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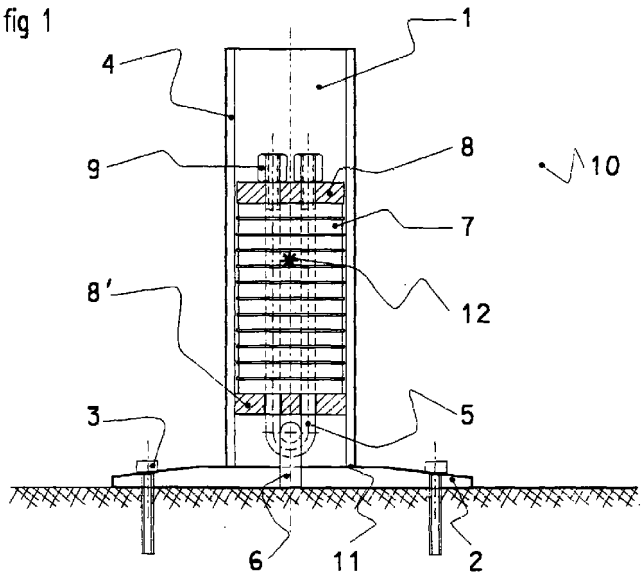
(54) Impact-resistant and energy-absorbing safety post

(57) A safety post (10) is described to safeguard objects from impact by moving objects, the post having a double tilting action comprising a first elastic impact-absorbing tilting action to reduce damage to both post and object, followed by a second rigid action to arrest the moving object. An anchor plate (2) for anchoring the post to a foundation surface is provided, the anchor plate (2) having two major surfaces, the first major surface being provided for being placed in contact with the foundation surface at which time the second major surface is remote from the foundation surface.

The post includes a tiltable rigid housing (4) which extends from a position abutting or adjacent to the second major surface of the anchor plate as well as a an energy absorbing mechanism located entirely within the outer envelope of the housing (4), the energy absorbing mechanism comprising one or more resilient elements which are deformed when the post is tilted by the impact of the moving object.

fig 1



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Description

[0001] The present invention concerns a safety post and/or barrier to moving vehicles and especially a post or barrier for the protection of property, persons and/or animals and/or objects from damage by moving vehicles while, in addition or optionally reducing damage to the vehicle to a minimum especially with low speed impacts.

TECHNICAL BACKGROUND

[0002] Safety posts are known, for instance in US Patent No. 3,693,940 and US Patent Number 4,729,690 energy absorbing and auto adjustable posts are described, with a steel spring mechanism to be found in socket beneath the ground level. Moreover, these posts do not have the capacity to halt vehicles elasticity, because they tilt over so far that they become horizontal under a sufficiently high impact. The placing of and the maintenance of such posts are labour-intensive because of their anchoring system in the ground which can fill up with water. These posts are primarily meant to serve as non-destructive road marks. An even lighter design of such posts can be found in the field of skiing, for instance in US Patent Number 4,806,046.

[0003] In patent application EP 0,571,082 an impact-absorbing post is described that acts at the same time as a barrier for vehicles. The energy absorbing mechanism is placed in a rigid socket attached to the ground. If the socket is not counter-sunk into the ground only a part of the visible construction has energy-absorbing properties. Low lying objects such as the loads of fork-lift trucks can hit the socket and not the post with resulting damage to the load.

[0004] US Patent Number 5,566,926 describes a resilient mounting system in which the energy absorbing mechanism is a rubber ring located under the end of the tube forming the post housing. The rubber ring is unsupported and is exposed to the atmosphere. Unsupported rubber rings have low energy absorbing characteristics. Exposed rubber can degrade.

[0005] An object of the invention is to provide a more compact safety post or barrier in the broadest sense of the word that, as a result of an impact by a moving object, will move and absorb energy and stop the object while reducing installation costs.

[0006] Another object of the invention is to provide a safety post or barrier that can restrain objects from close to the ground up to the full height of the post.

