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(54) Manually operable braking device for a line

(57) A manually operable braking device for a line (e.g. a rope) such as a descender has a body 2,3 defining a path A including a braking surface 5,6 for the line 12. A moveable control member 1 is pivotally connected to the body and includes a manually operable control handle protruding from the body and a braking element co-operating with the braking surface to apply a braking force on the line. The control handle is pivotable away from the body to reduce the braking force applied to the line and is pivotable towards the body to increase the braking force on the line. The body and moveable member are configured such that, on releasing the handle, a loading on a line passing through the path urges the handle towards the body to increase the braking force on the line.

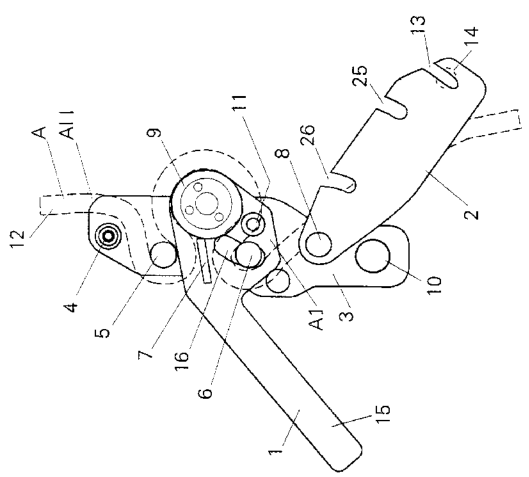

FIG. 1

EP 0 694 317 A2

Description

The invention relates to a manually operable braking device for a line, such as, for example, a descender (or descendeur) of the type used by mountaineers and the like.

In this document the term "line" is to be interpreted to include any sort of rope, cable, cord or other elongate flexible supporting means.

A descender is known which includes a body defining a path including a braking surface for a line, (e.g. a rope), a moveable control member pivotally connected to the body and including a manually operable control handle protruding from the body and a braking element co-operating with the braking surface to apply a braking force on the rope. In use a climber's harness can be attached to the body of descender by means of a karabiner so that a load is applied to a rope passing through the device. If the climber does not operate the handle, the descender applies a braking force to the rope which will normally hold the climber at a fixed position. In order to descend the rope, the climber grips the handle against the body of the device with a controlled force in order to reduce the degree of braking by a desired amount thus allowing the rope to slip though the device. To stop a descent, the climber has to release the handle to apply the brake.

However, the known device has a serious flaw which has lead to a number of accidents. In particular, if a climber, particularly an inexperienced climber, panics (for example if the climber loses his footing), the natural tendency is to grab the descender or the rope for support. Unfortunately, this can lead to the climber gripping the handle of the descender causing the brake to be fully released and the climber to descend rapidly down the rope.

An object of the present invention is, therefore, to provide a manually operable braking device for a line which overcomes this disadvantage of the prior art.

In accordance with the invention there is provided a manually operable braking device for a line, said device comprising:a body defining a path for said line including a braking surface at or near a first side of said body; a moveable control member including a manually operable control handle protruding from said first side of said body and a control plate extending beyond said braking surface towards a second side of said body; a braking element on said control plate, beyond said braking surface towards a second side of said body, for co-operating with said braking surface to apply a braking force to said line; a pivotal connection between a position on said control plate of said moveable control member and a position on said body such that said control handle is pivotable away from said body to reduce said braking force applied to said line and is pivotable towards said body to increase said braking force on said line.

With a device in accordance with the invention, where pivoting the control handle towards the body of the device causes the braking force to increase, unintentionally gripping the handle of the device towards the body of the device, for example in a panic situation, will cause the brake to be applied reducing the risk of injury.

A device in accordance with the invention finds applications not only as a descender for use in mountaineering, caving, tree felling, etc., where the device is connected to the climber, caver, tree feller, etc., but also as a device for allowing the controlled descent of a load where the device is secured at fixed location to a rock, tree, crane, etc., and a load is lowered at the end of a line passing though the device.

Preferably, in order that the device will also permit a descent to be braked if the user releases the control handle, for example as a result of losing grip of the device or the user fainting or being rendered unconscious, the body and the moveable control member are configured such that, on releasing the handle, a loading on a line passing through the path urges the handle towards the body and increases the braking force on the line.

Preferably, said pivotal connection between a position on said control plate of said moveable control member intermediate said control handle and said braking element and a position on said body beyond said braking member towards said second side of said body intermediate said control handle and said braking element. More particularly, the pivot point between the moveable control member and the body is at the centre of an "X" with uneven length arms to provide a scissor-like action in the manner of a pair of pliers to provide a compact construction, good control and a mechanical advantage on operating the handle.

One disadvantage of the known device is that two-handed operation is necessary in order to avoid fouling of the line, one hand being used to operate the lever and the other hand being used to guide the line to the entry point of the device to avoid fouling the line before entry (which is loaded only by the weight of the length of line left) with the line after exiting from the device (which is additionally loaded by the climber, etc.).

The device in accordance with the invention preferably defines a path with a serpentine form extending between an upstream entry to the path and a downstream exit from the path. It has been found that by arranging a serpentine path in this manner the entry and exit points can be located substantially in line with the direction of relative movement between the line and the device. In other words the exit point can be located above the entry point where the device is used as a descender. This reduces the risk of fouling the line compared to the known device (where the entry point is located above the exit point in use) with the result that one handed operation of a device in accordance with the invention can be practised safely.

