



EUROPEAN PATENT APPLICATION

(43) Date of publication:
28.05.2014 Bulletin 2014/22

(51) Int Cl.:
E01F 9/018 (2006.01)

(21) Application number: **13194665.9**

(22) Date of filing: **27.11.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(71) Applicant: **Sapa Profiles NL B.V.**
5151 RW Drunen (NL)

(72) Inventor: **van Boxtel, Sebastiaan Johannes Matheus**
5491 CJ Sint-Oedenrode (NL)

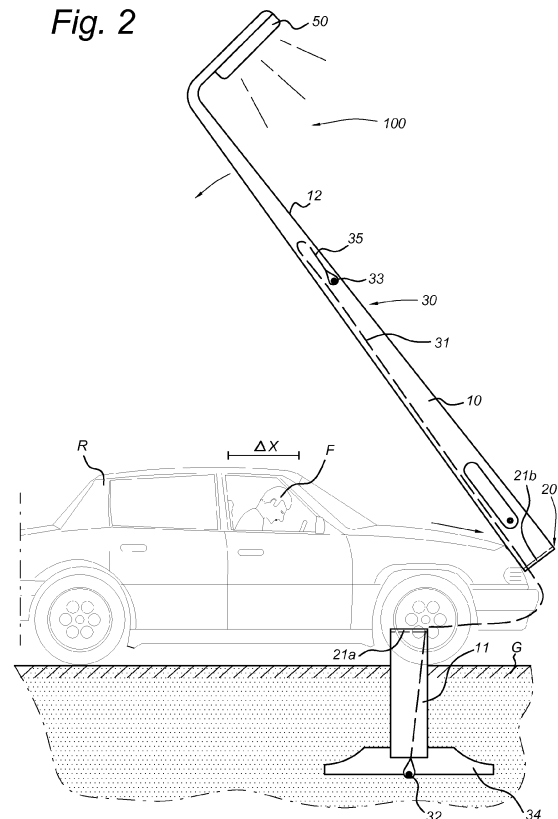
(30) Priority: **27.11.2012 NL 2009887**

(74) Representative: **Nederlandsch Octrooibureau**
P.O. Box 29720
2502 LS The Hague (NL)

(54) **A traffic-safe and collision energy absorbing pole**

(57) A traffic-safe and collision energy absorbing pole 10 comprises a first collision energy absorbing arrangement 20 for absorbing a first amount of collision energy upon a collision impact of a road vehicle R with the pole; and a second collision energy absorbing arrangement 30 for absorbing a second amount of collision energy. The second arrangement only provides substantial absorption of the second amount of collision energy a first time span after a start of absorption of the first amount of collision energy by the first collision energy absorbing arrangement. The first and second collision energy absorbing arrangements can be provided such that substantially no collision energy is being absorbed after end of absorption of the first amount of collision energy by the first collision energy absorbing arrangement during a second time span before start of absorption of the second amount of collision energy by the second collision energy absorbing arrangement.

Fig. 2



Description

FIELD OF THE INVENTION

[0001] The present invention relates to a traffic-safe and collision energy absorbing pole comprising a collision energy absorbing arrangement for absorbing an amount of collision energy upon a collision impact of a road vehicle with the pole.

BACKGROUND OF THE INVENTION

[0002] Such poles are known and applied along roads as, for instance, a lamp post or a sign post carrying traffic signs or other types of signs such as a bill board. The poles can be configured to satisfy certain safety regulations, such as according to the European EN 12767 standard.

[0003] The poles may be designed and configured according to satisfy a high energy (HE) absorbing category regulation, a low energy (LE) absorbing category regulation or a non energy (NE) absorbing category regulation, in which the energy to be absorbed is the collision energy of a vehicle colliding into the pole. The regulations prescribe the exit velocity of the car after the collision when it hits the pole at a certain velocity. The impact conditions are predetermined in the regulations. The other important criterion in certifying a pole for a safety category are the Theoretical Head Impact Velocity (THIV) and the Acceleration Severity Index (ASI). Both values should also not exceed certain predetermined values.

[0004] The energy absorbing category is important when secondary hazards, because of a secondary impact (for occupants of the vehicle and/or for pedestrians), play an important role. ASI and THIV are important for the primary hazard for the vehicle occupant. The lower ASI and THIV upon collision impact, the better for the occupant. The lower the exit speed after the collision, the lower the secondary risks for vehicle occupants and/or pedestrians. The best occupant-safety level can be achieved in combination with a non energy absorbing category (NE) since the vehicle will experience a limited deceleration at collision impact. A high energy absorbing category (HE) often goes in combination with a lower performance for the occupant safety.

[0005] Generally, when a low/non secondary risk is required, the highest possible occupant safety level is desired as well. To achieve so, the highest energy absorbing category in combination with the highest possible occupant safety level is to be achieved.

[0006] A standard aluminium pole generally has by itself a certain level of passive safety for vehicle occupants upon collision impact by a vehicle since it only absorbs a low amount of energy upon collision impact, but in some cases a better performance is desired. This can be achieved by adding a shear-off solution as known from EP 2 014 850 A for enhanced vehicle occupant safety. Such poles can be employed in situations where the site

itself does not give rise to secondary hazards because there will be, for instance, no pedestrians or no further obstacles onto which the vehicle may collide. However, to achieve a decrease in secondary risks at a certain site a high energy absorbing category in combination with the highest possible occupant safety level is desired.

[0007] WO 2011/120069 A1 discloses a pole that can absorb collision energy by breaking of the pole and by a crushing or compression mechanism. The crushing mechanism is described as a sphere connected by a cable to a base of the pole. A crushable material is provided in between the sphere and the base to be crushed at a collision impact on the pole. The crushing mechanism will absorb collision energy immediately upon collision impact and at the same time as collision energy will be absorbed by breaking of the pole. The pole disclosed will therefore immediately provide a high absorption of collision energy and therefore a high ASI and THIV.

[0008] WO 03/033819 A1 also discloses a pole that will break upon collision impact and cables connected tensioned between a base and higher region of the pole in order to hold the pole together after impact. The arrangement with cables may also absorb collision energy upon collision impact, but will again do so immediately upon collision impact at the same time as breaking of the pole to provide a high absorption of collision energy, and therefore high ASI and THIV.

[0009] Also WO 85/02636 A1 discloses a pole that may absorb collision energy by breaking and a strap provided within the pole. Both fracturing of the pole and the strap arrangement will immediately absorb collision energy upon collision impact to provide high collision energy absorption, and thus high AS and THIV.

[0010] DE 28 30 875 A1 discloses a pole with a securing elastic cable which acts to keep a fractured upper portion of the pole in a vicinity of a base portion of the pole. In case the cable would absorb collision energy upon impact it will again do so immediately upon impact at the same time as breaking of the pole.

[0011] These prior art poles may provide a high collision energy absorption but do so at the cost of a high ASI and THIV, which is very much undesirable.

SUMMARY OF THE INVENTION

[0012] It is therefore an object of the invention to provide a pole suited for both high energy absorption to achieve low secondary risks, and high vehicle occupant safety when a road vehicle has a collision impact with the pole.

[0013] Such object and other objects are solved with a traffic-safe and collision energy absorbing pole comprising

- a first collision energy absorbing arrangement configured and arranged for absorbing a first amount of collision energy resulting from a collision impact of a road vehicle with the pole; and

- a second collision energy absorbing arrangement configured and arranged for absorbing a second amount of collision energy resulting from the collision impact, the second collision energy absorbing arrangement being configured and arranged such as to only provide substantial absorption of the second amount of collision energy a first time span after a start of absorption of the first amount of collision energy by the first collision energy absorbing arrangement.

[0014] In an embodiment the first and second collision energy absorbing arrangements are configured and arranged such that substantially no collision energy is being absorbed after end of absorption of the first amount of collision energy by the first collision energy absorbing arrangement during a second time span until a start of absorption of the second amount of collision energy by the second collision energy absorbing arrangement.

[0015] The second collision energy absorbing arrangement may be configured and arranged such as to provide absorption of the second amount of collision energy after the first time span during which a free object in the road vehicle will have travelled a predetermined distance with respect to the road vehicle as a result of the collision impact and absorption of the first amount of collision energy by the first collision energy absorbing arrangement. The conditions of the collision impact are generally predetermined by safety regulations. It allows the pole to be configured such that it absorbs a low first amount of energy to provide a high vehicle occupant safety and satisfies a high energy absorption category by absorbing the second amount of energy a time interval after the impact. After this time interval a vehicle occupant will have come into contact with the interior of the car so that the occupant at that moment has reached the THIV and will not experience a high ASI during the absorption of the second amount of energy. The first collision energy absorbing arrangement can be configured and arranged to absorb the first amount of collision energy such that the free object after the predetermined distance will have a velocity with respect to the road vehicle which is below a predetermined velocity value (the THIV).

