of the sliding or control systems and therefore the systems will work according to this customization or configuration. This results in an optimal lateral retention force against forces in any direction.

The fact that the springs (6, 8) are housed in a housing element (13) that is a movable element of the releasing control mechanism (17) (while in most of the state of the art bindings are housed in a fix part) provides important advantages, allowing more efficient and working designs. One of them is the great energy absorption previously described.

The combination of the “geometrical effect” involving increasing the distance (D) between the boot holding points (B, B′), in addition to the specially shaped sliding systems, and in addition to the movable housing element where the springs (6, 8) are contained, allows the binding to permit displacements of the boot in order to absorb the energy of forces that are not strong enough as to cause injury, but would cause a normal binding to release. When the position of the manual releasable retaining mechanism (16) separates from the stable position by more than a certain range, it separates totally from the boot (just due to the geometry of the system), thus, releasing the boot.

Friction is minimized, thus, minimizing work waste, so the retention force when the system or binding goes out of the initial or stable position is practically equivalent to the pushing force when the system or binding “comes back” to initial or stable position.

With this binding, due mainly to its automatic releasing control mechanism (17), it is possible to define the curve of retention at any point, this meaning that the motion will be retained in a way that allows a perfect retention, not only against the action of vertical and lateral forces but against any force composed by those two, avoiding having to increase the retention force higher than the optimal, due to vertical and lateral force addition. The use of the designed sliding or control systems, or cam and follower systems, allows unlimited possibilities of regulating the behavior of the binding. If the known bindings of the state of the art only have the possibility of settings in its retention force, bindings using the present invention can be adjusted to obtain different retention force values for different directions of forces and binding movements while keeping constant the retention force for each different direction.

In order to modify or customize the relative retention values in different directions it is only needed to modify the cam (2, 4) of the sliding or control systems. The change of the cams (2, 4) of a system is not the kind of setting that a common user will make. This is a "pre-setting" that can normally be made either by the manufacturer or by specialized workshops.

This is the basis of the features that permit guaranteeing that, no matter the magnitude, direction and point of application of the force on the ski, the loads on the leg will never exceed the values previously set. Apart from this, the energy absorption will be the maximum allowed for the range of movement of the binding. All the design is made to allow a long binding length permitting a long boot path from the retaining to the releasing state with the great advantages on energy absorption above mentioned.

However, this method and device is not limited to the connection between a user's leg and an apparatus (binding) but can be applied to other similar systems and fields. This method and mechanism can be applied in any case in which there are two elements where one is fixed and another one is movable, such that:

- The movable element can be positioned at any point on a surface that is a delimited part of a theoretical sphere with center at the fixed element and radius defined by the distance between the fixed element and the movable element
- There is a stable position or initial position of the movable element with respect to the fixed element.
- It is intended to apply a resistance force towards the stable position or initial position when forces tangential to the above mentioned theoretical spherical surface are applied on the movable element.
- It is intended to optimize the behavior of such resistance force when forces tangential to the above mentioned theoretical spherical surface are applied on the movable element.
- The optimal behavior of the system against tangential forces allows for a perfect functioning, including constant retention, when lateral forces are applied to it.

By using the method and device or mechanism of the present application, the values of resistant force in any position of the movable element can be defined as desired and the system will behave according to this definition.

Figures 3 to 10 of this application illustrate one non-limiting preferred embodiment of a binding and automatic releasable mechanism or device (17) in accordance with this invention for controlling the connection between a user and a ski on which the user's leg and/or foot is retained by a releasable retaining system or binding. For simplicity of the drawings to make them easier to understand the same have been limited to show the essential functional parts, not including bolts, washers and other complementary elements that one skilled in the art would know to provide in light of this disclosure and thus not needed to understand the functioning of the system or mechanism.

In the figures, there is an automatic releasing control mechanism (17) with a connecting element (1) similar to the cross of a universal joint with two arms, one arm, vertical, longer than the other, horizontal, both arms defining respective axis, one in the vertical plane (14 in Fig. 3) and the other in the horizontal plane (15 in Fig. 3). This connecting element (1) is connected somehow to the ski (40). The intersection or crossing point of these axes define a point A (Fig. 7) which is the center of a virtual or theoretical sphere that delimits the movement of the elements or components of the binding not fixed to the ski. We will refer to this connecting element (1) as a cross (1) too.

The vertical arm of the cross (1) is specially shaped, defining a carved surface (2 in Fig. 3) following mathematical calculations to be the cam of a connecting sliding or control system (2, 7) which is a cam and follower system having one cam (2 Fig. 6) and one follower (7 in Fig. 6) of specific characteristics. The follower (7) moves along the surface of the cam (2).

The cross (1 Fig. 4) is connected by the lower end of the vertical arm to a supporting element (3 in Fig. 4) that is fixed to the ski in a way that allows the cross (1) to rotate around its vertical axis (14 in Fig. 4).

This supporting element (3 in Fig. 6), with two surfaces at square angles, is fixed to the ski by its lower surface and it might include a projection (12 in Fig. 6). This projection (12) is in this preferred embodiment made of some low friction material to allow a better sliding of the boot during transition from a retaining state to a releasing state. On the vertical surface of the supporting element (3) there is one supporting piece (19 in Fig. 4) bolted to the upper part of the vertical surface, which serves a dual purpose. First, it has in one of its faces a specifically defined surface (4 in Fig. 4) to be the cam (4) of a supporting sliding or control system (4, 5) or cam and follower system (4, 5), where the follower (5) moves along the surface of the cam (4). Second, it has in its lower end a housing to house the upper end of the cross (1) in a way that allows the cross (1) to rotate around its vertical axis (14 Fig. 4). The work performed by this supporting piece

(19) can be made by two independent elements, one acting as a cam and another acting as housing of the cross (1).

As mentioned, the cross (1) is connected by its upper end to the supporting piece (19 in Fig. 4) bolted to the upper part of the supporting element (3) in a way that permits the cross (1) to turn or rotate around its vertical axis (14 in Fig. 4)

The horizontal arm of the cross (1) is connected to a housing element (13 in Fig. 5) in a way that allows the housing element (13) to rotate around the horizontal arm of the cross (1), that is, around the horizontal axis (15 Fig. 5)

The housing element (13 in Fig. 5) has two housings, an upper housing (20 Fig. 5) and a lower housing (21 Fig. 5), which respectively accommodate two elastic devices, preferably springs, an upper spring (6 in Fig. 6) and an lower spring (8 in Fig. 6). Each spring (6, 8) has its own preload adjustment system, that for example can be an upper bolt (9) and a lower bolt 10 to adjust the load of each spring (6, 8), respectively. In this preferred embodiment the thread for moving the bolts are placed in a disc upholding the spring (6,8). In this way the bolts do not move inside – out and always keep the same position.

Both springs (6, 8 in Fig. 6) are inlay in/ protected by respective plungers (18,22) to prevent the bending of the springs (6,8). Other means to prevent bending can be used. The upper plunger (22) is not shown in Fig. 6 to help to see the upper spring (6) in its entire length.

The end of the upper plunger (22 in Fig. 10) abuts the supporting follower (5) or the supporting sliding or control system (4, 5), which is shaped to move in any direction following the changes in the relative position of point B (B in Fig. 7) with respect to point A (A in Fig. 7). As long as it moves, the abutted supporting follower (5) moves over the specifically defined surface of the supporting cam (4 in Fig. 6). In certain embodiments, supporting follower (5 in Fig. 6) can be made of two components: one concave surface and a ball combining optimal materials to minimize friction. The abutted supporting follower (5 in Fig. 6) of the upper plunger (22 in Fig. 10) plus the specifically defined surface of the supporting cam (4 in Fig. 6) form the supporting sliding or control system or upper cam and follower system.

The end of the lower plunger (18 in Fig. 6) abuts a the connecting follower (7 in Fig. 6) in this preferred embodiment, forming a housing to house a follower similar to a rolling pin that is shaped to move up and down along the surface of the connecting cam (2 in Fig. 6) following the changes in the relative position of point B (B in Fig. 7) respect to point A (A in Fig. 7). Optimal materials to minimize friction can be interposed between the rolling pin of the connecting follower (7) and its housing.

The combination of the lower spring (8) abutted connecting follower (7 in Fig. 6) with its housing and similar rolling pin in addition to the specifically defined surface of the connecting cam (2 in Fig. 6), form the connecting sliding or control system or lower cam and follower system.

Low friction pieces can be interposed between the spring housings (20, 21) and the plungers (18, 22) The friction pieces can be single or multiple in each spring. It is possible too to use low friction treatments instead.

Although for simplicity it is only shown in this preferred embodiment one layout in which the bidimensional control system or cam and follower system is in the lower position and the three dimensional control system or cam and follower system is in the upper position, this layout can be changed, being the three dimensional sliding or control system in the lower position and the bidimensional sliding or control system is in the upper position.

In another embodiment, not shown in the figures, the sliding or control systems might be inverted that is, with the cam in the extreme of the spring and the follower in the part joined to the ski.

Another embodiment, not shown in the figures, involves connecting the described Automatic Releasing Control mechanism (17) object of the present invention in an opposite way, that is, joined to the ski through the housing element (13 in Fig. 5) or a vertical plate (11 in Fig. 6) and placing the manual releasable retaining mechanism (16) for holding the boot to the binding joined to the support element (3 Fig.6), such that the elements that in the previously described embodiment were joined to the ski are now joined to the boot and the elements that were joined to the boot are in this latter embodiment joined to the ski.

