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Petzl et al.

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[54] **DISENGAGEABLE DESCENDER WITH SELF-LOCKING OF THE ROPE**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.**[6] **A63B 29/00**

[52] **U.S. Cl.** ..... **188/65.4**; 182/193; 24/134 KB

[58] **Field of Search** ..... 188/65.1–65.5; 182/5–9, 193; 24/132 WL, 134 R, 134 KB, 115 F

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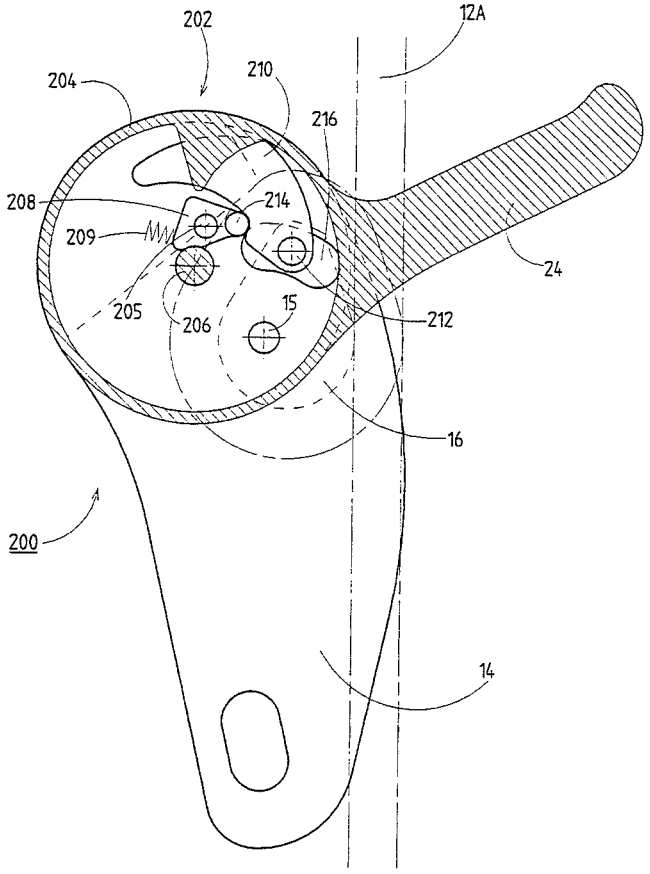
Attorney, Agent, or Firm—Watson Cole Stevens Davis, P.L.L.C.

[57] **ABSTRACT**

The invention relates to a self-locking descender wherein the pulley in the form of a cam is equipped with a drive finger cooperating with a mechanism having a transmission rod movable between an active engagement position with the finger to establish a unidirectional mechanical link between the handle and cam when the handle is actuated to an intermediate unlocking position in the course of the descending movement, and an inactive escape position to break said mechanical link after the intermediate position of the handle has been passed, causing disengagement of the pulley and automatic return of the cam to the locking position due to the action of the tension of the rope. The locking effect of the rope is thus preserved after disengagement, without maintaining a force on the handle.