[0016] In a preferred embodiment the first arrangement comprises a fracture position at which the pole will at least partially break under influence of the collision impact when an impact condition reaches or exceeds a predetermined value. Deformation followed by breaking of the pole provides an easy and efficient manner of absorbing the first amount of collision energy, which first amount of energy can be well defined.

[0017] In another preferred embodiment the second arrangement comprises a pull arrangement connected with the pole, the pull arrangement providing an excess length range providing for the first and/or second time span until substantial absorption of the second amount of collision energy. Such configuration provides an easy and efficient absorption of the second amount of collision

energy by the action of the pull arrangement, which second amount will only be absorbed after travelling the excess length range that can be chosen in accordance with travelling the predetermined distance by the free object in the car for reaching the THIV. The excess length range allows the car to travel unobstructed until the pull arrangement is pulled taut and the second amount will be absorbed. The amount of first collision energy absorbed and the excess length range can be chosen such that the free object hits the car at a low relatively velocity with respect to the car. In an actual collision the free object will be the head of the driver or passenger, which then will hit the steering wheel or dashboard at a relatively safe low relative velocity.

[0018] In an advantageous embodiment the fracture position provides two fracture sides in a direction along the pole, and the pull arrangement is connected with the pole at both a first connection on one fracture side and a second connection on the other fracture side. The fracture position divides the pole in two sections that become separated as a result of the collision. The pull arrangement keeps both sections connected. A bottom section of the pole will remain connected to the ground area to which the pole is fixed. A top section will be deformed by the car hitting the pole and be pulled under the car to absorb the second amount of energy until the car comes to a full stop or travels further with a low, safe velocity.

[0019] In an effective and efficient embodiment a length of the pull arrangement between the first and second connections is longer than a distance between the first and second connections as measured along the pole by an excess length providing the excess length range, the excess length being chosen such that the pull arrangement will be pulled taut at the end of the excess length range for subsequent substantial absorption of the second amount of collision energy. Advantageously, the pull arrangement comprises an element a pull element chosen from the group comprising at least a cable, a steel cable, a chain, a rope, a sling and a strap. Such an element provides easily and effectively for both the excess length and the connection of the pole sections. Advantageously, the pull arrangement comprises a steel cable comprising a plastic cladding. In an advantageous embodiment a lubrication material, like graphite or graphite powder, is provided on the steel cable and a tube, like a substantially plastic tube, is provided around the steel cable, in an embodiment the tube having a helically wound reinforcement. A steel cable is strong, flexible and bendable, but not resilient, and further will have a low weight with respect to the weight of the pole, which makes a steel cable a preferred choice for the pull arrangement. A plastic cladding reinforces a steel cable to prevent cutting of the cable due to sharp edges of pole or road vehicle, and acts as an isolator against electrical connection between cable and metal pole. A helically wound reinforcement strengthens the tube and further prevents cutting of the cable.

[0020] In an embodiment the excess length is larger

than 1.5 meter, in an embodiment larger than 2.5 meter, in an embodiment 3.5 meter, which generally will provide enough time in various circumstances to have the free object hit the steering wheel or dashboard at relatively low velocity after which absorption of the second amount of collision energy will occur. A maximum length of the cable is given by a maximum required exit velocity of the car after the collision. If the excess length would be too long, the exit velocity may remain too high. The exit velocity should remain below a prescribed value at 12 meter after the original position of the pole in the EN 12767 standard.

[0021] In an advantageous embodiment the first connection is provided on a bottom plate arranged substantially perpendicular to the pole at a bottom section of the pole, the bottom plate and bottom section provided in the ground when the pole is positioned in an upright position in place, which allows a secure connection of the first connection to the ground at a light weight base construction. In another advantageous embodiment the first connection is provided on a concrete base arranged at a bottom section of the pole, the concrete base and bottom section provided in the ground when the pole is positioned in an upright position in place, which also allows a secure connection of the first connection to the ground in situation where a more heavy base is required.

[0022] In yet another advantageous embodiment the second connection is provided in an upper section of the pole, as seen when the pole is positioned in an upright position in place, which provides the second connection at a location that will not immediately experience the effects of the impact and allows the excess length to be provided in a region that is not immediately influenced by the impact.

[0023] Advantageously, the second connection is provided such that the a length of the pull arrangement corresponding to the excess length is provided as a loop above the second connection, as seen when the pole is positioned in an upright position in place, which allows the excess length to be provided in a manner that is not impeded during a collision. In a further advantageous embodiment, the pole comprises a hollow tube, the second arrangement being provided substantially inside the tube, which further adds to an unobstructed spool off of the excess length.

[0024] In a preferred embodiment the pole comprises aluminium and as such provides the first collision energy absorbing arrangement, which has advantageous characteristics in providing the first collision energy absorbing arrangement in the pole. Such first arrangement is inherently provided in an aluminum pole comprising a substantially cylindrical tube having a diameter between 150 and 250 mm and having a wall thickness between 2 and 5 mm in a section between ground level and 1 meter above ground level, as seen when the pole is positioned in an upright position in place.

[0025] In an embodiment the conditions of the impact are predetermined by an applicable standard, especially

by the European EN 12767 normalisation standard. In a further embodiment the first collision energy absorbing arrangement (20) is configured and arranged such that a theoretical head impact velocity (THIV) satisfying an occupant safety level in accordance with the European EN 12767 normalisation standard is provided. In yet a further embodiment the second collision energy absorbing arrangement is configured and arranged such that the pole satisfies the HE energy absorption category and an occupant safety level 1, 2 or 3 at a predefined high speed collision impact velocity, such as at 50 km/hour, 70 km/hour or 100 km/hour.

[0026] In a specific embodiment the invention relates to a lamp post comprising a pole according to the invention. In another specific embodiment the invention relates to a sign post comprising a pole according to the invention.

[0027] In another aspect the invention relates to a method for absorbing the collision energy resulting from a collision impact of a road vehicle with a pole, the method comprising the steps of

- providing the pole with a first collision energy absorbing arrangement configured and arranged for absorbing a first amount of collision energy resulting from the collision impact of the road vehicle with the pole;
- providing the pole with a second collision energy absorbing arrangement configured and arranged for absorbing a second amount of collision energy resulting from the collision impact;
- having the road vehicle collide with the pole;
- in a first phase absorbing the first amount of collision energy; and
- in a second phase subsequent to the start of the first phase absorbing the second amount of collision energy, the second phase being started a first time span after a start of the first phase.

[0028] In an embodiment substantially no collision energy is absorbed after an end of absorption of the first amount of collision energy during a second time span until absorption of the second amount of collision energy.

[0029] Advantageously, the second phase is started after a time span in which a free object in the road vehicle will have travelled a predetermined distance with respect to the road vehicle as a result of the collision impact and absorption of the first amount of collision energy by the first collision energy absorbing arrangement.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] The invention will further be explained by reference to the accompanying drawings in which same or like reference numerals refer to same or like parts, and in which

Figure 1a shows a lamp post comprising an embod-

iment of a pole according to the invention;

Figure 1b shows another lamp post comprising another embodiment of a pole according to the invention;

Figure 2 shows the lamp post of figure 1a and a car just after a collision impact of the car against the pole; Figure 3 shows the lamp post of figures 1a and 2 after the collision impact with the pole halfway under the car;

Figures 4a to 4d show a graphical representation of the various stages of the collision impact of the car against a pole according to the invention;

Figure 5 show a graphical representation of the ASI before, during and after collision of a car into a pole according to the invention;

Figure 6 shows a detail of a steel cable with a tube provided around the cable;

Figures 7a and 7b show a lamp post and sign post, respectively, comprising a pole according to the invention; and

Figure 8 schematically shows a road situation in which a pole according to the invention can be employed.

DETAILED DESCRIPTION OF EMBODIMENTS

[0031] Figure 1a shows a lamp post 100 that comprises a pole 10 provided with a lamp fitting 50 at its top end. A bottom section 11 of the pole is provided in the ground G when the pole is in place such that the pole is in an upright position. A bottom plate 34 is arranged at the bottom end of the pole in an orientation such the bottom plate that is substantially perpendicular to the pole. The pole is in the embodiment shown manufactured from an aluminium tube or a tube of a mainly aluminium containing alloy. Any other suitable material such as a plastic or another metal may be used as well. The tube has a substantially cylindrical shape with a diameter between 150 and 250 mm, approximately 200 mm in the embodiment of figures 1 to 3, and a wall thickness in the range of 2 to 5 mm, about 3.3 mm in the embodiment shown, in the base section of the pole. The pole is shown to have an access door 13 to the inside of the pole. Any other suitable material such as a plastic or another metal may be used as well for manufacturing the pole.