Another embodiment schematically shown in Fig. 11 only has one pressure device, preferably a spring (25 Fig. 11), one housing (28 Fig. 11) and one cam (27 Fig. 11) and follower (26 Fig. 11) system. The cam surface (27 Fig. 11) is in a lower position, specifically, at the cross center where the horizontal (29 Fig. 11) and vertical axis (14) cross, and fixed to the supporting element in a way that allows the housing turn around a vertical axis (14 in Fig. 11) and allows the housing (28 Fig. 11) to turn free around a horizontal axis (29 Fig. 11). This disposition allows a lighter, smaller and simpler binding. However, it has the disadvantage that to change the ratio between the vertical and horizontal retention force it is needed to change the cam surface 27 while in the first preferred embodiment this ratio can be adjusted just by moving the spring preload.

Another embodiment schematically shown in Fig. 14 uses a ball and socket mechanism instead of using a universal joint type mechanism. The housing (13 in Fig. 14) is specially shaped to fit to the ball (35 in Fig. 14) allowing the housing (13 in Fig. 14) to turn around axes 14 and 15 (axes 15 is invisible in Fig. 14, see Fig. 5 and 15 for reference) with respect to the supporting element (34 in Fig. 14) attached to the ski. There is at least one three dimensional cam (4 in Fig. 14) and follower (5 in Fig. 14) mechanism, a spring (25 in Fig. 14) a plunger (18 in Fig. 14) and a mechanism to preload the spring (9 in Fig. 14).

Fig. 15 shows a top view of the above - mentioned preferred embodiment. In this view we can appreciate axis 15.

Another embodiment schematically shown in Fig. 12 is a mechanism that can be used in most of the expressed preferred embodiments to manage the compression of the pressure device (25 in fig. 12). It comprises a pivoting member (30 Fig. 12) that can turn around a horizontal axis (31 Fig. 12). The pivoting member (30 Fig. 12) is shaped in a way to hold the pressure device, preferably a spring (24 Fig. 12), by one side and to hold a control surface (37 in Fig. 12) or cam by its other side. This pivoting member (30) turns around its axes (31 in Fig. 12) under the pressure of the ball (36 in Fig. 12) when the housing (13 in Fig. 12) moves in any direction pressing the spring, thus, inducing a resistant force against the movement of the housing depending on the shape of the surface (37 in Fig. 12) for any particular direction. This pivoting member moves one spring end mainly in a horizontal direction with a minor movement in the vertical direction, maintaining the spring in a correct position along the compression range without the need of any other help. The inclusion of this pivoting member reduces the friction forces with respect to the embodiments using plungers. The axis (31 in Fig. 12) of the pivoting member (30 in Fig. 12) can optionally be placed in the lower part of the housing (13 in Fig. 12). This option is not shown in the figures.

Fig. 17 shows a top view of the above - mentioned preferred embodiment. In this perspective axis 31 is clearly illustrated.

Fig. 16 shows a side view of an optional feature of the above-mentioned preferred embodiment. It comprises a cylindrical abutment (38 in Fig. 16) of the ball (35 in Fig. 16) that moves along a longitudinal groove (39 in Fig. 16) carved in the part of the housing (13 in Fig. 16) forming the socket. This combination of groove and abutment prevents the housing from turning around X axis while allowing the rest of the ball and socket degrees of freedom.

In another preferred embodiment shown in Fig. 13 the manual releasable mechanism (16 in Fig. 13) has a projection to permit the mechanism to turn around an axis (33 in Fig. 13). The connecting means between the manual releasing retaining mechanism (16 in Fig. 1) and the automatic release control mechanism (17 in Fig. 1) in such a case, are then configured to permit this movement.

Functionality of the system

As explained above, the supporting element (3 in Fig. 4) is fixed to the ski (40), so it cannot move.

The housing element (13 in Fig. 5) can turn or rotate around both axes, a vertical axis (14 in Fig. 5) and an horizontal axis (15 in Fig. 5), meaning that it can move vertically, horizontally and in diagonal by the combination of the vertical and horizontal movements.

The manual releasable retaining mechanism (16 in Fig. 1) keeps the boot connected to the automatic release control mechanism (17).

The shapes of the surfaces of the connecting cam (2 in Fig. 4) and supporting cam (4 in Fig. 4) are such that, the pre-load of the upper (6) and lower (8) springs transmitted to the surfaces of the cams (2, 4) maintains the mechanism in a stable position corresponding to the ideal position of the boot in the ski.

Due to the disposition of the surfaces of the connecting cam ((2 in Fig. 4) which is joined to the cross (1) and consequently free to rotate around the vertical axis (14 in Fig. 4), and the supporting cam (4 in Fig. 4) joined to the supporting element (3 in Fig. 4) and therefore not free to rotate, when the boot and consequently the automatic release control mechanism (17) moves vertically, the followers (5, 7) placed on both spring ends (6, 8) move along the surfaces of their corresponding cams (4, 2) producing the compression of both springs (6 and 8 in Fig. 6), that is, opposition to the movement of the boot.

However, when the boot and consequently the automatic release control mechanism (17) moves laterally, only the supporting follower (5) of the upper spring (6) moves through its corresponding surface producing only the compression of the upper spring (6 in Fig. 6), so that opposition to the movement is relatively weaker.

By specifically calculating, designing and shaping both surfaces of the cams (2, 4), it is possible to obtain a system that fulfills one or more of the objects or advantages of the invention. In particular, the "diagonal management" that is, apart from an optimal behavior when lateral and vertical forces are applied on the ski, the binding provides optimal behavior when a combination of both is involved, avoiding that the horizontal (H Fig. 2) and vertical (V Fig. 2) components of a diagonal force sum and, thus, producing a resultant diagonal that exceeds the injury safe values.

The manual releasable retaining mechanism (16), that is, the mechanism or device holding a boot end, can be at any moment positioned at any point (B) of a surface that is part of a theoretical or virtual sphere that has its center at a point (A) close to the connecting element (1). In other words, in this preferred embodiment, the point B is always positioned at any point of a theoretical sphere with its center in point A, point where the vertical axis (14) and the horizontal axis (15) of the connecting element (1) or cross (1), and where the radius is equal to the distance (AB) between the center point A and point (B in Fig. 7).

As a consequence, the distance D between point B (Fig. 1, Fig. 9) and point B′ (Fig. 1, Fig. 9), where B′ corresponds to point B but on the other manual releasable and retaining mechanism (16) on the ski, increases as long as the releasing control mechanism (17) moves in any direction due to the limitation of the point B (Fig. 7) to move restricted to the theoretical sphere with radius (AB in Fig. 7). This makes the boot released just by a geometric effect, that is, because the manual releasable and retaining mechanism holding the boot end (16 in Fig. 1), separates from the boot end (Fig. 9).

In another preferred embodiment the boot is released by a combination of geometric and mechanical effects that is, when the releasing control mechanism (17) reaches a certain position, triggers a mechanism in the manual releasable retaining mechanism (16) in such a way that the manual releasable mechanism releases the boot. In this case, the manual mechanism (16) can be considered as a "manual – automatic releasable retaining mechanism".

In another preferred embodiment the pressure exerting elements or pressure devices that maintain the contact between the follower and the cam, are pneumatic instead of elastic. In another embodiment the pressure devices are magnetic instead of elastic. Other mechanisms for applying pressure can be used as well.

In another preferred embodiment, the cam surface (4 in Fig. 6) is in the pressure device or spring (6) side and the ball (5 in Fig. 6) of the follower is on the supporting element (3) side.

In another preferred embodiment the rolling pin (7 in Fig. 6) of the follower is on the cross or connecting element (1) side and the cam surface (2 in Fig. 6) is on the pressure device or spring (8) side.

In another preferred embodiment the rolling pin (7 in Fig. 6) of the follower is in the cross or connecting element (1) side and the cam surface (2 in Fig. 6) is on the pressure device or spring (8) side and the cam surface (4 in Fig. 6) is on the pressure device or spring side (6) side and the ball (5 in Fig. 6) of the follower is on the supporting element (3) side.

CLAIMS

1. A coupling system for a retention and release mechanism for retaining a person's foot to an apparatus, comprising:

a first coupling configured to connect at least one of a toe end and heel end of a person's foot to the apparatus;

a second coupling configured to connect at least the other of the toe end and heel end of the person's foot to the apparatus;

the first coupling comprising at least a first control system to allow automatic release of the person's foot from the apparatus, the first control system comprising a first control surface in abutment with a second control surface, the first control surface and the second control surface maintained in abutment under the force of a first pressure device, the first control system configured to allow relative three dimensional movement between the first control surface and the second control surface.

2. The coupling system of claim 1, wherein the first coupling comprises a fixed portion attached to the apparatus and a moveable portion moveable relative to the apparatus, the first control surface is fixed to one of the fixed portion and the moveable portion.

3. The coupling system of claim 2, wherein the first control surface is fixed to the fixed portion and the second control surface is fixed to the moveable portion.

4. The coupling system of claim 2, wherein the first control surface and the second control surface are a cam and follower, respectively.

5. The coupling system of claim 4, wherein the cam is fixed to the moveable portion and the follower is fixed to the fixed portion.

6. The coupling system of claim 4, wherein the follower is fixed to the moveable portion and the cam is fixed to the fixed portion.

7. The coupling system of claim 1, wherein the first control surface is a surface of a pivoting member that pivots about a horizontal axis while maintaining contact with the second control surface.

8. The coupling system of 1, wherein the first pressure device resists linear compression and is connected to the first control system.

9. The coupling system of claim 8, wherein the first pressure device is one of a spring, a pneumatic device and a magnetic device.