SUMMARY OF THE INVENTION

[0007] The present invention may provide a safety post or barrier comprising an above ground part that allows a limited elastic impact- and energy-absorbing tilting motion when an object collides with the post or barrier at low speed. This tilting motion absorbs the kinetic energy of the moving object by deformation of an elastic or resilient material while damage to the post or barrier and damage to the colliding object are minimised. With collisions at higher speed the tilt angle increases and the post or barrier becomes more like a rigid steel construction, whereby the objects or persons to be protected behind the post or barrier are still safeguarded to the full extent. The post is anchored to the ground or other suitable surface such as road surface, concrete, etc. by means of a bottom anchor plate. The impact and energy absorbing mechanism is incorporated in the above ground part of the post, that is it lies on the same side of the anchor plate as the part of the post which is to receive the impact. The energy absorbing elastic mechanism may comprise a single compressible rubber or elastomer block or a stack of disc-shaped rubber or elastomer elements, for instance. The use of springs is included within the scope of the present invention, e.g. a stack of high pressure disc springs (Bellvue disks). The post is designed so that tilt movements of the post are translated into deformation, in particular compression of the elastic energy absorbing mechanism, e.g. the rubber or elastomeric block or stack. The lateral extension of the rubber or elastomer block or stack under compression may be confined or limited by an outer rigid tube whose inner diameter is the same as or somewhat larger than the outer diameter of the block or stack. The allowed tilt direction may be 360°(the moving object may hit from any direction) or may be less than this if desired. The allowed tilt angle before the post blocks and becomes rigid may be selected for the application but is preferably in the range 15 to 40° from the vertical. Larger tilts are possible but there is the danger that the post acts like a ramp and the moving vehicle rides up the post if the angle to the vertical gets too large. The compression of the elastic energy absorbing material such as a rubber block may be provided by a restraining member which is pivotably connected to the base plate. Preferably, the restraining member is adjustable in length so that the elastic material may be pre-compressed to a desired degree in order to provide specific force versus tilt characteristics to the post. The pre-compression of the elastic resilient elements also affects the angle of tilt before the post behaves like a rigid post.

[0008] To make the protection more efficient and to assist in reducing the impact, the post may optionally comprise a detection mechanism. Optionally this mechanism may activate an alarm. In accordance with a particular embodiment of the present invention at least two posts may be connected together by flexible tie members such as chains to form a barrier so that movement of one safety post causes movement of adjacent posts thus sharing the load over several posts and also providing protection between posts.

[0009] The post or barrier in accordance with the present invention can be used advantageously in places with slow traffic or vehicles like parking spaces, for the

protection of machinery or other installations, for the protection of pedestrians, for the protection of indoor or outdoor passages of all kinds, even for the protection against vandalism of businesses by its barricading function. The impact absorption and the elastic properties can be adapted to the expected impact by adjustment of the material (hardness) of the rubber or elastomeric block or of the number and type of rubber or elastic disc elements. Optionally or additionally the degree of pre-compression may be adjusted by altering the length of the restraining member.

[0010] The action of the post under a high impact by a moving object comprises two steps. In a first step, the post will tilt as a result of the impact. This will lead to a deformation of the elastic elements in the post. Preferably the deformation is elastic, that is resilient. The post itself does not deform appreciably. After the arrest of the impact, the post will return to its original position once the object has been removed. During the deformation of the elastic elements, the energy of the impact will be absorbed by the latter. The elastic elements are positioned inside the above-ground part of the post. They comprise one or several rubber or elastomeric discs kept together by a restraining member made for instance, from metal, e.g. a steel clamp which may be a straight rod or a U-shaped member, for instance. The restraining member is rotationally anchored to the base plate. For instance the anchor plate may have a ring through which a U-shaped clamp is passed. Alternatively the anchor plate may include a socket into which a ball fits which is attached to a rod restraining member. The restraining member and the anchor plate form a resilient hinge. The plate is anchored to the underlying surface by means of bolts or other rigid anchors.

[0011] Depending on magnitude of the envisaged elastic deformation and the expected impact energy of the moving objects under the envisaged circumstances, e.g. impacting, cars, trucks, fork-lift trucks, the elastic elements can be adapted in density, hardness, stiffness or in number or the degree of pre-compression in order to absorb differing imposed kinetic energies and to provide different resilient forces.

[0012] After maximal exploitation of the energy-absorption via the elastic shock-absorbing elements, e.g. the elastomeric discs, the rest impact is absorbed by the metal structure of the post that now acts as a rigid construction. Also in this situation the magnitude of the expected impact determines the dimensions of the rigid post, for example determines the choice of materials, the thickness of these materials as well as their hardness or strength. At this higher level of impact the first design criterion is the protecting or barricading property as safeguarding element of objects or persons to be protected rather than trying to prevent damage to the impacting object.

[0013] The post may also be equipped with a motion detection and an alarm system. This intends to render the protection more efficient by warning the driver of the impacting vehicle and, if necessary, the persons in the surroundings. This timely warning allows the driver to react and to prevent irreversible damage to post and/or vehicle. The detection can be carried out by a multitude of sensors; the alarm system can be any suitable alarm system, e.g. auditory and/or visual.

[0014] The detector may be mounted in the post and can include a motion, a tilt, a vibration or an acceleration sensor. The alarm can be located in or affixed to the outside of the post. The alarm may be implemented in different ways to provide the most adequate monitoring, either in an auditory way, either visually using rotating (flashing) lights, flashing lights, stroboscopes etc., or using both ways. The alarm can also be connected to an electronic registration apparatus or to telemetry to record accurate impact data for inspection or police investigation purposes.