[0032] A steel cable 31 is arranged within the pole. At the bottom section 11 of the pole the steel cable is at one end connected to the pole at a first connection 32. As shown in the figures, the first connection 32 is rigidly provided on the bottom plate 34 or the concrete base 38. The other end of the steel cable 31 is connected to a second connection 33 in an upper section 12 of the pole. The first and second connections 32, 33 are a distance D apart as measured in a direction along the pole. The length of the cable 31 is longer than the distance D. The additional length of cable 31 is provided as a loop above the second connection 33. The additional length provides for an excess length range 35 as will be explained further

below.

[0033] The steel cable 31 may be a bare steel cable, but can also be provided with a plastic coating or cladding. The steel cable should have sufficient thickness and strength. A thickness of 10 mm or 16 mm has shown to provide good results for an ordinary steel cable. Any other element like a chain, a rope, a sling, a strap and the like can also be employed instead of cable 31.

[0034] An alternative embodiment of the pole is shown in figure 1b. A concrete base or foundation 38 is arranged at the bottom end of the pole and provided in the ground G. The first connection 32 is provided on the concrete base.

[0035] The pole as shown in figures 1a and 1b is generally positioned along roads. Cars travel along the road, and an accident may occur when the car accidentally leaves the road and collides into the pole. Such a situation is shown in figure 2. The figure shows the situation just after the impact on the pole of figure 1a, but equally applies to other poles according to the invention. The pole is constructed such that it comprises a first collision energy absorbing arrangement 20, which provides for absorption of a first amount of collision energy of the road vehicle or car R upon the collision impact of the car with the pole. Some deformation of the pole will take place and the pole will break at a fracture position 21. The fracture position may be specifically designed into the pole at a certain position by a dedicated arrangement or weakening as schematically shown in figure 1a, or by a stiffness change of the pole at such nominal fracture position, which might be provided by the opening in the pole provided for the door 13 as is shown in figure 1b (this weakening by the door could be compensated by an internal reinforcement, which would also introduce a stiffness change where the pole is most likely to break). The fracture position can be provided, for instance, by a shear-off arrangement as disclosed in EP 2 014 850 A. In the embodiment shown in figure 1b the first collision energy absorbing arrangement 20 and the fracture position are intrinsic characteristics of the pole since it is made from an aluminium or aluminium alloy tube having a diameter and wall thickness indicated above in at least a base section from ground level to about 1 meter above ground level. If a car collides into such pole with sufficient velocity the pole may break near the position where the car hits the pole or the base part below door 13 may deform first after which the pole will break in the region of door 13. Fracture location 21 in figure 1b is indicated for illustrative purposes only. The actual position of the fracture position 21 in the embodiment of figure 1b is not accurately known beforehand, whereas such will generally be the case for a shear-off arrangement as shown in figure 1a. The embodiments of figures 1a and 1b are examples only. A fracture position by a stiffness change as shown in figure 1b, for instance, could be employed in the embodiment of figure 1a, and the shear-off arrangement as shown in figure 1a could be employed in the embodiment of figure 1b as well.

[0036] Figure 2 shows that the pole has broken, but it is only a schematic representation. The fracture 21 shows to have a first fracture side 21a at a part of the pole having first connection 32 and a second fracture side 21b at a part of the pole having the second connection 33. The part of the pole having fracture side 21a and shown to stick out of the ground G will in a practical collision impact situation be deformed and substantially flat at the ground level. The other part of the pole having fracture side 21b will also deform.

[0037] By having the first collision energy arrangement 20 the pole absorbs a well defined amount of collision energy. Such absorption of collision energy results in a slowing down of the car with a certain velocity. A free object F within the car will, however, just after the collision impact continue to travel at the velocity of car and free object just before the collision impact. The head of the driver or a passenger could be considered as such a free object. Figures 4A and 4B graphically represent the situations just before and after the collision impact, respectively. Figure 4A shows that both car R and free object F at a position X0 just before the collision impact travel at a velocity V0. At a position X1 just after the collision impact the car R has slowed down to a velocity V1, while the object F still travels at the velocity V0. This provides for a velocity difference ΔV equal to $V0 - V1$ between car and free object.

[0038] After having travelled some distance ΔX with respect to the car, which is schematically indicated in figure 2, the free object (representing the head of the driver or a passenger) will hit a part of the car, such as the dashboard or the steering wheel. Such velocity difference between free object and car should be small enough to not cause damage (injury) to the free object, or only cause some light damage. Safety regulations, like the European EN 12767 normalisation standard that is applicable to such poles that are to be positioned along roads, therefore prescribe a maximum allowable value for the relative velocity at which the free object hits the car. In the EN 12767 standard the relative impact velocity of a free object is called the Theoretical Head Impact Value (THIV), which should not exceed 27 km/hour when the car hits the pole with a mandatory low speed of 35 km/hour or with a selected high speed exceeding 50 km/h. The pole according to the invention satisfies such safety regulation. The first collision energy absorbing arrangement provides for a gradual low energy absorption, which results in low ASI and THIV values.

[0039] Figure 4C shows the situation at which the free object F just has come into contact with the car at a position X2. At that point the velocities of car and free object F will have become equal. They are shown to be both a velocity V1 in the figure. Upon impact the car will experience a relative low energy absorption. The pole will break upon the collision impact. After breaking of the pole at first substantially no or limited energy absorption will occur.

[0040] The conditions under which such poles are test-

ed and for which the poles should satisfy the standard are prescribed: the car should have a mass of 900 ± 40 kg and collide into the pole at an angle of 20 degrees. A further condition is that the free object should have travelled a predetermined distance ΔX of 60 centimetres with respect to the car when its relative velocity or THIV is determined.

[0041] To satisfy the HE safety level in the EN 12767 standard the pole should satisfy a maximum prescribed exit velocity of the car at 12 meters after the collision impact, which is 12 meters after the initial position of the pole before the impact. At a collision impact velocity that exceeds a velocity at which the pole will break, the car will continue to travel at the velocity V1 after breaking of the pole. At the 12 meter position the car velocity should be reduced to a value that satisfies a required safety regulation. To this end the pole comprises a second collision energy absorbing arrangement to absorb a second amount of collision energy after the first amount has been absorbed and after the free object (or the head of a person in the car) has come into contact with the car in a travelling direction of the car. The car and free object will then be further decelerated jointly, which will not contribute to the relative collision velocity (THIV) of the free object against the car. This is schematically shown in figure 4D. When the second collision energy absorbing arrangement has come into action both the velocity of the car R and the free object F are decelerated further to a velocity value V2 that is smaller than the velocity V1 shown in figure 4C.

[0042] The second collision energy absorbing arrangement 30 comprises the steel cable 31 connected to both the first and second connections 32, 33. At the moment of the collision when the pole 10 is still intact, the length of the steel cable is still longer than the distance D between the first and second connections as measured along the pole by an excess length. The excess length is provided as a loop in the cable above the second connection 33 within the pole. This is to achieve a free spool off of the excess length of cable because in its upper part the pole will almost not be deformed during spool off. After the pole has broken and the car travels further after the collision the distance between the first and second connection will increase until the cable has been pulled taut. The excess length of cable provides an excess length range in between collision energy absorption by the first and second collision absorbing arrangements 20, 30, respectively. The excess length of cable is chosen such that the free object has travelled the predetermined distance ΔX with respect to the car for coming into contact with the car. In practice the excess length is at least 1.5 meter, in embodiments that have shown good performance over 2.5 meter, and in a well performing embodiment about 3.5 meter. The steel cable 31 connected to the first and second connections 32, 33 provides a pull arrangement acting to keep both the bottom and upper sections 11, 12 together and acting to exert a pulling force on the car R to further slow it down.

[0043] Figure 3 shows the situation in which the steel

cable 31 has been pulled taut between the first and second connections 32, 33. The pull arrangement of the steel cable connected to the pole also ensures that the pole is pulled under the car. The pole will then be deformed by the care and absorb the second amount of collision energy, which will substantially only occur after the excess length range of the pull arrangement as provided by the excess length of cable. Figure 3 is only a schematic representation and shows both the bottom and upper sections 11, 12 of the pole still largely intact. As indicated earlier, in practice they will be deformed and flattened.

[0044] The first connection 32 connecting the cable 31 with the pole is provided on the bottom plate 34 for the embodiment shown in figure 1a. The bottom plate is arranged substantially perpendicular to the pole in the ground G, so that it will provide resistance to the cable 31 when a car collides into the pole. The ground plate is not easily pulled out of the ground and will stay in place, which is important for the functioning of the pull arrangement. This is also achieved with a concrete base 38 where the end of the cable is connected for the embodiment shown in figure 1b.