Preferably, the braking element comprises an eccentric cam. This means that the braking force can be applied in a controlled and progressive manner.

Preferably also, the body, for defining the path, comprises a first guide pillar upstream of the eccentric cam and a second guide pillar downstream of the eccentric cam, the eccentric cam being offset with respect to the first and second guide pillars such that the path for the line passes around and adjacent to the first guide pillar and between the guide pillars, then around the eccentric cam and then between the guide pillars once more and around and adjacent to the second guide pillar such that a load applied to an end of a line passing along the path causes the eccentric cam to be drawn towards the first and/or the second guide pillar(s). This enables the path to be defined in a compact manner between the entry point and the exit point and to enable automatic braking to be effected if the control handle is released.

Preferably, pivoting the control handle towards the body causes the eccentric cam to be drawn towards the first and/or the second guide pillar(s), whereby the same mechanism provides controlled, panic and automatic braking by the device.

Preferably the surfaces of the first and/or the second guide pillars form the braking surface. Using the guide pillars both for guiding and braking simplifies the design of the device.

Preferably the guide pillars are narrower in their centre to define a curved braking surface to spread the braking effect on a line passing though the path.

Preferably also, the eccentric cam is provided with a circumferential surface in which a groove of curved cross-sectional shape is formed for defining part of the path and for receiving and guiding a line passing along the path, the cross-section of the groove changing around the circumference of the eccentric cam. This also serves to spread the braking load on a line passing through the device. By providing curved surfaces on the eccentric cam and/or the guide pillars means that a braking force can be applied to the outer surface of the cams with a minimum of distortion of the line. This means that less wear of the surfaces and the line occurs, a higher degree of control of the braking force and a higher absolute braking force is possible because of the increased contact area.

Preferably the body comprises a back plate, a front plate substantially parallel to but spaced from the back plate, and a pivot pillar extending between and spacing the front and back plates, whereby the front plate is rotatable substantially within the plane of the plate about the pivot pillar. Pivotal opening of the front plate enables the line readily to be threaded along the path defined in the device by the guide pillars and the braking element.

Preferably, the pivot pillar is located towards an end of the device beyond an upstream end of the path. This means that a simple construction of a mounting point for a karabiner further beyond the pivot point can be provided. Preferably a hole for the connection of a karabiner, in turn connected to a climber's harness, is provided in a portion of the back plate extending beyond the pivot axis of the pivot pillar.

Preferably the moveable control member is pivotally mounted to the back plate and the pivot axis is substantially perpendicular to the plane of the back plate. By locating the pivot axis of the moveable control member nearer to the eccentric cam than to the portion of the control handle gripped by the user, a mechanical advantage can be won.

In accordance with another aspect of the invention there is provided a locking mechanism for locking the front plate of a device such as defined above in a closed position, the locking mechanism comprising a slot formed in the front plate with a counter-bore, a locking pillar mounted on the back plate and a sprung pin located within a bore in the locking pillar, the pin having an upper portion of reduced cross-section narrower than the slot and a lower portion wider than the slot configured to fit within the counter-bore, the locking pillar comprising a mushroom shaped head with a dished cap enabling the upper portion of the locking pin to be depressed for receiving the locking pillar within the slot, whereby, when the upper portion is released with the front plate in the closed position, the wider lower portion of the pin is received within the counter-bore locking the front plate. This construction provides for secure locking of the front and back plates after insertion of the line into the path.

A particular embodiment of the invention is described hereinafter, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a front view of an embodiment of a device in accordance with the invention in a first orientation for use as a descender, the device being shown in an open or loading state;

Figure 2 is a front view of the device of Figure 1 in the orientation of that Figure, the device being shown in a closed or working state;

Figure 3 is a side view of the device of Figure 2 in the orientation and state of that Figure;

Figure 4 is a front view of the device of Figure 1 in an orientation for controlled descent of a line (e.g. a rope) under load, the device being shown in a closed or working state with the brake applied;

Figure 5 is a front view of the device of Figure 4 in the orientation of that Figure, the device being shown without a front plate with the brake released;

Figure 6 is a side view of the device of Figure 5 in the orientation and state of that Figure;

Figures 7 and 8 are front views of the device of Figures 1 to 6 illustrating the operation of a locking mechanism for a front plate in an open or loading state and a closed or working state respectively; and

Figure 9 is an exploded view of part of the locking mechanism.

Figure 1 is a front view of an embodiment of a device in accordance with the invention. The device is shown in a first orientation for use as a descender and in an open or loading state.

The device comprises a control plate 1, a front plate 2 and a back plate 3. The front, back and control plates can be made of any suitable material. In a preferred embodiment they are made of HP30 aluminium. The front plate is pivotally connected to the back plate by means of a pivot pillar 8.

The control plate 1 is also pivotally mounted to the back plate 3 at a pivot point 11 and provides for the mounting of an eccentric cam 9 such that the eccentric cam 9 may be pivoted towards guide pillars 5 and 6. The guide pillars 5 and 6 are located near one side (the left side in Figure 1) of the back plate from which a handle 15 of the control plate 1 extends. The pivot point is located towards the other (the right side in Figure 1) of the back plate. The guide pillars 5 and 6 form part of a guide path for a line (e.g. a rope), but also act with the eccentric cam 9 as friction surfaces when a load is applied to the line 12. On pivoting the control plate 1 the gaps between the eccentric cam 9 and the guide pillars 5,6 can be varied. The friction applied to a line (e.g. a rope) 12 can thus be varied as a function of the pressure applied to the rope between the eccentric cam and the guide pillars, allowing variable braking. The guide pillars and the eccentric cam can be made of any suitable material. In a preferred embodiment they are made of surface hardened steel.