10. The coupling system of claim 2, wherein the first pressure device is part of the moveable portion of the first coupling.

11. The coupling system of claim 2, wherein the first pressure device is part of the fixed portion of the first coupling.

12. The coupling system of claim 4, wherein the cam is a curved surface and the follower is a rolling ball.

13. The coupling system of claim 7, wherein the first control surface is a curved surface and the second control surface is a rolling ball.

14. The coupling system of claim 4, wherein the cam is a curved surface and the follower is a rolling ball, and the pressure device is coupled to the rolling ball at one end of the resistance member.

15. The coupling system of claim 13, wherein one end of the pressure device presses the curved surface against the rolling ball.

16. The coupling system of claim 2, further comprising a second control system comprising a third control surface in abutment with a fourth control surface, the third control surface and the fourth control surface maintained in abutment under the force of a second pressure device.

17. The coupling system of claim 16, wherein the third control surface and the fourth control surface are a cam and follower, respectively.

18. The coupling system of claim 16, wherein the second control system is configured to allow only two-dimensional relative movement between the third control surface and the fourth control surface.

19. The coupling system of claim 1, further comprising a ball and socket joint that connects the first control system to the apparatus.

20. The coupling system of claim 7, further comprising a ball and socket joint that connects the first control system to the apparatus.

21. The coupling system of claim 1, further comprising a cardan joint that connects the first control system to the apparatus.

22. The coupling system of claim 1, further comprising a joint to which one of the first control surface and the second control surface is connected, wherein the joint is rotatably coupled to the apparatus about a vertical axis so that the first control system as a whole is rotatable about the same vertical axis.

23. The coupling system of claim 18, further comprising a joint to which one of the third control surface and the fourth control surface is connected,. wherein the joint is rotatably coupled to the apparatus about a vertical axis so that the second control system as a whole is rotatable about the same vertical axis.

24. The coupling system of claim 18, further comprising a housing or bracketry that contains the first control system and the second control system and that is pivotally coupled to the apparatus with a cardan joint.

25. The coupling system of claim 22, wherein the joint is a universal joint defining two rotational axes that cross in a single point.

26. The coupling system of claim 1, wherein the pressure device is elastic.

27. The coupling system of claim 18, wherein the second control system is arranged below and parallel to the first control system.

28. The coupling system of claim 1, wherein the retention and release mechanism is a ski binding for releasably retaining a ski boot to a ski.

29. The coupling system of claim 28, further comprising a first claw or jaw coupled to the first coupling on one side of the first claw or jaw and configured to be coupled to a toe end or heel end of the ski boot on the other side; and a second claw or jaw coupled to the second coupling on one side of the second claw or jaw and configured to be coupled to the other of the toe end or heel end of the ski boot on the other side.

30. The coupling system of claim 28, wherein the first coupling is configured to release the ski boot when the toe end or the heel end of the ski boot that is connected to the first coupling moves by a predetermined amount relative to the fix portion of the first coupling.

31. The coupling system of claim 28, configured to release the boot due a change in a distance between the first coupling and the second coupling.

32. The coupling system of claim 29, configured to release the boot by opening the first claw or jaw or the second claw or jaw or both when a line passing through the center of the first claw or jaw and the second claw or jaw is offset by a predetermined angle relative to the longitudinal axis of the ski.

33. The coupling system of claim 7, further comprising a cardan joint that connects the first control system to the apparatus.

34. The coupling system of claim 2, further comprising a ball and socket joint that connects the fixed portion to the movable portion.

35. The coupling system of claim 2, further comprising a cardan joint that connects the fixed portion to the movable portion.

36. A coupling system according to claim 1 wherein the second coupling is a conventional binding to connect a toe end or heel end of the person's foot to the apparatus.

37. A ski binding system comprising the coupling system of claim 1.

38. The ski binding system of claim 37, comprising a ski boot and a first claw or jaw coupled to the first coupling on one side of the first claw or jaw and coupled to a toe end or heel end of the ski boot on the other side; and a second claw or jaw coupled to the second coupling on one side of the second claw or jaw and coupled to the other of the toe end or heel end of the ski boot on the other side.

39. The ski binding system of claim 37, wherein the first coupling and first claw or jaw and the second coupling and second claw or jaw are configured to receive the ski boot at the user's option toe end first and heel end first.

40. The ski binding system of claim 37, wherein the second coupling is a conventional binding to connect a toe end or heel end of the person's foot to the apparatus.

41. A method for controlling a connection between a user and an apparatus on which the user is retained in a releasable manner, comprising:

providing the coupling system of claim 1;

retaining one of the toe end or heel end of the person's foot to the apparatus using the first coupling; and

retaining the other of the toe end or heal end of the person's foot to the apparatus using the second coupling.