[0015] The most advantageous use of the post is to be found in applications where an impact at low speed occurs for example, on the shop floor where fork-lift trucks operate, loading or landing wharves where trucks usually have to position backwards, all operations near the positioning of goods onto transport vehicles or production machinery and places where persons should be safeguarded. This may be, for instance, everywhere where persons and objects require secure and high quality protection against collisions, for instance, also the prevention of vandalism to shop-windows, road marking, fencing of locations dangerous to vehicles, protection of fences and gates, safety and crash barriers and safeguarding of persons in all kinds of situations.

[0016] In general, dimensions and materials of the post may be chosen so that, moving objects exerting forces of at least 100 kN, or forces of at least 200 kN or forces up to 400 kN can be resisted. via the energetic impact absorption, without permanent deformation. The post may be designed to arrest the motion of a 10 tonne, 20 tonne, 30 tonne or 40 tonne vehicles moving at speeds less than 5 kmph within the elastic deformation of the post, i.e. by tilting or by a combination of the elastic tilting and rigid restraint. In some cases, either to reduce the dimensions of the post or to increase the width across which the protection must be effective, two or more posts can be interconnected, e.g. by a rigid or flexible tie such as one or more chains or hawsers.

[0017] The post described in this invention has certain specific advantages. Mounting can be done by simple anchoring of the base plate to an existing flat surface without having to excavate a hole. Simple bolt connections can be used. The absence of elements beneath the ground level makes major excavation unnecessary and prevents submersion and seeping of water into the post with subsequent corrosion.

[0018] During maintenance or replacement of mechanical parts, the post can be disassembled on the spot with simple tools and if necessary pans/components can be replaced. All energy absorbing elastic ele-

ments are above ground and inside the post and are located at easily accessible places.

[0019] Each point over the entire height of the post is an effective point for receiving the application of external forces without loss of the impact-absorbing properties. The range of the impact-absorption of an individual post can easily be adapted to changing circumstances by adapting the number and the type of the elastic mechanism, e.g. the rubber block or discs, or the degree of pre-compression (i.e. length of the restraining member) in situ. The optimal operation of the post is not influenced by the direction of the collision. The working radius (allowed impact direction) is 360° or less as desired.

[0020] The dependent claims define independent and separate embodiments of the present invention. The present invention will now be described with reference to the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1 is a schematic representation of a first embodiment of a safety post in accordance with the present invention.

Fig. 2 shows the safety post of Fig. 1 in a position of maximal elastic tilt

Fig. 3 is a schematic representation of a second embodiment of a safety post in accordance with the present invention.

Fig. 4 shows a detail of the post shown in Fig. 3.

Fig. 5 is a schematic representation of a third embodiment of a safety barrier in accordance with the present invention.

DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENTS

[0022] The present invention will be described with reference to certain embodiments and with reference to certain drawings, but the present invention is not limited thereto but only by the claims.

[0023] A first embodiment of the present invention is shown schematically in Figs. 1 and 2. The safety post 10 comprises a base plate or anchor plate 2, which may be attached to a flat surface by means of bolts 3. The base plate 2 is preferably made from a strong non-brittle material such as steel. The external housing 4 of the post 10 preferably comprises a robust, rigid cylindrical member, for instance a pipe, preferably thick-walled and made of a material which is robust, non-brittle, non-corrosive or corrosion protected, for example a steel pipe. The cylindrical member 4 extends from a position at or adjacent to the anchor plate 2 up to the top of the post 10.

[0024] An energy absorbing mechanism is provided within the post 10 and on the side of the anchor plate 2 which is remote from the surface to which the plate 2 will be fixed. The energy absorbing mechanism may include a restraining member such as a U-bracket 5 pivotably anchored to the plate 2 via a U-shaped member or an eye 6. The base plate 2 by preference is made out of cast iron or cut out of a rigid flat steel plate with a welded on eye 6.

[0025] The energy absorbing mechanism may comprise several rubber or elastomeric synthetic discs 7, separated by thin circular discs with a diameter almost equal to the inner diameter of the housing 4 in the case that several discs 4 are used. The energy absorbing mechanism is fixed by means of two pressure plates 8 and 8'. By means of hexagon nuts the discs 7 are clamped and the energy absorbing mechanism is kept together. The lower pressure plate 8' may be welded to the inner side of the housing 4 of post 10. The neregy absorbing mechanism is substantially entirely above.