The front plate 2 retains the rope when the device is in use. Slots 25, 26 in the top plate allow it to pass under the heads of the guide pillars 5 and 6 and the locking pillar 4 to prevent the top plate from bending away from the back plate 3 under load.

The pivot pillar 8 allows the top plate to be retained when the top plate is in an open or loading/unloading position.

The slot 13 (furthest from the pivot point) is provided with a counter-bore 14 to allow a sprung button in the locking pillar 4 to lock the front plate 2 in the working position.

The back plate 3 provides a platform to which the following elements shown in Figure 1 are mounted: the locking pillar 4 which performs a combined function of a guide pillar and a safety catch as well as providing a friction surface; the guide pillars 5 and 6, which also provide friction or braking surfaces; a pivot pillar 8 for the front plate 2, which pivot pillar also acts as a guide pillar and provides a friction surface; and the pivot 11 for the control plate 1.

A serpentine path A for a rope 12 is defined through the device between the front 2 and back 3 plates from an entry AI to an exit AII by means of the pivot pillar 8, the guide pillar 6, an anti-fouling bar 7 mounted on the control plate 1, a grooved eccentric cam 9 mounted on the control plate 1, the guide pillar 5, and the locking pillar 4. With the device in the open or loading position illustrated in Figure 1 it is an easy matter to load the rope 12 along the serpentine path A. The distance between the centre of the eccentric cam 9 and the pivot point 11 for the control plate 1 can be varied to accommodate ropes of different diameters and frictional characteristics.

The anti-fouling bar 7 serves to prevent the rope 12 at the upstream side of the eccentric cam 9 by the guide pillar 6 from, in use, fouling with the rope at the downstream side of the eccentric cam 9 by the guide pillar 5. When descending a rope the relative movement of the rope and the device means that the guide pillar 6 is upstream of the eccentric cam 9 and the guide pillar 5 is downstream of the eccentric cam 9.

After the rope has been laid along the path A, the control plate 2 is swung in an anti-clockwise direction as viewed in Figure 1 and 2 until the slot 13 in the upper portion of the plate 2 latches in the locking pillar 4. A control button in the locking pillar 4 cooperates with a counter-bore or recessed portion 14 in the front plate to lock the front plate 2 such that removal of the rope is not possible without positive operator involvement.

An attachment hole 10 for a karabiner or for attaching a load is provided at the lower end of the back plate 3 as viewed in Figure 1, that is at the side of the pivot pillar 8 opposite to a pivot point 11 for the control plate 1. Typically a karabiner will be attached after the front plate 2 has been swung into the closed position shown in Figure 2, although it could of course be attached before closing the front plate 2.

The side view of Figure 3 shows that the locking pillar 4, the guide pillars 5 and 6 and the pivot pillar 8 extend between and through the front and back plates 2 and 3. For this purpose the front plate 2 is provided with slots 25 and 26 to be received within grooves (not shown) in the guide pillars 5 and 6, respectively.

As can be seen in Figure 3, the guide pillars 5 and 6 have a concave shape. This shape of the guide pillars assists in guiding a rope passing though the path A. The guide pillars 5 and 6 also provide braking or friction surfaces for cooperation with the eccentric cam 9 to apply a braking force to a rope 12 passing along the path A.

The cam 9 is provided with a circumferential surface having a concave groove of curved cross-sectional shape (see Figure 3). This assists in guiding the rope 12 along the path A. The cam is eccentrically mounted and the concave cross-section of the groove changes around the circumferential surface to enable a controllable braking force to be applied in a manner which increases in direct proportion to an increase in the load applied.

The braking effect is achieved by pivoting the control plate 1 about the pivot 6 such that the handle 15 moves towards the body of the device, formed by the front and back plates 2 and 3, in an anti-clockwise direction as viewed in Figure 2 and represented by the arrow B. As seen in Figure 1, the eccentric cam 9 is offset with respect to the guide pillars 6 and 5. The path A passes around and adjacent to the guide pillar 6 and between the guide pillars (specifically between the guide pillar 6 and the anti-fouling bar 7), then around the outside of the eccentric cam 9 and then between the guide pillars (specifically between the guide pillar 5 and the anti-fouling bar 7) and around and adjacent to the guide pillar 5. This arrangement means that when a load is applied to an end of a rope passing along the path A and the control handle is released, a moment of force F acts on the eccentric cam 9 causing the control plate 1 automatically to rotate in the direction of the arrow B applying a braking force between the eccentric cam 9 and guide pillars 6 and 5.

Moreover, the braking force will be effected in the same way if an operator grips the control handle 15 and body 2,3 of the device in a panic squeezing the handle in the direction of the arrow B.

Controlled braking is achieved by applying a controlled force to the control handle 15. In order to counteract the automatic braking effect of the device to provide controlled braking, the operator has, in fact, to rotate the control handle in a clockwise direction as represented in Figure 2 by the direction opposite to the arrow B, thus effectively applying a controlled release of braking.

The brake can be completely released by rotating the control handle 15 as far as it will go in the clockwise direction, the range of movement of the control handle being limited by a slot 16 in the control plate 1 which engages with the guide pillar 6.