[0045] The pull arrangement preferably comprises a steel cable 31 as disclosed. The excess length of the steel cable can be provided in a loop above the second connection 33 where it will not be obstructed in case it is pulled taut at a collision impact. One might also another pull element like a chain. However, a chain provides as such no rigidity so that the excess length of a chain can be provided above the second connection. The excess length of a chain will drop to a bottom section of the pole where it could be obstructed during a collision impact and deteriorate proper functioning of the first and second collision energy absorbing arrangements. It could be ensured by other measures that the excess length of a chain could be held above or near the second connection, but this would add complexity to the pole. A chain is further generally heavy with respect to the mass of the pole. A cable providing appropriate rigidity but also appropriate bending flexibility is preferred. A steel cable provides such characteristics and also provides enough strength to withstand the forces during a collision impact. Preferable, the steel cable has a coating or cladding of a plastic material to provide some lubrication when the cable slides or cuts through the pole after a collision impact. It shows in experiments that the cable may cut through the wall of the pole. The steel cable may be provided with some lubrication material, like graphite or graphite powder, on its surface around which some cladding like a plastic tube is provided. This will prevent high friction by the cable and the risk of cutting the cable at a collision impact. A coating or cladding also provides resistance against corrosion, and reduces noise when the cable might tap against the inside wall of the pole when it would move back and forth because of, for instance, wind forces. Having a tube around a steel cable provided with graphite powder also allows a "clean" working with the cable during production of the pole. The steel cable can

be of stainless steel. Other types pull elements providing the appropriate characteristics could be employed.

[0046] Figure 6 shows a specific embodiment of the cable 31 with a tube 40 provided around the cable. The cable is provided with graphite powder on its surface for lubrication purposes, which does not show in the figure. The tube 40 is substantially of plastic, but has a helically wound reinforcement 41, which may be made of steel, incorporated in the tube wall. Such helically wound reinforcement further reduces the risk of cutting of the cable by sharp edges of pole or car.

[0047] The pull element (cable) 31 keeps the bottom and upper sections of the pole together after a collision and prevents such pieces from flying around, which might cause further damage to persons or objects in the vicinity of the pole after a collision. It can further reduce the exit speed of the car after the collision to a very low velocity, which can be a stand-still of the car. Yet further, a pull arrangement like a cable can easily and efficiently provided to a pole.

[0048] By having the second collision energy absorbing arrangement the car will undergo high energy absorption of collision energy after a collision impact, which is according to the HE level in the EN 12767 standard. A pole that would satisfy the NE or LE level in the EN 12767 standard is upgraded to the HE level in the pole according to the invention. The pole as disclosed satisfies the HE level since it comprises both the first and second collision energy absorbing arrangements 20, 30 and an arrangement that provides for substantially no energy absorption and acts in between action by the first and second arrangements 20, 30 or during action by the first arrangement 20 upon a collision impact by a car. The high energy absorption arrangement provides that the car is slowed down to a safe velocity or to a standstill to safeguard the occupants of the car against the consequences of a second impact against objects, such as, for instances, trees, behind the pole. It also safeguards other persons or objects in the vicinity against the car that got off the road to collide into the pole. It can be configured such that it satisfies an occupant safety level of 1, 2 or 3 in accordance with the EN 12767 standard.

[0049] Figure 5 shows a graphical representation of the Acceleration Severity Index (ASI) before, during and after the collision, which is at a time 0 in the figure. The figure is based on an actual measurement on a car crashing into a pole according to the invention. Negative times are before the collision, and positive times after the collision. The time values are indicated in milliseconds. From such a measurement the THIV can be derived. The time intervals for which figures 4a, 4b 4c and 4d apply are indicated in figure 5 by 4a, 4b, 4c and 4d, respectively. The situation of figure 4a holds until the collision, so for negative times in figure 5. At collision the pole at first will deform, which gives rise to the first amount of energy absorption until the pole breaks at the point of maximum ASI in time interval 4b. At the end of time interval 4b a free object has travelled the predetermined distance with-

in and with respect to the car, and the THIV is calculated. For the measurement on which figure 5 is based, it was calculated to be below 27 km/h. At that moment time interval 4c starts, for which the situation of figure 4c applies. An occupant of the car will have come into contact with the car and during that time interval travel at the same speed as the car. At the end of time interval 4c the cable has been pulled taut and absorption of the second amount of energy starts. Time interval 4d starts at that time and shows another peak in the ASI due to the absorption of the second amount of energy by the second energy absorbing arrangement. Interval 4c also shows a small peak in the ASI, which is due to the actual construction of the pole. Important is that the ASI remains below the safety level S of 1.0 in figure 5 for all time intervals to achieve the best occupant safety level. The ASI is dimensionless.

[0050] At the moment of maximum ASI in time interval 4b the pole breaks and the excess length of the cable comes in. The cable is pulled taut at the end of time interval 4c and the start of interval 4d. The time interval L corresponds to an excess length of cable of 3.5 meter in pole used for the measurement, which excess length is pulled taut in about 0.17 seconds. The impact speed of the car of 903.5 kg was 99.1 km/h (27.53 m/s) at a time of 0 ms in figure 5.

[0051] The pole according to the invention can be incorporated in a lamp post 100 as described above. It can also be incorporated in a sign post, such as a post or pole carrying a traffic sign 51 or a billboard 52 as shown in figures 7a and 7b.

[0052] Further, the pole can also be employed as such as a safety object in certain locations to act as a crash barrier and protect car passengers and drivers from the risks of a collision impact against objects along roads. Such a location might be at the of an exit lane 70A from a road 70 where elongated crash barriers 60 arranged alongside the road would join at a crash barrier corner 61. This is shown in figure 8. The pole 10 according to the invention could then be placed in the position as shown. A distance in between pole 10 and crash barrier corner 61 should be chosen large enough for a vehicle to slow down after crashing into the pole, which could be around 12 meter or so. Figure 8 is only a schematic representation, which is not to scale and from which actual distances cannot be derived. The barrier corner can also be configured in turned-down configuration in which the barrier gradually lowers down and possibly into the ground level, as is schematically shown by 61a. The pole 10 according to the invention can be provided within such barrier corner 61a to prevent, inter alia, that cars driving onto the turned-down barrier corner 61a to become airborne.

[0053] Other uses and applications of the inventive traffic-safe and collision energy absorbing pole can easily be envisioned when having read and understood the foregoing description, the clauses below and the accompanying claims.

[0054] The embodiments disclosed in the foregoing are to be considered as examples only. Elements or parts described for one embodiment can, for example, be used in another embodiment as well.

CLAUSES

[0055]

1. A traffic-safe and collision energy absorbing pole (10) comprising

- a first collision energy absorbing arrangement (20) configured and arranged for absorbing a first amount of collision energy resulting from a collision impact of a road vehicle (R) with the pole; and
- a second collision energy absorbing arrangement (30) configured and arranged for absorbing a second amount of collision energy resulting from the collision impact, the second collision energy absorbing arrangement (30) being configured and arranged such as to only provide absorption of the second amount of collision energy a first time span after a start of absorption of the first amount of collision energy by the first collision energy absorbing arrangement.

2. The pole according to clause 1, wherein the first and second collision energy absorbing arrangements (20, 30) are configured and arranged such that substantially no collision energy is being absorbed after end of absorption of the first amount of collision energy by the first collision energy absorbing arrangement during a second time span until a start of absorption of the second amount of collision energy by the second collision energy absorbing arrangement.

3. The pole according to clause 1 or 2, wherein the second collision energy absorbing arrangement (30) is configured and arranged such as to provide absorption of the second amount of collision energy after the first time span during which a free object (F) in the road vehicle (R) will have travelled a predetermined distance (ΔX) with respect to the road vehicle as a result of the collision impact and absorption of the first amount of collision energy by the first collision energy absorbing arrangement (20).

4. The pole according to the preceding clause, wherein the first collision energy absorbing arrangement (20) is configured and arranged to absorb the first amount of collision energy such that the free object (F) after the predetermined distance (ΔX) will have a velocity (ΔV) with respect to the road vehicle (R) which is below a predetermined velocity value.

5. The pole according to any one of the preceding clauses, wherein the first arrangement (20) comprises a fracture position (21) at which the pole will at

least partially break under influence of the collision impact when an impact condition reaches or exceeds a predetermined value.

6. The pole according to any one of the preceding clauses, wherein the second arrangement (30) comprises a pull arrangement connected with the pole (10), the pull arrangement providing an excess length range (35) providing for the first and/or second time span until absorption of the second amount of collision energy.

7. The pole according to clause 5 and 6, wherein the fracture position (21) provides two fracture sides (21a, 21b) in a direction along the pole (10), and the pull arrangement is connected with the pole at both a first connection (32) on one fracture side (21a) and a second connection (33) on the other fracture side (21b).

8. The pole according to clause 7, wherein a length of the pull arrangement between the first and second connections (32, 33) is longer than a distance (D) between the first and second connections as measured along the pole by a excess length providing the excess length range (35), the excess length being chosen such that the pull arrangement will be pulled taut at the end of the excess length range for subsequent substantial absorption of the second amount of collision energy.

9. The pole according to clause 8, wherein the pull arrangement comprises a pull element (31) chosen from the group comprising at least a cable, a steel cable, a chain, a rope, a sling and a strap.