12 Claims, 15 Drawing Sheets



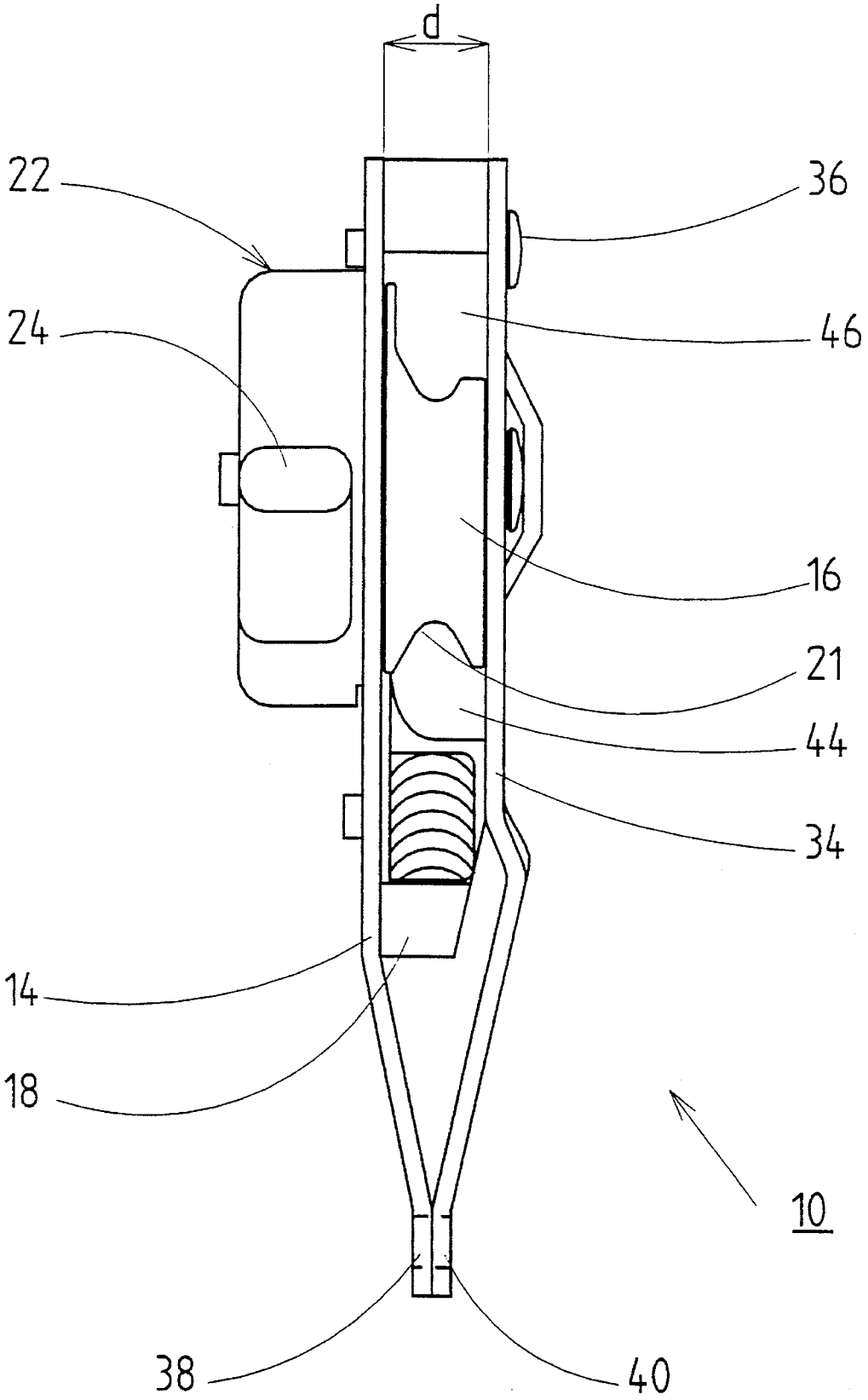


FIGURE 1

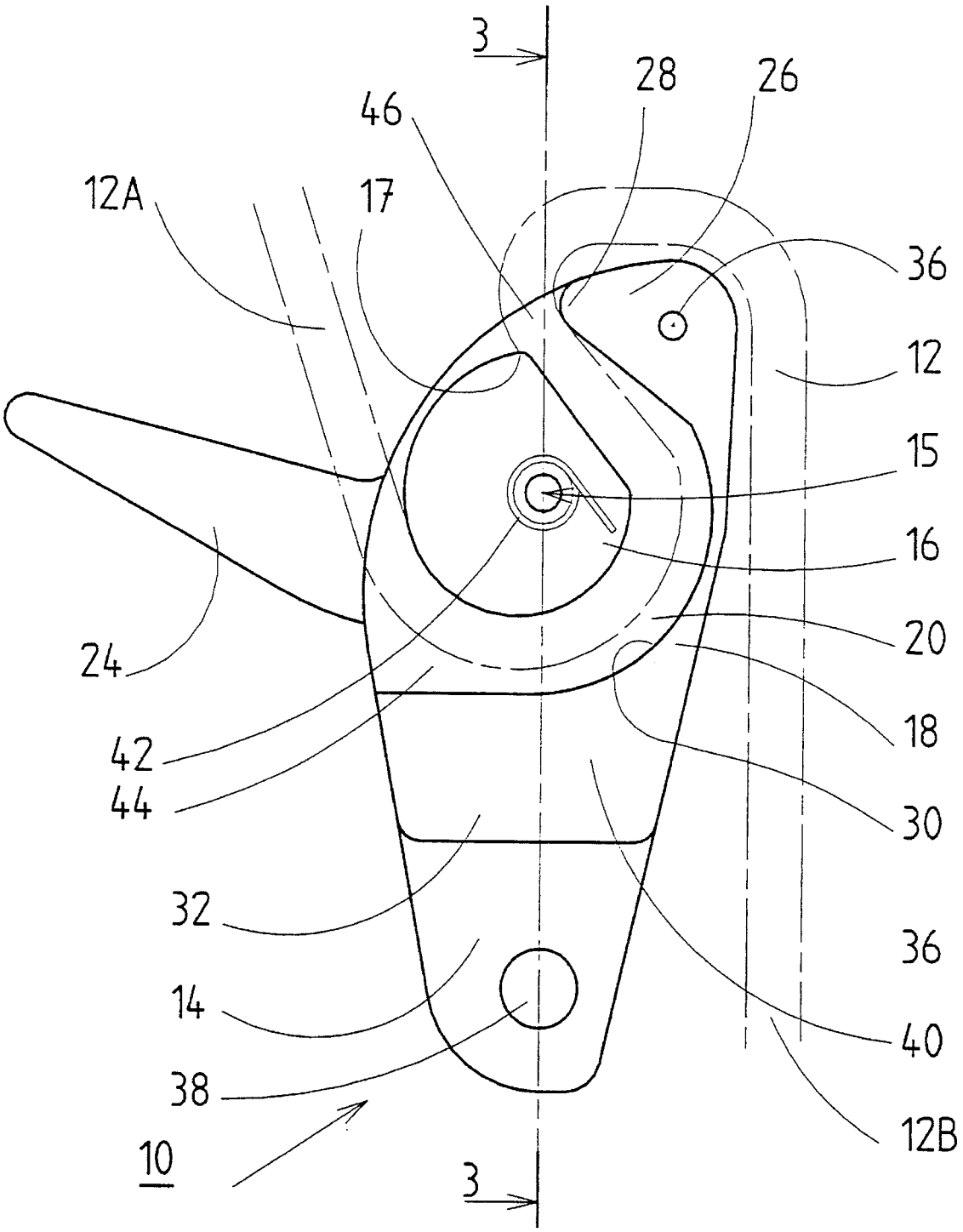


FIGURE 2

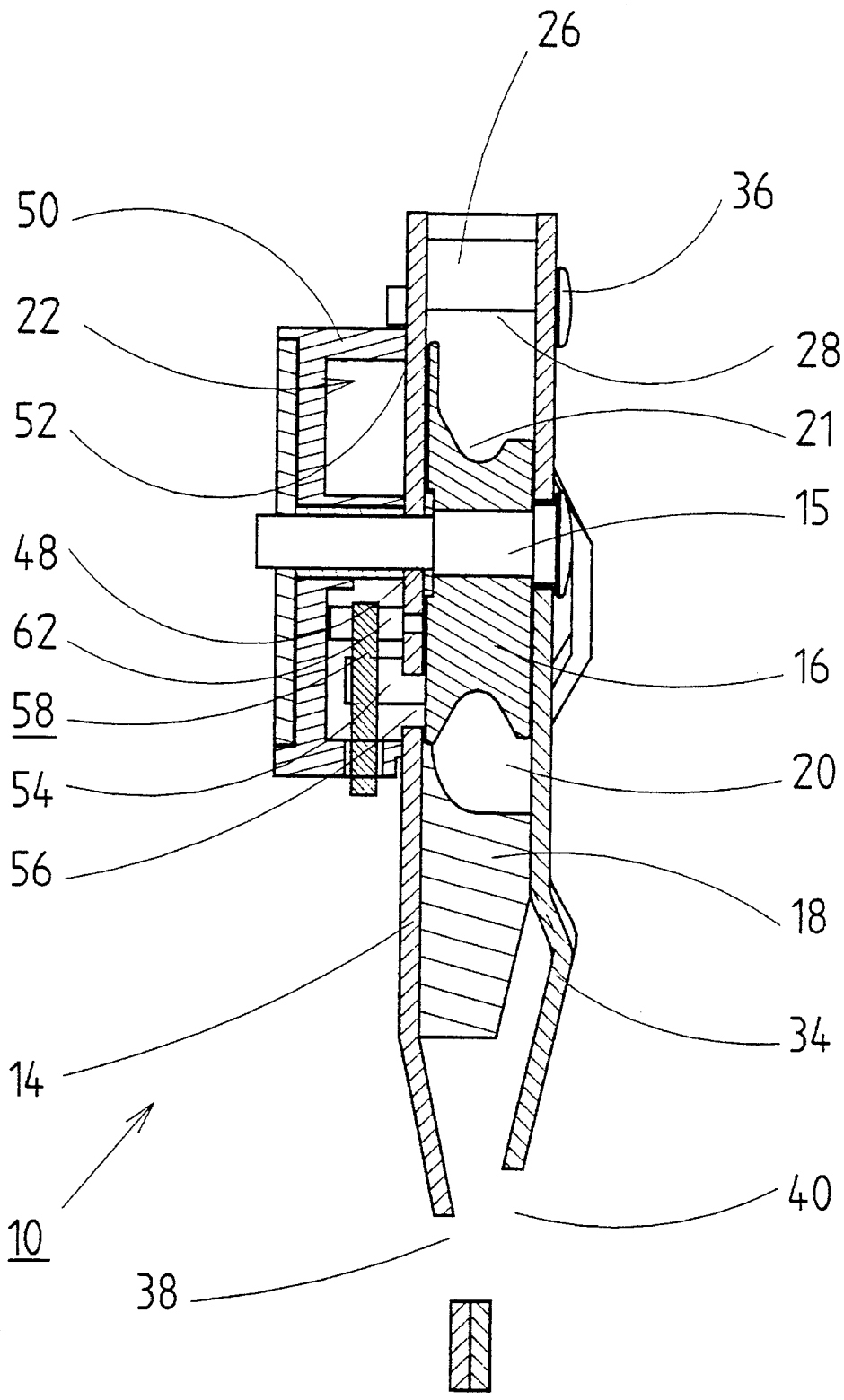
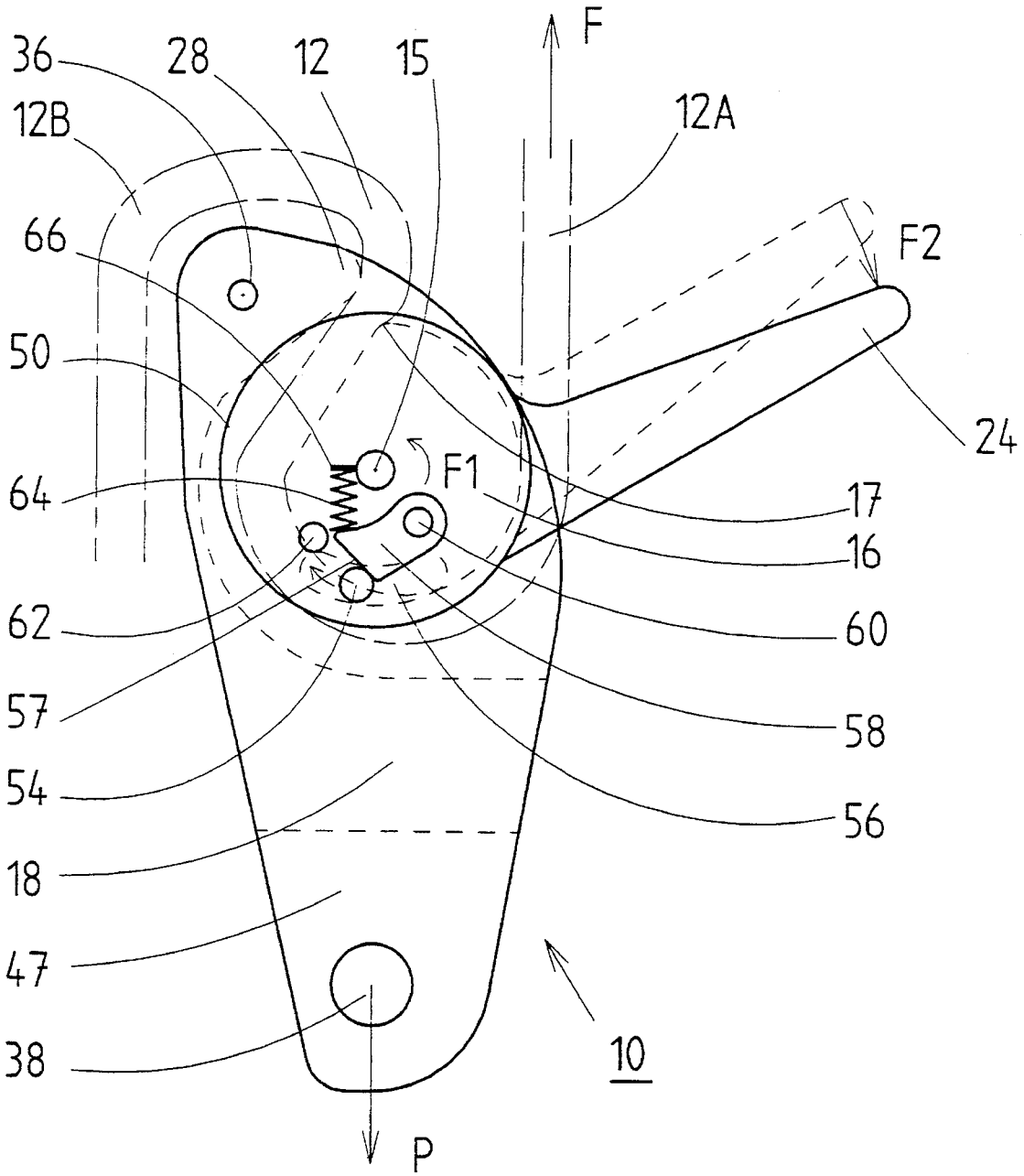


FIGURE 3


36
28
12
15
F
12B
12A
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F2
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64
17
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P