The concave surfaces of the guide pillars 5 and 6 and the groove in the eccentric cam 9 serve to spread the braking load on a rope passing through the device over the outer surface of the rope 12 with a minimum of distortion of the rope. This results in reduced wear of the surfaces and of the rope 12, a high degree of control of the braking force and a high absolute braking force being possible.

The serpentine path A means that the entry AI and exit AII points can be located substantially in rope with the direction of relative movement of the rope 12 with respect to the device represented by the upward arrow D. In the orientation where the device is to be used as a descender, the exit point AII is located above the entry point AI.

As the rope enters from below the device and exits above the device as the climber descends the rope, having the exit point AII above the entry point AI means that fouling of the rope is unlikely and that one-handed operation of the device (for controlling the braking force with the control handle 15) can be practised safely leaving a hand free for other purposes.

The pivot axis 11 of the control plate 1 is substantially perpendicular to the plane of the back plate 3 and is located nearer to the eccentric cam 9 than to the portion of the control handle 15 gripped by the user. This enables a mechanical advantage to be won.

Figure 4 shows the device of Figures 1 to 3 in a second orientation in which it is used for lowering a load at the end of a line (e.g. a rope 12). Thus, in Figure 4 which shows the device in the closed and working position corresponding to Figure 2, the device is attached to a support (not shown) by means of a suitable load-bearing link 17. The load 18 is attached to the lower end of the rope 12 passing along the path A. The construction of the device and the path A of the rope through the device are the same as in Figures 1 to 3. The only difference is the inverted orientation of the device. In Figure 4 it is assumed that no-one is touching the control handle 15. Accordingly, the eccentric cam 9 is pulled automatically towards the guide pillars 6 and 5 to apply a braking force to the rope between the eccentric cam 9 and the guide pillars 6 and 5 thus locking the rope and causing the control handle 15 automatically to adopt the position adjacent to the body 2, 3 of the device.

Figure 5 illustrates the same arrangement of Figure 4, although for illustrative purposes the front plate 2 is omitted from the drawing. In practice the front plate 2 would be in place as in Figure 4. Figure 5 differs from Figure 4 in that the control handle 15 has been moved fully clockwise in the direction of the arrow C by the user (note the relative location of the slot 16 and the guide pillar 6). This means that the pressure and braking force on the rope between the eccentric cam 9 and the guide pillars 6 and 5 is reduced to a minimum permitting the load 18 attached to the rope 12 to draw the rope 12 through the device in the direction of the arrows E1, E2.

Figure 6 illustrates a side elevation of the device in the orientation of Figures 4 and 5 with the rope 12 omitted for clarity.

Figures 7, 8 and 9 illustrate in more detail aspects of the locking mechanism for locking the front plate 2.

Figure 7 illustrates selected features of the device in a closed or working position. The front plate 2 is shown overlying the back plate 3 with the locking pillar 4 engaged within the slot 13 in the front plate 2. Also shown are the front of the pivot pillar 8, and the fronts of the guide pillars 5 and 6 within their respective slots 25 and 26 in the front plate 2.

Figure 7A shows a lateral view of the locking pillar 4 in the locked position with the sprung safety catch button 43 located in the counter bore 14, that is the portion of reduced thickness either side of the slot 13 on the back of the front plate 2.

Figure 8 corresponds generally to Figure 7, but shows the device in a partially open position. Figure 8A corresponds generally to Figure 7A, but shows the sprung safety catch button 43 in a depressed, or released position. This allows the larger diameter portion 41 of the sprung button 43 to be removed from the counter bore 14 in the front plate 2 and allows the slot 13 in the front plate 2 to pass the reduced diameter portion 41 of the sprung button and to pivot around the pivot pillar 8 in the direction of the arrow F into the open position for loading/unloading of the rope 12.

Figure 9 is an exploded view of the locking pillar 4. The locking pillar 4 comprises a central pillar portion 44 with a mushroom head 45 with groove 46 either side of a central support rib 47 for receiving the slot 13 of the front plate 2. A lower portion of the central pillar portion is provided with a concave profile 48 forming a friction guide as part of the path A for the rope 12. The central pillar portion 44 is secured to the back plate 3 by means of a retaining bolt 49 with pocket for a spring 50 used for spring loading the button 43. A pin 51 locates and prevents the rotation of the central pillar portion 44. The mushroom head 45 has a dished surface which is configured such that the portion of the safety catch button of reduced diameter protrudes in the bottom of the dished portion only just enough to enable the portion of wider diameter of the safety button to be released from the counter-bore 14 in the front plate on the operator positively pressing the button.

Thus there has been described an embodiment of a device in accordance with the invention which enables a person to control a descent of a fixed single line in a controlled and safe manner. The described device allows the advantage of providing braking as a result of intended or involuntary squeezing of the control handle as well as automatically braking the descent of the operator when the control handle is released by design or incapacitation. The design of the device increases the braking action in direct proportion to an increase in the load applied.

In particular, there has been described a manually operable braking device for a line, said device comprising a body defining a path including a braking surface for said line, a moveable control member pivotally connected to said body and including a manually operable control handle protruding from said body and a braking element co-operating with said braking surface to apply a braking force to said line, said control handle being pivotable away from said body to reduce said braking force applied to said line and being pivotable towards said body to increase said braking force on said line.