10. The pole according to clause 9, wherein the pull arrangement comprises a steel cable (31) comprising a plastic cladding.

11. The pole according to clause 10, wherein a lubrication material, like graphite or graphite powder, is provided on the steel cable and a tube (40), like a substantially plastic tube, is provided around the steel cable, in an embodiment the tube (40) having a helically wound reinforcement (41).

12. The pole according to any one of the preceding clauses and clause 8, 9 or 10, wherein the excess length is larger than 1.5 meter, in an embodiment larger than 2.5 meter, in an embodiment 3.5 meter.

13. The pole according to any one of clauses 7 to 12, wherein the first connection (32) is provided on a bottom plate (34) arranged substantially perpendicular to the pole (10) at a bottom section (11) of the pole, the bottom plate and bottom section provided in the ground (G) when the pole is positioned in an upright position in place.

14. The pole according to any one of clauses 7 to 12, wherein the first connection (32) is provided on a concrete base (38) arranged at a bottom section (11) of the pole, the concrete base and bottom section provided in the ground (G) when the pole is positioned in an upright position in place.

15. The pole according to any one of clauses 7 to

14, wherein the second connection (33) is provided in an upper section (12) of the pole, as seen when the pole is positioned in an upright position in place.

16. The pole according to clause 15, wherein the second connection (33) is provided such that the a length of the pull arrangement corresponding to the excess length (35) is provided as a loop above the second connection, as seen when the pole is positioned in an upright position in place.

17. The pole according to any one of the preceding clauses, wherein the pole (10) comprises a hollow tube, the second arrangement (30) being provided substantially within the tube.

18. The pole according to any one of the preceding clauses, wherein the pole (10) comprises aluminium and as such provides the first collision energy absorbing arrangement (20).

19. The pole according to clause 17 and 18, wherein the pole (10) comprises a substantially cylindrical tube having a diameter between 150 and 250 mm and having a wall thickness between 2 and 5 mm in at least a section between ground level and 1 meter above ground level, as seen when the pole is positioned in an upright position in place.

20. The pole according to any one of the preceding clauses, wherein the conditions of the impact are predetermined by an applicable standard.

21. The pole according to clause 20, wherein the conditions of the impact are predetermined by the European EN 12767 normalisation standard.

22. The pole according to clause 20, wherein the first collision energy absorbing arrangement (20) is configured and arranged such that a theoretical head impact velocity (THIV) satisfying an occupant safety level in accordance with the European EN 12767 normalisation standard is provided.

23. The pole according to clause 21 or 22, wherein the second collision energy absorbing arrangement (30) is configured and arranged such that the pole satisfies the HE energy absorption category and an occupant safety level 1, 2 or 3 at a predefined high speed collision impact velocity, such as at 50 km/hour, 70 km/hour or 100 km/hour.

24. A lamp post (100) comprising a pole (10) according to any one of clauses 1 to 23.

25. A sign post, such as a traffic sign post, comprising a pole (10) according to any one of clauses 1 to 23.

26. A method for absorbing the collision energy resulting from a collision impact of a road vehicle (R) with a pole (10), the method comprising the steps of

- providing the pole with a first collision energy absorbing arrangement (20) configured and arranged for absorbing a first amount of collision energy resulting from the collision impact of the road vehicle (R) with the pole;
- providing the pole with a second collision energy absorbing arrangement (30) configured and ar-

- ranged for absorbing a second amount of collision energy resulting from the collision impact;
- having the road vehicle collide with the pole;
 - in a first phase absorbing the first amount of collision energy; and
 - in a second phase subsequent to the start of the first phase absorbing the second amount of collision energy, the second phase being started a first time span after a start of the first phase.

27. The method according to clause 26, wherein substantially no collision energy is absorbed after an end of absorption of the first amount of collision energy during a second time span until absorption of the second amount of collision energy.

28. The method according to clause 26 or 27, wherein the first time span is chosen such that a free object (F) in the road vehicle (R) will have travelled a predetermined distance (ΔX) with respect to the road vehicle as a result of the collision impact and absorption of the first amount of collision energy by the first collision energy absorbing arrangement (20).

Claims

1. A traffic-safe and collision energy absorbing pole (10) comprising
 - a first collision energy absorbing arrangement (20) configured and arranged for absorbing a first amount of collision energy resulting from a collision impact of a road vehicle (R) with the pole; and
 - a second collision energy absorbing arrangement (30) configured and arranged for absorbing a second amount of collision energy resulting from the collision impact, the second collision energy absorbing arrangement (30) being configured and arranged such as to only provide absorption of the second amount of collision energy a first time span after a start of absorption of the first amount of collision energy by the first collision energy absorbing arrangement.
2. The pole according to claim 1, wherein the first and second collision energy absorbing arrangements (20, 30) are configured and arranged such that substantially no collision energy is being absorbed after an end of absorption of the first amount of collision energy by the first collision energy absorbing arrangement during a second time span until a start of absorption of the second amount of collision energy by the second collision energy absorbing arrangement.
3. The pole according to claim 1 or 2, wherein the first arrangement (20) comprises a fracture position (21)

at which the pole will at least partially break under influence of the collision impact when an impact condition reaches or exceeds a predetermined value.

4. The pole according to any one of the preceding claims, wherein the second arrangement (30) comprises a pull arrangement connected with the pole (10), the pull arrangement providing an excess length range (35) providing for the first and/or second time span until absorption of the second amount of collision energy.
5. The pole according to claim 3 and 4, wherein the fracture position (21) provides two fracture sides (21a, 21b) in a direction along the pole (10), and the pull arrangement is connected with the pole at both a first connection (32) on one fracture side (21a) and a second connection (33) on the other fracture side (21b).
6. The pole according to claim 5, wherein a length of the pull arrangement between the first and second connections (32, 33) is longer than a distance (D) between the first and second connections as measured along the pole by a excess length providing the excess length range (35), the excess length being chosen such that the pull arrangement will be pulled taut at the end of the excess length range for subsequent substantial absorption of the second amount of collision energy.
7. The pole according to claim 6, wherein the excess length is larger than 1.5 meter, in an embodiment larger than 2.5 meter, in an embodiment 3.5 meter.
8. The pole according to any one of claims 5 to 7, wherein the second connection (33) is provided in an upper section (12) of the pole, as seen when the pole is positioned in an upright position in place, the second connection (33) being provided such that the a length of the pull arrangement corresponding to the excess length (35) is provided as a loop above the second connection, as seen when the pole is positioned in an upright position in place.
9. The pole according to any one of the preceding claims, wherein the pole (10) comprises a hollow tube, the second arrangement (30) being provided substantially within the tube.
10. The pole according to any one of the preceding claims, wherein the pole (10) comprises aluminium and as such provides the first collision energy absorbing arrangement (20).
11. The pole according the claim 9 and 10, wherein the pole (10) comprises a substantially cylindrical tube having a diameter between 150 and 250 mm and

having a wall thickness between 2 and 5 mm in at least a section between ground level and 1 meter above ground level, as seen when the pole is positioned in an upright position in place.

5

12. A lamp post (100) comprising a pole (10) according to any one of claims 1 to 11.

13. A sign post, such as a traffic sign post, comprising a pole (10) according to any one of claims 1 to 11.

10

14. A method for absorbing the collision energy resulting from a collision impact of a road vehicle (R) with a pole (10), the method comprising the steps of

15

- providing the pole with a first collision energy absorbing arrangement (20) configured and arranged for absorbing a first amount of collision energy resulting from the collision impact of the road vehicle (R) with the pole;

20

- providing the pole with a second collision energy absorbing arrangement (30) configured and arranged for absorbing a second amount of collision energy resulting from the collision impact;

25

- having the road vehicle collide with the pole;

- in a first phase absorbing the first amount of collision energy; and

- in a second phase subsequent to the start of the first phase absorbing the second amount of collision energy, the second phase being started a first time span after a start of the first phase.

30

15. The method according to claim 14, wherein substantially no collision energy is absorbed after an end of absorption of the first amount of collision energy during a second time span until absorption of the second amount of collision energy.