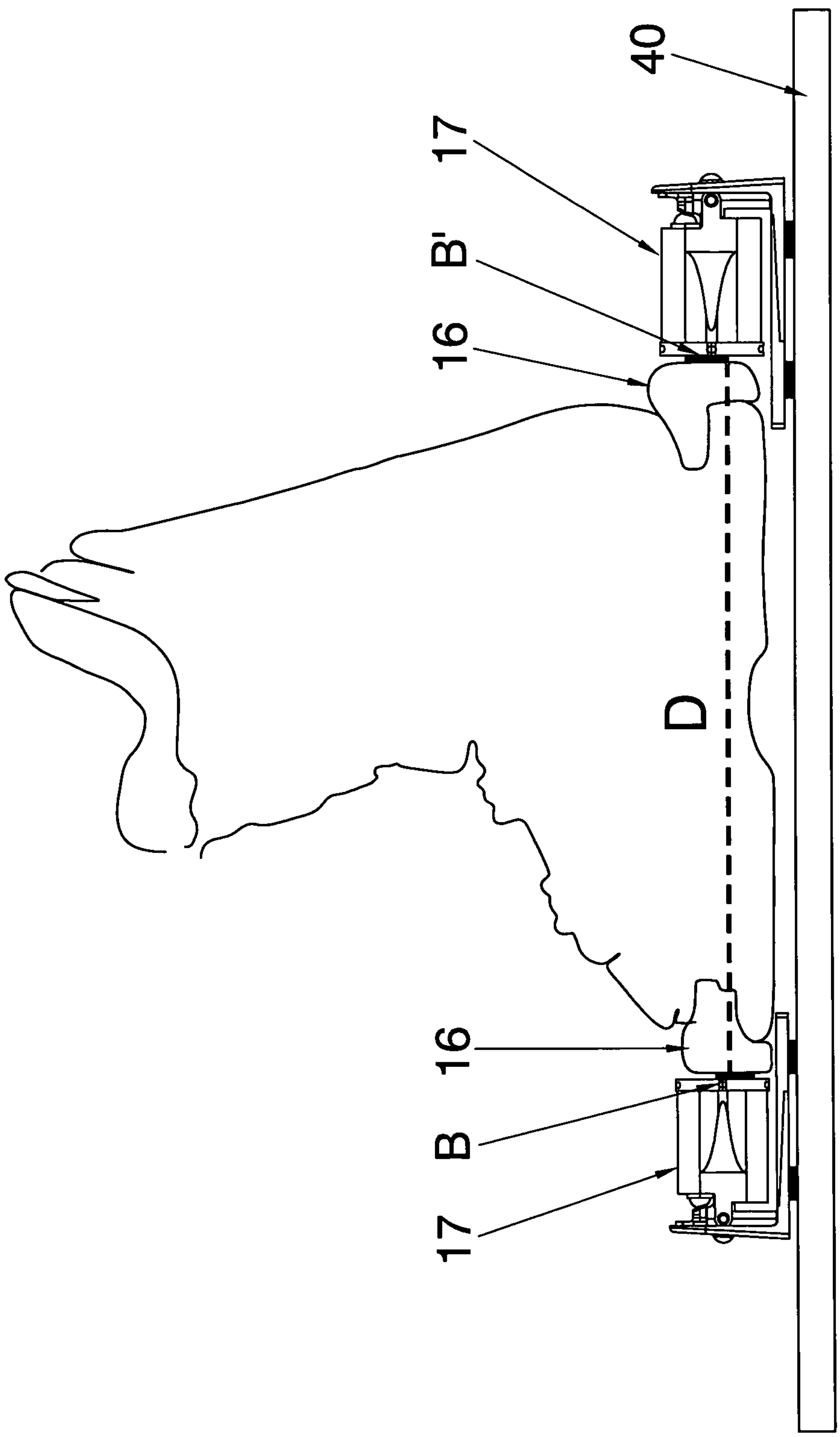

FIG. 1

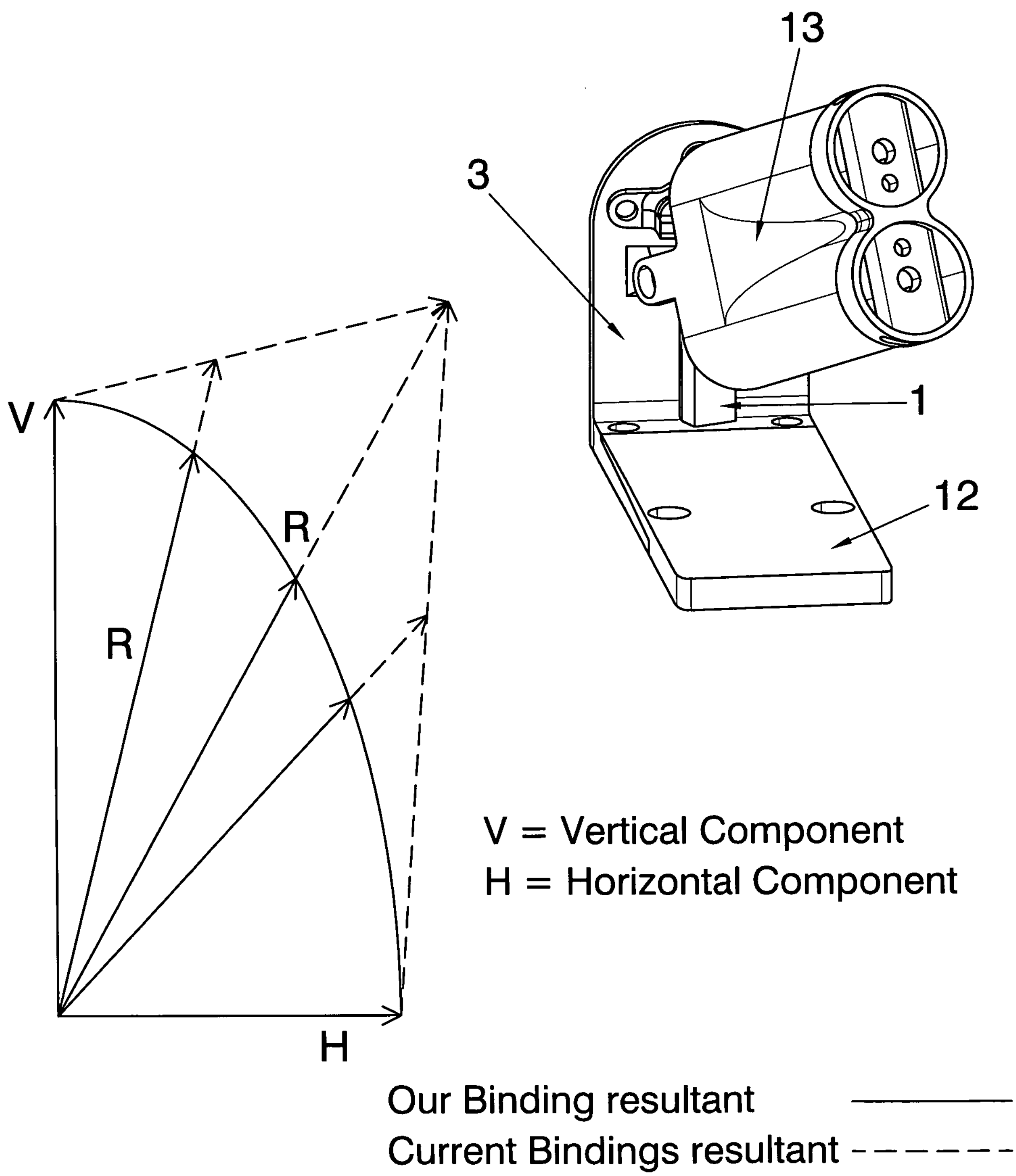
13
3
1
12
V
R
R
H
V = Vertical Component
H = Horizontal Component
Our Binding resultant
Current Bindings resultant