More particularly, there has been described a manually operable braking device for a line, said device comprising: a body defining a path for said line including a braking surface at or near a first side of said body; a moveable control member including a manually operable control handle protruding from said first side of said body and a control plate extending beyond said braking surface towards a second side of said body; a braking element on said control plate for co-operating with said braking surface to apply a braking force to said line; a pivotal connection between a position on said control plate of said moveable control member intermediate said control handle and said braking element and a position on said body beyond said braking member towards said second side of said body such that said control handle is pivotable away from said body to reduce said braking force applied to said line and is pivotable towards said body to increase said braking force on said line.

It will be appreciated that the invention is not limited to the particular details of the embodiment described and that modifications and/or additions are possible within the scope of the invention.

For example, although in the embodiment described both of the guide pillars 5 and 6 form braking surfaces for cooperating with the cam 9, in another embodiment the braking force could be provided between one guide pillar and the moveable cam.

Also, although in the described embodiment the pivot point 8 for the front plate 2 is located at the same end of the device as the hole 10 provided for the attachment of a load, in another embodiment these could be provided at opposite ends.

Although in the specific description reference is made to the use of the device with a rope, it will be appreciated that it may be used with other forms of line, such as a cable, cord, etc.

Claims

1. A manually operable braking device for a line, said device comprising:

   a body defining a path for said line including a braking surface at or near a first side of said body;

   a moveable control member including a manually operable control handle protruding from said first side of said body and a control plate extending beyond said braking surface towards a second side of said body;

   a braking element on said control plate, beyond said braking surface towards a second side of said body, for co-operating with said braking surface to apply a braking force to said line;

   a pivotal connection between a position on said control plate of said moveable control member and a position on said body such that said control handle is pivotable away from said body to reduce said braking force applied to said line and is pivotable towards said body to increase said braking force on said line.

2. A device according to claim 1, wherein said pivotal connection between a position on said control plate of said moveable control member intermediate said control handle and said braking element and a position on said body beyond said braking member towards said second side of said body intermediate said control handle and said braking element.

3. A device according to claim 1 or claim 2, wherein said body and said moveable control member are configured such that, on releasing said handle, a loading on a line passing through said path urges said handle towards said body and increases said braking force on said line.

4. A device according to any preceding claim, wherein said path has a serpentine form extending between an upstream entry to said path and a downstream

exit from said path.

5. A device according to any preceding claim, wherein said braking element comprises an eccentric cam.

6. A device according to claim 5, wherein said body, for defining said path, comprises a first guide pillar upstream of said eccentric cam and a second guide pillar downstream of said eccentric cam, said eccentric cam being offset with respect to said first and second guide pillars towards said second side of said body such that said path for said line passes around and adjacent to said first guide pillar and between said guide pillars, then around said eccentric cam and then between said guide pillars once more and around and adjacent to said second guide pillar such that a load applied to an end of a line passing along said path causes said eccentric cam to be drawn towards said first and/or said second guide pillar(s).

7. A device according to claim 6, wherein pivoting said handle towards said closed position causes said eccentric cam to be drawn towards said first and/or said second guide pillar(s).

8. A device according to claim 6 or claim 7, wherein the surface(s) of said first and/or said second guide pillars form said braking surface.

9. A device according to any one of claims 6 to 8, wherein said guide pillars are narrower in their centre to define a curved braking surface to spread the braking effect on a line passing though said path.

10. A device according to any one of claims 5 to 9, wherein said eccentric cam is provided with a circumferential surface in which a groove of curved cross-sectional shape is formed for defining part of said path and for receiving and guiding a line passing along said path, said cross-section of said groove changing around said circumference of said eccentric cam.

11. A device according to any one of the preceding claims, wherein said body comprises a back plate, a front plate substantially parallel to but spaced from said back plate, and a pivot pillar extending between and spacing said front and back plates, whereby said front plate is rotatable substantially within the plane of said plate about said pivot pillar.

12. A device according to claim 11 wherein said pivot pillar is located towards an end of said device beyond an upstream end of said path.

13. A device according to claim 11 or claim 12, wherein said moveable control member is pivotally mounted on said back plate and said pivot axis is substantially perpendicular to said plane of said back plate.

14. A device according to any one of claims 11 to 13 comprising a locking mechanism for locking said front plate in a closed position, said locking mechanism comprising a slot formed in said front plate with a counter-bore, a locking pillar mounted on said back plate and a sprung pin located within a bore in said locking pillar, said pin having an upper portion of reduced cross-section narrower than said slot and a lower portion wider than said slot configured to fit within said counter-bore, said locking pillar comprising a mushroom shaped head with a dished cap enabling said upper portion of said locking pin to be depressed for receiving said locking pillar within said slot, whereby, when said upper portion is released with said front plate in said closed position, said wider lower portion of said pin is received within said counter-bore locking said front plate.