35

40

45

50

55

Fig. 1a

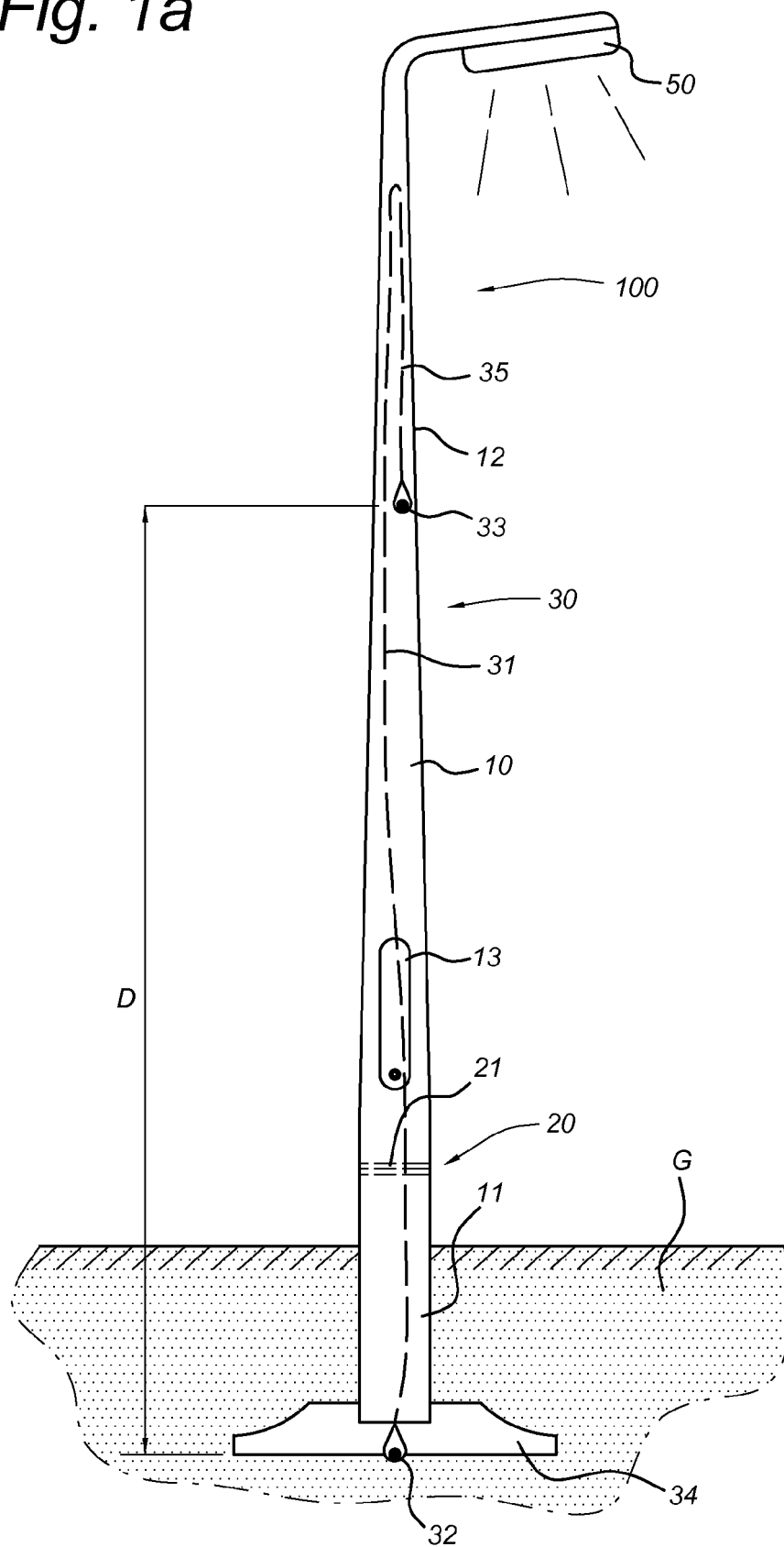


Fig. 1b

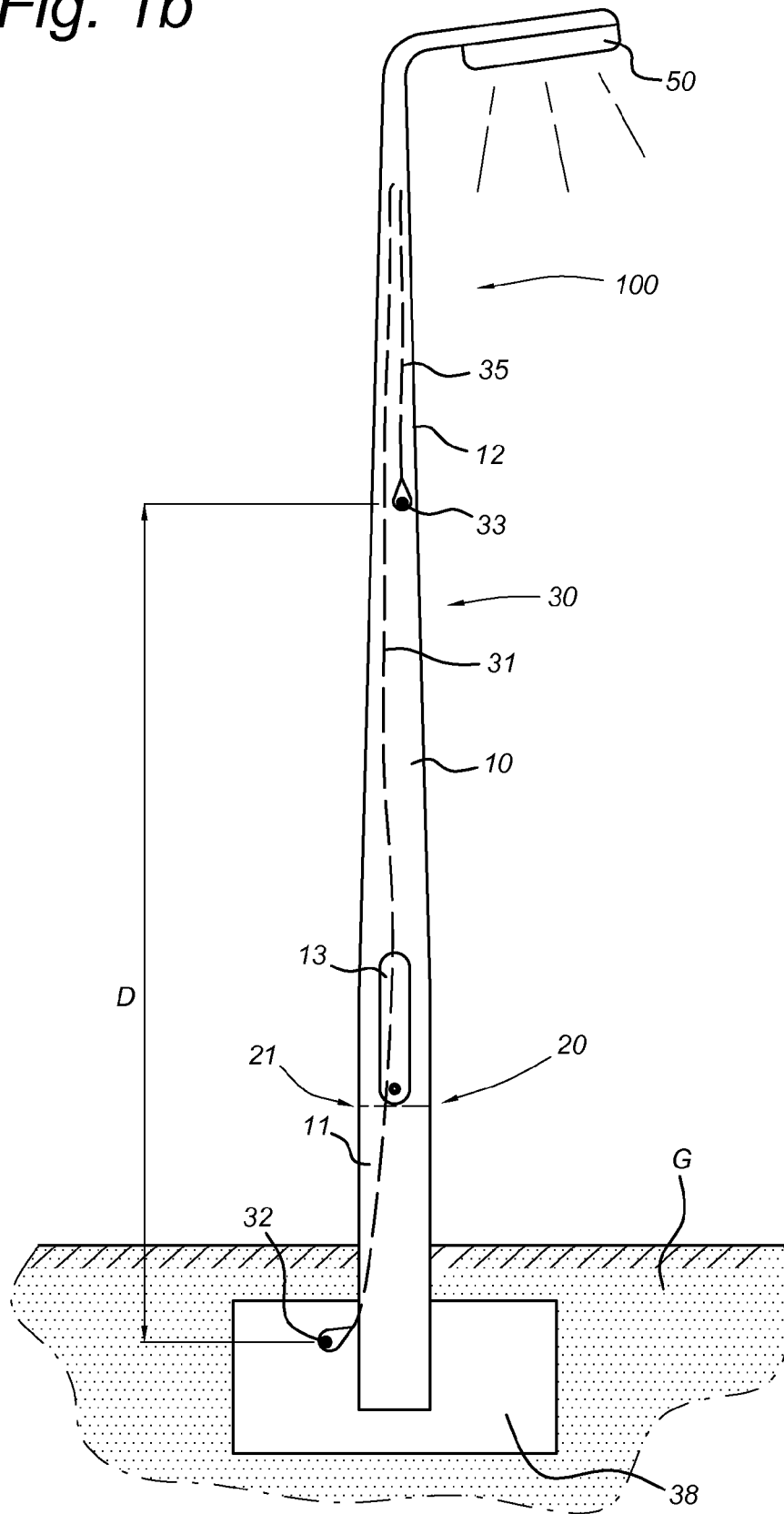


Fig. 2

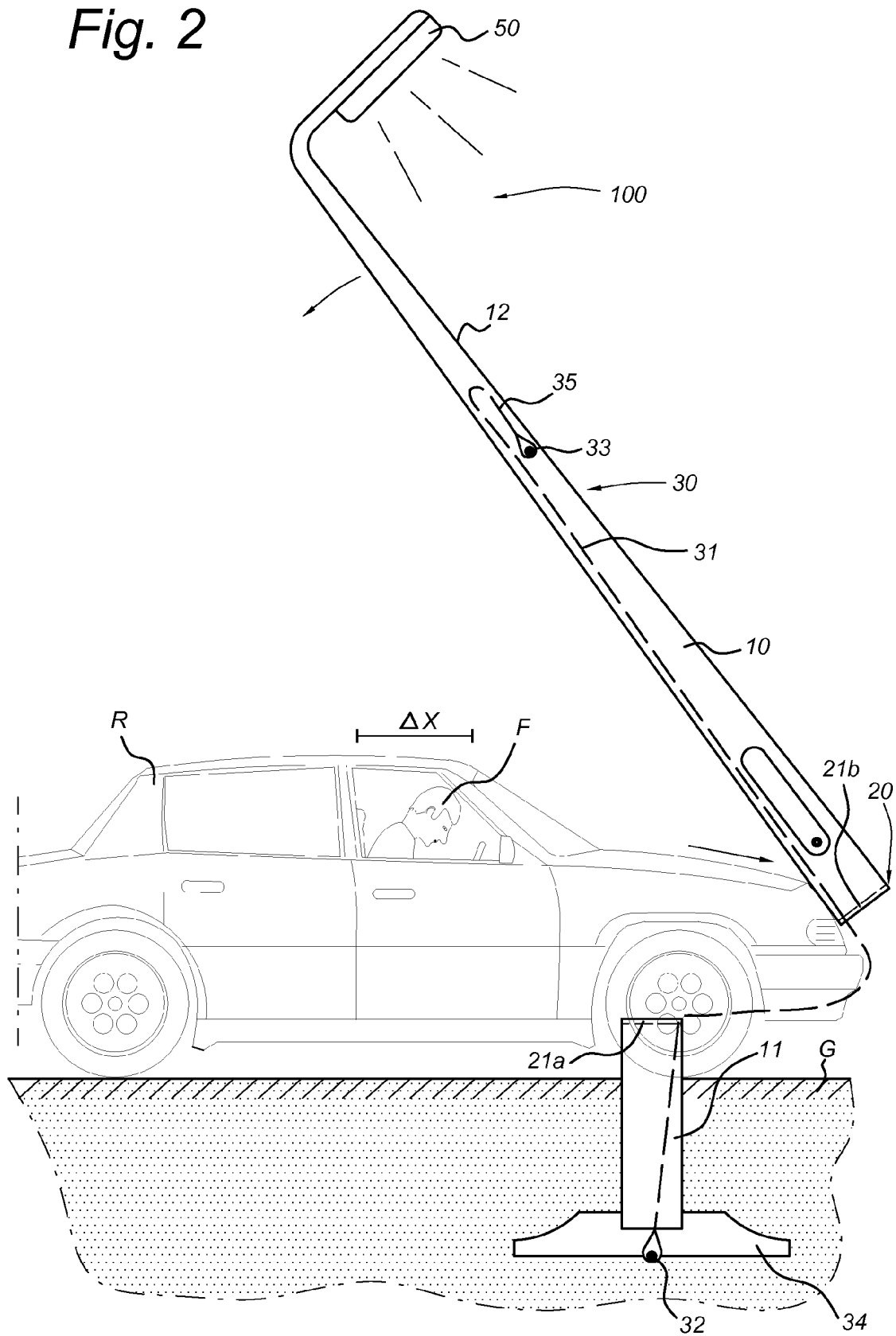


Fig. 3