FIGURE 4

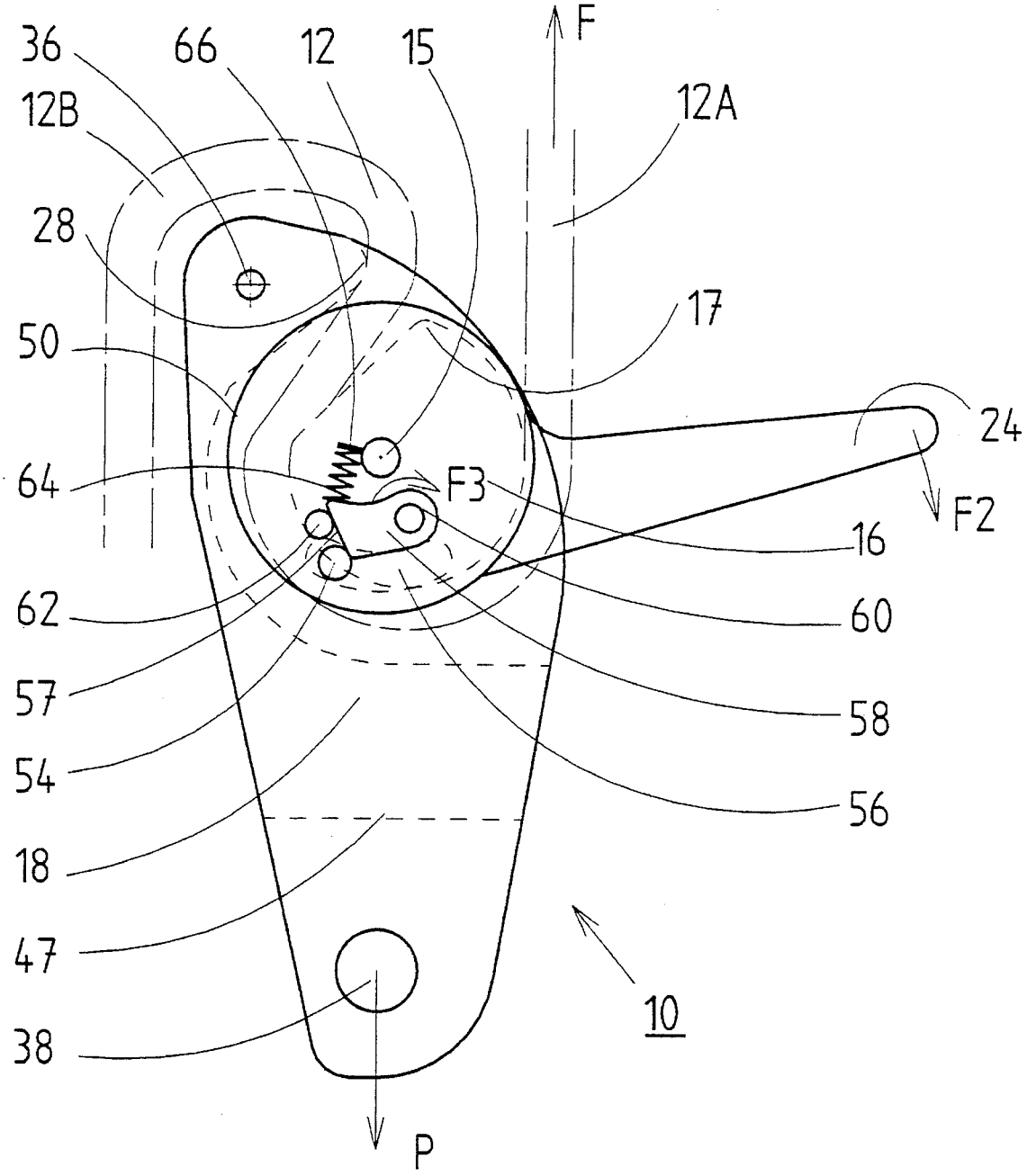
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FIGURE 5