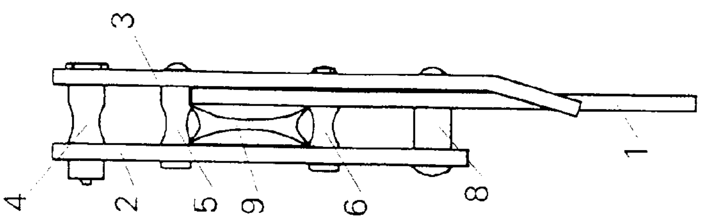

FIG. 3

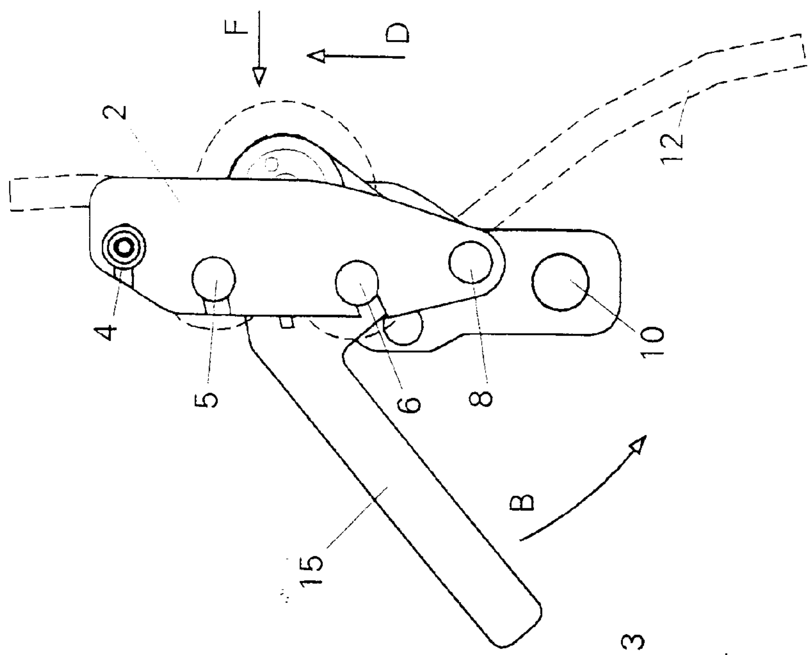

FIG. 2

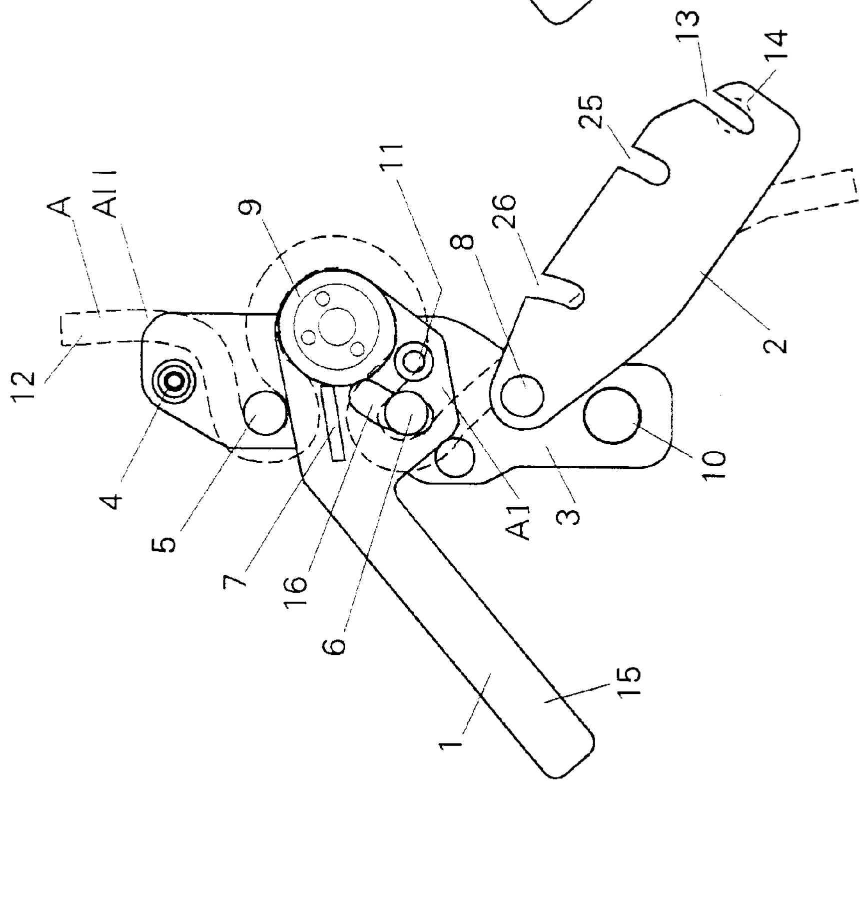

FIG. 1