FIG. 2

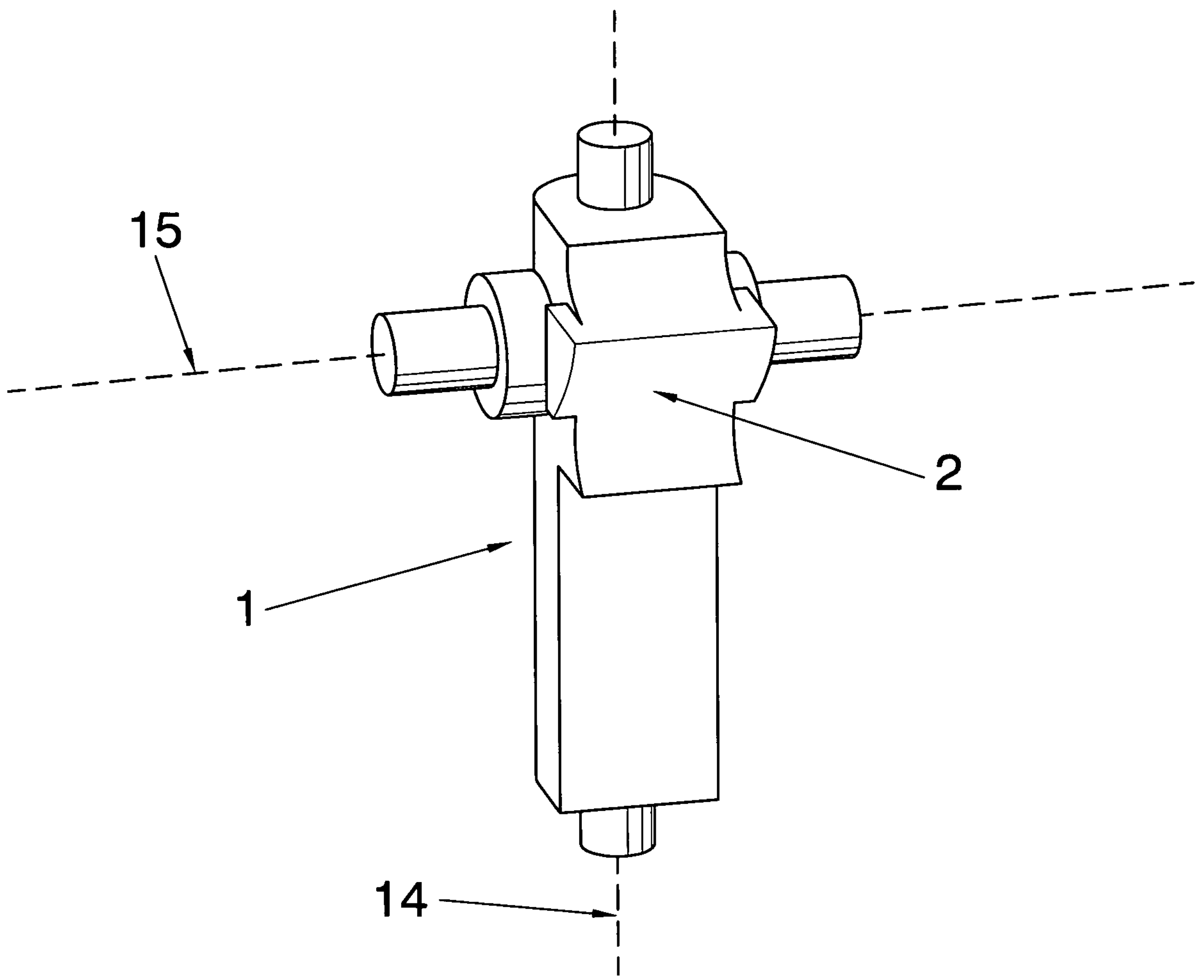

FIG. 3

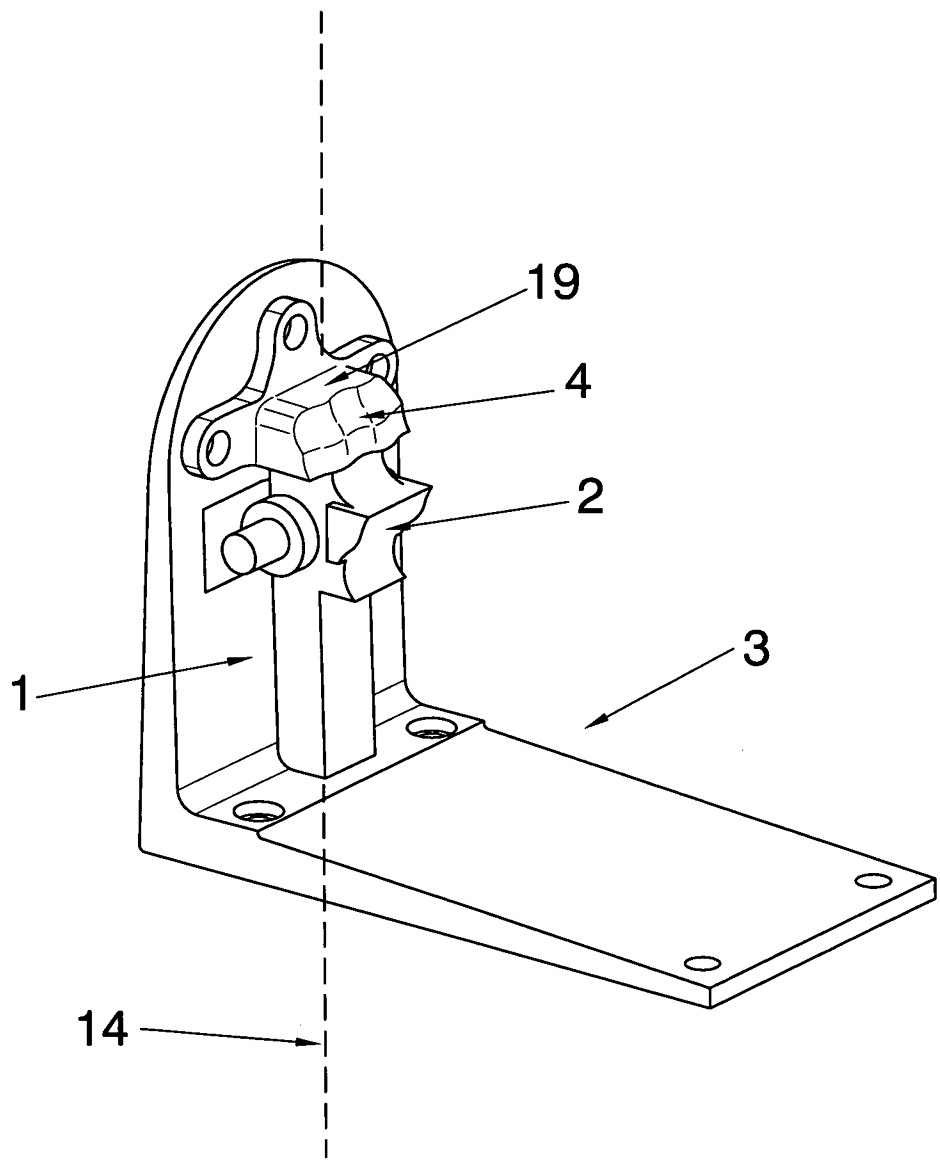

FIG. 4

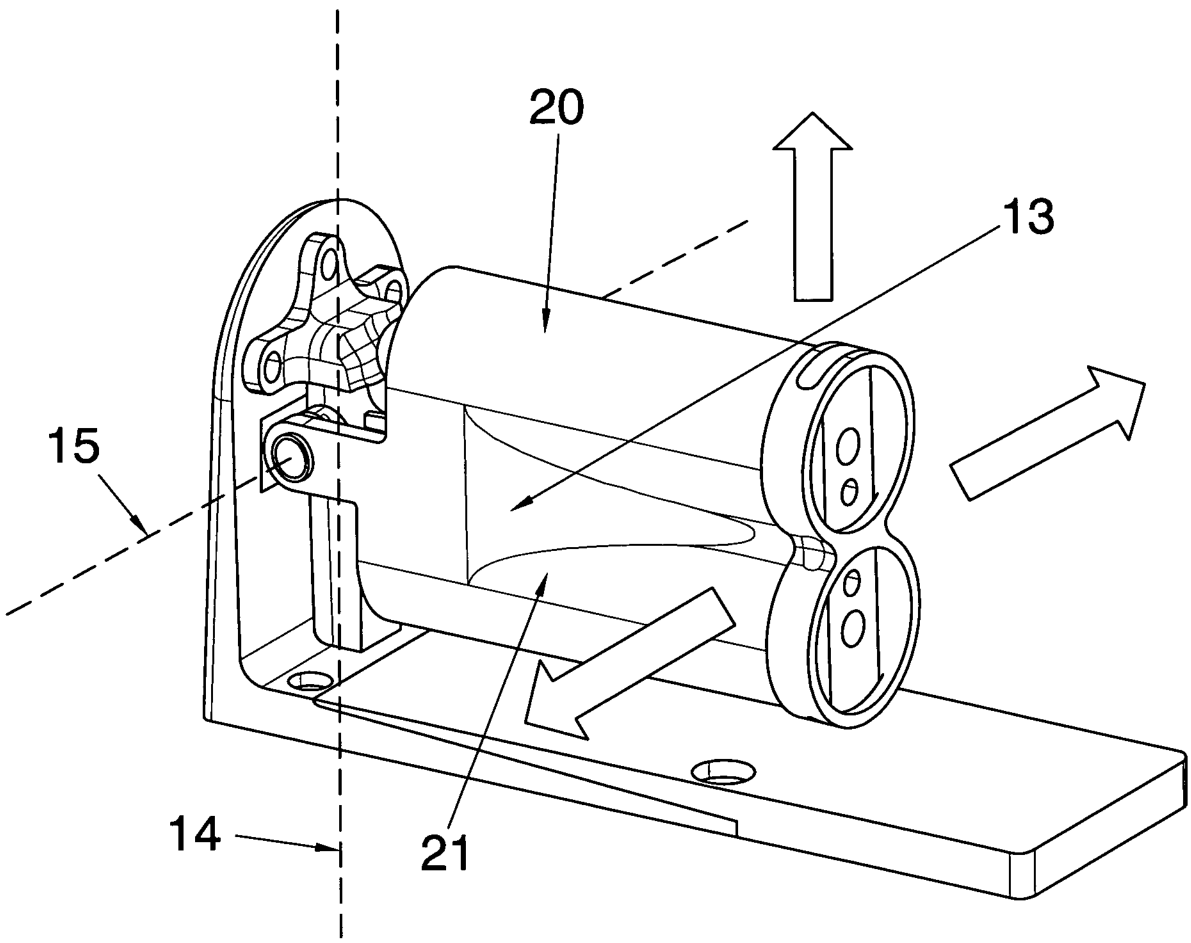

FIG. 5

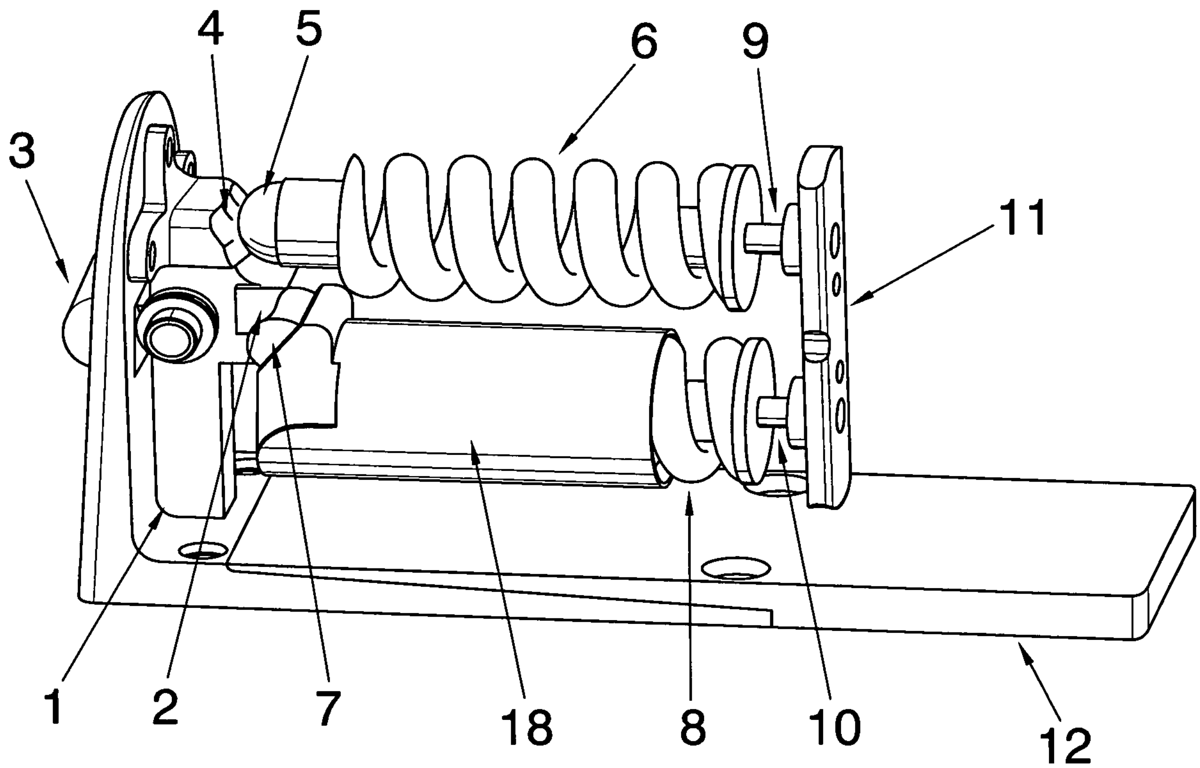

FIG. 6