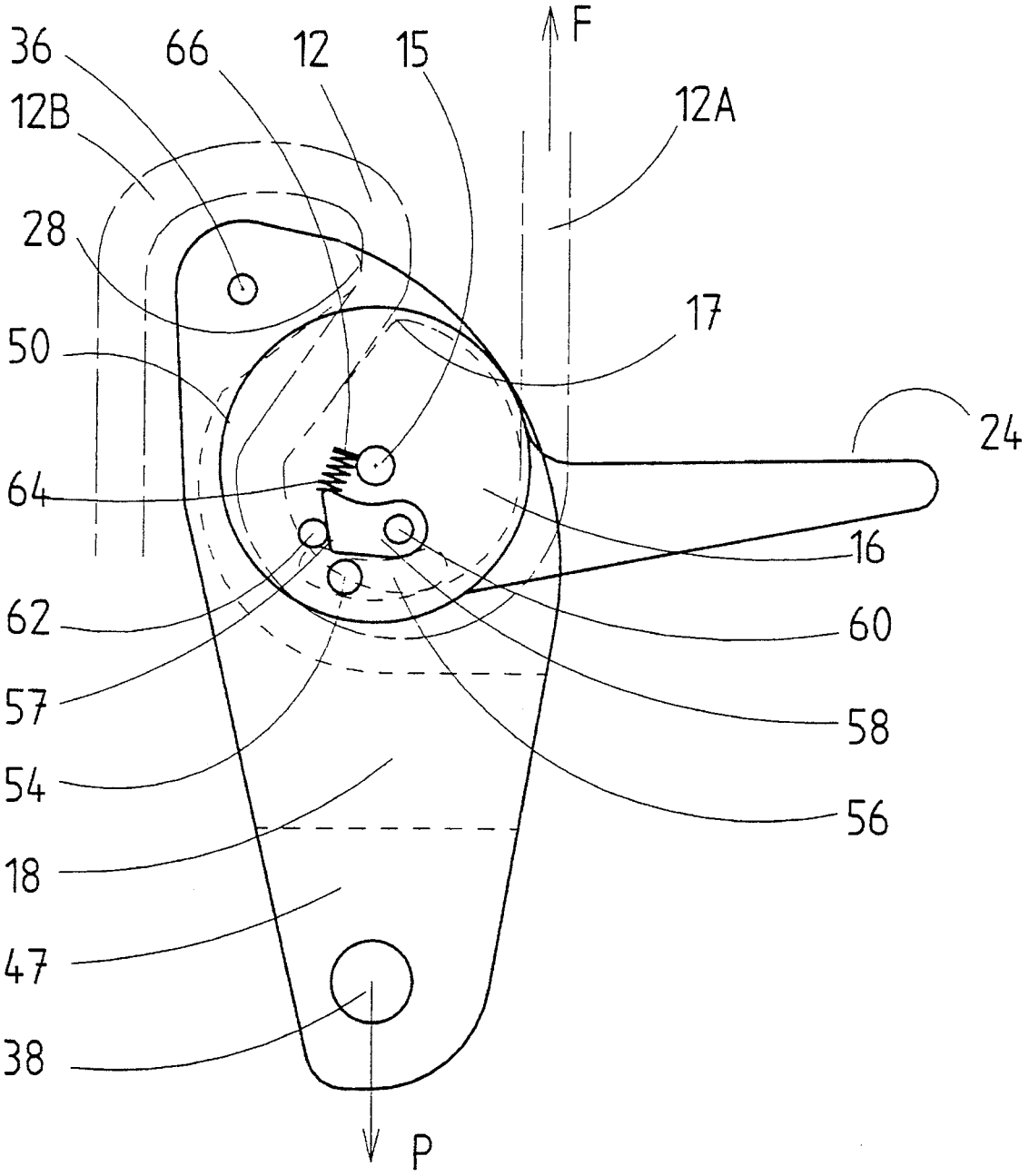

FIGURE 6

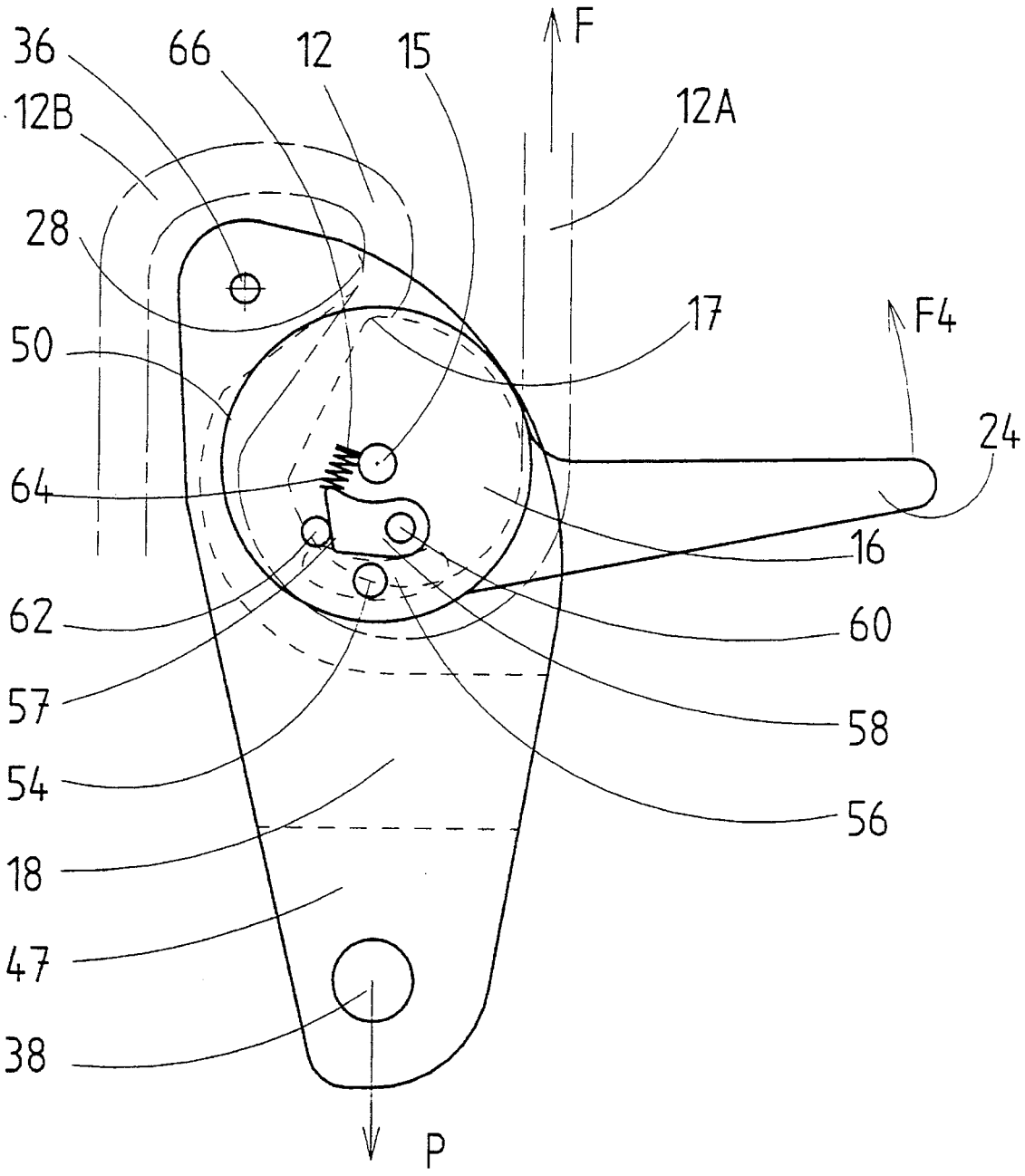

FIGURE 7

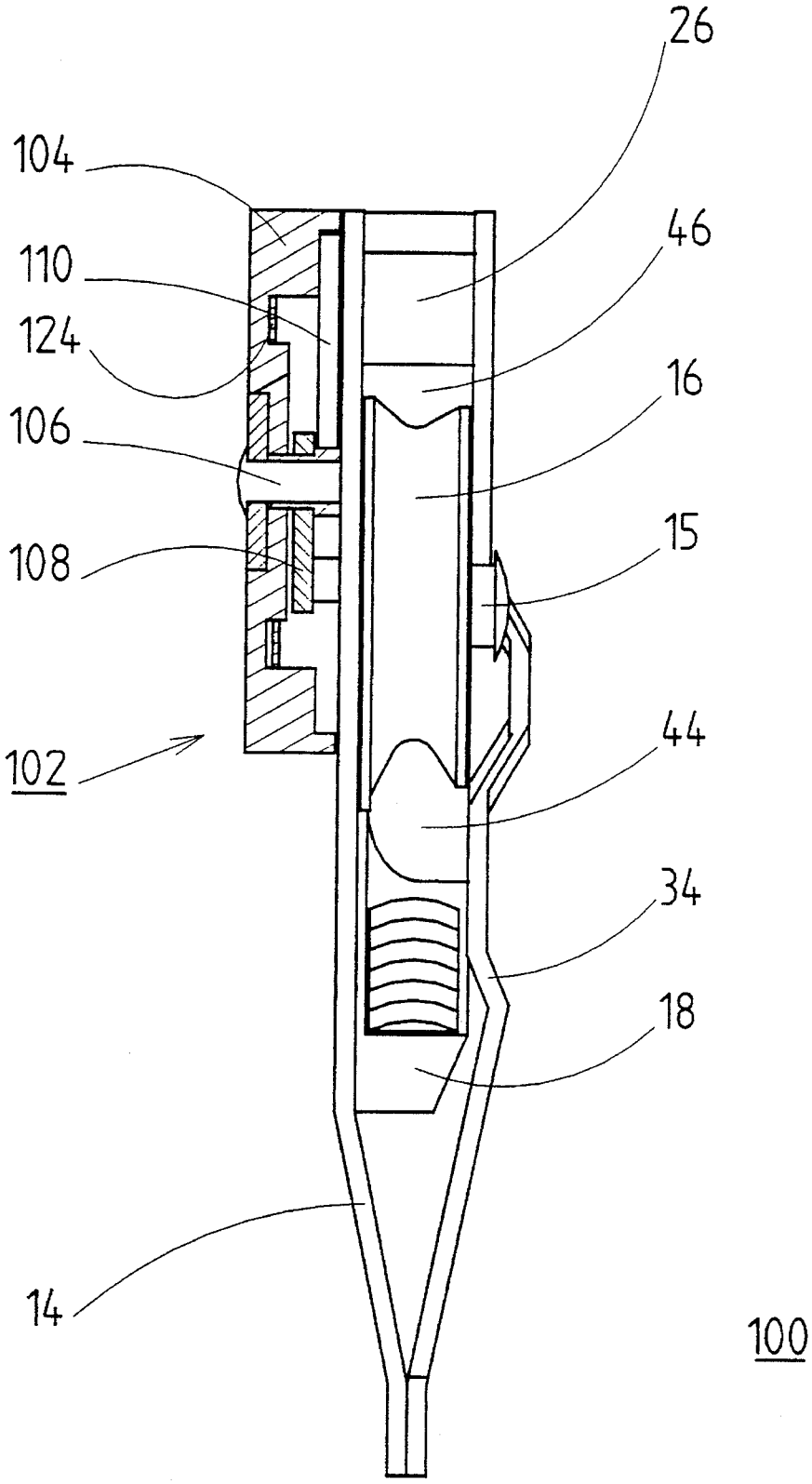

FIGURE 8

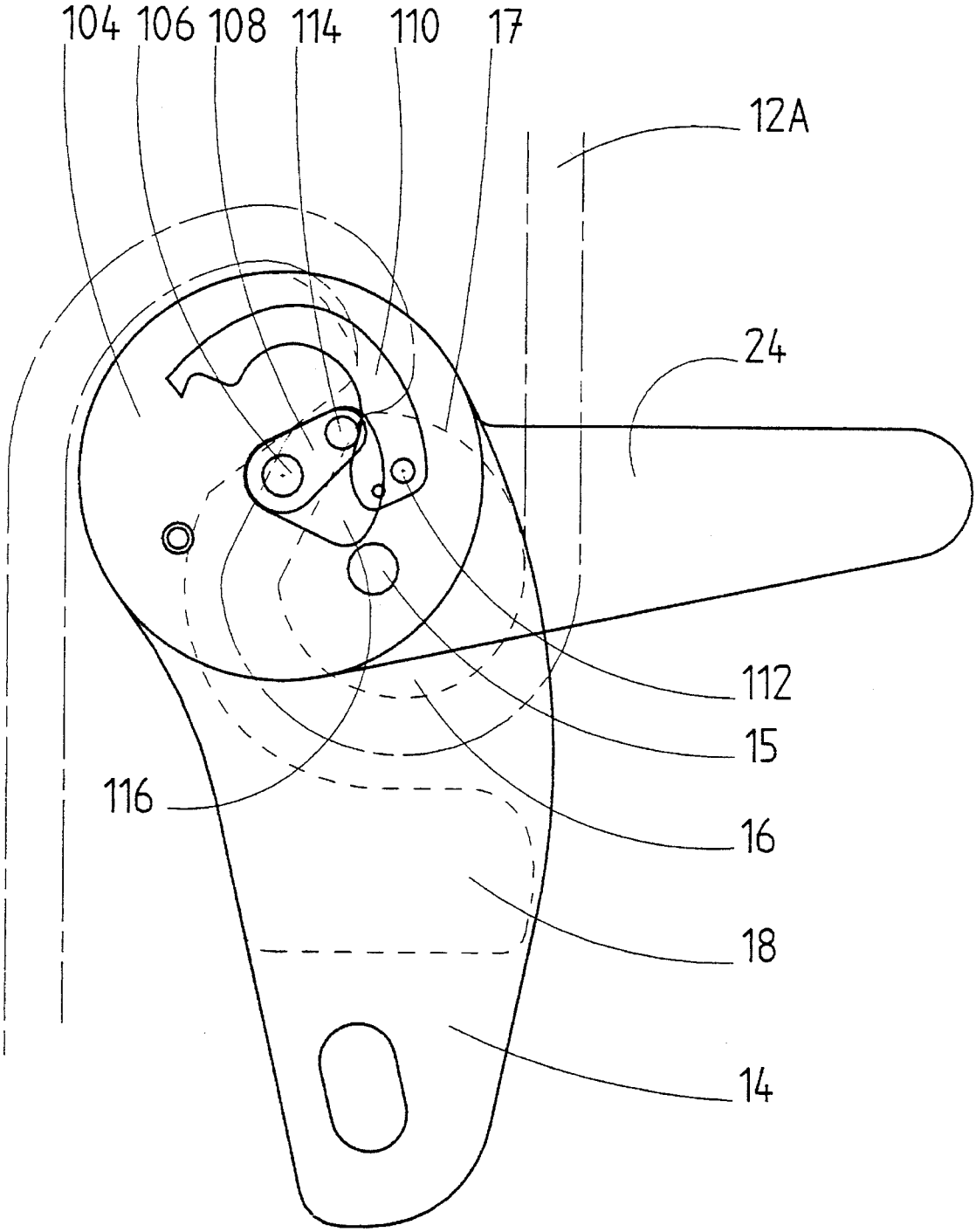

FIG 9

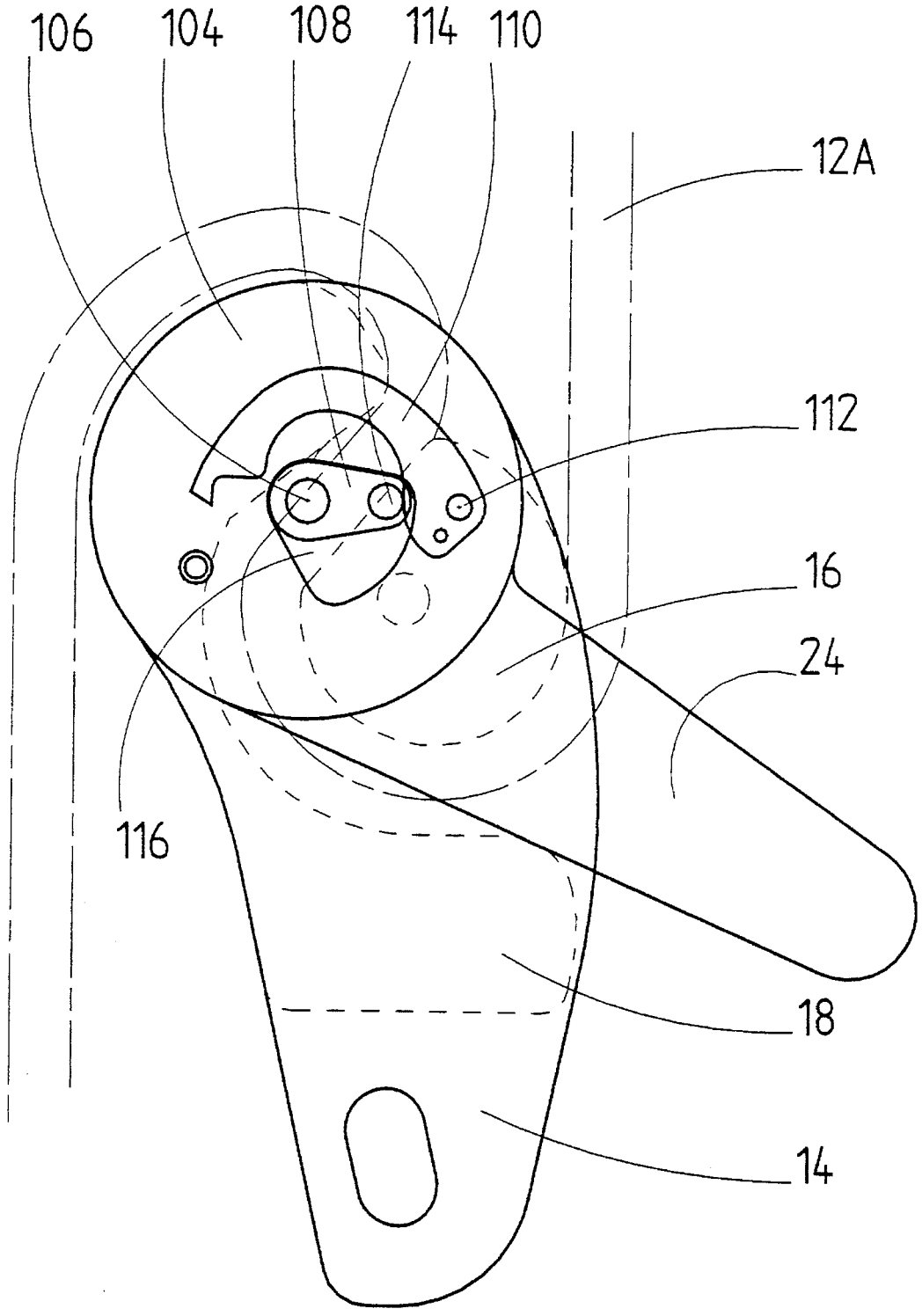

FIG 10

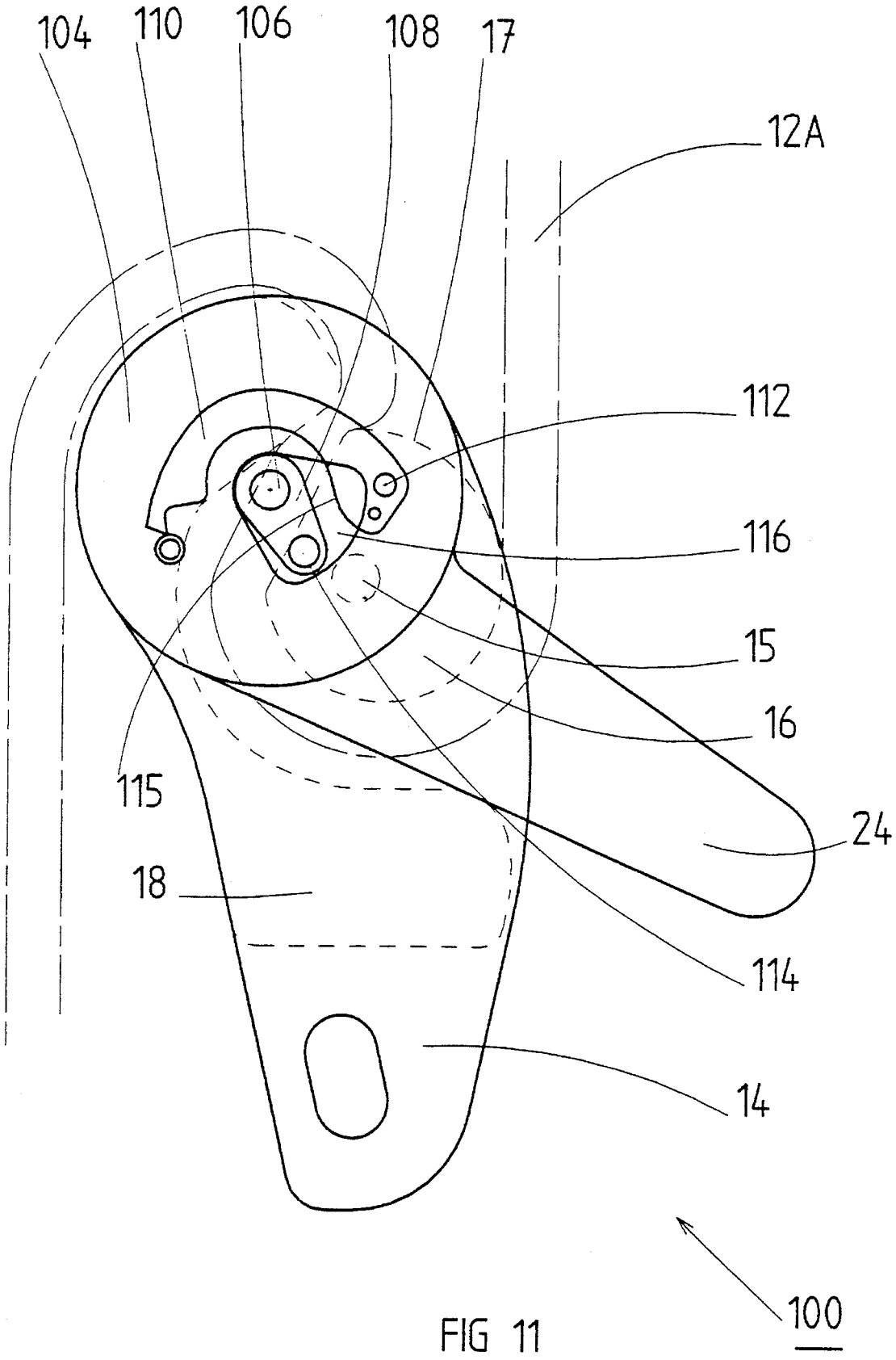

FIG 11

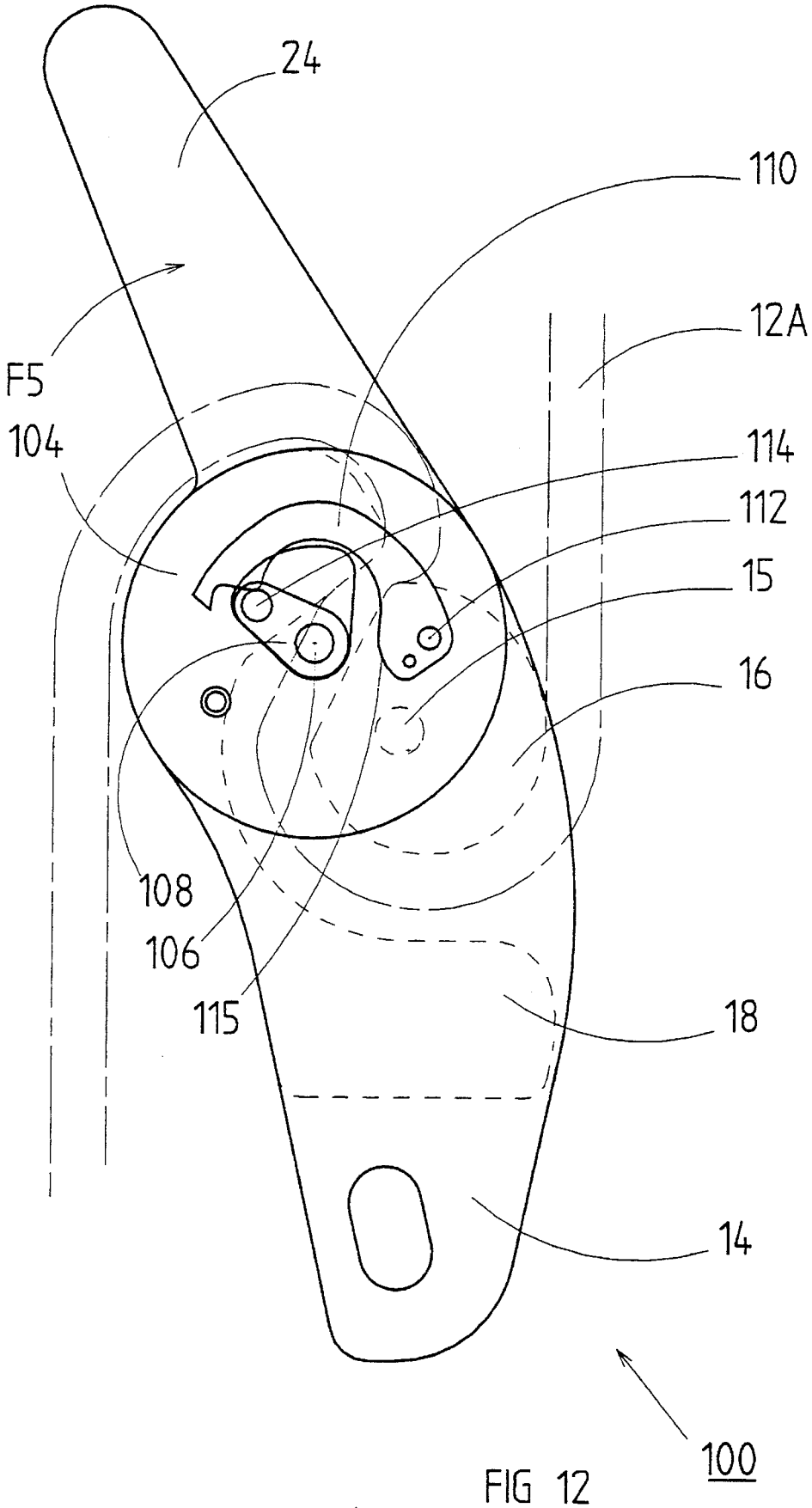

FIG 12

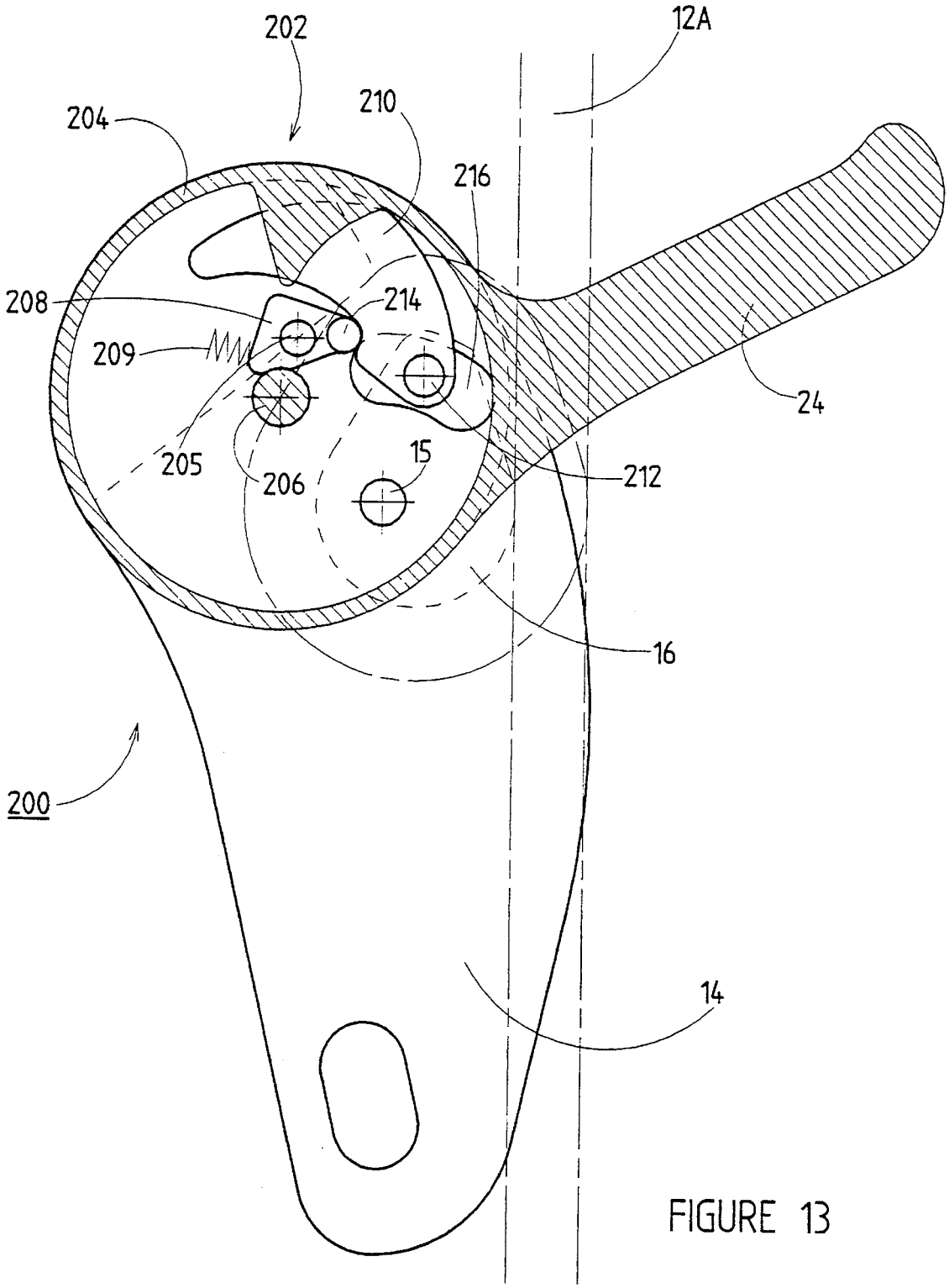

FIGURE 13

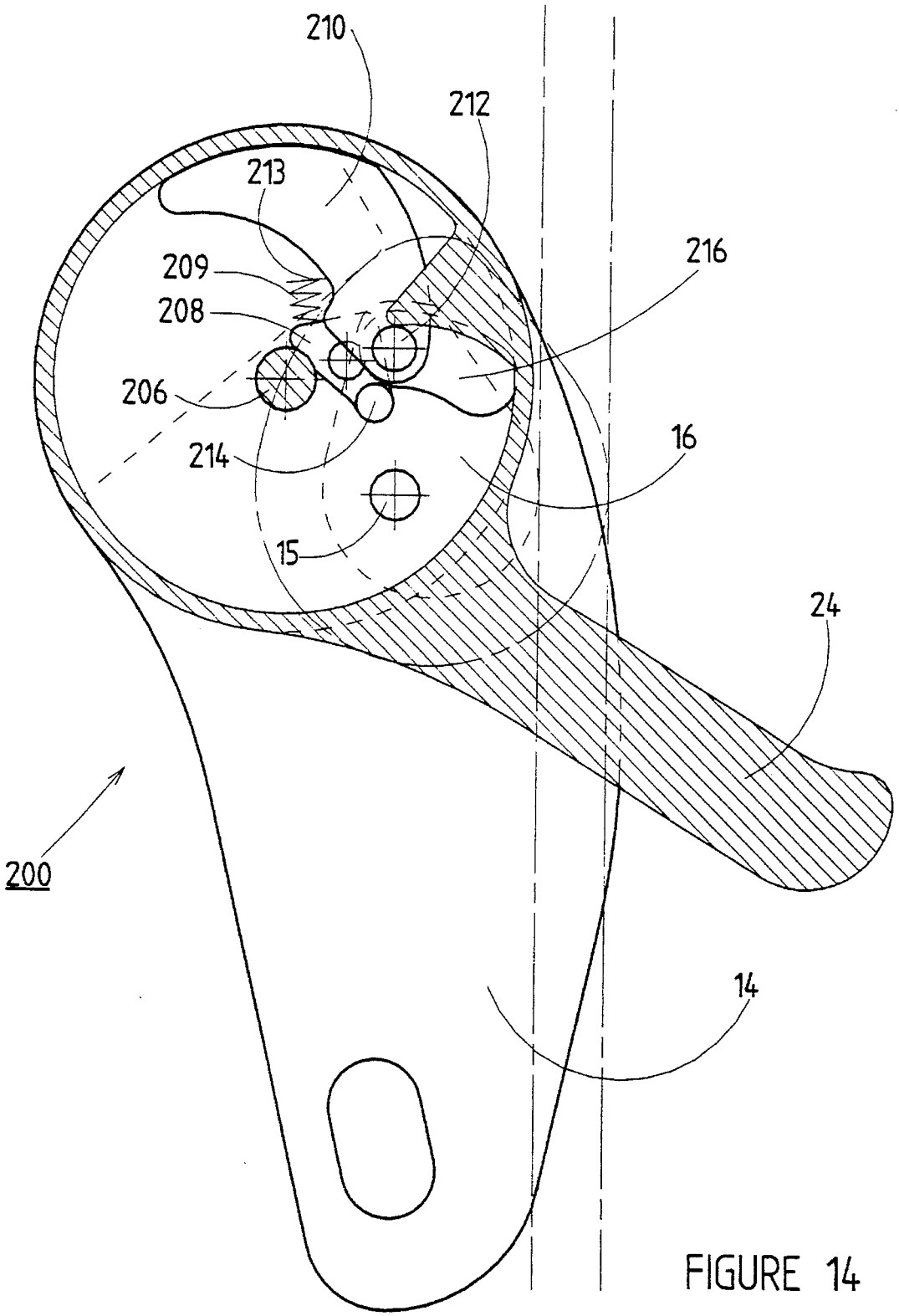

FIGURE 14