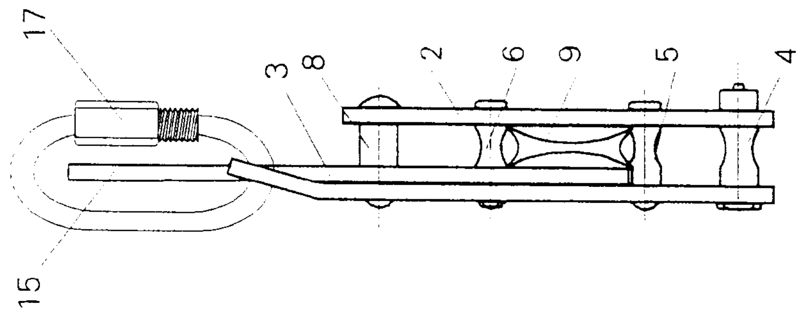

FIG. 6

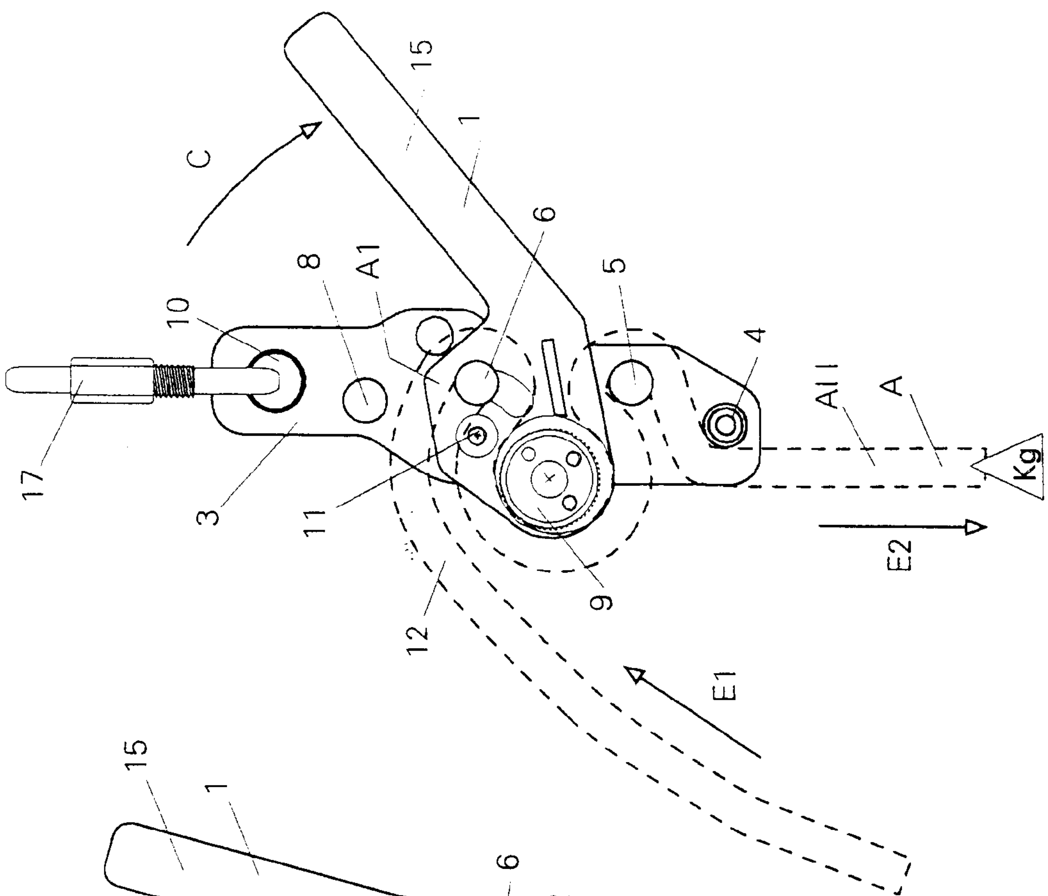

FIG. 5

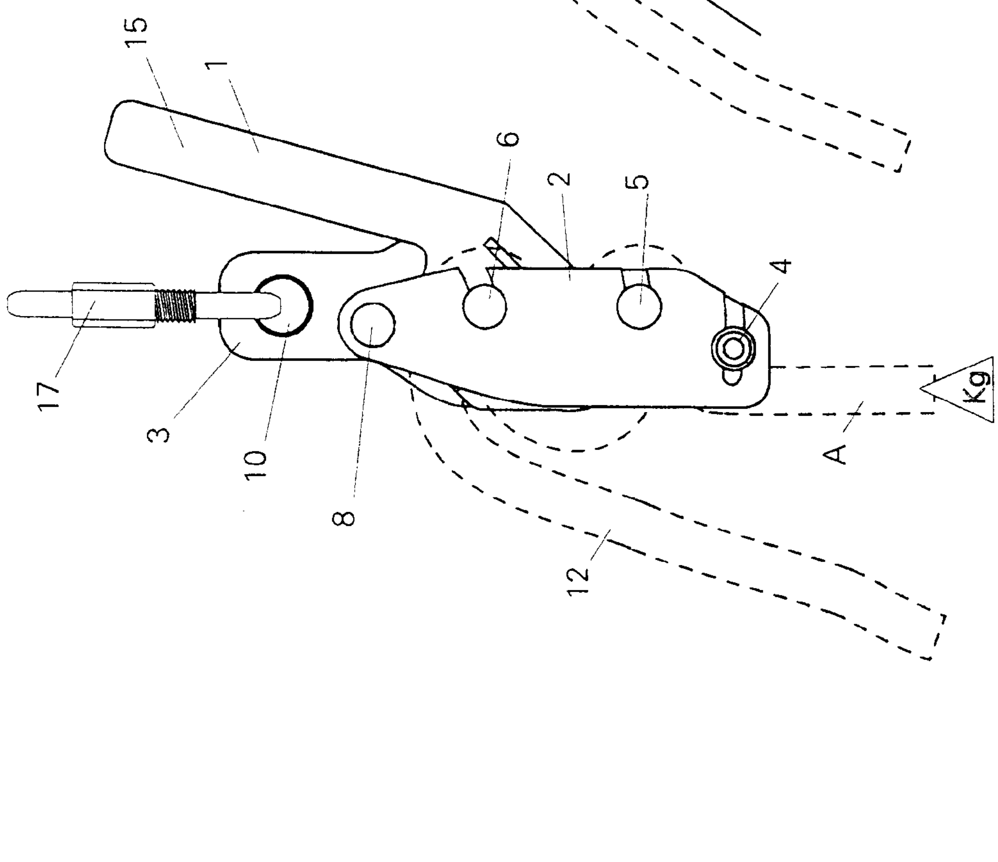

FIG. 4