[0026] Fig. 2 shows the post 10 of Fig. 1 when tilted from the vertical by an applied force. The bottom of the cylindrical member 4 has a pivot rim, pivot ring or pivot line 11. When a force is applied to the post 10 it tends to incline or tilt by pivoting about a point on the pivot rim 11 which is most remote from the application point of the force. As it pivots on this point, the distance between the centre of gravity 12 of the cylinder 4 and the eye 6 increases. As the length of the bracket 5 remains constant, the energy absorbing mechanism is compressed. The force applied to the post 10 causes a compression of the rubber discs whereby the distance between the two pressure plates 8 and 8' is reduced. The lateral extension of the discs is restrained by the housing 4. At the point that the rubber discs are compressed at their maximum, the largest tilt of the post 10 and thus the largest angle of tilt is reached. In the free space 1 above the energy absorbing mechanism there is typically enough space to house sensors and/or a auditory and/or visual alarm. The auditory and/or visual alarm system can project through holes in the upper part of the post housing 4.

[0027] The cross-section of the housing 4 is preferably circular if a uniform tilt force independent of the direction of impact is desired. If however, it is desired to have a stiffer post in one direction than in a direction 90° thereto, the housing 4 may be given an oval cross-section. Such asymmetric load patterns are useful when the posts are used to guid traffic through an opening or aver a bridge. Within the opening or on the bridge the majority of impacts are glancing blows as a vehicle driver makes a small error in driving direction. The tilt angle before blocking can be reduced to a small angle such as 5° in the direction perpendicular to the road direction. The small tilt means that the vehicle is guided back onto a straight path quickly. Parallel to the road direction the tilt may be made larger so that occaisonal high angle impacts are arrested over a longer distance. Hence the major axis of the oval cross-section of the post housing 4 is placed perpendicular to the road

direction.

[0028] The entire height of the post 10 is envisaged to be between 50 and 160 cm, with a typical height of 80 cm. The outer diameter of the post may be, for example, between 10 cm to 40 cm, with a typical diameter of 22 cm. The wall thickness of the post housing 4 can be, for example between 5 mm and 20 mm, with a typical thickness of 15 mm. The base plate 2 can be made out of a solid flat plate, though preferably the base plate 2 comprises a cast iron plate having a diameter, for example, between 35 and 70 cm, with a typical diameter of 40 cm. The envisaged movement of the top of the post 10 may be, for example, 25 and 50 cm, with a typical tilt of 40 cm. The base plate 2 can be anchored with bolts, expansion bolts or other means of anchorage.

[0029] The choice of the elastic material of the energy absorbing mechanism, the number and density of elastomeric disks, the degree of pre-compression by the restraining member is dependent on the expected normal mean impact load. The mass of the impacting objects such as vehicles and the speed at which they impact the safety post. should be used as parameters for dimensioning the post 10 especially the energy absorbing mechanism.

[0030] A second embodiment of the present invention is shown schematically in Figs. 3 and 4. The post 20 comprises a housing 24 which comprises, over at least a part of its length, a cylindrical tube 34 pivotally attached to a base or anchor plate 22 via a connection 33. At the bottom of the tube 34 (adjacent the plate 22) a pivot rim or ring 31 is provided which may be made from hardened steel and is integral with or welded to the housing 24. The portion of the pivot ring 31 which bears onto the plate 22 may be rounded and may fit into a matching annular hollow 35 in plate 22.

[0031] The energy absorbing mechanism comprises a elastic member, for example a block of rubber 27 clamped between two rigid plates 28 and 28' by means of a restraining member such as a rod or bolt 25. The head of bolt 25 is located in a hollow truncated semi-spherical cavity 36 within a connection block 37 which is fixed to plate 22, e.g. by welding or bolting. The bolt 25 passes through a truncated semi-spherical member 38 whose periphery matches the shape of the hollow 36 and is pivotably and optionally rotatably mounted therein. Member 38 may be made of bronze. The end of bolt 25 has a screw thread onto which a nut 29 may be placed to clamp the rubber block 27. Movement of the nut 29 alters the degree of pre-compression of the rubber block 27.

[0032] When post 20 is subjected to an impact it tends to tilt by pivoting about a point on the pivot rim 31. This increases the distance between the centre of gravity 32 of the housing 24 and the connection block 37. As rod 25 remains constant in length the rubber block is compressed. Preferably the inner diameter of tube 24 is made equal to or slightly larger than the outer diameter of the rubber block 27 so that any sideways expansion of block 27 during compression is limited or prevented by the tube 24.

[0033] At a certain angle of tilt, the rubber block 27 is compressed to its limit. An increase in impacting force by the post 20 as a solid (rigid) construction. As explained with respect to the previous embodiment, the angle of tilt at which this happens depends on the dimensioning and materials used in the construction of post 20.

[0034] A third embodiment of the present invention is shown in Fig. 5. It comprises at least two posts 10, 20 in accordance with the present invention (described above) which are linked by at least one transverse member or tie 42. Member 42 may be rigid but it is preferred in accordance with this embodiment if member 42 is flexible, e.g. a metal hawser or chain. The member 42 should be installed in such a way that when an object impacts against the member 42, tension is applied to one or both of the posts 10, 20 causing it or them to tilt. By this means an impact energy may spread among two or more posts 10, 20. Also an impact between two posts can be safely arrested.