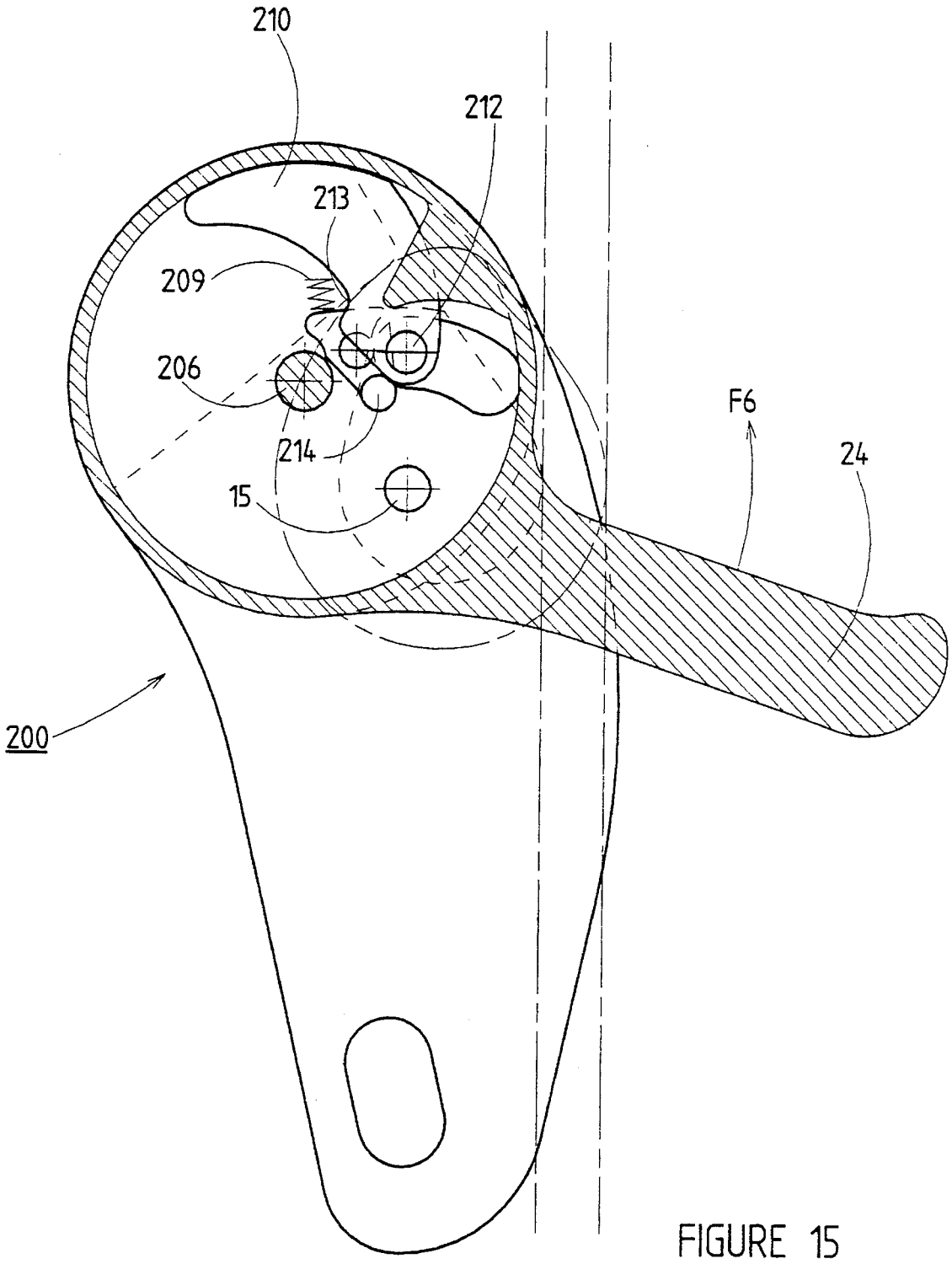

FIGURE 15

DISENGAGEABLE DESCENDER WITH SELF-LOCKING OF THE ROPE

BACKGROUND of the INVENTION

The invention relates to a self-locking safety descender for descending along a rope, comprising:

- a first fixed flange supporting a braking pad and a mobile pulley in the form of a cam, said pulley being mounted with limited rotation on a first articulation spindle between a locking position and an unlocking position, and separated from the pad by a space for passage of the rope,
- a second retractable flange, separated from the first flange by a transverse gap, and able to occupy a withdrawn position for fitting or removal of the rope, and a closed position, in which the rope is held captive in the space,
- an actuating handle of the pulley to perform manual unlocking of the rope,
- and a first spring to return the pulley to the unlocking position when the tension of the rope is lower than a preset threshold.