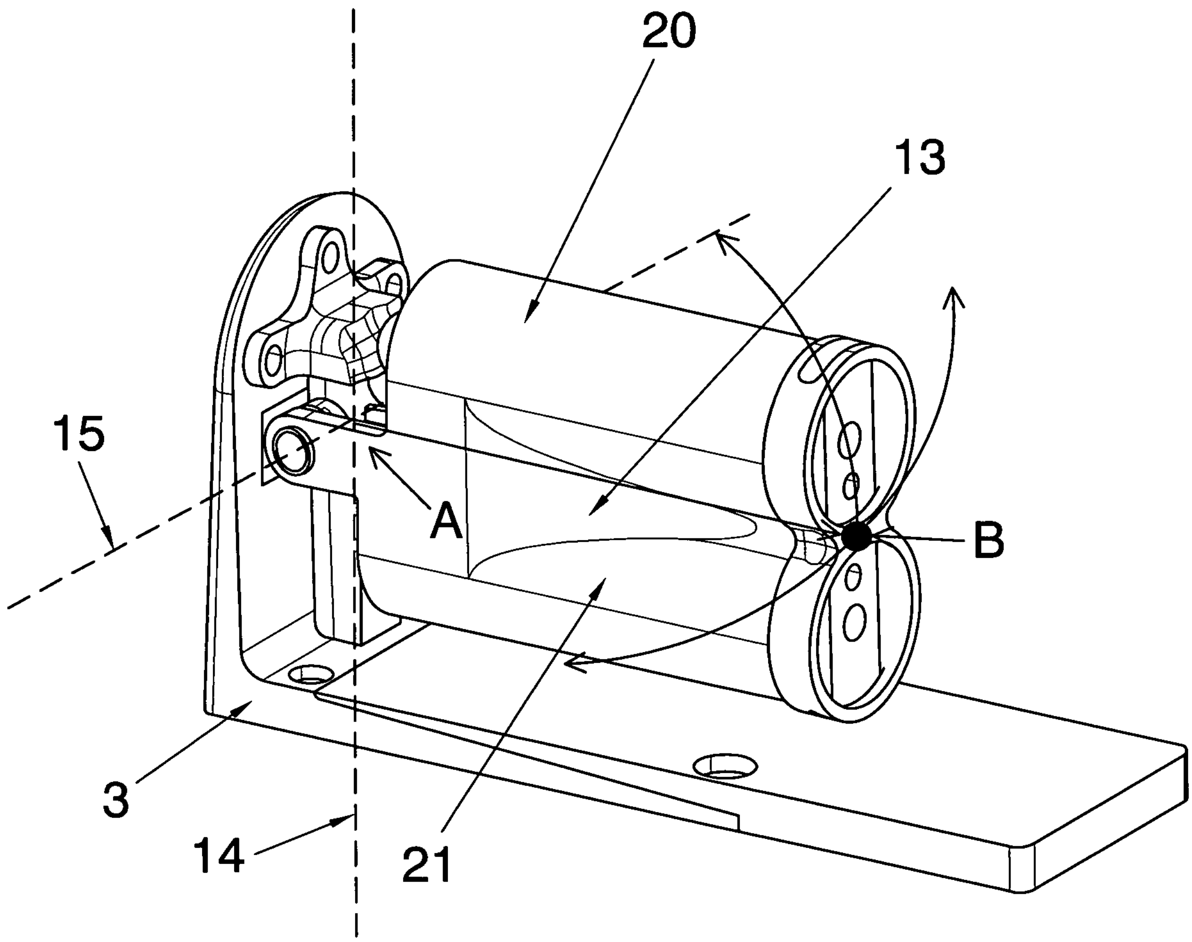

FIG. 7

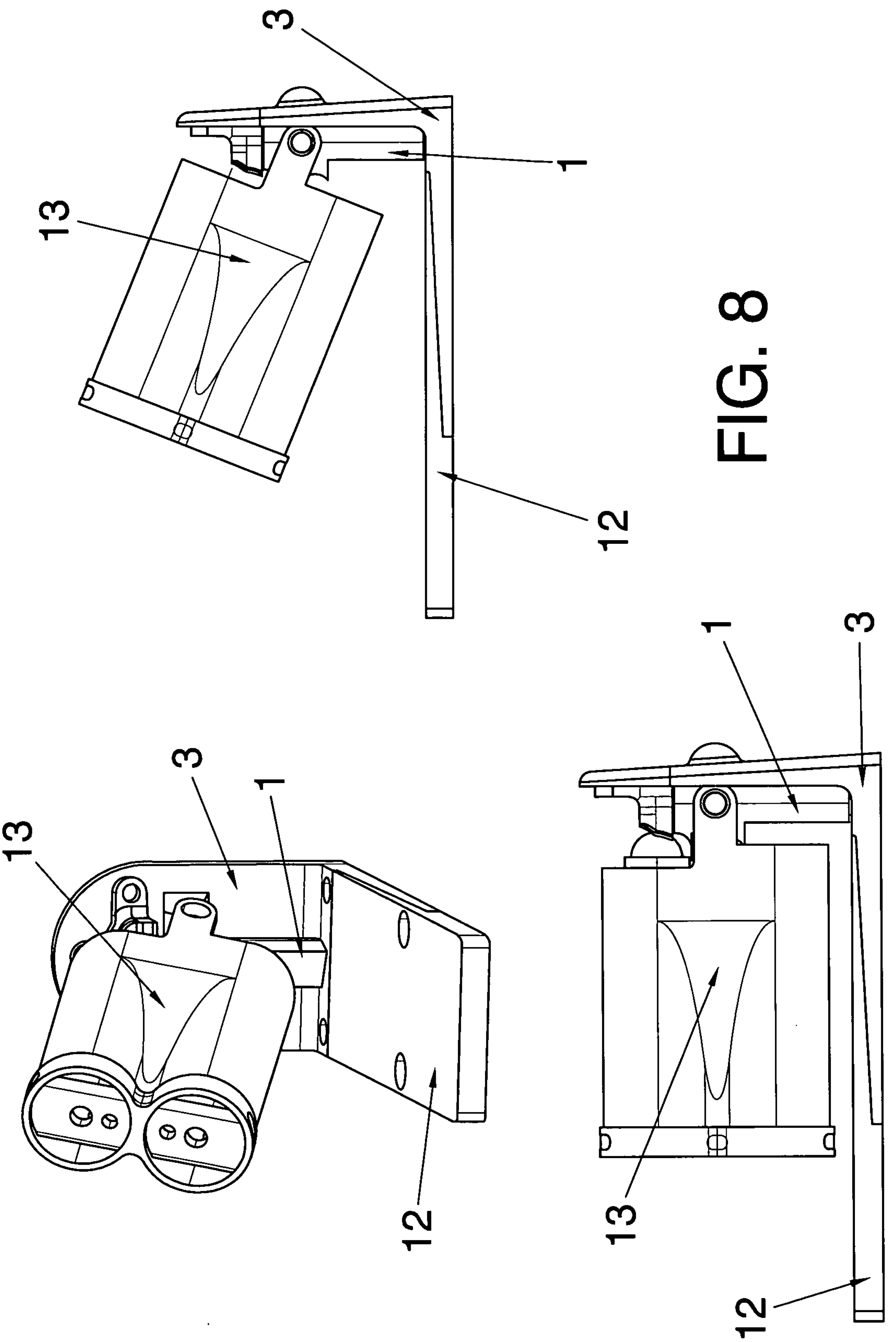

FIG. 8

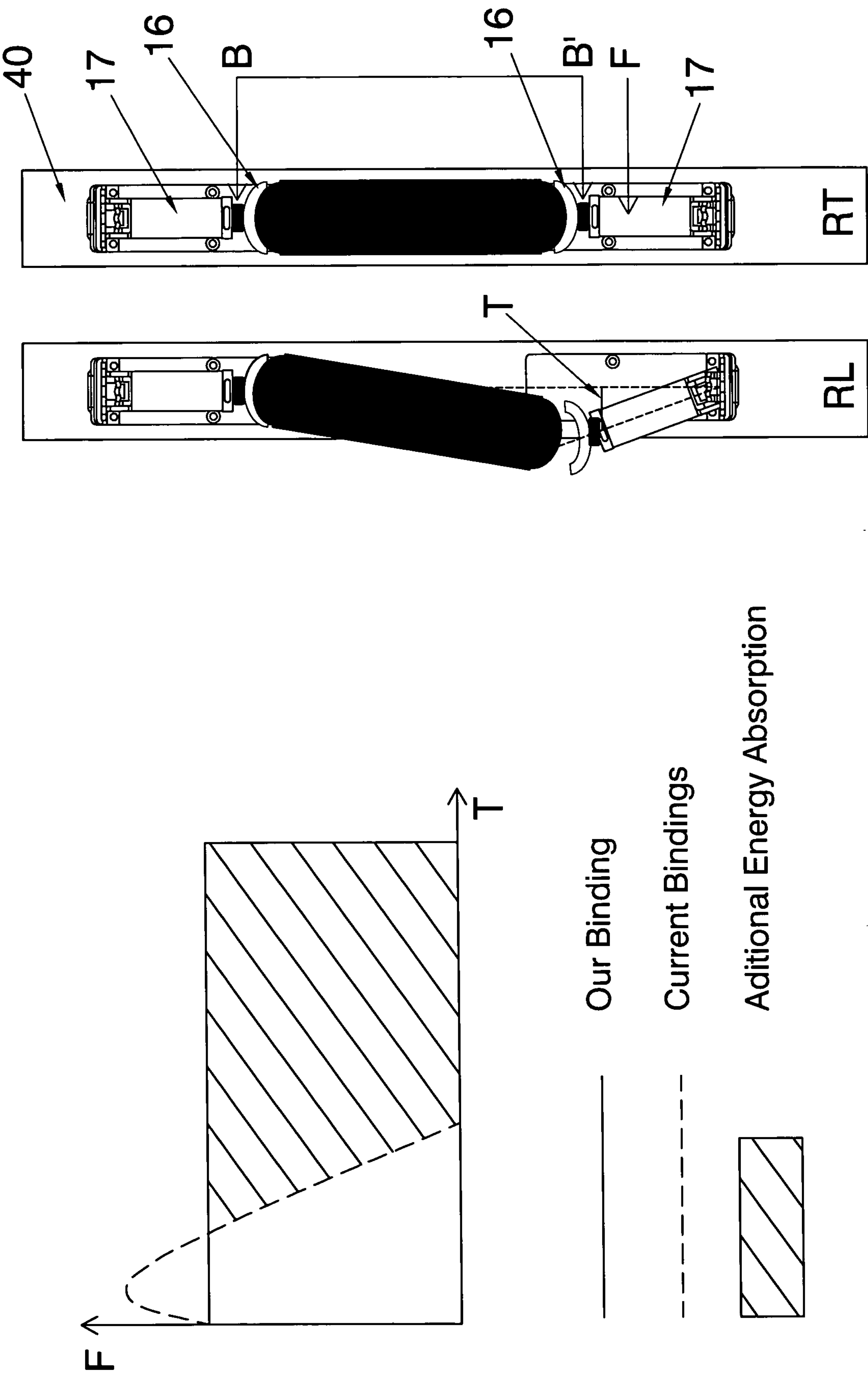
40
17
16
B
16
B'
F
17
RT
T
RL
F
T
Our Binding
Current Bindings
Aditional Energy Absorption