[0035] In addition to the transverse member or tie 42 additional transverse members or ties 43 may be provided. Optionally cross-members 44 may be provided between two or more transverse members 42, 43 in order to form a catch net. This net may also catch and restrain flying or loose objects.

[0036] From the above embodiments it will be appreciated that the energy absorbing mechanism is located entirely within the envelope of the housing 4, 34 which prevents external tampering with or wilful damage of the energy absorbing mechanism by unwanted third parties as well as a reduction of environmental degradation of the resilient rubber elements.

[0037] While the invention has been shown and described with reference to preferred embodiments, it will be understood by those skilled in the art that various changes or modifications in form and detail may be made without departing from the scope and spirit of this invention.

Claims

1. Safety post to safeguard objects from impact by moving objects, the post having a double tilting action comprising a first elastic impact-absorbing tilting action to reduce damage to both post and object, followed by a second rigid action to arrest the moving object, comprising:

   an anchor plate for anchoring the post to a foundation surface, the anchor plate having two major surfaces, the first major surface being provided for being placed in contact with the foundation surface at which time the second major surface is remote from the foundation surface; and

a tiltable rigid housing which extends from a position abutting or adjacent to the second major surface of the anchor plate; characterised by:

an energy absorbing mechanism located entirely within the outer envelope of the housing, the energy absorbing mechanism comprising one or more resilient elements which are deformed when the post is tilted by the impact of the moving object.

2. A safety post according to claim 1, characterised by an end of the rigid housing which is located abutting or adjacent to the second major surface of the anchor plate comprising a pivot ring.

3. The safety post according to claim 1 or 2, characterised in that the one or more resilient elements are rubber or elastomeric disk elements that are compressed under the influence of a tilting of the post, caused by the impacting object.

4. The safety post according to claim 3, characterised in that an inner diameter of the housing is dimensioned so that lateral extension of the one or more resilient elements is limited.

5. Safety post according to any previous claim, wherein the one or more resilient elements are restrained by a restraining member which is pivotably connected to the anchor plate.

6. Safety post according to any previous claim, further comprising a collision detection mechanism and optionally an alarm system.

7. Safety post according to claim 6, further characterised by an internal collision detection mechanism and an internal or outer alarm system.

8. The safety post according to claim 6 or 7, characterised in that the detection mechanism comprises at least one of a motion, vibration, deceleration, tilting sensor.

9. The safety post according to claim 6 or 7, characterised in that the alarm system comprises a visual and/or auditory monitor.

10. The safety post according to any of claims 6 to 9, characterised in that the collision detection mechanism is adapted to activate a registration and/or tele-registration apparatus.

11. The safety post according to any of the previous claims wherein the energy absorbing mechanism has an adjusting device for adjusting the degree of pre-compression of the wherein the one or more resilient elements.

12. The safety post according to any previous claim, further adapted so that the impact of the moving object is absorbed at any position along the length of the post.

13. A barrier comprising at least two posts according to any of the claims 1 to 12, further comprising a linking tie member between the two posts.