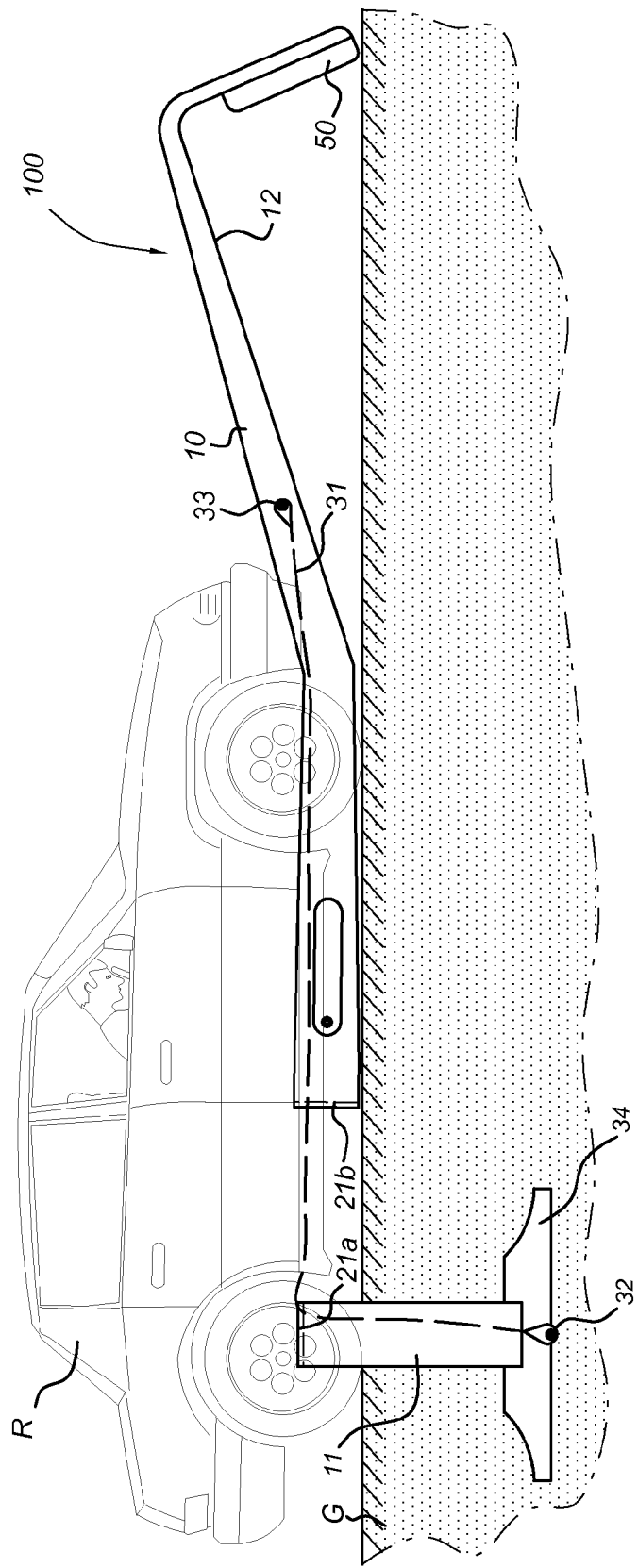


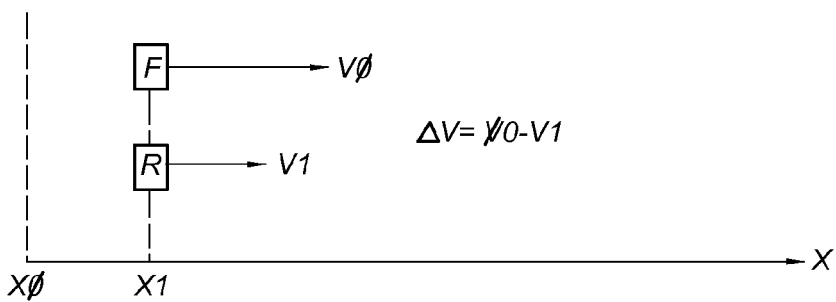
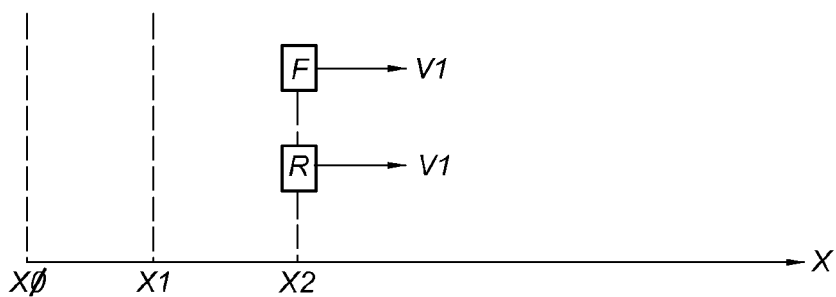
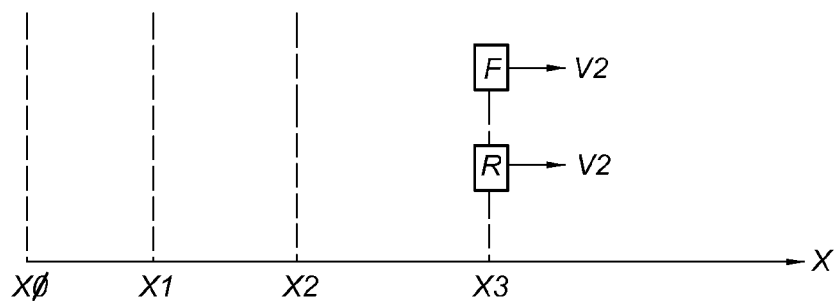
Fig. 4a*Fig. 4b**Fig. 4c**Fig. 4d*