FIG. 9

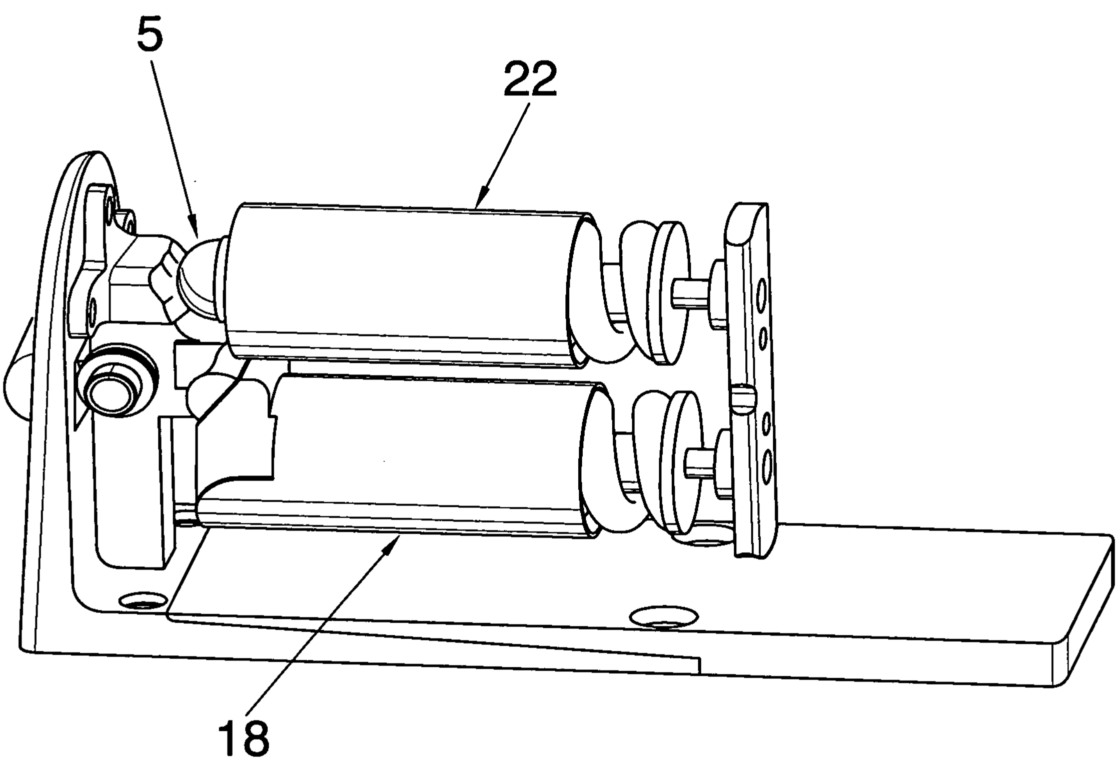

FIG. 10

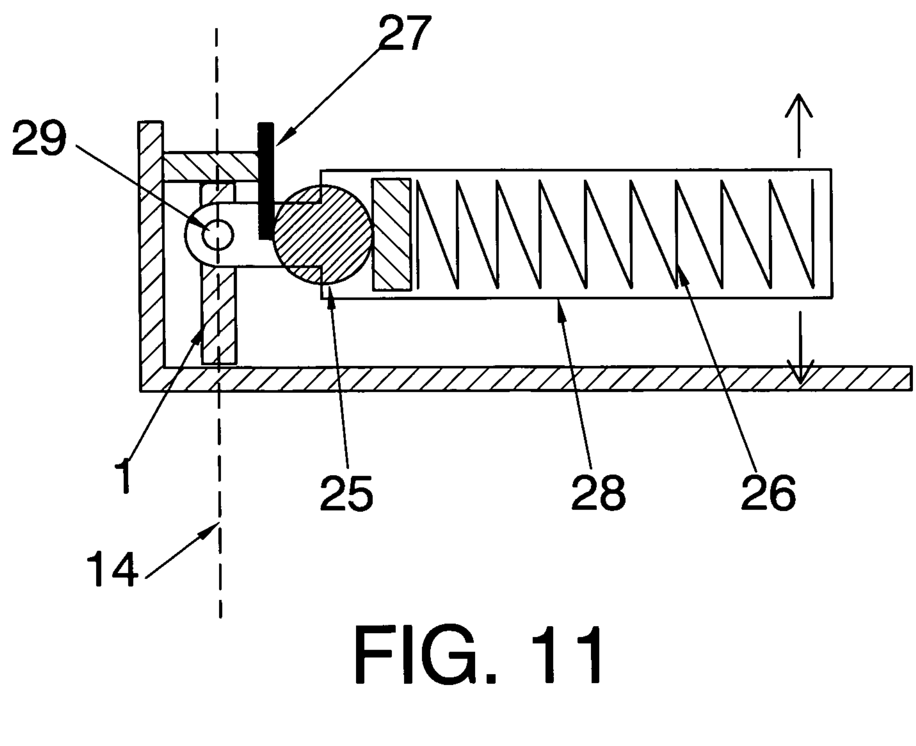

FIG. 11

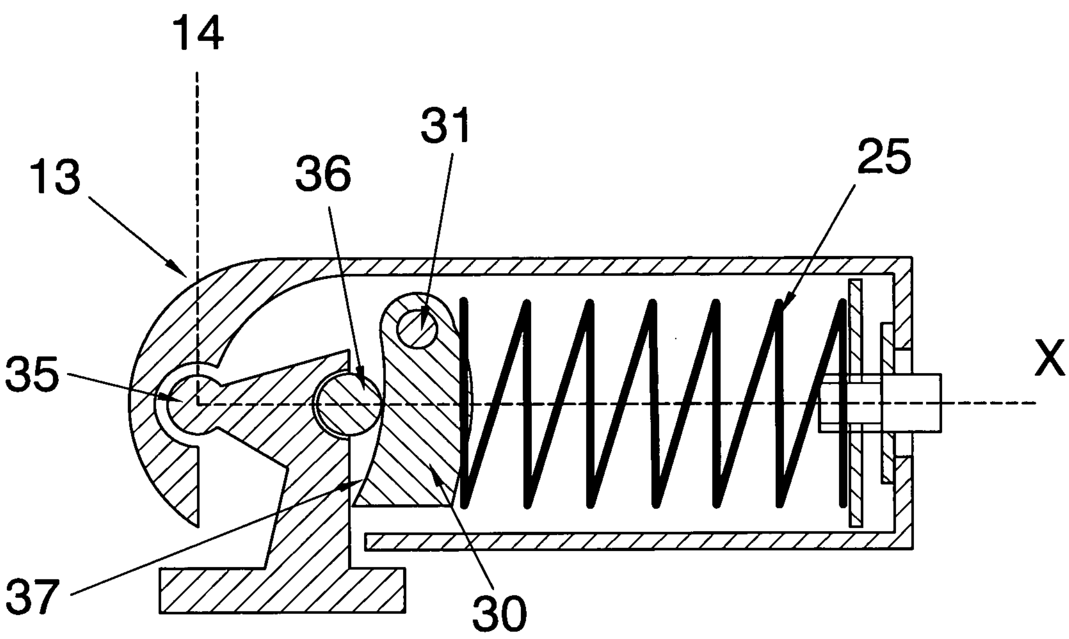

FIG. 12

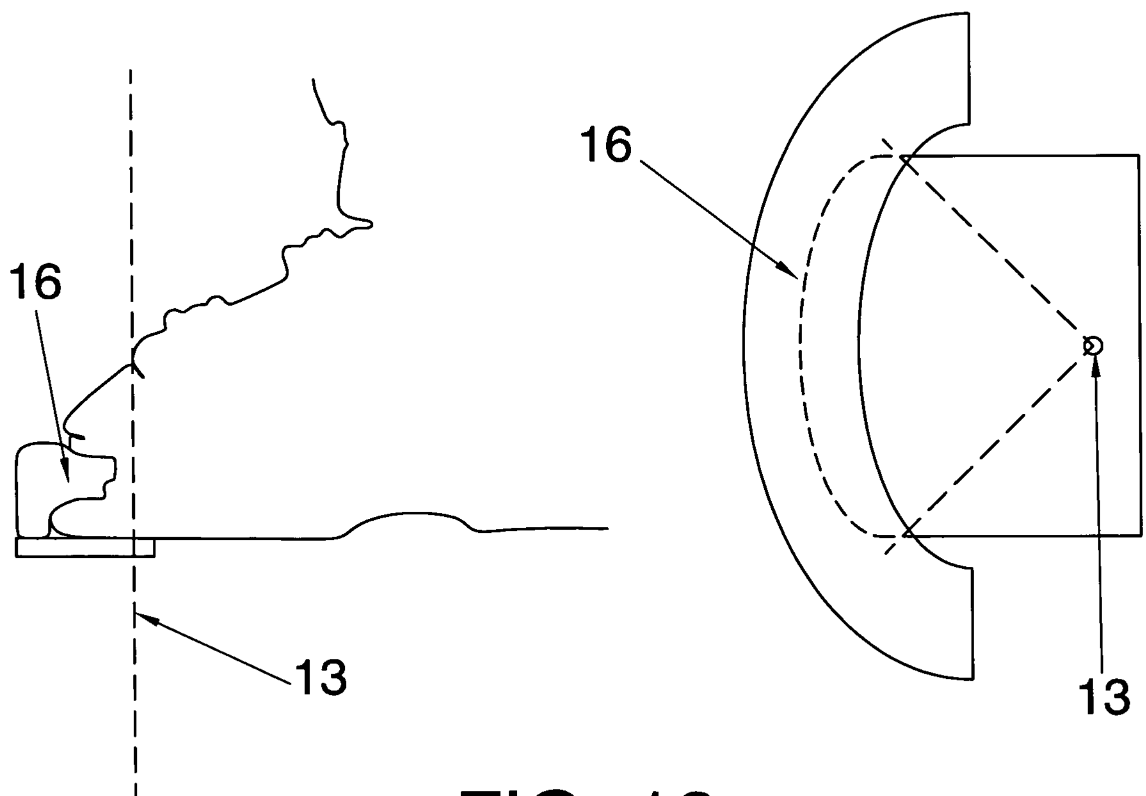