fig 1

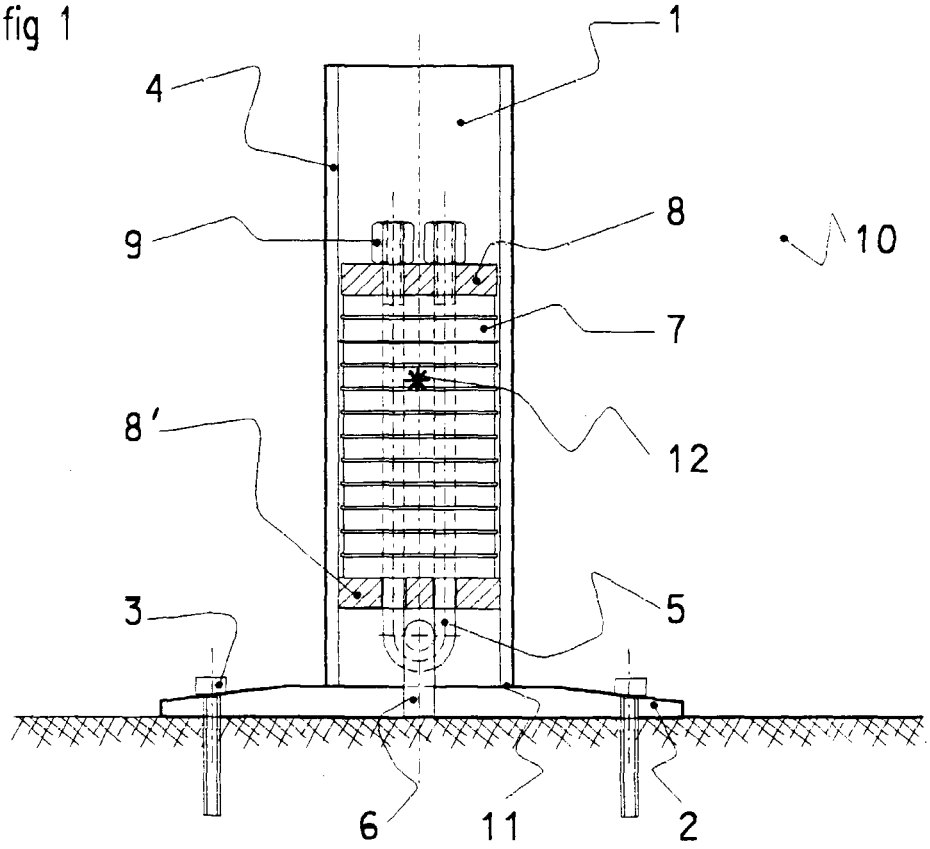


fig 2

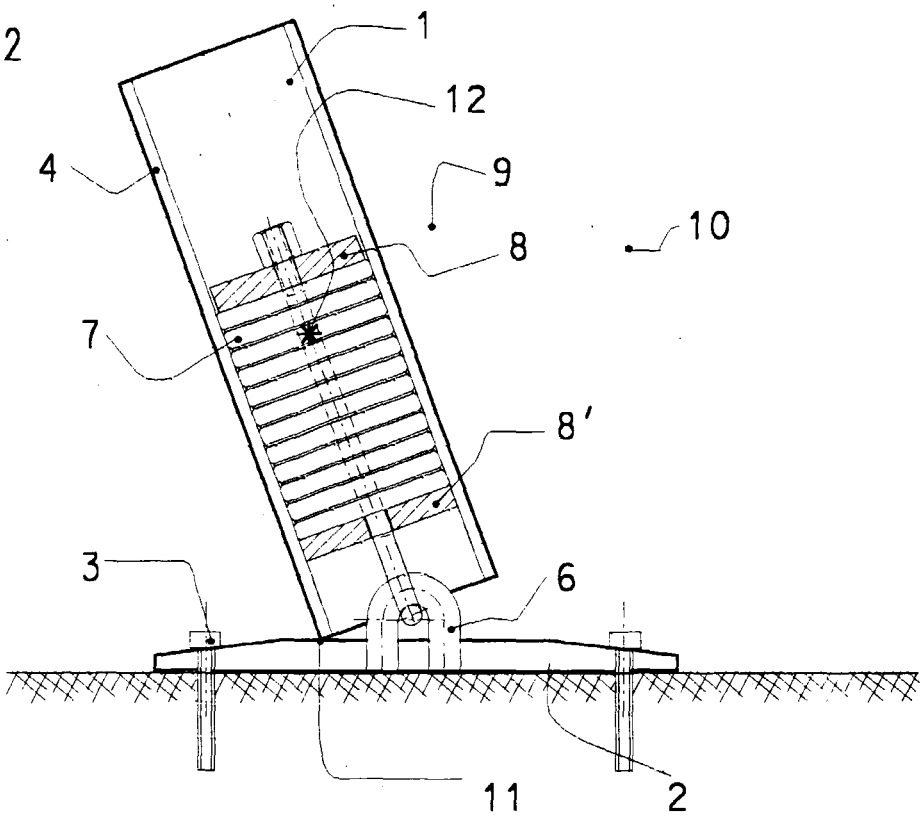