The document FR-A-2,451,752 refers to a self-locking descender having two possibilities of locking the rope depending on the spatial position of the actuating handle. The pulley is permanently securedly affixed to the handle and comprises for this purpose two angularly staggered bosses which alternately lock the rope against a fixed stud, depending on whether the handle is in a raised position or in a lowered position. Unlocking of the rope takes place in an intermediate position. The locking position is achieved following total release of the handle, resulting in rotation of the pulley due to the action of the tension of the rope and the clamping of the rope by the first boss. The second locking position results from the action of the second boss which clamps the rope against the fixed stud at a different place following maximum lowering of the handle. A permanent actuating force is however required on the handle in said lowered position to maintain this second locking of the rope. A decrease of the manual force on the handle, notably due to tiredness, may move the handle to the intermediate position, with a risk of unlocking the rope, which may jeopardize the safety of the person.

SUMMARY OF THE INVENTION

The object of the invention is to achieve a self-locking descender which is safe and easy to use.

The descender according to the invention is characterized in that the cam is associated to a drive finger cooperating with a mechanism having a transmission lever movable between an active engagement position with the finger to establish a unidirectional mechanical link between the handle and the pulley when the handle is actuated to an intermediate unlocking position in the course of the descending movement, and an inactive escape position to break said mechanical link after said intermediate position of the handle has been passed, causing disengagement of the pulley and automatic return of the cam to the locking position due to the action of the tension of the rope.

The presence of the interruptible mechanical link between the handle and pulley enables the effect of the second boss to be preserved after disengagement, without maintaining a force on the handle.

According to one feature of the invention, the drive finger and transmission part are housed inside a rotary base in the form of an annular drum with an open base adjoined to the first flange, the handle protruding out from said base.

According to a first embodiment, the transmission part is formed by a lever pivotally mounted on a second spindle securedly affixed to the base, and comprising a ramp cooperating with a cylindrical part of the finger movable in the opening, said opening being shaped as a circular sector centered on the first spindle, and having a length corresponding to the angular movement of the pulley between the locking and unlocking positions.

The ramp of the transmission lever cooperates with stop means after passing the intermediate position of the handle, resulting in pivoting of said lever to the inactive unlocking position for disengagement of the pulley.

According to two other embodiments, the transmission part is formed by a rod cooperating with the drive finger to form a toggle with dead point passage near to said intermediate position of the handle.

Each mechanism according to the invention is equipped with resetting means causing the transmission pan to return to the active position to reestablish the mechanical link between the handle and pulley. Resetting may be either manual by actuation of the handle or automatic after disengagement of the pulley.

BRIEF DESCRIPTION OF THE DRAWINGS

Other advantages and features will become more clearly apparent from the following description of several embodiments of the invention, given as non-restrictive examples only and represented in the accompanying drawings, in which:

FIG. **1** is a side view of the descender according to the invention;

FIG. **2** shows an elevational view of the descender after the second flange has been removed;

FIG. **3** is a cross-sectional view along the line **3**—**3** of FIG. **2**:

FIG. **4** represents the descender in the normal descent position following movement of the handle to the intermediate locking position;

FIGS. **5** and **6** are identical views to FIG. **4** showing the evolution of the disengagement phase after the handle has been moved beyond the intermediate position;

FIG. **7** shows the mechanism at the end of disengagement;

FIG. **8** is an identical view to FIG. **3** of an alternative embodiment;

FIGS. **9** to **12** show identical views to FIGS. **4** to **7** with the different disengagement phases of the descender according to the embodiment of FIG. **8**;

FIGS. **13** to **15** show identical views to FIGS. **9** to **12** of another alternative embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIGS. **1** to **7**, a safety descender, designated by the general reference **10**, is used for controlled descent of a person along a rope **12**. The descender **10** comprises a first fixed flange **14** having a first spindle **15** for articulation of a mobile pulley **16** shaped as a cam **17**, and a fixed spacer **18** for positioning and guiding of the rope, said spacer **18** being separated from the pulley **16** by a space **20** for passage of the

rope. The pulley **16** is provided with a gorge **21** for winding of the rope **12**.

The pulley **16** is mechanically linked to an operating mechanism **22** equipped with a pivoting manual actuating handle **24**.

The upper part of the fixed spacer **18** is arranged as a fixed pad **26** having a braking surface **28** against which the rope **12** is pressed by the locking action of the cam **17**.

The intermediate part of the spacer **18** extends externally along the righthand side (FIG. **2**) of the first flange **14**, and presents a curved internal sector **30**, substantially centered on the spindle **15**. The lower part of the spacer **18** comprises a cross-piece **32** extending horizontally between the two opposite side edges of the flange **14**.

A second mobile flange **34** (FIGS. **1** and **3**), having a similar shape to that of the first flange **14**, is mounted rocking on a pivot **36** fixed to the first flange **14**, and passing through the spacer **18** near the pad **26**. The pivot **36** extends parallel to the first spindle **15** of the pulley **16**, in a direction perpendicular to the first flange, such that the movement of the second flange **34** takes place in a plane parallel to the first flange **14** following manual action by the user between a closed position (FIGS. **1** and **3**) in which the rope **12** is held captive in the space **20**, and a separated position (not represented) enabling the rope **12** to be fitted in place or removed. The two flanges **14**, **34** of the descender **10** are separated from one another by a transverse gap d, having a thickness corresponding to that of the spacer **18** and to that of the pulley **16**.

Each flange **14**, **34** comprises at its base a circular or oblong-shaped orifice **38**, **40**, designed for the passage of a karabiner (not represented) to attach the descender **10** to the user's harness. In the closed position of the second flange **34**, the two orifices **38**, **40** are aligned, and fitting the karabiner keeps the descender **10** closed preventing any inadvertent opening of the second flange **34**.

A first return spring **42** (FIG. **2**), notably of the torsion type, is arranged on the spindle **15** and biases the pulley **16** to an unlocking position when the tension on the rope **12** is lower than a preset threshold.

The clearance between the cam **17** and the braking surface **28** of the fixed pad **26** is then maximum. The upstream strand **12A** of the rope **12** is hooked onto an anchoring device (not represented) fixed to the wall or rock above the descender **10**, whereas the downstream strand **12B** falls downwards due to the force of gravity. Inside the descender **10**, the rope **12** is wound in an S-shape between the two opposite ends **44**, **46** providing access to the space **20**. The upstream strand **12A** enters the space **20** via the bottom end **44**, passes around the pulley **16** and exits via the top end **46** arranged near the braking surface **28** of the pad **26**.

The mechanism **22** with the actuating handle **24** is located outside the gap d on the opposite side to the second flange **34**, and bears on the rear external surface **47** of the first flange **14**. The first spindle **15** of the pulley **16** passes through a hole **48** (FIG. **3**) of the first flange **14**, and also acts as pivoting part for a rotary base **50** to which base the handle **24** is securedly affixed. The base **50** is formed by an annular drum having an open end **52** on the same side as the rear surface **47** of the fixed flange **14**. The base **50** and handle **24** assembly is constituted by a single part, made of metallic or insulating material, mounted with limited rotation on the first spindle **15**.

The pulley **16** is equipped with a drive finger **54** passing through an oblong opening or aperture **56** of the first flange **14** to cooperate with a ramp **57** of a transmission lever **58**, which lever is pivotally mounted on a second spindle **60** of the base **50** of the handle **24**. According to the position of the handle **24**, the ramp **57** can also slide along a fixed stop **62** securedly affixed to the first flange **14**, causing pivoting of the transmission lever **58** from an active locking position with the drive finger **54** to an inactive unlocking position to release said finger **54**. A second return spring **64**, notably of the compression type, is arranged between a bearing face **66** of the rotary base **50** and the transmission lever **58**, so as to bias said lever to the active position. The oblong opening **56** allowing movement of the drive finger **54** is formed by a sector corresponding to the angular movement of the pulley **16** between the locking and unlocking positions.

The different phases of operation of the safety descender **10** are illustrated in FIGS. **4** to **7**:

In the course of a descent along the rope **12**, the weight P is applied to the lower part of the flanges **14**, **34**, and any voluntary or involuntary release of the handle **24** causes rotation of the pulley **16** in the direction of the arrow F1 by the reaction of the tension F on the rope. Locking of the rope **12** is then exerted against the braking surface **28** by the clamping action of the cam **17**, and the handle **24** is urged to a raised position (broken line). To resume the descending movement, the handle **24** simply has to be lowered from the raised position in the direction of the arrow F2 (FIG. **4**). The mechanical action of the ramp **57** of the transmission lever **58** on the drive finger **54** causes rotation of the pulley **16** in the opposite direction to the arrow F1 until maximum clearance of the cam **17** is achieved. Unlocking of the rope **12** enabling the descending movement to be continued takes place in an intermediate position of the handle **24**, represented in unbroken lines in FIG. **4**. During this first normal descent phase, the unidirectional mechanical link between the handle **24** and pulley **16** is permanent and is formed by the lever **58** comming into engagement with the finger **54**, said lever **58** being held in the active locking position by the spring **64**. Forced movement of the finger **54** to the left-hand end of the opening **56** by the unidirectional thrust action of the ramp **57** is performed from the raised position (in broken lines) to the intermediate position (in unbroken lines) of the handle **24** (FIG. **4**).