FIG. 13

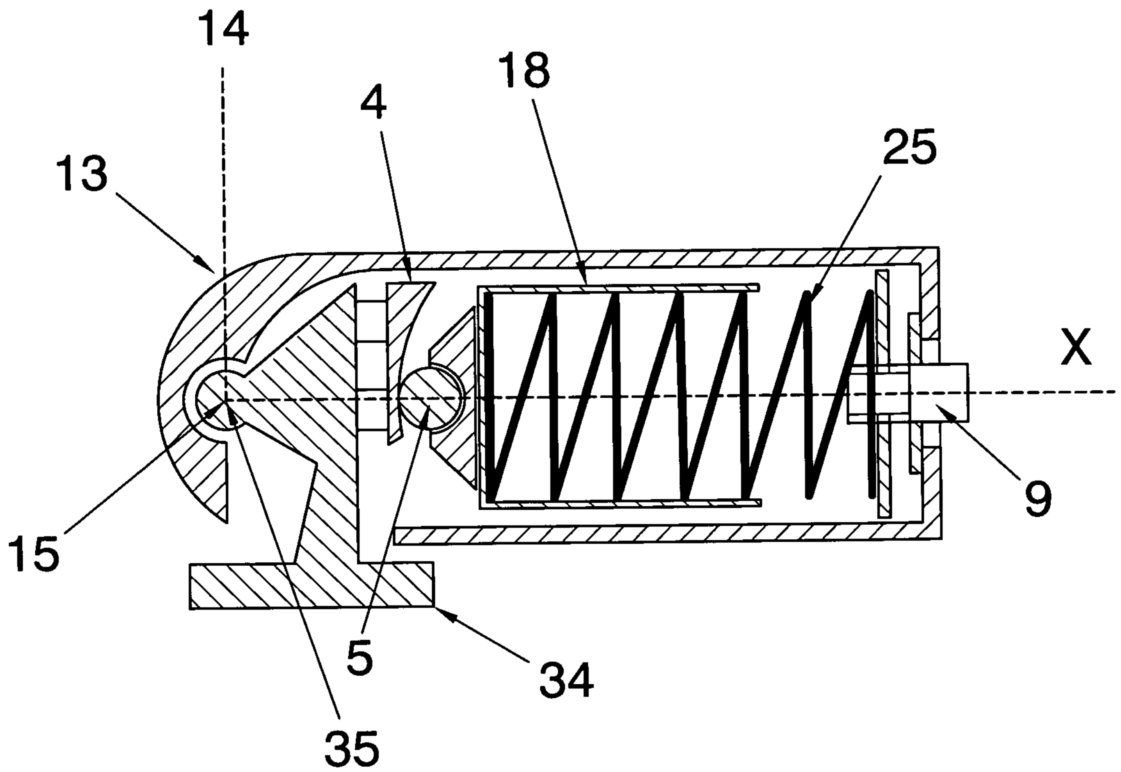

FIG. 14

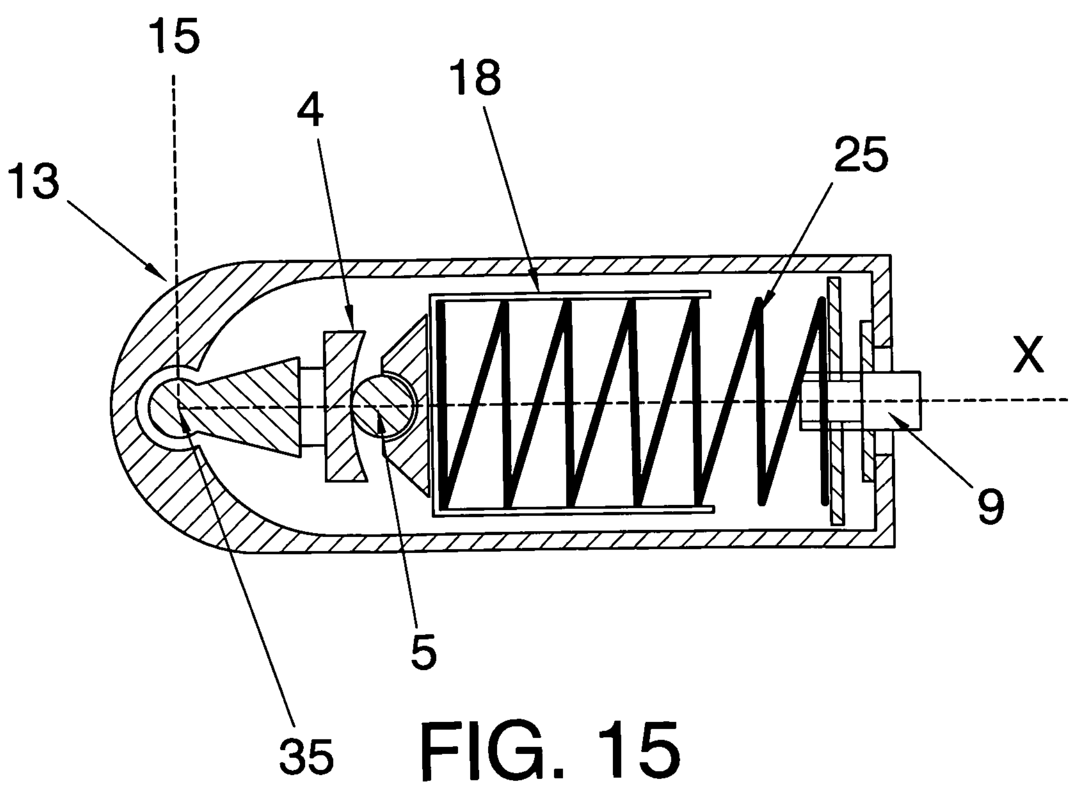

FIG. 15

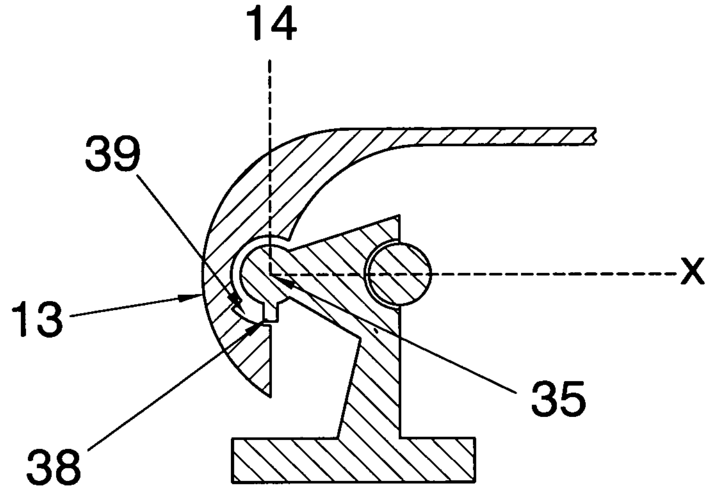

FIG. 16

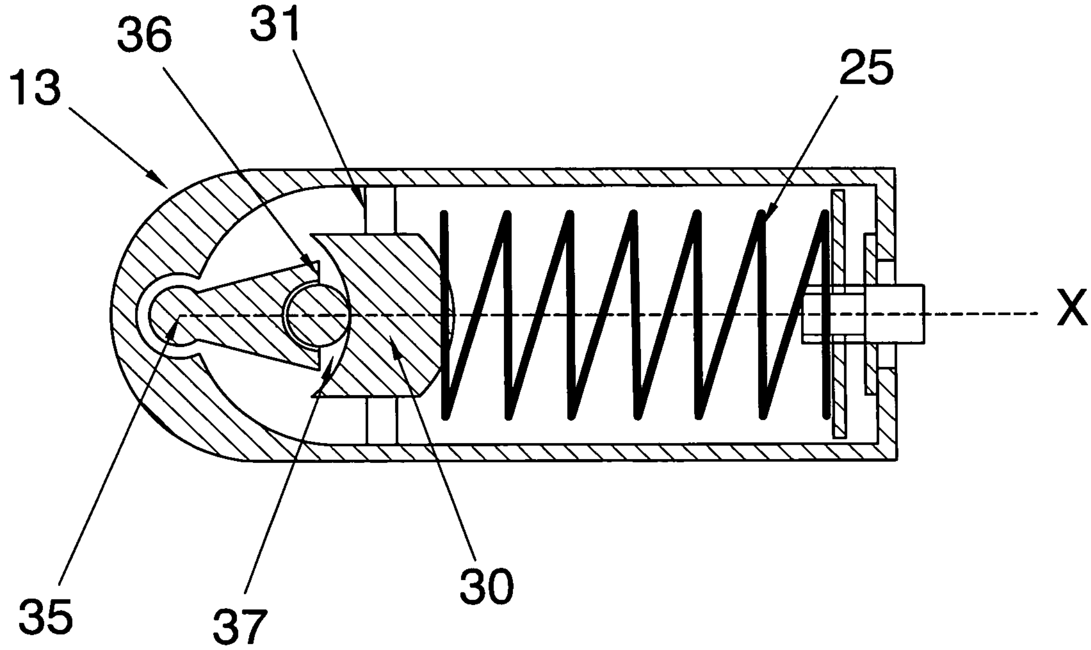

FIG. 17