fig 3

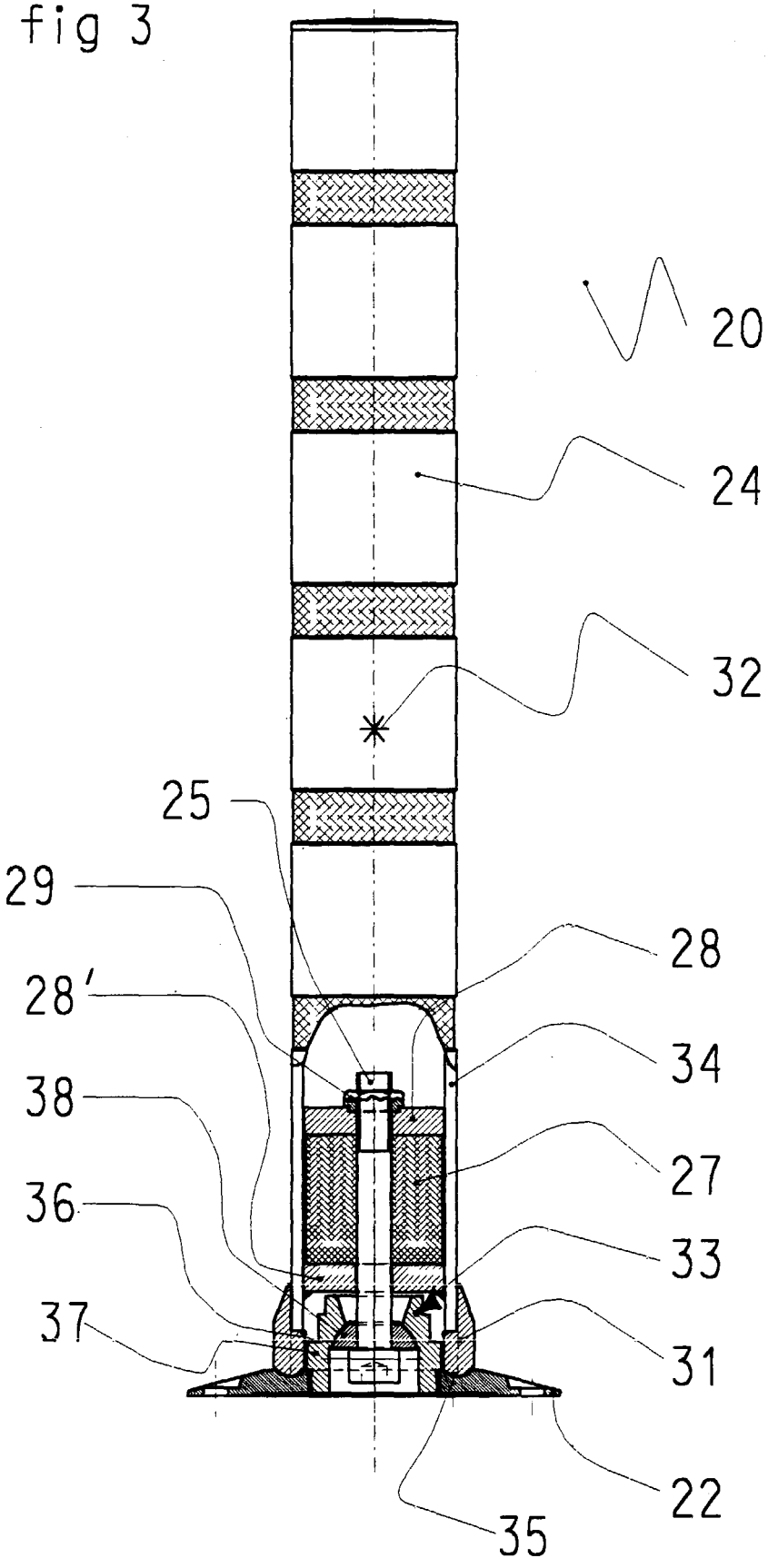
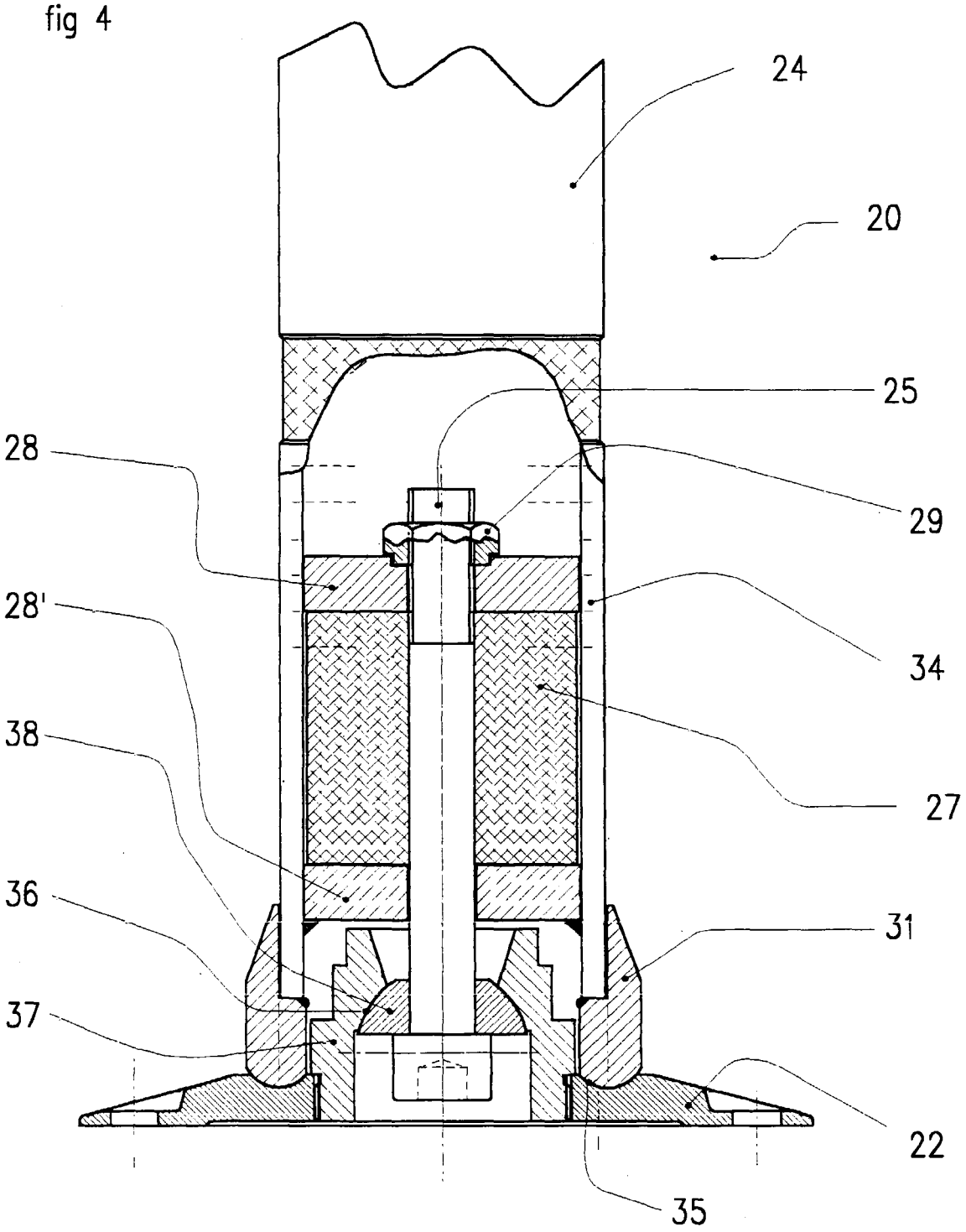