Fig. 5

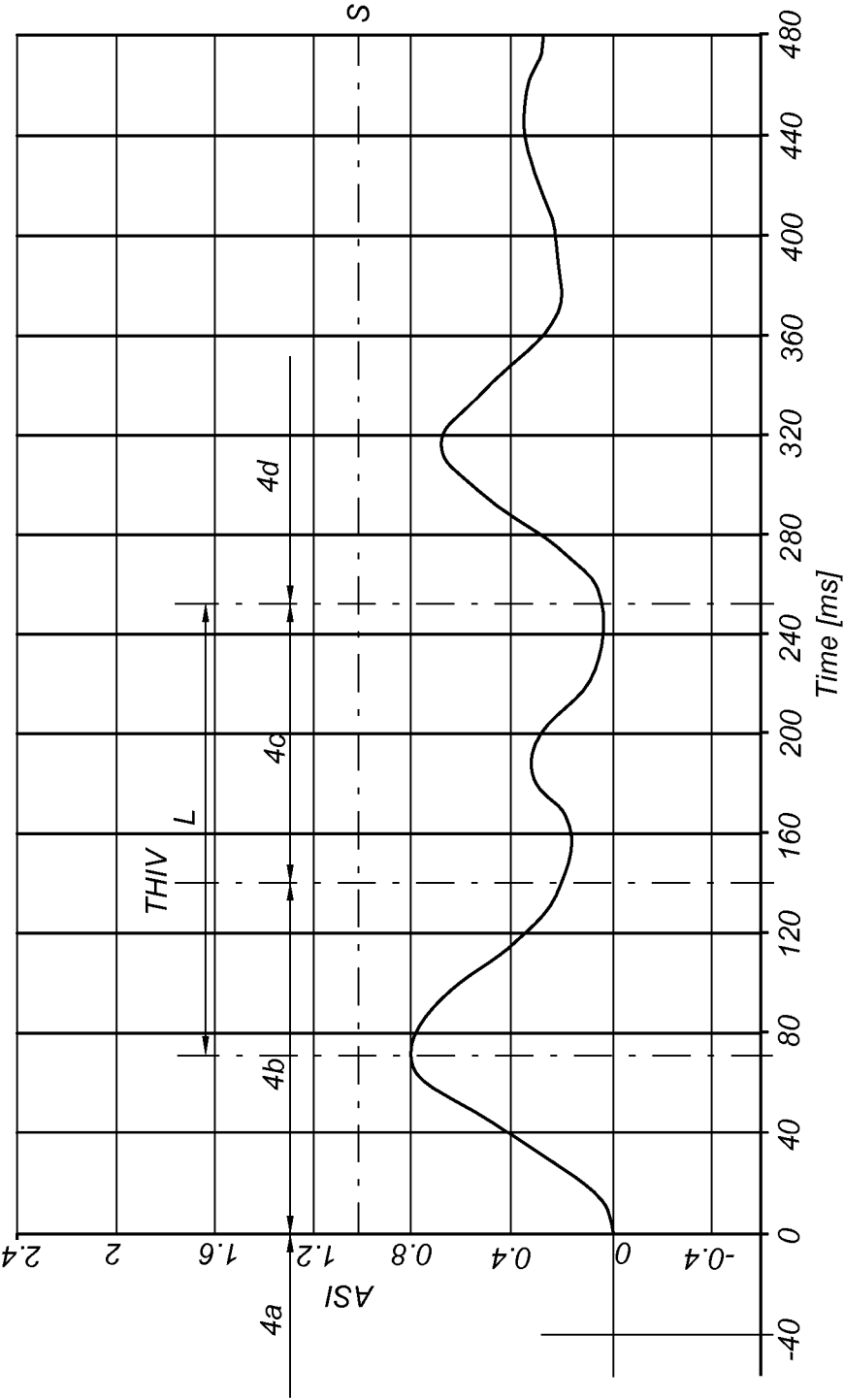


Fig. 6

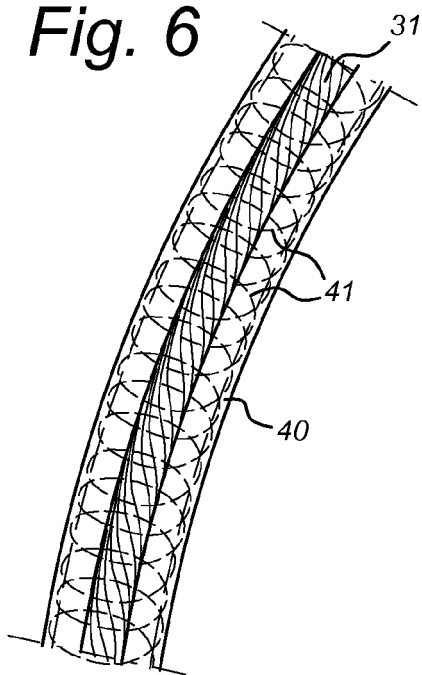


Fig. 7a

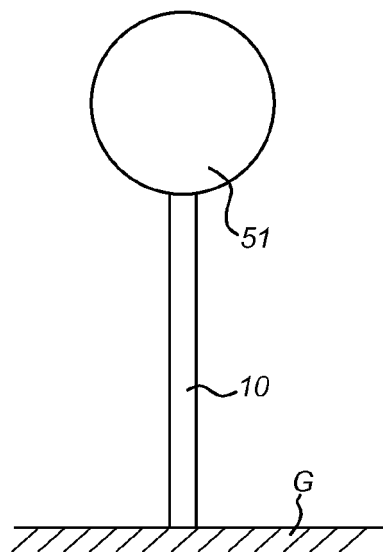


Fig. 7b

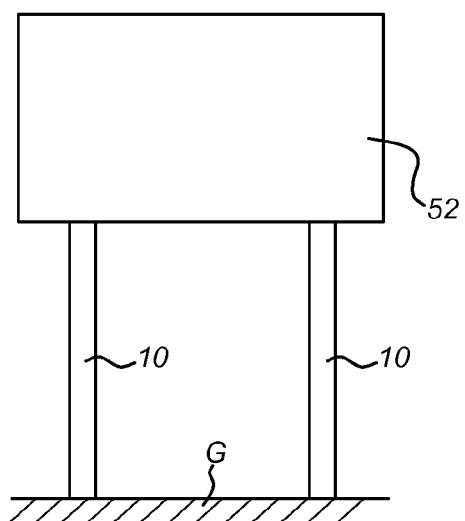
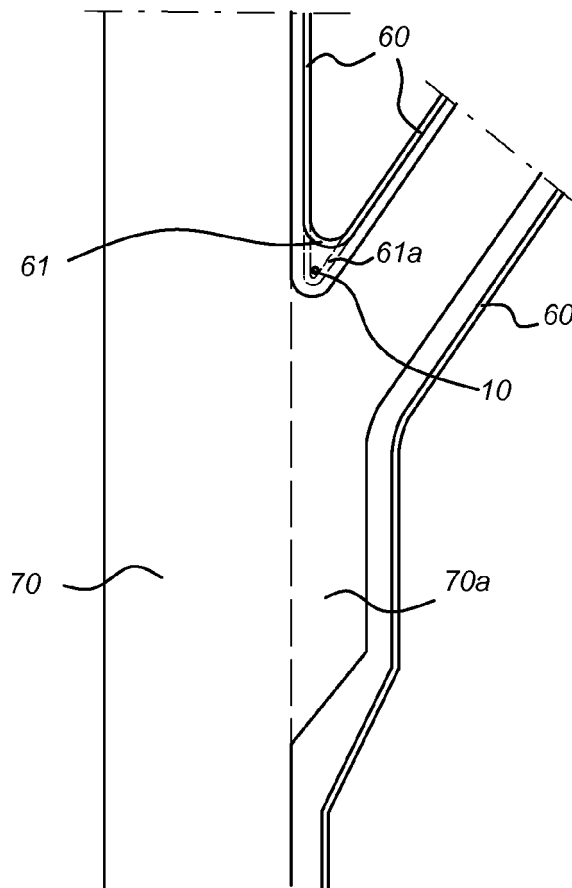


Fig. 8





EUROPEAN SEARCH REPORT

Application Number
EP 13 19 4665

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 85/02636 A1 (GEBELIUS SVEN RUNO VILHELM) 20 June 1985 (1985-06-20) * the whole document *	1-7, 12-15	INV. E01F9/018
X	DE 22 11 237 A1 (SIEMENS AG) 13 September 1973 (1973-09-13) * the whole document *	1,2,4, 12-15	
X	WO 2011/120069 A1 (GRIFFITHS MICHAEL [AU]; JARVIE JOHN MICHAEL [AU]) 6 October 2011 (2011-10-06) * page 12, line 7 - page 14, line 21; figures 5-7 *	1,3, 12-14	
X	DE 28 30 875 A1 (VULKAN WERK GMBH) 31 October 1979 (1979-10-31) * the whole document *	1-3, 12-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			E01F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 24 March 2014	Examiner Flores Hokkanen, P
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 19 4665

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

24-03-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 8502636 A1	20-06-1985	AT 37056 T	15-09-1988
		AU 577822 B2	06-10-1988
		DE 3473896 D1	13-10-1988
		EP 0193532 A1	10-09-1986
		JP S61500677 A	10-04-1986
		SE 445656 B	07-07-1986
		US 4747725 A	31-05-1988
		WO 8502636 A1	20-06-1985

DE 2211237 A1	13-09-1973	NONE	

WO 2011120069 A1	06-10-2011	CA 2794871 A1	06-10-2011
		EP 2553173 A1	06-02-2013
		US 2013008096 A1	10-01-2013
		WO 2011120069 A1	06-10-2011

DE 2830875 A1	31-10-1979	DE 2830875 A1	31-10-1979
		EP 0006984 A1	23-01-1980

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 2014850 A [0006] [0035]
- WO 2011120069 A1 [0007]
- WO 03033819 A1 [0008]
- WO 8502636 A1 [0009]
- DE 2830875 A1 [0010]