In FIG. **5**, continued lowering of the handle **24** beyond the intermediate position of FIG. **4** results in continued sliding of the ramp **57** on the stop **62** of the flange **14**. The transmission lever **58** rotates clockwise around the second spindle **60** (arrow F3) until the inactive unlocking position is reached (FIG. **6**). In this position, breaking of the mechanical link between the handle **24** and pulley **16** takes place, and the drive finger **54**, which is no longer subjected to the mechcanical action of the ramp **57**, is released.

Disengagement of the pulley **16** is then performed beyond the intermediate position of the handle **24**. The tension F of the rope **12** drives the pulley **16** in rotation in the direction of the arrow F1, against the restoring force of the spring **42**, and the cam **17** automatically clamps the rope against the braking surface **28** of the pad **26**, followed by stopping of the descending movement (FIG. **7**). During this locking travel by the cam **17**, the drive finger **54** of the pulley **16** moves along the curved opening **56** towards the right-hand end. The mechanical link between the finger **54** and transmission lever **58** remains uninterrupted in the lowered position of the handle **24**.

To reset the mechanism **22**, the unidirectional mechanical link between the handle **24** and pulley **16** simply has to be re-established. Resetting is performed manually after the handle **24** has been raised in the direction of the arrow F4,

from the lowered position (FIG. 7) to the raised position (FIG. 4). The ramp **57** leaves the stop **62** after counterclockwise rotation of the transmission lever **58**, and the lever **58** returns to the active locking position in contact with the drive finger **54** of the pulley **16**.

According to an alternative embodiment, resetting can also be performed in automatic manner by means of a return spring of the transmission lever **58**, which automatically returns to the active locking position after disengagement and after the handle **24** has been released.

The double locking function of the rope **12** by the cam **17** takes place in the loaded state of the descender **10** for two distinct positions of the handle **24**:

- either a raised position after the handle **24** has been released;
- or after disengagement of the mechanical link between the transmission lever **58** and the finger **54** of the pulley **16** when the handle **24** is lowered beyond the intermediate position.

The user who releases or grasps onto the handle **24** is in total safety due to this double locking system of the rope **12**.

In the second embodiment of the descender **100** described in FIGS. **8** to **12**, the same reference numbers will be used to designate identical or similar parts to those of the descender **10** of FIGS. **1** to **7**. The arrangement of the descender **100** between the flanges **14, 34** is identical to that of the descender **10**, but the operating mechanism **102** has different kinematics from those of the first mechanism **22**.

The mechanism **102** comprises a cylindrical base **104** in the form of a drum associated to the handle **24**, and mounted in rotation on a third spindle **106** fixed to the rear face of the first flange **14**. The spindle **106** is offset with respect to the spindle **15** of the cam **17**.

Inside the base **104** there is located a transmission rod **108** pivotally mounted on the third spindle **106** and cooperating with a drive finger **110** of the pulley **16**. The finger **110** is formed by a lever of curved shape articulated on a fourth spindle **112** securedly affixed to the mobile pulley **16**. The free end of the rod **108**, opposite the third spindle **106**, is provided with an operating pin **114** designed to come into engagement against the inside edge of the finger **110** to perform driving in rotation of the pulley **16** when the handle **24** is actuated. The rod **108** and finger **110** assembly forms a dead point passage toggle.

FIG. **9** shows the descender **100** in the normal descent state corresponding to the intermediate position of the handle **24**. Movement of the handle **24** from the raised locking position of the rope to the intermediate unlocking position causes clockwise rotation of the rod **108**, and the simultaneous thrust of the pin **114** on the finger **110**. The cam **17** of the pulley **16** moves away from the pad **26** to enable the descending movement by sliding of the rope in the gorge of the pulley **16**.

In FIG. **10**, continued downwards movement of the handle **24** causes alignment of the transmission rod **108** with the fourth spindle **112** of the drive finger **110**. The pin **114** of the rod **108** remains in contact with the convex part **115** of the finger **110**, but this alignment position of the toggle is unstable.

Overshooting the dead point of the toggle of the mechanism **102** takes place in FIG. **11** when continued lowering of the handle **24** is performed. The spindles **106, 112** are no longer aligned with the pin **114**, which pin is released and escapes downwards due to the presence of the aperture **116** arranged in the base **50**. The pin **114** escaping causes the drive finger **110** to be released and breaking of the mechanical link between the rod **108** and pulley **16**. The friction of the rope on the pulley **16** urges the cam **17** counterclockwise to the locking position of the rope against the pad **26**. After this unlocking phase of the descender **102**, the user is stopped automatically in his descending movement.

To return to the normal descent state illustrated in FIG. **9**, the handle **24** simply has to be turned three-quarters of a turn in the same direction F5 (see FIG. **12**), until the pin **106** comes into contact with the convex part **115** of the drive finger **110**. The toggle is reset and enables the pulley **16** to be rotated to unlock the rope following lowering of the handle **24**. In the third embodiment of the descender **200** described in FIGS. **13** to **15**, the same reference numbers will be used to designate identical parts, whereas the parts modified with respect to those of the previous descender **100** will be assigned a **2** as the hundreds digit instead of a **1**.

The mechanism **202** is also of the toggle type, but the transmission device rod **208** is pivotally mounted on a fifth spindle **205** offset with respect to the third spindle **206** of the rotary base **204**. The drive finger **210** is articulated on the pulley **16** at the level of the fourth spindle **212** moving along a sot **216** arranged in the flange **14**, and comprises a curved bearing surface **213** in its intermediate part. This bearing surface **213** cooperates with the operating pin **214** of the rod **208**, and enables the thrust action on the finger **210** to be increased to unlock the pulley **16** (see FIG. **13**).

The rod **208** is associated to a return spring **209** which urges the rod up against the stop formed by the third spindle **206**.

FIG. **14** shows the disengagement phase which is similar to that described previously in FIG. **11**. After the dead point of the toggle has been passed, the pin **214** leaves the housing defined by the curved bearing surface **213**, and causes breaking of the toggle and of the mechanical link between the rod **208** and pulley **16**.

The toggle mechanism **202** can be reset by reversing the direction of operation of the handle **24** (arrow F6, FIG. **15**) from the disengaged position to the intermediate position, in which the pin **214** of the rod **208** passes the hangup point of the finger **210** and houses itself in the recess of the bearing surface **213**. The rotary resetting movement of the mechanism **202** of FIGS. **13** to **15** is opposed to that of the descender **100** illustrated in FIG. **12**.

We claim:

1. A self-locking safety descender for descending along a rope, comprising:

a first fixed flange supporting a braking pad and a mobile pulley in the form of a cam, said cam being mounted with limited rotation on a first articulation spindle between a locking position and an unlocking position, and separated from the pad by a space for passage of the rope,

a second retractable flange separated from the first flange by a transverse gap, and able to occupy a withdrawn position for fitting or removal of the rope, and a closed position, in which the rope is held captive in the space,

an actuating handle of the pulley to perform manual unlocking of the rope,

and a first spring to return the pulley to the unlocking position when the tension of the rope is lower than a preset threshold, wherein the cam is associated to a drive finger cooperating with a mechanism having a transmission part movable between an active engagement position with the finger to establish a unidirectional mechanical link between the handle and the pulley when the handle is actuated to an intermediate unlocking position in the course of the descending movement, and an inactive escape position to break

said mechanical link after said intermediate position of the handle has been passed, causing disengagement of the pulley and automatic return of the cam to the locking position due to the action of the tension of the rope.

2. The descender according to claim **1**, wherein the mechanism is located outside the gap between the two flanges, and the drive finger of the pulley comprises a part passing through an opening of the first flange.

3. The descender according to claim **1**, wherein the drive finger and transmission part are housed inside a rotary base in the form of an annular drum with an open base adjoined to the first flange, the handle protruding out from said base.

4. The descender according to claim **3**, wherein the transmission part is formed by a lever pivotally mounted on a second spindle securedly affixed to the base, and comprising a ramp cooperating with a cylindrical part of the finger movable in the opening, said opening being shaped as a circular sector centered on the first spindle, and having a length corresponding to the angular movement of the pulley between the locking and unlocking positions.

5. The descender according to claim **4**, wherein the ramp of the transmission lever cooperates with stop means after passing the intermediate position of the handle, resulting in pivoting of said lever to the inactive unlocking position for disengagement of the pulley.

6. The descender according to claim **4**, wherein a second return spring is disposed between a bearing face of the base and the transmission lever to bias the latter to the active locking position, in which the ramp is bearing against the drive finger.

7. The descender according to claim **4**, wherein the rotary base is mounted on an aligned extension of the first spindle passing perpendicularly through the first flange, and the stop means are formed by a fixed pin securedly affixed to the first flange and extending parallel to the second spindle of the transmission lever.

8. The descender according to claim **1**, wherein the transmission part is formed by a rod cooperating with the drive finger to form a toggle with a dead point near to said intermediate position of the handle.

9. The descender according to claim **8**, wherein the base of the handle is mounted with rotation on a third spindle securedly affixed to the first flange, and the transmission rod comprises an operating pin, designed to come into engagement with a curved bearing surface of the drive finger, which finger is articulated on a fourth spindle securedly affixed to the pulley.

10. The descender according to claim **1**, wherein the mechanism is equipped with resetting means causing the transmission part to return to the active position to re-establish the mechanical link between the handle and pulley.

11. The descender according to claim **10**, wherein the resetting means are activated by a manual actuation movement of the handle resulting in the transmission part coming into engagement in the active position with the drive finger.

12. The descender according to claim **10**, wherein the resetting means are arranged to cause an automatic return to an active position after the disengaged handle has been released.

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