fig 4



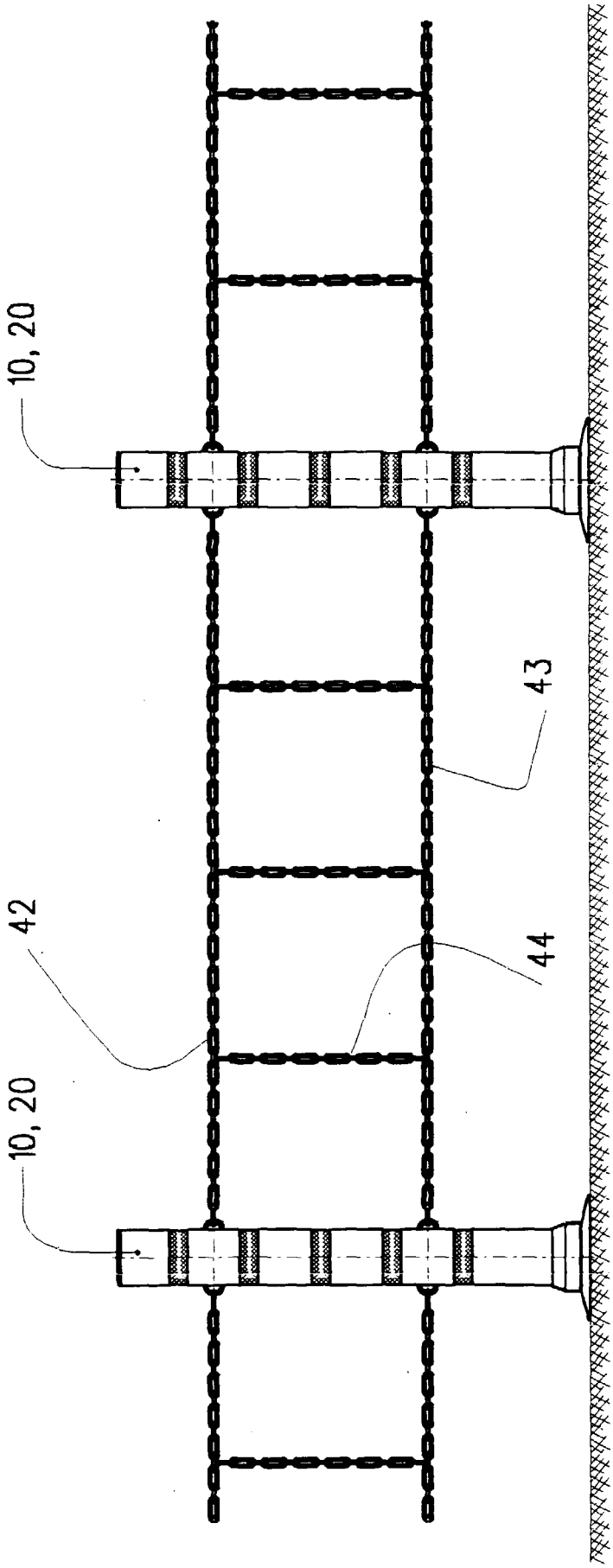


fig 5