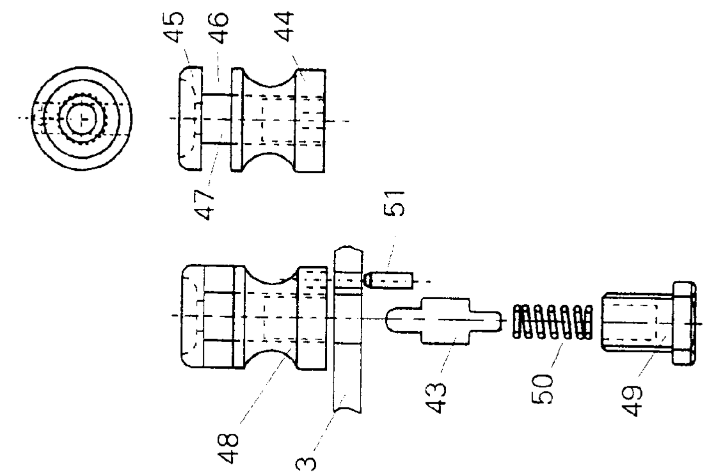

FIG. 9

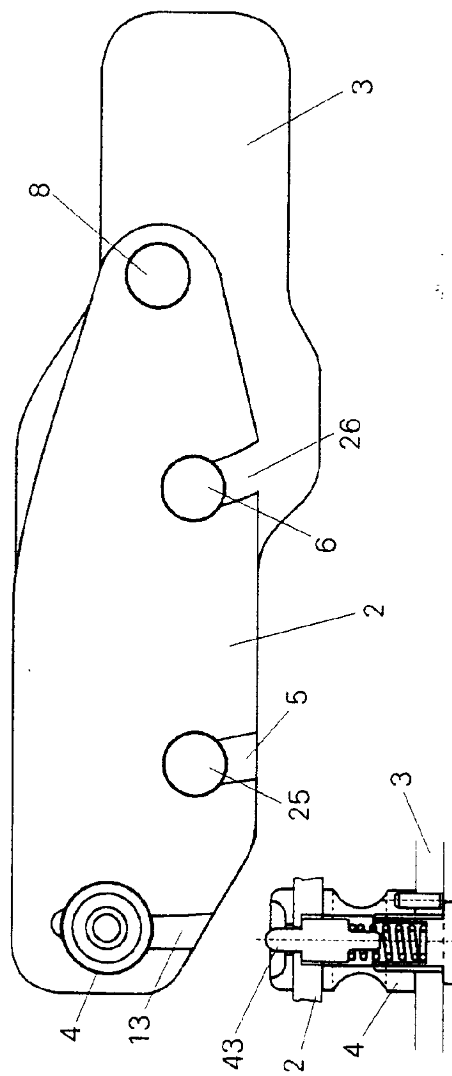

FIG. 7

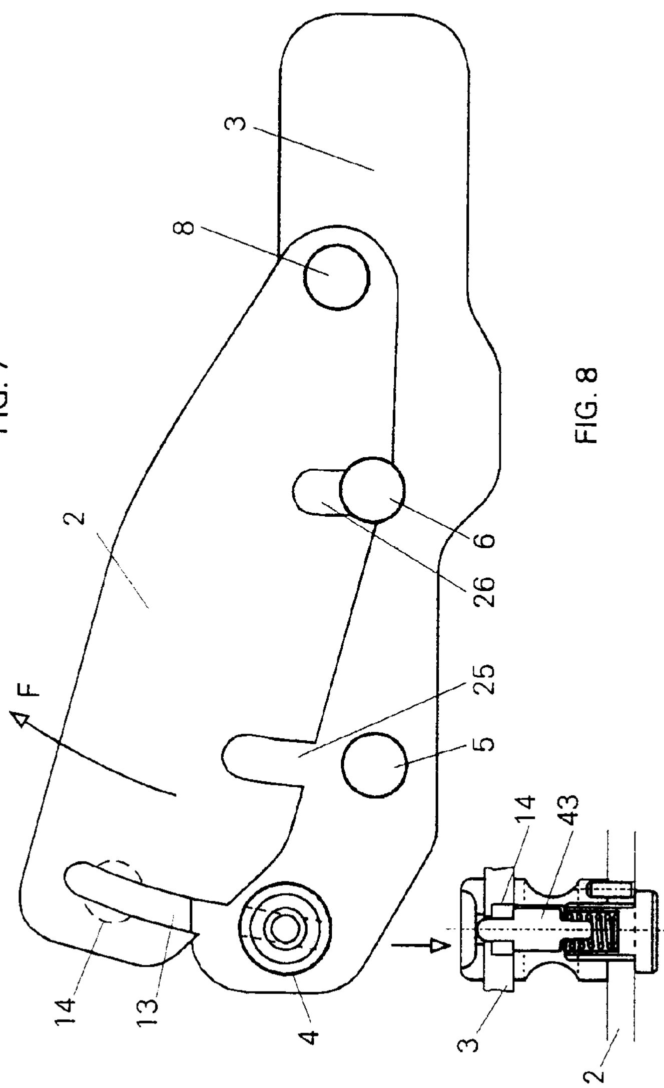

FIG. 8